Memorandum

To: Deputy Area Manager, Columbia-Cascades Area Office
   Yakima, Washington

From: Field Supervisor, Bend Field Office
       Bend, Oregon

Subject: Formal Consultation on the Approval of Contract Changes to the 1938 Inter-District Agreement for the Operation of Crane Prairie and Wickiup Dams, and Implementation of Review of Operations and Maintenance and Safety Evaluation of Existing Dams Programs at Crane Prairie and Wickiup Dams, Deschutes Project, Oregon

This memorandum transmits the U. S. Fish and Wildlife Service's Biological Opinion on the Bureau of Reclamation's 2-year proposed action of (1) approving contract changes to the 1938 Inter-District Agreement for the Operation of Crane Prairie and Wickiup Dams and (2) implementing the Review of Operations and Maintenance and Safety Evaluation of Existing Dams Programs at Crane Prairie and Wickiup Dams, located in Deschutes County, Oregon. The Biological Opinion addresses effects to the Oregon spotted frog (Rana pretiosa) and its designated critical habitat in the short-term, while we are developing the Deschutes Basin Habitat Conservation Plan. Formal consultation was conducted in accordance with section 7 of the Endangered Species Act of 1973, as amended (16 U.S.C. 1531 et seq.) (ESA). Your request for formal consultation was received on December 30, 2016.

The attached Biological Opinion is based on information provided in the December 30, 2016, Biological Assessment, hydrological modeling conducted by the Bureau of Reclamation (2017a and 2017b), hydrological reports provided by Biota Pacific (R2 and Biota Pacific 2016; Vaughn 2017a), telephone conversations, field investigations, and other sources of information as described in the Biological Opinion. A complete record of this consultation is on file at the U.S. Fish and Wildlife Service's Bend Field Office.
If you have any questions regarding the attached Biological Opinion or our shared responsibilities under the Endangered Species Act, please contact my staff, Jennifer O’Reilly, at 541-312-6426.

Attachment

cc:  Gregg Garnett, Bend Field Supervisor, Bureau of Reclamation
     Scott Hoefler, ESA Policy Coordinator, Bureau of Reclamation
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BIOLOGICAL OPINION

U.S. Fish and Wildlife Service Reference:
01EOFW00-2017-F-0528

Approval of Contract Changes to the 1938 Inter-District Agreement for Operation of Crane Prairie and Wickiup Dams and Implementation of Review of Operations and Maintenance and Safety Evaluation of Existing Dams Programs at Crane Prairie and Wickiup Dams

Deschutes County, Oregon

Federal Action Agency:
Bureau of Reclamation

Consultation Conducted By:
U.S. Fish and Wildlife Service
Bend Field Office
Bend, Oregon

Date: 29 September 2017

Bridget N. Moran
Field Supervisor, Bend Field Office

Clerical errors corrected on pages 202, 214 on 10/23/17
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INTRODUCTION

This document represents the U. S. Fish and Wildlife Service's (Service) Biological Opinion (Opinion) based on our review of the Bureau of Reclamation’s (Reclamation) proposed approval of contract changes to the 1938 Inter-District Agreement for the Operation of Crane Prairie and Wickiup Dams, and implementation of the Review of Operations and Maintenance (ROM) and Safety Evaluation of Existing Dams (SEED) programs at Crane Prairie and Wickiup Dams, in Deschutes County, Oregon. This Opinion addresses effects to the Oregon spotted frog (*Rana pretiosa*) and its designated critical habitat in accordance with section 7 of the Endangered Species Act of 1973, as amended (16 U.S.C. 1531 *et seq.*) (ESA). Your request for formal consultation was received on December 30, 2016.

The attached Opinion is based on information provided in the December 30, 2016, Biological Assessment, hydrological modeling conducted by Reclamation (2017a and 2017b), hydrological and biological reports provided by Biota Pacific (R2 and Biota Pacific 2016; Vaughn 2017a; Biota Pacific 2016), telephone conversations, field investigations, and other sources of information as described in the Opinion. A complete record of this consultation is on file at the Service’s Bend Field Office.

CONSULTATION HISTORY

The following is a summary of important events associated with this consultation:

- **August 27, 2015** – The Service met with Reclamation staff, Chris Eder, Doug Deflitch and Scott Willey, to discuss the scope of the action, process, timing and data needs for the consultation.

- **September 18, 2015** – The Service received a letter from Reclamation initiating Section 7 consultation on the approval of changes to the 1938 inter-district contract needed to implement the Oregon Spotted Frog Proposal, Deschutes Project, Oregon.

- **September 21, 2015** – The Service sent a letter to Reclamation acknowledging receipt of Reclamation’s request for consultation.

- **October 21, 2015** – The Service met with Reclamation staff, Chris Eder and Carolyn Chad to discuss data and monitoring needs for the consultation.

- **December 30, 2015** – The Service met with Reclamation staff, Chris Eder and Carolyn Chad to discuss survey and monitoring needs, and the need for coordination on the model needed to assess the action.

- **January 20, 2016** – The Service met with Reclamation staff, Chris Eder and Carolyn Chad to discuss egg mass survey proposals and the need for a workshop regarding modeling the proposed action.
January 27, 2016 – The Service met with Reclamation staff, Jennifer Johnson, Chris Eder, Scott Willey and irrigation district representatives, David Fillippi and Marty Vaughn to discuss assumptions necessary to model the proposed action.

From January, 2016 to August, 2016 – The Service provided technical assistance to the Department of Justice (DOJ) related to Oregon spotted frog litigation in federal court.

August 4, 2016 – The Service met with Reclamation biologist, Scott Willey, to discuss the proposed action, the biological assessment and an approach to the effects analysis for spotted frogs. The Service received a draft biological assessment, dated August 2, 2016, without a hydrology baseline or effects analysis. The Service agreed to review this version of the BA and provide comments on immediate deficiencies.

August 18 and 19, 2016 – The Service met with Scott Willey and Marty Vaughn, consultant to irrigation districts, via telephone to discuss comments on the first version of the BA. The Service explains the need to provide a detailed description of the proposed action. The proposed action uses minimums to describe the water operations which the Service feels will be difficult to analyze.

October 4, 2016 – The Service met with Marty Vaughn and Jennifer Johnson, RiverWare modeling expert with Reclamation, to review modeled results of the proposed action.

October 31, 2016 – The Service received a draft BA (238 pages) as per settlement agreement.

November 8, 2016 – The Service met with Scott Willey and Marty Vaughn, to discuss the draft BA submitted.

December 20, 2016 – The Service received proposed revisions to Chapters 1 through 3 of the BA from Chris Eder of Reclamation.

December 21, 2016 – The Service met via telephone with Chris Eder and Scott Hoefer of Reclamation to discuss the changes made to the BA since the Oct 31 draft BA. The Service agreed to further review the changes and provide comments as soon as possible.

December 23, 2016 – The Service sent an email to Reclamation (Chris Eder) to explain that the Final BA needs work and that the Proposed Action would be difficult to interpret for the analysis in the Opinion because flow releases were expressed in minimums. The Service also expressed that it appeared from what was written that there could be substantive changes to operations during the fall ramp down.

December 30, 2016 – The Service received a BA to initiate Section 7(a)(2) formal consultation on the Bureau of Reclamation’s approval of changes to the 1938 Inter-District Agreement for the operations of Wickiup and Crane Prairie Dams.

January 31 to February 1, 2017 – The Service and Reclamation biologist, Scott Hoefer,
met to review the BA and additional needs for information for the Opinion. The Service articulated the need to clarify the proposed action in the BA so that they could conduct and effects analysis. Specifically, the water releases, presented as minimums in the BA, do not represent what actually occurs during storage and release.

- **February 6, 2017** – The Service met with Jennifer Johnson, Scott Hoefer and (Acting Bend Manager) to discuss an approach to the effects analysis with the hydrological modeling conducted for the BA. Jason Gritzner, Deschutes and Ochoco NF hydrologist also was present. After reviewing the ongoing effect to OSF habitat and discussing the Service’s approach to the effects analysis for the OPINION, Reclamation agreed to conduct additional modeling that could assist the Service with the analysis.

- **March 13-15, 2017** – The Service and Reclamation met to discuss how best to write the proposed action and environmental baseline within the context of the hydrological modeling.

- **April 7, 2017** – Call with Department of Justice (DOJ), DOI Solicitor’s with Reclamation and the Service, biologists with the Service and Reclamation - to discuss the term of the action, which was undefined in the biological assessment received in December 2016.

- **April 26, 2017** - Received hydro documents from Reclamation transmitted via DOJ.

- **May 2, 2017** – The Service requests and receives the hydro documents from Reclamation.

- **May 15-17, 2017** – The Service and Reclamation biologists met in Bend to discuss the construction of the BiOp.

- **May 22-24, 2017** – The Service and Reclamation biologist and GIS specialist met in Bend to discuss how to develop spatial layers in GIS for the effects analysis in the BiOp.

- **June 15, 2017** – A letter from Reclamation was received by the Service that outlined the various requests from the Service to supplement the information in the BA.

- **June 21, 2017** – Received a working copy of a DataViewer from Reclamation to compare RiverWare-modeled hydrographs for the Proposed Action, Environmental Baseline and Water Years 2016 and 2017.

- **July 28, 2017** – The Service’s Bend Field Office Supervisor, Bridget Moran, received a memorandum from Carolyn Chad, Reclamation’s Deputy Area Manager for the Columbia Cascade Area Office, clarifying the Proposed Action of approving changes to the 1938 Inter-District Agreement to implement the Oregon spotted frog Proposal (OSF Proposal).

- **August 1, 2017** – The Service’s Bend Field Office Supervisor, Bridget Moran, sent a
letter, dated July 31, 2017, to Carolyn Chad, Reclamation’s Deputy Columbia Cascades Area Manager, to inform her that the Service anticipates completion of the consultation no later than October 1, 2017.

BIOLOGICAL OPINION

1.0 DESCRIPTION OF THE PROPOSED ACTION

Reclamation’s proposed action includes two principal components: (1) approving contract changes to the 1938 Inter-District Agreement for the operation of Crane Prairie and Wickiup Dams as needed to implement the OSF Proposal, including monitoring wetland habitat, frog breeding, and flow to test the efficacy of these changes, and (2) implementing the ROM and SEED programs at Crane Prairie and Wickiup Dams. A detailed description of the proposed action and overview of the facilities management are included in Reclamation’s BA, dated December 2016. Hydrological modeling of the OSF Proposal using the RiverWare model developed for the Upper Deschutes basin is described in another Reclamation document that is supplemental to the BA (Reclamation 2017).

1.1 Background

On November 9, 2016 a settlement was reached in the Center for Biological Diversity v. Bureau of Reclamation1 litigation involving the effects of operations of the Wickiup and Crane Prairie dams on the spotted frog. The Service was not a party to the litigation, but provided expert opinion and technical assistance regarding the current status of the spotted frog as well as its conservation needs. Through a settlement agreement (SA), Reclamation (and the Districts) agreed to use its best efforts to assist the Service with completing the consultation and a biological opinion through interagency consultation pursuant to the requirements of section 7 of the ESA on its two-year proposal to approve changes to a 1938 Inter-District Agreement for operation of these dams to facilitate implementation of conservation measures for the spotted frog by the Districts; this Opinion concludes that consultation.

The irrigation districts committed to implement interim conservation measures that reduce the effect of their ongoing water management activities on the spotted frog while they pursue development of a Habitat Conservation Plan (HCP) in support of an incidental take permit application (ITP) under the ESA; the HCP effort is further discussed below. The ITP would authorize take of the spotted frog and two other listed species caused by the irrigation districts’ water management activities in the Deschutes River Basin. The dams on the Upper Deschutes (Crane Prairie and Wickiup) are transferred works2, meaning the facilities are owned by Reclamation, but operated and maintained by an irrigation district or other entity. In the Upper Deschutes the irrigation districts operate and manage the reservoirs; and manage the storage and release of water. In order to implement the conservation measures agreed to in the SA, the districts need to modify the 1938 agreement referenced above that defines water allocation in the

2 https://definedterm.com/a/definition/126539
Upper Deschutes River Basin. Reclamation must approve changes to this agreement, thus the Federal action at issue herein, is Reclamation’s approval of the agreement which facilitates the implementation of the Oregon spotted frog proposal by the irrigation districts. This Opinion addresses the effects of the interim measures agreed to in the SA, while the parties work to complete the Deschutes Basin Habitat Conservation Plan (DBHCP).

The Service and the National Marine Fisheries Service (NMFS, collectively the Services) have been working with eight Central Oregon irrigation districts through the Deschutes Basin Board of Control (DBBC) and the City of Prineville (collectively, Applicants) on the development of the DBHCP for water management in the Deschutes Basin for the past eight years. The Service has provided $3.6M in ESA Section 6 Habitat Conservation Planning grants to the DBBC to develop the HCP. The HCP planning area consists of the entire Deschutes River Basin, an area encompassing 10,500 square miles. The DBHCP will cover three ESA-listed species: the threatened Oregon spotted frog, threatened bull trout (*Salvelinus confluentus*), and the threatened mid-Columbia steelhead (*Oncorhynchus mykiss*); and two non-listed species: the sockeye salmon (*Oncorhynchus nerka*) and the Chinook salmon (*Oncorhynchus tshawytscha*) (Middle Columbia spring and summer/fall runs).

Conservation measures to be implemented through the DBHCP are intended to minimize and mitigate adverse impacts to the five covered species that may result from the storage, release, diversion and return of irrigation water by the eight irrigation districts that comprise the DBBC, as well as surface water diversion and groundwater withdrawal activities by the City of Prineville. The covered activities occur within six mainstem and tributary reaches of the Deschutes River Basin: (1) the Little Deschutes River and Crescent Creek; (2) Upper Deschutes River; (3) Middle Deschutes River; (4) Lower Deschutes River; (5) Whychus Creek; and (6) the Crooked River and its tributaries (Ochoco Creek, McKay Creek and Lytle Creek).

On July 24, 2017, the Service published a Federal Register notice announcing the beginning of the public involvement process (e.g., scoping) for the development of a draft Environmental Impact Statement (EIS) under the National Environmental Policy Act (NEPA) for the DBHCP. The Services held four public meetings during the comment period to inform stakeholders about the process and timeline, and how to provide comments on the development of the DBHCP. A 60-day comment period ended on September 22, 2017. The tentative timeline for publishing a draft EIS and draft HCP is the summer of 2018, with a final EIS and final HCP published in the Federal Register in the summer of 2019, and a permit decision by the Services shortly thereafter. These dates are tentative, and many factors may influence that schedule.

The Service’s mission is to conserve and recover threatened and endangered species, and the habitats upon which they depend. In the Upper Deschutes Basin, the spotted frog is listed on the ESA as a threatened species. The spotted frog was added to the list of threatened and endangered wildlife on August 29, 2014. The primary threats identified in the listing determination included: habitat loss and degradation, predation by nonnative species, small and isolated breeding locations, low connectivity, low genetic diversity within occupied sub-basins, and genetic differentiation between sub-basins. Water management in the Deschutes Basin was a primary threat.

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threat contributing to the ESA listing for the spotted frog, and subsequently became a priority issue to be addressed in the DBHCP.

The irrigation districts’ currently proposed conservation framework for the DBHCP would establish a series of flow targets over time that provide reliable water to irrigators, but coincides more effectively with the life history needs of the HCP-covered species, including the spotted frog. Specifically in the Upper Deschutes, the goal is to continue to increase winter flows to provide more stable over-wintering conditions for the spotted frog, reaching levels that mimic more natural hydrologic conditions. In the spring, releases are proposed that provide additional water to support spotted frog breeding in the connected wetlands that provide habitat. Further refinement of water management and levels in and between the Crane Prairie and Wickiup reservoirs is also currently being studied and assessed to optimize water levels for the spotted frog while minimizing impacts to water users. The current proposed term of the DBHCP is between 30 and 40 years.

The interim water management measures addressed in this Opinion represent the initial stages of that conservation approach, however, as articulated in this Opinion, due to the complexity and alteration of the system, a strong adaptive management component will need to be developed under the DBHCP to ensure the conservation measures achieve the conservation outcomes necessary to offset the adverse take impacts to the covered species.

1.2 Principal Components of the Proposed Action

The principal components of the proposed action are summarized below:

- Operational changes associated with the OSF Proposal, contractual changes needed to facilitate those operations, and the changes to the operation of Crescent Lake Dam and Reservoir by Tumalo Irrigation District (TID), including the federal contracting actions needed to implement the OSF Proposal, including monitoring conducted by Reclamation or the Districts to evaluate the efficacy of the OSF Proposal at achieving its conservation goals.

- Review of Operations and Maintenance (ROM) and Safety Evaluations of Existing Dams (SEED) programs and coordination of these activities to minimize adverse effects on Oregon spotted frog.

1.2.1 The OSF Proposal

The OSF Proposal changes the operations of Crane Prairie, Wickiup, and Crescent Lake reservoirs to increase minimum instream flows in the Deschutes River, Crescent Creek, and the Little Deschutes River, below its confluence with Crescent Creek, and to increase the period of inundation of wetlands adjoining Crane Prairie Reservoir. The OSF Proposal represents early conservation measures and monitoring activities to be implemented by the Districts prior to the completion of the Deschutes Basin Habitat Conservation Plan (DBHCP). Reclamation anticipates that when the DBHCP is complete, there will be additional conservation actions to address the long-term needs of all covered species, which will supplant the requirements of the
OSF Proposal (Section 1.3 in the BA; p. 2).

Water management operations set forth in the OSF Proposal are described by a set of rules, such as minimum flows during certain periods, minimum or maximum reservoir volumes, or ramping rates. Reclamation modeled the proposed action to describe the predicted flows at gages using a version of the RiverWare daily water management model adapted specifically to climatic, geologic and water use conditions in the Upper Deschutes River basin (Reclamation 2016). The effects analysis below includes the modeled outputs of predicted flows under the Proposed Action.

1.2.1.1 Crane Prairie Reservoir

At Crane Prairie reservoir, the OSF Proposal directs the operation of the reservoir by Central Oregon Irrigation District (COID) in three principal ways: (1) it limits reservoir storage volumes between 35,000 and 50,000 acre-feet (elevations 4440.6 to 4443.9 feet) for a maximum seasonal fluctuation of 3.3 feet, (2) it changes the priority with which Crane Prairie and Wickiup reservoirs fill and sets target elevations to guide the fill of Crane Prairie reservoir, and (3) it stabilizes water elevations during the Oregon spotted frog breeding season.

Active storage of irrigation water in Crane Prairie Reservoir would be reduced from the authorized maximum of 50,000 acre-feet annually to 15,000 acre-feet, and the rate and timing of reservoir fluctuations would be restricted. This would be accomplished by maintaining the reservoir between a minimum volume of 35,000 acre-feet (elevation 4440.6 feet above mean see level) and a maximum volume of 50,000 acre-feet (elevation 4443.9 feet). Regardless of how much water is stored during winter, COID would stop the release of stored water during the irrigation season when the reservoir volume drops to 35,000 acre-feet. Volumes less than 35,000 acre-feet may occur if reservoir inflow is less than the combination of evaporation, seepage, and targets for minimum instream flow in the Deschutes River downstream of Crane Prairie Dam (Table 1). Conversely, storage will stop at 50,000 acre-feet. While COID and Oregon Water Resources Department (OWRD) will attempt to manage flood risk within this maximum pool, elevations may exceed 50,000 acre-feet for short durations to avoid unforeseen flood events in the cities of Bend and Tumalo.

Within these overall limits, the reservoir would be operated to reach at least 45,000 acre-feet by March 15th of each year and to have minimal fluctuation in water surface elevation between March 15th and May 1st. During the winter storage season, filling Crane Prairie Reservoir would be given priority over Wickiup Reservoir to ensure that Crane Prairie Reservoir reaches at least 45,000 acre-feet by March 15th. Between May 1st and May 15th, if Wickiup Reservoir holds 180,000 acre feet or more, COID may store additional water in Crane Prairie Reservoir until the total volume reaches 50,000 acre-feet, which adds 1.1 feet in elevation over the elevation at 45,000 acre-feet.

From May 15th to July 15th, Crane Prairie Reservoir would again be operated to minimize fluctuations in water depth. No stored water would be released from the reservoir prior to July 15th. From July 16th to July 31st, storage in excess of 35,000 acre-feet would be released at a rate that would result in a drop in reservoir elevation of no more than 0.05 feet per day. After
July 31st, release would continue at a maximum rate of drop in reservoir elevation of 0.1 feet per day, until irrigation demand was met or reservoir volume reached 35,000 acre-feet, whichever occurs first.

The target instream flows (measured at OWRD gauge 14054000; CRAO), represented in Table 4 in the BA, are based on recommendations from ODFW (Vaughn, pers. comm. 2017) to protect habitat for redband trout and brown trout, with modifications to accommodate the specific conditions at Crane Prairie Reservoir. Table 1 represents the recommended flows for these fish species and the Proposed Action instream flows.

Table 1. Recommended and proposed instream flows for redband and brown trout critical life stages below Crane Prairie Dam, by Month.

<table>
<thead>
<tr>
<th></th>
<th>Months</th>
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<tbody>
<tr>
<td></td>
<td>JAN  FEB  MAR  APR  MAY  JUN  JUL  AUG  SEP  OCT  NOV  DEC</td>
</tr>
<tr>
<td><strong>Redband Trout Recommended Instream Flow (cfs)</strong></td>
<td></td>
</tr>
<tr>
<td>Minimum</td>
<td>-    -    100  100  100  100  100  -    -    -    -    -</td>
</tr>
<tr>
<td>Maximum</td>
<td>-    -    400  400  400  400  400  -    -    -    -    -</td>
</tr>
<tr>
<td><strong>Brown Trout Recommended Instream Flow (cfs)</strong></td>
<td></td>
</tr>
<tr>
<td>Minimum</td>
<td>-    -    -    -    -    -    -    75  75  75  -    -</td>
</tr>
<tr>
<td>Maximum</td>
<td>-    -    -    -    -    -    -    500 500 500  -    -</td>
</tr>
<tr>
<td><strong>Proposed Action Instream Flows (cfs)</strong></td>
<td></td>
</tr>
<tr>
<td>Minimum</td>
<td>100  100  100  100  100  100  100  100  75  75  75  75</td>
</tr>
<tr>
<td>Maximum</td>
<td>400  400  400  400  400  400  400  400  400  400  400  400</td>
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</tbody>
</table>

**1.2.1.2 Wickiup Reservoir**

The OSF Proposal modifies the operation of Wickiup Reservoir in two ways: (1) It supports minimum instream flows in the Deschutes River downstream of Wickiup Dam (as measured at OWRD Gage 14056500 (WICO)), and (2) It modifies ramping rates to provide a more gradual change in flows before and after the irrigation season. As described in the BA, the minimum instream flow at the WICO gage will be 600 cfs from March 31st through September 15th, and 100 cfs from September 16th through March 30th. Modeling of the proposed action across the period of record from 1980 through 2009 shows that flows will be greater than 600 cfs from mid-April through late September due to releases of irrigation storage and that the lowest the flow could go is 600 cfs during this time period. Flows will generally be 100 cfs from November to mid-March, unless an extreme runoff event, while both reservoirs are nearly full, requires
additional releases. From September 16th through October 31st, flows are above 100 cfs at WICO as irrigation releases are ramping down, and after mid-March, flows are above 100 cfs as flows are ramping up to achieve the 600 cfs minimum by March 31st.

The BA explains that from March 31st through April 30th, the flow at OWRD Gage 14056500 could be increased, but not allowed to decrease at any time, even if it were above 600 cfs. The maximum flow would be 800 cfs until April 15, after which the flow could exceed 800 cfs if needed to meet irrigation demands. Whenever the flow is at or below 800 cfs, the maximum rate of increase in flow would be 0.1 feet per 4-hour period and the maximum rate of decrease in flow would be 0.2 feet per 12-hour period.

From April 1st through July 15th, storage demands by Arnold Irrigation District (AID), COID and Lone Pine Irrigation District (LPID) would be met by releasing water from Wickiup Reservoir. Water released from Crane Prairie Reservoir after July 15th would be used to repay North Unit Irrigation District (NUID) for the use of Wickiup Reservoir storage by the other three districts. In addition, up to 5,600 acre-feet of storage in Wickiup Reservoir would be available for use by TID to facilitate the release of water at Crescent Dam during the storage season (October 1st through March 30th), as described in Section 1.3.

In order to describe the predicted flows that are likely to occur during these time periods under the Proposed Action, we use outputs of Reclamation’s Model to further define the Proposed Action to set the stage for the analysis within this Opinion. Table 2 is modified from Table 17 and 18 in the BA to describe the Proposed Action.

Table 2. RiverWare-modeled flows over 29-year simulation period (1980 through 2009) at the WICO and BENO gages under the Proposed Action.

<table>
<thead>
<tr>
<th></th>
<th>Modeled flows at WICO gage (cfs)</th>
<th>Modeled flows at BENO gage (cfs)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Low flow year (80% Exceedance)</td>
<td>Median Flow Year (50% Exceedance)</td>
</tr>
<tr>
<td></td>
<td>Low flow year (80% Exceedance)</td>
<td>Median Flow Year (50% Exceedance)</td>
</tr>
<tr>
<td>March 16 - 31</td>
<td>121</td>
<td>159</td>
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<tr>
<td>April 1 –15</td>
<td>800</td>
<td>821</td>
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<tr>
<td>April 16 - 30</td>
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<td>807</td>
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<tr>
<td>May</td>
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<td>January</td>
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<td>114</td>
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<td>February</td>
<td>102</td>
<td>122</td>
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<tr>
<td>March 1 - 15</td>
<td>107</td>
<td>128</td>
</tr>
</tbody>
</table>
1.2.1.3 Crescent Lake Reservoir

In order to implement the OSF Proposal, TID would continue to store, release, and use water from Crescent Lake Reservoir, but operation of the reservoir would be modified to increase minimum instream flows in Crescent Creek and the Little Deschutes River, and to moderate changes in flow at the beginning and end of the irrigation season.

Under the proposed action, the minimum instream flow in Crescent Creek below Crescent Dam (as measured at OWRD Gauge 14060000 (CREO)) will be 30 cfs from March 15th through November 30th, and 20 cfs from December 1st through March 14th. Releases of additional water from Crescent Lake Reservoir will continue during the summer to meet TID’s irrigation needs, but they will be lower than historical releases, because the release of additional water during winter would reduce the amount of storage available for release in summer. TID would accommodate the reduced availability of Crescent Lake storage water through a combination of reduced deliveries to patrons and transfers of water from other Deschutes Basin Board of Control (DBBC) districts on the Deschutes River, as described above with the 5,600 acre feet of storage in Wickiup Reservoir. The net effect may cause a delayed start of summer releases from Crescent Lake Reservoir (historically beginning early July), early cessation of releases (historically running into early or mid-September), and lower overall rates of flow during peak summer releases. Outside the irrigation season, flows below Crescent Lake Dam would not likely exceed the specified minimums (20 to 30 cfs), because irrigation is not needed. The minimum instream flows would only be exceeded during the fall, winter, and spring if reservoir capacity was exceeded (i.e., flood conditions).

The BA explains that from the end of the irrigation season until November 30th, the minimum instream flow below Crescent Dam would be 30 cfs. From December 1st through March 14th, the minimum would be 20 cfs. The transition from 30 cfs to 20 cfs is intended to coincide with seasonal increases in runoff from Crescent Creek tributaries downstream of Crescent Dam (particularly Big Marsh Creek) that reduce the need for the release of storage to maintain riparian wetlands. In case of a dry fall, when 30 cfs might be needed after November 30th, the transition from 30 cfs to 20 cfs would be delayed until the flow in the Little Deschutes River at La Pine (OWRD Gage 14063000 (LAPO)) is at least 110 cfs.

In order to describe the predicted flows that are likely to occur during these time periods under the Proposed Action, we use outputs of Reclamation’s Model to further define the Proposed Action to set the stage for the analysis within this Opinion. Table 3 is modified from Tables 20 and 21 in the BA to describe the Proposed Action.

Ramping rates would be regulated under the proposed action. The maximum rate of increase in flow at Gage 14060000 below Crescent Dam would be 30 cfs per day (plus or minus 2 cfs to account for imprecision in the release gate at Crescent Dam), and the maximum rate of decrease in flow would be 20 cfs (plus or minus 2 cfs) per 2-day period. Ramp-down of releases at Crescent Dam at the end of the irrigation season would begin no earlier than September 1st (to maintain summer habitat conditions as long as possible) and end no later than October 31st, prior to Oregon spotted frog movements into over-wintering habitat.
Table 3. RiverWare-modeled flows over 29-year simulation period (1980 through 2009) at the CREO and LAPO gages under the Proposed Action.

<table>
<thead>
<tr>
<th></th>
<th>Modeled flows at CREO gage (cfs)</th>
<th>Modeled flows at LAPO gage (cfs)</th>
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<tbody>
<tr>
<td></td>
<td>Low flow year (80% Exceedance)</td>
<td>Median Flow Year (50% Exceedance)</td>
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<td>March 16 - 31</td>
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<td>April 1 –15</td>
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<td>March 1 - 15</td>
<td>21</td>
<td>21</td>
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</table>

1.2.1.4 Federal Contract Actions

The OSF Proposal is currently inconsistent with the 1938 inter-district agreement. The 1938 inter-district agreement allocates the 50,000 acre-foot storage water right for Crane Prairie Reservoir between COID, AID, and LPID. The agreement also allocates the inflow to Crane Prairie Reservoir between Crane Prairie and Wickiup reservoirs according to a prioritized fill schedule. Under the OSF Proposal, annual irrigation storage in Crane Prairie Reservoir would be reduced to a maximum of 15,000 acre-feet, and Crane Prairie would receive higher priority for fill than envisioned under the 1938 contract. As a consequence, the Districts need to revise the 1938 inter-district agreement to ensure the proposed operations are consistent with the legal and contractual framework for dam operations. Under their repayment contract with Reclamation, COID may not enter into contracts that affect the operation of the dam without Reclamation’s prior approval. As stated in Reclamation’s July 28, 2017 letter, the changes to the 1938 agreement are limited to a two-year period (water years 2018 and 2019).

1.2.2 Monitoring Activities

The BA describes Reclamation’s support for ongoing monitoring efforts by the USFWS, Irrigation Districts, Forest Service, and USGS to continue to monitor Oregon spotted frog habitat for both the biological and hydrological effects associated with water management (pp. 32-34). Ongoing hydrological monitoring, conducted by the Districts since 2013, is also outlined in the BA (p. 34). The duration of the proposed monitoring activities is from 2017 to 2019. However, Reclamation has been, and will continue to provide, funding for spotted frog breeding surveys under a 5-year cooperative agreement with the USGS.

To understand the effects of the proposed action on the Oregon spotted frog and spotted frog
critical habitat, Reclamation proposes to: (1) provide funding to the USGS through a 5-year cooperative agreement to conduct OSF breeding surveys (i.e., egg mass monitoring) in key areas above and below Wickiup Dam; and (2) provide cameras and facilitate installation of cameras to be installed in wetland habitats along the Deschutes River downstream of Wickiup Dam to assess the timing and duration of inundation relative to the storage and release of water.

Irrigation Districts will continue to conduct monitoring of pressure transducers, installed at locations identified in Table 4 (Table 5 of the BA), to examine the hydrological relationship between stream flow and wetland habitat. To date, hydrologic monitoring has been initiated at two locations on the Deschutes River and four locations on Crescent Creek (Table 3). Data collection at all four sites will continue for multiple years to observe the effects of changes in weather as well as changes in operation of Crane Prairie, Wickiup, and Crescent Lake dams and reservoirs. Data collection may also be initiated at additional sites on the Deschutes River and Little Deschutes River; the need for these will be determined through consultation with USFWS, USFS and OWRD.

Table 4. Locations of on-going hydrologic monitoring in the Upper Deschutes River Basin.

<table>
<thead>
<tr>
<th>Water Body</th>
<th>Location Name</th>
<th>Location River Mile</th>
<th>Number of Transducers</th>
<th>Installation Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crescent Creek</td>
<td>BLM Wetland</td>
<td>2</td>
<td>1</td>
<td>Sep 2013</td>
</tr>
<tr>
<td>Crescent Creek</td>
<td>USFS Wetland</td>
<td>22</td>
<td>2</td>
<td>Jan 2015</td>
</tr>
<tr>
<td>Crescent Creek</td>
<td>Below Big Marsh Creek</td>
<td>23</td>
<td>2</td>
<td>Dec 2014</td>
</tr>
<tr>
<td>Crescent Creek</td>
<td>Above Big Marsh Creek</td>
<td>24</td>
<td>1</td>
<td>Dec 2014</td>
</tr>
<tr>
<td>Deschutes River</td>
<td>Slough Camp</td>
<td>180</td>
<td>7</td>
<td>Sep 2015</td>
</tr>
<tr>
<td>Deschutes River</td>
<td>Bull Bend</td>
<td>220</td>
<td>4</td>
<td>Sep 2015</td>
</tr>
</tbody>
</table>

1.2.3 Review of Operations and Maintenance (ROM) and Safety Evaluation of Existing Dams (SEED) Programs

The BA describes elements of the proposed action that relate to Reclamation’s ROM and SEED programs that require scheduled examinations of federally-owned dams with special requirements on high-hazard dams where failure or mis-operation could cause a loss of human life. These examinations include physical inspections and tests that require short-term changes in facility operation. Further, the program may recommend or require the Districts to complete specific maintenance activities that also require short-term changes in operations. Reclamation proposes to coordinate the scheduling of inspections and discretionary maintenance activities with the COID, NUID and USFWS.

1.2.3.1 Overview of the Examination Process

The ROM and SEED programs require three types of combined facility examinations to ensure that dams do not present an unacceptable risk to public safety and continue to operate effectively: (1) annual site inspection, (2) periodic facility review, and (3) comprehensive facility
review. Annual site inspections consist of a general assessment on the condition of pertinent dam features. Periodic facility reviews involve more in-depth review of the structural integrity and performance of the dam and the efficacy of management processes and procedures. Comprehensive facility reviews are the most in-depth of the three reviews, requiring thorough examination of normally inaccessible features. Both periodic and comprehensive facility reviews occur every 6 years on a staggered schedule, such that one or the other occurs every three years. The specific activities of each examination depend largely on the needs associated with each dam. If an examination activity is necessary to ensure the continued safe operation of a dam, the implementation of the activity is required within the year it is scheduled. However, Reclamation has discretion over the exact timing of the inspection activity within potential windows of opportunity.

After examination activities are complete, each of the three examination processes require Reclamation to identify additional examinations and recommended maintenance activities to remedy concerns identified during the examination. Maintenance recommendations fall within three categories. Category 1 recommendations address severe deficiencies for which immediate response is required to ensure structural safety and operational integrity. Category 2 recommendations address important matters that must be acted upon as soon as practicable. Category 3 recommendations are beneficial suggestions to improve or enhance Operations and Maintenance of the project or facility. Implementation of Category 1 and 2 recommendations is mandatory; although, Reclamation has some discretion in the timing of Category 2 recommendations. COID and NUID are responsible for implementing recommended maintenance activities for the dams they operate, and Reclamation works with the irrigation districts to develop a schedule.

Facility examination and maintenance activities may require short-term changes in operations that could shut down flows from the dams or reduce reservoir elevations below the specified minimum pool. For example, dive inspections of outlet or intake gates require flows to be shut down completely to allow divers safe access to the component of the dam to be inspected; gate valve tests require valves to be fully closed or opened to exercise the valves or to test for operational capability. Similarly, maintenance activities may require operational changes that could require reductions in pool elevations or minimum flows, ranging from a few minutes to 2 days, and may require flows to be completely shut down during the entire examination activity test.

Historically, Reclamation has coordinated requests for operational changes with COID, NUID and OWRD to limit disruptions in normal operations. Reclamation will add the USFWS to the scheduling-required examination and maintenance activities prior to the year in which they are required to occur. When possible, Reclamation will attempt to combine some of these inspections, tests, and maintenance items to limit interruptions in flow downstream from the facilities or minimum pool elevations.

1.2.3.2 Currently Scheduled Examination Activities and Maintenance Recommendations

Tables 4 and 5 identify Reclamation’s examination activities and the Districts’ corrective maintenance activities from 2017 to 2019. These actions are provided both as specific changes to
operations and as examples of future examination and maintenance shutdowns after 2019.

1.2.3.3 Crane Prairie Activities

At Crane Prairie Dam, examination activities and corrective actions will require operations that reduce or shut down flows below the dam for short periods. These operations will affect habitat in the dam stilling basin immediately below the dam outlet as well as in the Deschutes River between the dam and the upper extent of Wickiup Reservoir.

Table 5. Reclamation inspection and operational testing activities scheduled between 2017 and 2019 for Crane Prairie Dam.

<table>
<thead>
<tr>
<th>Crane Prairie Dam Activity</th>
<th>Details</th>
<th>Operational Requirements</th>
<th>Frequency</th>
<th>Last Inspection/</th>
<th>Next Inspection/</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dive Inspection of Stilling Basin</td>
<td>Requires no-to-low flows for visibility and safety. Can be completed in less than 2 hours.</td>
<td>2 hours at 0 cfs</td>
<td>6-years</td>
<td>2011</td>
<td>2017</td>
</tr>
<tr>
<td>Dive Inspection of Intake Tower</td>
<td>Reclamation safety guidelines do not allow divers near an intake structure at flows above 2 cfs. Velocities inside the trash screen and in front of the gate must be below these criteria.</td>
<td>2 hours at 0 cfs</td>
<td>6-years</td>
<td>2011</td>
<td>2017</td>
</tr>
<tr>
<td>Concrete Conduit Inspection</td>
<td>Conduit inspections require turning off flows and pumping upstream of the stilling basin flow spreading crest. Inspections are past due. Alternatively, stoplogs can be placed in front of the conduits, and the water can be pumped out. This still requires low flow conditions</td>
<td>6 hours at 25 cfs</td>
<td>6-years</td>
<td>2005</td>
<td>2017</td>
</tr>
<tr>
<td>Gate Full-Open/Full-Close Test</td>
<td>This SOP required test creates flow adjustments (500 cfs) for a few minutes downstream. We try to do an alternate test with the bulkhead in place to avoid these flow changes.</td>
<td>5 minutes at 500 cfs.</td>
<td>6-years</td>
<td>2013</td>
<td>2019</td>
</tr>
<tr>
<td>Recommendation 2015-2-C</td>
<td>Remove rock debris from the downstream end of the outlet works in the stilling basin. This requires divers to remove rocks.</td>
<td>3 hours at 0 cfs</td>
<td>1-time</td>
<td>N/A</td>
<td>2017</td>
</tr>
<tr>
<td>Recommendation 2015-2-F</td>
<td>2015-2-F Perform a closed-circuit television (CCTV) examination of the entire toe drain system as necessary to observe and record the condition of the toe drain and to determine if there is a T- intersection along the alignment of the left to drain pipe. This requires shutting down flows and draining the stilling basin.</td>
<td>6 hours at 0 cfs</td>
<td>6-years</td>
<td>2005</td>
<td>2018</td>
</tr>
</tbody>
</table>
2017 Actions

Dive inspections of the outlet tower and stilling-basin outlet works will occur in fall 2017 sometime between mid-October and mid-December. These dive inspections are required to determine the physical condition of the outlet tower infrastructure; they also determine if any erosion is occurring that could be the result of continuous operation at these facilities. The dive inspections require a complete shutdown period of 6 hours. The BA provides additional details in Section 3.4.2 (pg. 39).

An inspection of the dam outlet conduit is also scheduled to occur between mid-October and mid-December in 2017. This inspection requires that all flow within the main dam outlet be completely shut down for 6 hours. The toe drains at the base of the dam will be fully opened to allow for a flow of about 25 cfs during the inspection. See page 39 of the BA for additional details.

2018 Actions

Reclamation proposes to conduct an examination of the toe drain system at Crane Prairie Dam in 2018. This inspection is required to ensure that the toe drains that accumulate seepage water from the dam are not obstructed or indicate conditions that could lead to drain system failure. The inspection will require a complete outlet shutdown for 6 hours when the reservoir is at its lowest elevation. See page 39 of the BA for additional details.

2019 Actions

The main outlet gate value at Crane Prairie Dam will be scheduled for a full open/full close test in early summer 2019. This tests the gate to ensure that it can be fully closed and then fully opened over its full designed operating range. This requires that flows be alternately and completely shut down for a few minutes when the gate is fully closed and then requires releases of 500 cfs when the gate is subsequently fully opened for a period of 5 minutes. The gate test will occur when there are relatively high flows being released from Crane Prairie Dam.

1.2.3.4 Wickiup Activities

Testing and inspection actions, required to comply with Reclamation dam safety protocols, will also occur at Wickiup Dam from 2017 to 2019. Several of these testing and inspection actions will require short-term flow alterations to dam releases that may have an impact on Oregon spotted frog in areas of the Deschutes River downstream of the dam. However, in addition to short term flow alterations, Wickiup Dam flows will need to be altered for a more extensive period, as some corrective actions (e.g. concrete repairs) are needed at the Wickiup Dam facility. These corrective actions are anticipated to take longer to complete (days to a week).

It is anticipated that three separate inspection, testing, or corrective actions involving flow alterations to the Deschutes River below Wickiup Dam will occur between 2017 and 2019 (Table 5).
2017 Actions

Dive inspections of both the Wickiup Dam intake tower and stilling basin are proposed for the fall of 2017. The purposes and requirements of these dive inspections are similar to those for Crane Prairie Dam. The dive inspections will take up to 8 hours to complete. Flows between 25 and 40 cfs will be maintained during the dive inspections at Wickiup Dam.

2017 or 2018 Actions

In addition to the relatively short-term dive inspections scheduled in 2017, Reclamation is also attempting to schedule some corrective action repair activities at Wickiup Dam in fall 2017 or 2018. These actions involve concrete repair on two different structures within the stilling basin and dam outlet channel. Repair to these facilities requires low flow in the stilling basin, so that concrete work can be done during calm water conditions. In addition, a barge system will be required to make concrete repairs to the stilling basin splitter wall structure, which will require low flows for safe operation. Dam flows will be lowered for up to a 1 week. These repairs can be accomplished while 25 to 40 cfs from the dam’s toe drain system. This work will be scheduled for mid-October to mid-December 2017 or 2018. See Section 3.4.3 (pg. 41) of the BA for additional details.

2019 Actions

Reclamation proposes to conduct a tube valve inspection at Wickiup Dam in 2019 between mid-October and mid-December. This inspection will require approximately 2 days to complete. During this inspection period, it is anticipated that a combination of toe drain and outlet channel flows of 35 to 50 cfs can be provided.
Table 6. Summary of Reclamation inspection and operational testing activities scheduled for Wickiup Dam between 2017 and 2019 (Table 4 of the BA).

<table>
<thead>
<tr>
<th>Wickiup Dam Activity Type</th>
<th>Details</th>
<th>Operational Requirements</th>
<th>Frequency</th>
<th>Last Inspection/</th>
<th>Next Inspection/</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dive Inspection of Stilling Basin</td>
<td>This dive requires no-to-low flows for visibility and safety. When divers are in place, flow is shut off and divers get 15 minutes to complete the dive. Toe drain flows of 25-40 cfs are used to meet river flow requirements.</td>
<td>8 hours. Ramp Down/Ramp Up (alternate every 15 minutes, 25-40 cfs</td>
<td>6-years</td>
<td>2011</td>
<td>2017</td>
</tr>
<tr>
<td>Dive Inspection of Intake Tower</td>
<td>Reclamation safety guidelines do not allow divers near an intake structure above 2 cfs. Currently, the only way to ensure low velocity is to shut the flow to near zero and use toe drain flows of 25 to 40 cfs to meet river flow requirements.</td>
<td>6 hours, 25 to 40 cfs</td>
<td>6-years</td>
<td>2011</td>
<td>2017</td>
</tr>
<tr>
<td>Tube Valve Inspection</td>
<td>Getting into the tube valve to complete inspections requires flows to be about 10 cfs maximum. Above that, the water washes into the tube valve during inspection and is a safety concern. This will require at least 2 days for dewatering, inspection, and recharging the conduit. Toe drain flows between 25 to 40 cfs plus 10 cfs from bypass pipe are used to meet river flow requirements.</td>
<td>2 days, 35-50 cfs</td>
<td>6-years</td>
<td>2013</td>
<td>2019</td>
</tr>
<tr>
<td>Recommendation 2013-2-B</td>
<td>Patch the cracked concrete areas of exposed reinforcing steel on the outlet works stilling basin splitter wall. Repairs should be performed when low flows such as 20-30 cfs occur and can be routed to the toe drain. This will require a barge to be moved into the stilling basin. Water will have to be calm. Toe drain flows only, between 25 to 40 cfs.</td>
<td>1 week, toe drain flow only, 25-40 cfs</td>
<td>1-time</td>
<td>N/A</td>
<td>Fall 2017 or 2018</td>
</tr>
<tr>
<td>Recommendation 2013-2-F</td>
<td>Patch the exposed concrete aggregate on the valve house window and bridge over the outlet works stilling basin. Water will have to calm so concrete is dry. Toe drain flows between 25 to 40 cfs plus 10 cfs from bypass pipe would supplement the flow to the river.</td>
<td>2 days, toe drain flow only, 35-50 cfs</td>
<td>1-time</td>
<td>N/A</td>
<td>Fall 2017 or 2018</td>
</tr>
</tbody>
</table>

1.2.3.5 Examination Activities and Corrective Maintenance Not Identified in Tables 4 and 5

The activities in Tables 4 and 5 provide examples of the frequency, duration, and extent of operational changes needed to accommodate examination and corrective maintenance activities.
Additional activities not described in these tables are likely to occur in the future. Reclamation will evaluate in separate documents those activities not identified in tables 4 and 5 and also those that require substantial changes to operations greater than 1 week or that pose additional, non-operational effects. Reclamation also acknowledges that some examination and corrective maintenance activities may be non-discretionary or emergency in nature. For those activities, Reclamation will coordinate with the USFWS to identify the appropriate Section 7 process, to evaluate the effects of those actions not already addressed.

Action Area

The action area is defined as all areas to be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action (50 CFR 402.02). In delineating the action area, we evaluated the farthest reaching physical, chemical, and biotic effects of the action on the environment.

The action area analyzed in this Opinion includes: Crane Prairie and Wickiup reservoirs; the Deschutes River between these two reservoirs; the mainstem Deschutes River downstream of Wickiup Dam to the city of Bend, Oregon (including off-channel areas hydrologically connected to the Deschutes River); Crescent Creek from Crescent Lake Dam to the confluence with the Little Deschutes River; and the Little Deschutes River from the confluence of Crescent Creek to the confluence of the Deschutes River (Figure 1).

2.0 ANALYTICAL FRAMEWORK FOR THE JEOPARDY DETERMINATION

2.1 Jeopardy Determination

In accordance with policy and regulation, the jeopardy analysis in this Opinion relies on four components: (1) the Status of the Species, which evaluates the Oregon spotted frog rangewide condition, the factors responsible for that condition, and its survival and recovery needs; (2) the Environmental Baseline, which evaluates the condition of the Oregon spotted frog in the action area, the factors responsible for that condition, and the relationship of the action area to the survival and recovery of the Oregon spotted frog; (3) the Effects of the Action, which determines the direct and indirect impacts of the proposed Federal action and the effects of any interrelated or interdependent activities on the Oregon spotted frog; and (4) Cumulative Effects, which evaluates the effects of future, non-Federal activities in the action area on the Oregon spotted frog.

In accordance with policy and regulation, the jeopardy determination is made by evaluating the effects of the proposed Federal action in the context of the species’ current status, taking into account any cumulative effects, to determine if implementation of the proposed action is likely to cause an appreciable reduction in the likelihood of both the survival and recovery of the species in the wild.

The jeopardy analysis in this Opinion emphasizes consideration of the rangewide survival and recovery needs of the Oregon spotted frog and the role of the action area in the survival and recovery of the Oregon spotted frog. It is within this context that we evaluate the significance of
the effects of the proposed Federal action, taken together with cumulative effects, for purposes of making the jeopardy determination.

2.2 Adverse Modification Determination

In accordance with policy and regulation, the adverse modification analysis for proposed critical habitat in this Opinion relies on four components: 1) the Status of Critical Habitat, which evaluates the range-wide condition of critical habitat for the Oregon spotted frog in terms of primary constituent elements (PCEs), the factors responsible for that condition, and the intended recovery function of the critical habitat overall; 2) the Environmental Baseline, which evaluates the condition of the critical habitat in the action area, the factors responsible for that condition, and the recovery role of the critical habitat in the action area; 3) the Effects of the Action, which determines the direct and indirect impacts of the proposed Federal action and the effects of any interrelated or interdependent activities on the PCEs and how that will influence the recovery role of affected critical habitat units; and 4) Cumulative Effects, which evaluates the effects of future, non-Federal activities in the action area on the PCEs and how that will influence the recovery role of affected critical habitat units.

For purposes of the adverse modification determination, the effects of the proposed Federal action on Oregon spotted frog critical habitat are evaluated in the context of the rangewide condition of the critical habitat, taking into account any cumulative effects, to determine if the critical habitat rangewide would remain functional (or would retain the current ability for the PCEs to be functionally established in areas of currently unsuitable but capable habitat) to serve its intended recovery role for the Oregon spotted frog.

The analysis in this Opinion places an emphasis on using the intended rangewide recovery function of Oregon spotted frog critical habitat and the role of the action area relative to that intended function as the context for evaluating the significance of the effects of the proposed Federal action, taken together with cumulative effects, for purposes of making the adverse modification determination.

3.0 STATUS OF THE SPECIES - OREGON SPOTTED FROG

3.1 Listing Status

The Oregon spotted frog was listed as threatened under the Endangered Species Act (ESA) on August 29, 2014 (79 FR 51658).

3.2 Taxonomy

The scientific name Rana pretiosa (order Anura; family Ranidae) was first applied to a series of five specimens collected in 1841 by Baird and Girard (1853, p. 378) from the vicinity of Puget Sound. Subsequently, the “spotted frog” was separated into two species, Rana pretiosa (Oregon spotted frog) and Rana luteiventris (Columbia spotted frog) based on genetic analyses (Green et al. 1996, 1997).
Phylogenetic analyses conducted on samples of Oregon spotted frogs collected from 3 locations in Washington and 13 locations in Oregon indicate that there are two well-supported clades (a group of biological taxa, as species, that includes all descendants of one common ancestor) nested within the Oregon spotted frog: the Columbia clade (Trout Lake Natural Area Preserve (NAP) and Camas Prairie) and the southern Oregon clade (Wood River and Buck Lake in the Klamath Basin) (Funk et al. 2008).

Blouin et al. (2010) performed genetic analyses on Oregon spotted frogs from 23 locations in British Columbia, Washington, and Oregon for variation at 13 microsatellite loci and 298 base pairs of mitochondrial DNA. Their results indicate that Rana pretiosa is comprised of six major genetic groups: (1) British Columbia; (2) the Chehalis River drainage in Washington; (3) the Columbia River drainage in Washington; (4) Camas Prairie in northern Oregon; (5) the central Cascades of Oregon; and (6) the Klamath Basin (Blouin et al. 2010, pp. 2184–2185). Within the northern genetic groups, the British Columbia (Lower Fraser River) and Chehalis (Black River) populations form the next natural grouping (Blouin et al. 2010, p. 2189). Recently discovered locales in the Sumas, South Fork Nooksack, and Samish Rivers occur in-between these two groups. While no genetic testing has been done on these newly found populations, it is reasonable to assume that they are likely to be closely related to either the British Columbia or Chehalis group, or both, given their proximity and use of similar lowland marsh habitats (79 FR 51659).

3.3 Physical Description

The Oregon spotted frog is named for the black spots that cover the head, back, sides, and legs. The dark spots are characterized by ragged edges and light centers that grow and darken with age (Hayes 1994, p. 14). Body color also varies with age. Juveniles are usually brown or, occasionally, olive green on the back and white, cream, or flesh-colored with reddish pigments on the underlegs and abdomen developing with age (McAllister and Leonard 1997, pp. 1–2). Adults range from brown to reddish brown but tend to become redder with age. The Oregon spotted frog is a medium-sized frog, ranging from 44 to 100 millimeters (1.74 to 4 inches) in body length. Females are typically larger than males and can reach up to 100 millimeters or more (4 inches) (Rombough et al. 2006, p. 210).

3.4 Life History

Adult Oregon spotted frogs begin to breed by one to three years of age, depending on sex, elevation, and latitude. Male Oregon spotted frogs are not territorial and often gather in large groups of 25 or more individuals at specific locations (Leonard et al. 1993, p. 132). Breeding occurs in February or March at lower elevations and between early April and early June at higher elevations (Leonard et al. 1993, p. 132). The majority of egg masses are laid communally in groups of a few to several hundred (Licht 1971, p. 119; Nussbaum et al. 1983, p. 186; Cook 1984, p. 87; Hayes et al. 1997 p. 3; Engler and Friesz 1998, p. 3). Females may deposit their egg masses at the same locations in successive years, in shallow, often temporary, pools of water; gradually receding shorelines; on benches of seasonal lakes and marshes; and in wet meadows. These sites are usually associated with the previous year’s emergent vegetation, are generally no
more than 14 inches (35 centimeters (cm)) deep (Pearl and Hayes 2004, pp. 19–20). Most of these sites dry up later in the season (Joe Engler, USFWS, pers. comm. 1999), but are connected via surface water to permanently-wetted areas, such as creeks, wetlands, and springs. Shallow water is easily warmed by the sun, and warmth hastens egg development (McAllister and Leonard 1997, p. 8). However, laying eggs in shallow water can result in high mortality rates for eggs and hatching larvae due to desiccation or freezing.

Eggs usually hatch within three weeks after oviposition. Tadpoles metamorphose into froglets during their first summer. Tadpoles are grazers, having rough tooth rows for scraping plant surfaces and ingesting plant tissue and bacteria. They also consume algae, detritus, and probably carrion. Post-metamorphic spotted frogs feed on live animals, primarily insects.

Similar to many North American pond-breeding anurans (belonging to the Order Anura, which contains all frogs), predators can strongly affect the abundance of larval and post-metamorphic spotted frogs. The heaviest losses to predation are thought to occur shortly after tadpoles emerge from eggs, when they are relatively exposed and poor swimmers (Licht 1974, p. 624). However, the odds of survival appear to increase as tadpoles grow in size and aquatic vegetation matures, thus affording cover (Licht 1974, p. 624).

Licht (1974, pp. 617–625) documented the highly variable mortality rates for spotted frog life-history stages in marsh areas in the lower Fraser Valley, BC: embryos (30 percent), tadpoles (99 percent), and post-metamorphic (after the change from tadpole to adult, or “metamorphosis”) frogs (95 percent). Licht (1974, p. 625) estimated mortality of each life stage and predicted only a 1 percent chance of survival of eggs to metamorphosis, a 67 percent chance of juvenile survival for the first year, and a 64 percent adult annual survival with males having a higher mortality rate than females. An average adult between-year survival of 37 percent was estimated by a mark-recapture study at Dempsey Creek in Washington between 1997 and 1999 (Watson et al. 2000, p. 19).

### 3.5 Habitat

The Oregon spotted frog is highly aquatic; it is almost always found in or near a perennial body of water that includes zones of shallow water and abundant emergent or floating aquatic plants, which the frogs use for basking and cover. Watson et al. (2003, p. 298) summarized the conditions required for completion of the Oregon spotted frog life cycle as shallow water areas for egg and tadpole survival, perennially deep, moderately vegetated pools for adult and juvenile survival in the dry season, and perennial water for protecting all age classes during cold wet weather. Characteristic vegetation includes grasses, sedges, and rushes, although eggs are laid where the vegetation is low or sparse, such that vegetation structure does not shade the eggs (McAllister and Leonard 1997, p. 17). While native vegetation is the preferred substrate, the frog may also use short, manipulated reed canarygrass/native vegetation mix (J. Engler, pers. comm. 1999). Full solar exposure seems to be a significant factor in breeding habitat selection (McAllister and White 2001, p. 12; Pearl and Hayes 2004, p. 18). The availability of the unique characteristics of traditional egg-laying sites is limited, and adults may have limited flexibility to switch sites (Hayes 1994, p. 19). This may make the spotted frog particularly vulnerable to modification of egg-laying sites (Hayes 1994, p. 19).
After breeding, during the dry season, spotted frogs move to deeper, permanent pools or creeks (Watson et al. 2003, p. 295). They are often observed near the water surface basking and feeding in beds of floating and submerged vegetation (Watson et al. 2003, pp. 292–298; Pearl et al. 2005a, pp. 36–37).

Known overwintering sites are associated with flowing systems, such as springs and creeks, that provide well-oxygenated water (Hallock and Pearson 2001, p. 15; Hayes et al. 2001, pp. 20–23; Tattersall and Ultsch 2008, pp. 123, 129, 136) and sheltering locations protected from predators and freezing (Risenhoover et al. 2001b; Watson et al. 2003, p. 295). Oregon spotted frogs burrow in mud, silty substrate, clumps of emergent vegetation, woody accumulations within the creek, and holes in creek banks when inactive during periods of prolonged or severe cold (Watson et al. 2003, p. 295; Hallock and Pearson 2001, p. 16; McAllister and Leonard 1997, p. 17); however, they are intolerant of anoxic (absence of dissolved oxygen) conditions and are unlikely to burrow into the mud for more than a day or two (Tattersall and Ultsch 2008, p. 136) because survival under anoxic conditions is only a matter of 4–7 days (Tattersall and Ultsch 2008, p. 126). This species remains active during the winter and selects microhabitats that can support aerobic metabolism and minimize exposure to predators (Hallock and Pearson 2001, p. 15; Hayes et al. 2001, pp. 20–23; Tattersall and Ultsch 2008, p. 136). In central Oregon, where winters generally result in ice cover over ponds, spotted frogs follow a fairly reliable routine of considerable activity and movement beneath the ice during the first month following freeze-up. Little movement is observed under the ice in January and February, but activity steadily increases in mid-March, even when ice cover persists (Bowerman 2006, pers. comm.; Hallock 2009, pers comm.; Hayes et al. 2001, pp. 16–19).

Movement studies specific to Oregon spotted frogs are limited in number and scope. Results of a habitat utilization and movement study at Dempsey Creek in Washington indicate that adult frogs made infrequent movements between widely separated pools and more frequent movements between pools in closer proximity (Watson et al. 2003, p. 294), but remained within the study area throughout the year. Home ranges averaged 5.4 ac (2.2 ha), and daily movement was 16–23 ft (5–7 m) throughout the year (Watson et al. 2003, p. 295). During the breeding season (February–May), frogs used about half the area used during the rest of the year. During the dry season (June–August), frogs moved to deeper, permanent pools, and occupied the smallest range of any season, then moved back toward their former breeding range during the wet season (September–January) (Watson et al. 2003, p. 295). Individuals equipped with radio transmitters stayed within 2,600 ft (800 m) of capture locations at the Dempsey Creek site (Watson et al. 1998, p. 10) and within about 1,312 ft (400 m) at the Trout Lake NAP (Hallock and Pearson 2001, p. 16).

Recaptures of spotted frogs at breeding locations in the Buck Lake population in Oregon indicated that adults often move less than 300 ft (100 m) between years (Hayes 1998a, p. 9). However, longer travel distances, while infrequent, have been observed between years and within a single year between seasons. Three adult spotted frogs (one male and two females) marked in a study at Dempsey Creek and the Black River in Washington moved a distance of 1.5 mi (2.4 km) between seasons along lower Dempsey Creek to the creek’s mouth from the point where they were marked (McAllister and Walker 2003, p. 6). An adult female spotted frog
traveled 1,434 ft (437 m) between seasons from its original capture location at the Trout Lake Wetland NAP (Hallock and Pearson 2001, p. 8). Two juvenile frogs at the Jack Creek site in Oregon were recaptured the next summer 4,084 ft (1,245 m) and 4,511 ft (1,375 m) downstream from where they were initially marked, and one adult female moved 1.7 miles (2.7 km) downstream (Cushman and Pearl 2007, p. 13). Spotted frogs at the Sunriver site routinely make annual migrations of 1,640 to 4,265 ft (500 to 1,300 m) between the major egg-laying complex and an overwintering site (Bowerman 2006, pers. comm.).

Although these movement studies are specific to Oregon spotted frogs, the number of studies and size of the study areas are limited. Studies have not been conducted over multiple seasons or years. In addition, the ability to detect frogs is challenging because of the difficult terrain and the need for the receiver and transmitter to be in close proximity. Hammerson (2005) recommends that a 3.1-mile (5-km) dispersal distance be applied to all ranid frog species, because the movement data for ranids are consistent. The preponderance of data indicates that a separation distance of several kilometers may be appropriate and practical for delineation of occupancy, despite occasional movements that are longer or that may allow some genetic interchange between distant populations (for example, the 6.2-mi (10-km) distance noted by Blouin et al. 2010, pp. 2186, 2188). Based on the best available scientific information, the Service considers that spotted frog habitats are connected for purposes of genetic exchange when occupied/suitable habitats fall within a maximum movement distance of 3.1 mi (5 km) (USFWS 2013, p. 53587).

3.6 Distribution

Historically, the Oregon spotted frog ranged from British Columbia to the Pit River basin in northeastern California (Hayes 1997; p. 40; McAllister and Leonard 1997, p. 7). Oregon spotted frogs have been documented at 61 historical localities in 48 watersheds (3 in British Columbia, 13 in Washington, 29 in Oregon, and 3 in California) in 31 sub-basins (McAllister et al. 1993, pp. 11–12; Hayes 1997, p. 41; McAllister and Leonard 1997, pp. 18–20; COSEWIC 2011, pp. 12–13).

Currently, the spotted frog is found within 15 sub-basins ranging from extreme southwestern British Columbia south through the Puget Trough, and the Cascades Range from south-central Washington at least to the Klamath Basin in southern Oregon (Table 1 79 FR 51662-51663). Oregon spotted frogs occur in lower elevations in British Columbia and Washington and are restricted to high elevations in Oregon (Pearl et al. 2010 p. 7). In addition, spotted frogs currently have a very limited distribution west of the Cascade crest in Oregon, are considered to be extirpated from the Willamette Valley in Oregon (Cushman et al. 2007, p. 14), and may be extirpated in the Klamath and Pit River basins of California (Hayes 1997, p. 1).

In British Columbia, spotted frogs no longer occupy the locations documented historically, but they currently are known to occupy four disjunct locations in a single sub-basin, the Lower Fraser River (Canadian Oregon Spotted Frog Recovery Team 2012, p. 6).

In Washington, spotted frogs are known to occur only within six sub-basins/watersheds: the Sumas River, a tributary to the Lower Chilliwack River watershed and Fraser River sub-basin;
the Black Slough in the lower South Fork Nooksack River, a tributary of the Nooksack River; Samish River; Black River, a tributary of the Chehalis River; Outlet Creek (Conboy Lake), a tributary to the Middle Klickitat River; and Trout Lake Creek, a tributary of the White Salmon River. The Klickitat and White Salmon Rivers are tributaries to the Columbia River. The spotted frogs in each of these sub-basins/watersheds are isolated from frogs in other sub-basins (79 FR 51663).

In Oregon, Oregon spotted frogs are known to occur only within eight sub-basins (scale equivalent to Hydrologic Unit Code 8): (1) Lower Deschutes River; (2) Upper Deschutes River; (3) Little Deschutes River; (4) McKenzie River; (5) Middle Fork Willamette; (6) Upper Klamath; (7) Upper Klamath Lake; and (8) the Williamson River. Oregon spotted frogs in most of these sub-basins are isolated from spotted frogs in other sub-basins. However, Oregon spotted frogs in the lower Little Deschutes River are aquatically connected with those in the Deschutes River downstream of the confluence of the rivers in the Upper Deschutes River sub-basin. Oregon spotted frog distribution west of the Cascade Mountains in Oregon is restricted to a few lakes in the upper watersheds of the McKenzie River and Middle Fork Willamette River sub-basins, which represent the remaining 2 out of 12 historically occupied sub-basins west of the Cascades in Oregon (79 FR 51663).

In California, this species has not been detected since 1918 (California Academy of Science Museum Record 44291) at historical sites and may be extirpated (Hayes 1997 pp. 135). However, there has been little survey effort of potential habitat since 1996, so this species may still occur in California (79 FR 51663).

3.7 Population Dynamics

The Services’ final rule to list the Oregon spotted frog estimated the total minimum breeding adult populations within each of the 15 occupied sub-basins using egg mass counts from known breeding locations (79 FR 51663-51667). Although there are limitations with using egg mass data to evaluate population size and status at the site level and sub-basin scale, egg mass counts do indicate that many breeding locations within sub-basins have small numbers of breeding adults. Adams et al. (2013) recommends assessing trends in amphibian populations by documenting the change in the number of populations using occupancy modeling rather than a change in abundance at individual sites. However, long-term spotted frog population trends using occupancy modeling are not yet available.

Modeling across a variety of amphibian taxa suggests that pond-breeding frogs have high temporal variances of population abundances and high local extinction rates relative to other groups of amphibians, with smaller frog populations undergoing disproportionately large fluctuations in abundance (Green 2003, pp. 339–341). The vulnerability of spotted frog egg masses to fluctuating water levels (Hayes et al. 2000, pp. 10–12; Pearl and Bury 2000, p. 10), the vulnerability of post-metamorphic stages to predation (Hayes 1994, p. 25), and low overwintering survival (Hallock and Pearson 2001, p. 8) can contribute to relatively rapid population turnovers, suggesting spotted frogs are particularly vulnerable to local extirpations from stochastic events and chronic sources of mortality (Pearl and Hayes 2004, p. 11). The term “rapid population turnovers” refers to disproportionately large fluctuations in abundance.
Oregon spotted frogs concentrate breeding efforts in relatively few locations (Hayes et al. 2000, pp. 5–6; McAllister and White 2001, p. 11). For example, Hayes et al. (2000, pp. 5–6) found that 2 percent of breeding sites accounted for 19 percent of the egg masses at the Conboy Lake NWR. Similar breeding concentrations have been found elsewhere in Washington and in Oregon. Moreover, spotted frogs exhibit relatively high fidelity to breeding locations, using the same seasonal pools every year and often using the same egg-laying sites. In years of extremely high or low water, the frogs may use alternative sites. For example, the Trout Lake Creek and Conboy Lake frogs return to traditional breeding areas every year, but the egg-laying sites change based on water depth at the time of breeding. A stochastic event that impacts any one of these breeding locations could significantly reduce the Oregon spotted frog population associated with that sub-basin.

Egg mass count data suggests a positive correlation and significant link between site size and spotted frog breeding population size (Pearl and Hayes 2004, p. 12). Larger sites are more likely to provide the seasonal microhabitats required by spotted frogs, have a more reliable prey base, and include overwintering habitat. The observation that extant spotted frog populations tend to occur in larger wetlands led Hayes (1994, Part II pp. 5, 7) to hypothesize that a minimum size of 9 acres (ac) (4 hectares (ha)) may be necessary to reach suitably warm temperatures and support a large enough population to persist despite high predation rates. However, spotted frogs also occupy smaller sites and are known to occur at sites as small as 2.5 ac (1 ha) and as large as 4,915 ac (1,989 ha) (Pearl and Hayes 2004, p. 11). Smaller sites generally have a small number of frogs and, as described above, are more vulnerable to extirpation. Pearl and Hayes (2004, p. 14) believe that these smaller sites were historically subpopulations within a larger breeding complex and spotted frogs may only be persisting in these small sites because the sites exchange migrants or seasonal habitat needs are provided nearby.

Egg mass counts are believed to be a good metric of adult population size and are the most time-efficient way to estimate population size (Phillipsen et al. 2010, p. 743). Adult females are believed to lay one egg mass per year (Phillipsen et al. 2010, p. 743), and the breeding period occurs within a reliable and predictable timeframe each year (McAllister 2006, pers. comm.). If egg mass numbers are collected in a single survey timed to coincide with the end of the breeding season, when egg laying should be complete, then the egg mass count should represent a reliable estimate of total egg masses. Because one egg mass is approximately equivalent to one breeding female plus one to two adult males, a rough estimate of adult population size can be made if a thorough egg mass census is completed (Phillipsen et al. 2010, p. 743). However, using egg mass counts to estimate population size has some weaknesses. For example, researchers have uncertainties about whether adult females breed every year, only lay one egg mass per year, and find difficulty in distinguishing individual egg masses in large communal clusters. However, a minimum adult population estimate can be derived from the total egg mass count multiplied by two (one egg mass equals two adult frogs). While there are weaknesses in these estimates, they are the best estimates available for Oregon spotted frog numbers.

Egg mass counts, as currently conducted at most sites, do not allow for evaluation of trends within a site nor between sites because surveys are not standardized. Survey effort, area coverage, and timing can differ between years at individual sites. In addition, method of survey
can differ between years at individual sites and differ between sites. Because of the weaknesses associated with the egg mass counts, site estimates derived from egg mass counts are considered to be a minimum estimate and generally should not be compared across years or with other sites. However, some breeding locations have been surveyed in a consistent manner (in some cases by the same researcher) and for enough years that trend data are available and considered to be reliable (e.g., Big Marsh or Sunriver).

Most species’ populations fluctuate naturally in response to weather events, disease, predation, or other factors. However, these factors have less impact on a species with a wide and continuous distribution. Small, isolated populations are generally more likely to be extirpated by stochastic events and genetic drift (Lande 1988, pp. 1456–1458).

Funk et al. (2008, p. 205) found low genetic variation in Oregon spotted frogs, which likely reflects small effective population sizes, historical or current genetic bottlenecks, and/or low gene flow among populations. Genetic work by Blouin et al. (2010) indicates low genetic diversity within and high genetic differentiation among each of the six Oregon spotted frog groups (British Columbia, Chehalis and Columbia drainages, Camas Prairie, central Oregon Cascades, and the Klamath Basin). This pattern of genetic fragmentation is likely caused by low connectivity between sites and naturally small populations sizes. Gene flow is very limited between locations, especially if separated by 6 mi (10 km) or more, and at the larger scale, genetic groups have the signature of complete isolation (Blouin et al. 2010, p. 2187). At least two of the locations sampled by Blouin et al. (2010) (Camas Prairie and Trout Lake) show indications of recent genetic drift.

Movement studies suggest spotted frogs are limited in their overland dispersal and potential to recolonize sites. Oregon spotted frog movements are associated with aquatic connections (Watson et al. 2003, p. 295; Pearl and Hayes 2004, p. 15). Oregon spotted frogs rely on an aquatic connection between breeding sites to maintain population viability.

### 3.8 Rangewide Threats

Large historical losses of wetland habitat have occurred across the range of the Oregon spotted frog. Wetland losses are estimated from between 30 to 85 percent across the species range with the greatest percentage lost having occurred in British Columbia. These wetland losses have directly influenced the current fragmentation and isolation of remaining spotted frog populations. Loss of natural wetland and riverine disturbance processes as a result of human activities has and continues to result in degradation of spotted frog habitat. Historically, a number of disturbance processes created early successional wetlands favorable to spotted frogs throughout the Pacific Northwest: (1) Rivers freely meandered over their floodplains, removing trees and shrubs and baring patches of mineral soil; (2) beavers created a complex mosaic of aquatic habitat types for year-round use; and (3) summer fires burned areas that would be shallow water wetlands during the spotted frog breeding season the following spring. Today, all of these natural processes are greatly reduced, impaired, or have been permanently altered as a result of human activities, including stream bank, channel, and wetland modifications; operation of water control structures (e.g., dams and diversions); beaver removal; and fire suppression.
The historical loss of Oregon spotted frog habitats and lasting anthropogenic changes in natural disturbance processes are exacerbated by the introduction of reed canarygrass, nonnative predators, and potentially climate change. In addition, current regulatory mechanisms and voluntary incentive programs designed to benefit fish species have inadvertently led to the continuing decline in quality of Oregon spotted frog habitats in some locations in Washington. The current wetland and stream vegetation management paradigm is generally a no-management or restoration approach that often results in succession to a tree- and shrub-dominated community that unintentionally degrades or eliminates remaining or potential suitable habitat for Oregon spotted frog breeding. Furthermore, incremental wetland loss or degradation continues under the current regulatory mechanisms. If left unmanaged, these factors are anticipated to result in the eventual elimination of remaining suitable Oregon spotted frog habitats or populations. The persistence of habitats required by the species is now largely management dependent.

In the Final Rule to list the frog as threatened (79 FR 51658), the Service determined that the Oregon spotted frog is impacted by one or more of the following factors to the extent that the species meets the definition of a threatened species under the ESA:

- Habitat necessary to support all life stages is continuing to be impacted and/or destroyed by human activities that result in the loss of wetlands to land conversions; hydrologic changes resulting from operation of existing water diversions/manipulation structures, new and existing residential and road developments, drought, and removal of beavers; changes in water temperature and vegetation structure resulting from reed canarygrass invasions, plant succession, and restoration plantings; and increased sedimentation, increased water temperatures, reduced water quality, and vegetation changes resulting from the timing and intensity of livestock grazing (or in some instances, removal of livestock grazing at locations where it maintains early seral stage habitat essential for breeding);
- Predation by nonnative species, including nonnative trout and bullfrogs;
- Inadequate existing regulatory mechanisms that result in significant negative impacts such as habitat loss and modification; and
- Other natural or manmade factors including small and isolated breeding locations, low connectivity, low genetic diversity within occupied sub-basins, and genetic differentiation between sub-basins.

Also, there are cumulative effects of the several threats that the Oregon spotted frog faces. All occupied sub-basins are subjected to multiple threats, which cumulatively pose a risk to individual populations. Many of these threats are intermingled, and the magnitude of the combined threats to the species is greater than the individual threats (79 FR 51658).

### 3.9 Consulted-on Effects

Consulted-on effects are those effects that have been analyzed through section 7 consultation as reported in a Biological Opinion. These effects are an important component of objectively characterizing the current condition of the species.
Formal Consultations have been completed for Oregon spotted frog habitat restoration activities in the Middle Klickitat River sub-basin in Washington and within the Little and Upper Deschutes River sub-basins in Oregon (Table 7). These restoration activities, described briefly below, were designed to improve habitat for Oregon spotted frog and will have short-term adverse but long-term beneficial effects to spotted frog habitat.

Conboy Lake National Wildlife Refuge (NWR), located within the Middle Klickitat River sub-basin in Klickitat County, WA, will improve habitat conditions for Oregon spotted frogs through decommissioning and cleaning approximately 0.75 miles of ditches and other management actions. Ditch decommissioning reduces the amount of habitat used by non-native predatory and competitive species (ex: bullfrogs and brown bullhead). Ditch cleaning is essential for maintaining water flow into the wetlands that are used by Oregon spotted frogs for breeding and rearing. These conservation actions paired with continued removal of predatory and competitive species and reed canarygrass management support recovery of this large and isolated population of spotted frogs.

The Ryan Ranch Restoration Project, located downstream of Wickiup Dam within the Upper Deschutes River sub-basin on the Deschutes National Forest, will restore approximately 65 acres of emergent marsh habitat that was historically occupied by Oregon spotted frog prior to being bermed and disconnected from the Deschutes River. The Ryan Ranch Restoration Project intends to reconnect the river with its floodplain and increase the extent and duration of inundation. Given that the restoration site is directly downstream of an area that is occupied by spotted frogs and altered by ongoing water management, the Ryan Ranch Restoration Project is likely to support the conservation of Oregon spotted frogs in the reach of the Deschutes River downstream of Wickiup Dam.

The Marsh Project, located within the Little Deschutes River sub-basin on the Deschutes National Forest in Klamath County, OR, will improve habitat conditions for Oregon spotted frog through hydrological restoration and lodgepole pine removal. The Big Marsh project area represents approximately 80 percent of the adult breeding population in the Little Deschutes River sub-basin at the time of the ESA Listing. The Big Marsh Oregon spotted frog population is essential to the conservation of the spotted frog because it is the source population for downstream habitats within Big Marsh Crescent, Crescent Creek, and the Little Deschutes River. Therefore, the Big Marsh Restoration Project supports the recovery of Oregon spotted frogs within the Little Deschutes River sub-basin.
Table 7. Completed formal consultations or conferences involving effects of Federal actions on the Oregon spotted frog.

<table>
<thead>
<tr>
<th>Project/Consultation/Conference Name</th>
<th>Sub-basin Affected</th>
<th>Type of Take (Harm or Harass)</th>
<th>Amount of Take (eggs, tadpoles, frogs, or habitat surrogate)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Colorado Avenue Dam Paddle Trail Improvements Project Biological Opinion</td>
<td>Upper Deschutes</td>
<td>Harm</td>
<td>2.72 acres overwintering habitat permanent loss</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Harass</td>
<td>3.44 acres of disturbance</td>
</tr>
<tr>
<td>Ryan Ranch Restoration Conference Opinion</td>
<td>Upper Deschutes</td>
<td>Harm</td>
<td>2,940 tadpoles</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Harass</td>
<td>14 adults, 7 egg masses (avg. of 600 eggs per mass) and 7 juveniles</td>
</tr>
<tr>
<td>Old Mill CCAA 20-year Permit Conference Opinion</td>
<td>Upper Deschutes</td>
<td>Harm</td>
<td>12 adult/juvenile spotted frogs and 20 egg masses or up to 8,400 tadpoles</td>
</tr>
<tr>
<td>Antelope Grazing Allotments Project Biological Opinion</td>
<td>Williamson River</td>
<td>Harm</td>
<td>2 adults, 4 juveniles, 2 metamorphs, and 237 tadpoles</td>
</tr>
<tr>
<td>Marsh Biological Opinion</td>
<td>Little Deschutes</td>
<td>Harm</td>
<td>29 adults, 29 sub adults and 216 juveniles – mortality within 0.10 acre</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Harass</td>
<td>adults, sub-adults, and juveniles with 153 acres</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Harass</td>
<td>294 adult spotted frogs, 294 sub-adult and 2,157 juveniles via capture and handling</td>
</tr>
<tr>
<td>Wickenup Hydro Opinion</td>
<td>Upper Deschutes</td>
<td>Harm</td>
<td>&lt;.5% increase in brown trout</td>
</tr>
</tbody>
</table>

3.10 Rangewide Conservation Needs

The overall reproductive success of the Oregon spotted frog is directly influenced by the timing and availability of water in habitats that support all life stages and maintaining aquatic connectivity within suitable habitat areas and between populations. Synchronizing and modifying, as needed, water management activities within Oregon spotted frog habitat to ensure the proper function of habitats that support all spotted frog life stages and to ensure connectivity within suitable habitat areas and between spotted frog populations are vital to the survival and recovery of this species. Of equal importance is maintaining low emergent wetland vegetative structure with a high level of solar exposure (low canopy closure) during breeding and the early stages of rearing. Maintaining and restoring complex wetland habitats of variable water depths and native vegetation structure and diversity will provide quality habitat that is suitable for all life stage of spotted frogs. These habitats should be without non-native predators such as bull frogs.

Currently, Oregon spotted frogs are mostly found in small isolated sites occupied by a small number of individuals in a very small portion of its historic range. Therefore, re-establishing and maintaining adequate areas of high quality, connected wetland and aquatic habitat for the spotted
frog is a vital conservation need. Conservation efforts focused on improving water management to create habitats that are suitable for all life stages and reducing or removing non-native plant and animal species that reduce the suitability of habitat or result in direct predation of spotted frog are necessary.

General criteria for Oregon spotted frog recovery (delisting) are currently being developed by the Service. A draft recovery plan is anticipated to be completed in winter 2018. Recovery will require removing and reducing threats to the species coupled with building self-sustaining populations of spotted frogs across their current and possibly historical range by maintaining, restoring, and expanding the habitat on which they depend. Portions of the historical range, including the Pit River Basin of California, Willamette Valley lowlands of Oregon and Central Puget Lowlands of Washington, will require further evaluation to determine if populations can be re-established within the current highly modified habitat condition. Development of recovery metrics may vary geographically in order to create discrete recovery goals across the range of the species. The Service does not have an estimated recovery time for this species.

Long and short-term spotted frog conservation and recovery needs include managing hydrology, reducing or removing invasive animals and plants, and improving connectivity among sites and populations. Conservation efforts will focus on maintaining and increasing population numbers and expanding distribution into suitable habitat within the current and historical range to allow for adequate genetic interchange and re-population of areas following stochastic events.

4.0 STATUS OF OREGON SPOTTED FROG CRITICAL HABITAT

The Fish and Wildlife Service designated critical habitat for Oregon spotted frog on 65,038 acres and 20.3 stream miles in Washington and Oregon on May 11, 2016 (81 FR 29336). Critical habitat for Oregon spotted frog was designated within 14 units, delineated by river sub-basins where spotted frogs are extant: (1) Lower Chilliwack River; (2) South Fork Nooksack River; (3) Samish River; (4) Black River; (5) White Salmon River; (6) Middle Klickitat River; (7) Lower Deschutes River; (8) Upper Deschutes River; (9) Little Deschutes River; (10) McKenzie River; (11) Middle Fork Willamette River; (12) Williamson River; (13) Upper Klamath Lake; and (14) Upper Klamath. The final rule for critical habitat provides descriptions of ownership, acreages and threats for each Unit (pp. 29356 – 29360). A summary of area or length and ownership can be found in Tables 7 and 8 below.
Table 8. Approximate area and landownership in designated critical habitat units for the Oregon spotted frog in Oregon and Washington.

<table>
<thead>
<tr>
<th>Critical Habitat Unit</th>
<th>Federal Ac (Ha)</th>
<th>State Ac (Ha)</th>
<th>County Ac (Ha)</th>
<th>Private/local municipalities Ac (Ha)</th>
<th>Total</th>
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</thead>
<tbody>
<tr>
<td>1. Lower Chilliwack River</td>
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<td>2. South Fork Nooksack River</td>
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<td>3. Samish River</td>
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<td>4. Black River</td>
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<tr>
<td>5. White Salmon River</td>
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<td></td>
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<tr>
<td>6. Middle Klickitat River</td>
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<tr>
<td>7. Lower Deschutes River</td>
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<td>8. Upper Deschutes River</td>
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<tr>
<td>9. Little Deschutes River</td>
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<tr>
<td>10. McKenzie River</td>
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<td></td>
</tr>
<tr>
<td>11. Middle Fork Willamette River</td>
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<td></td>
</tr>
<tr>
<td>12. Willamison River</td>
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<td></td>
<td></td>
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<tr>
<td>13. Upper Klamath Lake</td>
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<td></td>
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<tr>
<td>14. Upper Klamath</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1 (&lt;1)</td>
<td>1 (&lt;1)</td>
</tr>
<tr>
<td><strong>Washington</strong></td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1 (&lt;1)</td>
<td>1 (&lt;1)</td>
</tr>
</tbody>
</table>

*Note:* Area sizes may not sum due to rounding. Area estimates reflect all land and stream miles within critical habitat unit boundaries.

Table 9. Approximate river mileage and ownership within proposed critical habitat units for the Oregon spotted frog in Washington State only. No river miles were designated in Oregon.

<table>
<thead>
<tr>
<th>Critical habitat unit</th>
<th>Federal river mile (km)</th>
<th>Federal/ private * river mile (km)</th>
<th>State river mile (km)</th>
<th>State/private river mile (km)</th>
<th>County river mile (km)</th>
<th>County/private river mile (km)</th>
<th>Private/local municipalities river miles (km)</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Lower Chilliwack River</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0.97 (1.56)</td>
</tr>
<tr>
<td>2. South Fork Nooksack River</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0.97 (1.56)</td>
</tr>
<tr>
<td>3. Samish River</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0.97 (1.56)</td>
</tr>
<tr>
<td>4. Black River</td>
<td>0.06 (0.10)</td>
<td>0.06 (0.10)</td>
<td>0.49 (0.79)</td>
<td>0.05 (0.07)</td>
<td>0.64 (1.02)</td>
<td>0.26 (0.42)</td>
<td>0.90 (1.49)</td>
<td>1.73 (2.78)</td>
</tr>
<tr>
<td>5. White Salmon River</td>
<td>0.91 (1.46)</td>
<td>0.06 (0.10)</td>
<td>0.49 (0.79)</td>
<td>0.05 (0.07)</td>
<td>0.64 (1.02)</td>
<td>0.26 (0.42)</td>
<td>0.99 (1.66)</td>
<td>2.30 (3.70)</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>0.97 (1.56)</strong></td>
<td><strong>0.06 (0.10)</strong></td>
<td><strong>0.49 (0.79)</strong></td>
<td><strong>0.05 (0.07)</strong></td>
<td><strong>0.64 (1.02)</strong></td>
<td><strong>0.26 (0.42)</strong></td>
<td><strong>0.99 (1.66)</strong></td>
<td><strong>2.30 (3.70)</strong></td>
</tr>
</tbody>
</table>

*Ownership—multi-ownership (such as Federal/Private) indicates different ownership on each side of the river/stream/creek.

*Note:* River miles (km) may not sum due to rounding. Mileage estimates reflect stream miles within critical habitat unit boundaries that are not included in area estimates in Table 8.

### 4.1 Physical or Biological Features and Primary Constituent Elements

When designating critical habitat, the Service identifies “the physical or biological features [PBFs] essential to the conservation of the species and which may require special management considerations or protection” (50 CFR §424.12; 81 FR 29351). “These include, but are not limited to: 1) space for individual and population growth and for normal behavior; 2) food, water, air, light, minerals, or other nutritional or physiological requirements; 3) cover or shelter; 4) sites for breeding, reproduction, or rearing (or development) of offspring; and 5) habitats that are protected from disturbance or are representative of the historical, geographical, and ecological distributions of a species” (81 FR 29351). The final rule for critical habitat identifies the physical or biological features that are essential to the conservation of Oregon spotted frog (USDI FWS 2016, pp. 29351 – 29354). Primary Constituent Elements (PCEs) are those specific...
elements of the physical and biological features that provide for a species’ life history processes and are essential to the conservation of the species.

The following PCEs of critical habitat were identified for the Oregon spotted frog:

1. Nonbreeding (N), Breeding (B), Rearing (R), and Overwintering Habitat (O) - Ephemeral or permanent bodies of fresh water, including, but not limited to natural or manmade ponds, springs, lakes, slow-moving streams, or pools within oxbows adjacent to streams, canals, and ditches that have one of more of the following characteristics:
   - Inundated for a minimum of 4 months per year (B, R) – timing varies by elevation but may begin as early as February and last as long as September. Inundated from October through March (O).
   - If ephemeral, areas are hydrologically connected by surface water flow to a permanent water body (e.g., pools, springs, ponds, lakes, streams, canals, or ditches) (B, R).
   - Shallow water areas (less than or equal to 30 cm (12 inches), or water of this depth over vegetation in deeper water (B, R).
   - Total surface area with less than 50% vegetative cover (N).
   - Gradual topographic gradient (<3% slope) from shallow water toward deeper, permanent water (B, R).
   - Herbaceous wetland vegetation (i.e. emergent, submergent, and floating-leaved aquatic plants), or vegetation that can structurally mimic emergent wetland vegetation through manipulation (B, R).
   - Shallow water areas with high solar exposure or low (short) canopy cover (B, R)
   - An absence or low density of nonnative predators (B, R, N).

2. Aquatic movement corridors - Ephemeral or permanent bodies of fresh water that have one or more of the following characteristics:
   - Less than or equal to 5 km (3.1 miles) linear distance from breeding areas;
   - Impediment free (including, but not limited to, hard barriers such as dams, impassable culverts, lack of water, or biological barriers such as abundant predators, or lack of refugia from predators).

3. Refugia habitat – Nonbreeding, breeding, rearing, or overwintering habitat or aquatic movement corridors with habitat characteristics (e.g., dense vegetation and/or an abundance of woody debris) that provide refugia from predators (e.g., nonnative fish or bullfrogs).
4.2 Special Management Considerations

Threats to the physical or biological features that are essential to the conservation of this species and that may warrant special management considerations or protection include, but are not limited to: 1) habitat modifications brought on by nonnative plant invasions or native vegetation encroachment (trees and shrubs); 2) loss of habitat from conversion to other uses; 3) hydrologic manipulation; 4) removal of beavers and features created by beavers; 5) livestock grazing; and 6) predation by invasive fish and bullfrogs. These threats also have the potential to affect the PCEs if conducted within or adjacent to designated units.

4.3 Consulted-on Effects to Oregon Spotted Frog Critical Habitat

Consulted-on effects are those effects that have been analyzed through section 7 consultation as reported in a biological opinion. These effects are an important component of objectively characterizing the current condition of the Critical Habitat designated for Oregon spotted frog.

Formal Consultations have been completed for Oregon spotted frog habitat restoration activities in Critical Habitat Units 6, 8 (subunit 8A) and 9. All actions have had short-term adverse but long term beneficial effects to critical habitat. All consulted on activities to date, briefly described below, are designed to improve habitat conditions within Oregon spotted frog designated critical habitat.

Conboy Lake National Wildlife Refuge (NWR) in Klickitat County, WA, comprises the majority of the critical habitat in Unit 6. The Service determined that actions at Conboy NWR long-term beneficial effects to PCEs of the critical habitat, but in improving overall conditions there would be some loss of PCEs 1 and 2 through the decommissioning of 0.75 miles of ditches and a short term loss of PCE 3 through 0.75 miles of ditch cleaning.

The Ryan Ranch Restoration Project, located within CHU 8 (subunit 8A) on the Deschutes National Forest, in Deschutes County, OR, plans to restore approximately 65 acres of critical habitat for the Oregon spotted frog. PCE 1 will be improved by increasing the extent and duration of inundation within a floodplain wetland that was historically occupied by spotted frogs. PCE 2 will be improved by re-establishing an aquatic movement corridor between this wetland and the Deschutes River.

The Marsh Project, located within CHU 9 on the Deschutes National Forest in Klamath County, OR, will improve all PCEs through hydrological restoration and lodgepole pine removal. The Big Marsh project area represents approximately 25% or 2,847 acres of critical habitat in CHU 9. Implementation of the Marsh Project is likely to enhance the recovery support function of CHU 9 by improving the physical and biological features of critical habitat that will support life history processes that are essential for the conservation of the spotted frog.

The Wickiup Hydro Project, located within CHU 8B, on the Deschutes National Forest, in Deschutes County, OR, will increase the number of non-native fish species, adversely affecting PCE 1 and PCE 2.
5.0 ENVIRONMENTAL BASELINE

Regulations implementing the ESA (50 CFR §402.02) define the environmental baseline as the past and present impacts of all Federal, State, or private actions and other human activities in the action area. Also included in the environmental baseline are the anticipated impacts of all proposed Federal projects in the action area which have undergone section 7 consultation, and the impacts of State and private actions which are contemporaneous with the consultation in progress. Pursuant to the analytical framework described above, we evaluate the condition of the spotted frog in the action area, the factors responsible for that condition, and the relationship of the action area to the survival and recovery of the spotted frog. We also do this same analysis for spotted frog critical habitat.

The action area is within the Upper Deschutes River basin. The broader basin includes the Upper and Little Deschutes River sub-basins, both of which are occupied by Oregon spotted frogs. All areas occupied by spotted frogs are within designated critical habitat. Figure 1 depicts the geographic extent of the area occupied by spotted frogs that is affected by the ongoing water management influenced by Reclamation’s Deschutes Project and implemented by the irrigation districts. Nearly all of the area affected by the Proposed Action is within designated critical habitat. These Upper and Little Deschutes river sub-basins are hydrologically connected and the ongoing storage and release of water for irrigation in one sub-basin often influences water management in the other. Natural hydrological events in the Little Deschutes River influence spotted frog habitat in the Upper Deschutes River, specifically those located downstream of its confluence with the Deschutes River near Sunriver, Oregon.

We describe the environmental baseline condition for spotted frogs in the Upper and Little Deschutes River sub-basins. This delineation by sub-basin reflects the grouping of spotted frog sites or populations in the final listing rule and the units in the final critical habitat rule. Therefore, the habitat conditions described in the environmental baseline also illustrate the functioning condition of critical habitat. Figures 2 and 3 represent spotted frog sites or breeding locations/populations within the two sub-basins that are both within the action area and outside of the area affected by the Deschutes Project.

For the purposes of this Opinion, we refer to some sites as populations. Sites may be referred to as populations where breeding sites are grouped within a waterbody such as Crane Prairie Reservoir. Sites may also be referred to as a population where they are separated by large distances such as the breeding areas located along the Deschutes River downstream of Wickiup Dam. Within the Little Deschutes River sub-basin, areas that occur along the river systems such as Crescent Creek or the Little Deschutes River are referred to as breeding locations or sites. Due to large areas of private, unsurveyed lands that contain wetlands that are suitable habitat for spotted frogs, we assume that there are other areas outside of those where breeding counts have occurred that also are inhabited by spotted frogs. We assume that there is connectivity between these breeding locations along these river corridors. Therefore, without genetic work to elucidate population groups, we refer to these spotted frogs by breeding location within the river system where they occur. Big Marsh, represents a large, wetland complex inhabited by spotted frogs within the Little Deschutes River sub-basin and we refer to this site as a population. The
current distribution and abundance of spotted frogs and hydrological condition of spotted frog habitat is described by sub-basin and site below.

Figure 1. Geographic area occupied by spotted frogs that is affected by Reclamation’s Deschutes Project in the Upper Deschutes River and Little Deschutes River sub-basins.
Figure 2. Oregon spotted frog breeding sites within the Upper Deschutes River Sub-basin above Wickiup Dam. Sites identified with green circles are those that are affected by ongoing irrigation storage and release operations. Sites identified with yellow circles are sites that are outside of the influence of storage and release operations.
Figure 3. Oregon spotted frog breeding sites within the Upper Deschutes River Sub-basin below Wickiup Dam. Sites identified with green circles are those that are affected by ongoing irrigation storage and release operations. Sites identified with yellow circles are sites that are outside of the influence of storage and release operations.
5.1 Status of the Spotted Frog in the Upper Deschutes River Sub-basin

Spotted frogs in the Upper Deschutes River Sub-basin occur in high-elevation lakes up to 5,000 ft (1,524 m), wetland ponds, and riverine wetlands and oxbows along the Deschutes River. At the time of listing in 2014, there were less than 20 known breeding locations (i.e., sites) within four watersheds (HUC 10) in the sub-basin: (1) Charleton Creek; (2) Browns Creek; (3) Fall River; and (4) the North Unit Diversion Dam watershed. All of these known sites, except for the Sunriver and Old Mill/LSA Marsh sites, are located on the Deschutes National Forest. The distribution of Oregon spotted frog sites remains essentially the same as it was at the time of listing in 2014.

5.1.1 Spotted Frog Sites/Populations in Areas Unaffected by the Proposed Action

Nearly half of the known breeding site/population locations in the Upper Deschutes River sub-basin are in lakes, ponds and riverine wetlands that are not affected by the storage and release of water from Crane Prairie and Wickiup Reservoirs under the proposed action (Figure 2). Table 10 lists the spotted frog sites in this sub-basin that are outside of the area affected by the Deschutes Project by waterbody or drainage.

Table 10. Spotted frog-occupied sites or populations within the Upper Deschutes River Sub-basin that are not affected by the Deschutes Project.

<table>
<thead>
<tr>
<th>Watershed (HUC 10)</th>
<th>Waterbody or Drainage</th>
<th>Site Name/Population</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deschutes River- Charleton Creek</td>
<td>Isolated</td>
<td>Hosmer Lake</td>
</tr>
<tr>
<td>Deschutes River</td>
<td>Isolated</td>
<td>Lava Lake</td>
</tr>
<tr>
<td>Deschutes River</td>
<td>Little Lava Lake</td>
<td></td>
</tr>
<tr>
<td>Deschutes River</td>
<td>Upper and Lower Blue Pools</td>
<td></td>
</tr>
<tr>
<td>Deschutes River</td>
<td>Oxbow N of FS RD 40</td>
<td></td>
</tr>
<tr>
<td>Deschutes River</td>
<td>Cow Meadow Camp oxbows</td>
<td></td>
</tr>
<tr>
<td>Cultus Creek</td>
<td>Winoope Lake</td>
<td></td>
</tr>
<tr>
<td>Cultus Creek</td>
<td>Muskrat Lake</td>
<td></td>
</tr>
<tr>
<td>Deer Creek</td>
<td>Little Cultus Lake</td>
<td></td>
</tr>
<tr>
<td>Browns Creek - Deschutes River</td>
<td>Unnamed tributary to</td>
<td>Odell Creek fen - Scotty Big Boy</td>
</tr>
<tr>
<td></td>
<td>Odell Creek/Davis Lake</td>
<td></td>
</tr>
<tr>
<td>Fall River - Deschutes River</td>
<td>Deschutes River</td>
<td>Dilman Meadow</td>
</tr>
</tbody>
</table>

Threats to spotted frog sites above and outside of the influence of the reservoir system primarily include lodgepole pine encroachment and non-native predatory fish introductions. Bull frogs are not currently present at these sites and reed canarygrass abundance, if present, is relatively low.

This consultation will focus primarily on the effects of the proposed action on spotted frog-occupied sites that are likely to be affected by water management operations (Figures 2 and 3). Therefore, there will be no further discussion of the above-mentioned spotted frog sites unless these areas provide demographic support to populations within the action area.
5.1.2 Spotted Frog Sites/Populations in Areas Affected by the Proposed Action

The extent of the action area within the Upper Deschutes River Sub-basin includes Crane Prairie and Wickiup Reservoirs, and the Deschutes River between the reservoirs and downstream of Wickiup Dam to the city of Bend, Oregon. Within this geographic area, there are approximately 17 known spotted frog-occupied sites or populations that will be described below in the context of ongoing water management operations (Table 11). For the purposes of this opinion, we refer to some sites as populations. For example, there are several breeding sites in and around Crane Prairie Reservoir. Therefore, we may refer to the Crane Prairie population of spotted frogs. In the geography downstream of Wickiup Dam, spotted frog sites are separated by large distances and we suspect that there is limited genetic exchange. Therefore some of these sites may be referred to as a population. For example, the Old Mill area represents the most downstream extent of the spotted frog’s current distribution; this area is located 12 miles downstream of the Slough Camp spotted frog site. Given the large distance between the locations of frogs and other factors described below, we describe these areas as populations. Genetic work is needed to properly assess population groupings.

Table 11. Spotted frog populations or sites within the Upper Deschutes River Sub-basin that are affected by ongoing water management activities.

<table>
<thead>
<tr>
<th>Upper Deschutes River Sub-basin</th>
<th>Watershed -10th Field Hydrological Unit Code</th>
<th>Waterbody or River</th>
<th>Population/Sub-population/site Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Above Wickiup Dam</td>
<td>Deschutes River- Charleton Creek</td>
<td>Crane Prairie Reservoir</td>
<td>Crane Prairie Reservoir NE bay</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Crane Prairie Reservoir NW Bay</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Crane Prairie Reservoir SE shore</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Crane Prairie Reservoir ODFW Gold fish pond</td>
</tr>
<tr>
<td>Browns Creek – Deschutes River</td>
<td>Deschutes River - Wickiup Reservoir</td>
<td>Deschutes River Arm of Wickiup</td>
<td>Wickiup SE Bay</td>
</tr>
<tr>
<td>Below Wickiup Dam</td>
<td>Fall River – Deschutes River</td>
<td></td>
<td>Bull Bend*</td>
</tr>
<tr>
<td></td>
<td>North Unit Diversion Dam - Deschutes River</td>
<td></td>
<td>Dead Slough</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>La Pine SP SW Slough</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Private land*</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Island Loop* (private)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Sunriver</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>SW Slough Camp</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>East Slough Camp</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>S. Ryan Ranch*</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Private Preserve **</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Old Mill - LSA Marsh</td>
</tr>
</tbody>
</table>

* Occasional breeding detected.
** New site; only juveniles detected.

The geographic areas where spotted frogs occur are delineated in this section as above and below Wickiup Dam. This delineation corresponds to the critical habitat designation of sub-units 8A and 8B. The sites or populations are then described in terms of demographics using egg mass counts and other population level monitoring where it exists. A description of spotted frog habitat is then discussed in the context of ongoing water management operations. Subtle nuances to hydrological function at specific sites are then described where it is appropriate or
necessary to elucidate how spotted frogs are being affected by changing water conditions.

Over the entire action area within the Upper Deschutes River Sub-basin, spotted frog habitat has been significantly altered and continues to be influenced by the operation of Crane Prairie and Wickiup reservoirs. Current water management operations influence spotted frogs and their habitat differently upstream and downstream of Wickiup Dam. Generally, reservoir operations store water during the winter months (October to April) and release stored water during the spring and summer (April to October). Therefore, reservoirs may be very full during winter while habitats downstream of the dam are lacking water. The reverse scenario occurs at the onset of irrigation season in April when reservoirs are drawn down and flows return to the Deschutes River and adjacent wetland habitats. Clearly, the timing, duration and spatial extent of inundation vary across the entire geography where spotted frogs occur. Moreover, the temporal and spatial variation in inundation of habitats can vary between years in response to variations in weather relative to rain and snowfall.

The regulated hydrology of the reservoirs and Deschutes River, and the hydrological influence on spotted frogs and spotted frog habitat, are described below.

5.1.2.1 Monitoring Spotted Frog Habitat within the Context of Water Management

The following sections describe how we have and continue to assess hydrological conditions at various spatial scales (i.e., site versus landscape). We also describe ongoing biological surveys for spotted frogs. These monitoring efforts are ongoing and provide important data to inform the development of the Deschutes Basin HCP and to adaptively manage water to conserve the Oregon spotted frog while providing for irrigation and other recreational uses of water.

Photo Monitoring to Assess Hydrological Conditions

Much of the existing information on the effects of the water management on spotted frogs has been collected via ground observation and photos. Photos taken at the site-scale facilitate our understanding of the timing and duration of inundation in wetlands. Establishing a photo series over several years at particular sites facilitates our understanding of the variability in the hydrological system in response to managed storage and release of water as well as from the natural variation in rainfall and snow. Hydrological conditions may vary between years (e.g., wet years versus dry years) and irrigation management changes made in response to environmental conditions. For purposes of this analysis, we have used photos to describe the range of hydrological conditions within wetland habitats inhabited by spotted frogs in the action area.

In addition to site-scale photos, aerial flights have been conducted by the Service periodically prior to and during irrigation ramp up and ramp down along the Deschutes River and around the reservoirs to observe and photograph hydrological conditions at a larger spatial scale. These photos highlight habitat areas that may retain water through the winter and help to inform where to conduct breeding surveys in the spring. The photos elucidate when particular flows may inundate or dewater wetlands, and facilitate an assessment of hydrological connectivity at a landscape scale. Table 12 lists the flights that have been conducted by the Service to date with
corresponding flows measured at the WICO and BENO gauges.

Site-scale and aerial photos will be referred to within this document to describe hydrological conditions that affect the function of wetlands inhabited by spotted frogs and the life cycle of the spotted frog. The appendix contains reference images to facilitate the explanation of site conditions within the text below.

Table 12. Aerial flights to conduct photo monitoring of the action area between 2015 and 2017.

<table>
<thead>
<tr>
<th>Aerial flight dates</th>
<th>WICO gauge (cfs)</th>
<th>BENO gauge (cfs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>9_30_2015</td>
<td>864</td>
<td>1433</td>
</tr>
<tr>
<td>10_5_2015</td>
<td>787</td>
<td>1319</td>
</tr>
<tr>
<td>4_7_2016</td>
<td>604</td>
<td>1630</td>
</tr>
<tr>
<td>3_18_2016</td>
<td>28</td>
<td>744</td>
</tr>
<tr>
<td>3_17_2017</td>
<td>98</td>
<td>863</td>
</tr>
<tr>
<td>4_21_2017</td>
<td>632</td>
<td>1530</td>
</tr>
</tbody>
</table>

NOTE: Flows data are preliminary.

Assessing the Hydrological Function of the Deschutes River and Adjacent Wetlands

Wickiup Ramp Down Study

Sequential photo series have been used to monitor the Deschutes River and adjacent wetland habitats. In the fall of 2014, photo monitoring was conducted for a two-week period along approximately 53 miles of the Deschutes River between Wickiup Dam and Lava Island Falls during a staged ramp down of irrigation water between flows of approximately 700 and 47 cfs out of Wickiup Dam. The study, described in more detail below, included known spotted frog breeding habitat and numerous locations along the river that are within designated critical habitat for the spotted frog. Surface water elevational data were collected in addition to photos over the course of this monitoring effort. See photos in the Appendix that depict the current condition of spotted frog habitat photographed during the experimental ramp down in 2014.

Hydrological Monitoring - Quantitative

In cooperation with irrigation districts working to develop the Deschutes River Basin HCP, hydrological monitoring was initiated at two locations along the Deschutes River (Bull Bend and Slough Camp). The purpose of the monitoring has been to gain a better understanding of the relationships between reservoir operations and water surface elevations (water depths) in wetlands occupied by spotted frogs.

Through use of pressure transducers, surface water elevational changes in wetlands are correlated to changes in flow in the river. Stage data for the river is compared to stage data for the associated wetlands to determine the temporal relationships between changes in river flow and changes in wetland water depth. The hydrological connections between the river and the associated wetlands are variable over the 61 river miles from Wickiup Dam to Bend. Wetlands with direct surface connections to the river fluctuate in direct and immediate responses to
changes in river stage. Other wetlands with subsurface (groundwater) connections to the river may show lags of several days before water tables respond to changes in river flow. The data collected at transducer sites on the Deschutes River provide us with important information on the timing of changes in water levels within wetlands and quantify lag effects to changes in flow within the river due to irrigation storage and release operations. A preliminary report from Biota Pacific describes the network of transducers and the hydrological monitoring results from September 2015 through October 2016 in the Slough Camp wetlands (Vaughn 2017a), which are discussed in detail below.

Hydrological Modeling of Deschutes River Flows to Assess Floodplain Inundation

Floodplain inundation modeling techniques that utilize LiDAR (Light Detection and Ranging) are often used to assess the extent of spatial inundation, and hydrological experts have suggested that these techniques be developed for the Deschutes River Basin. However, existing LiDAR data in the Basin have been collected during the summer when the flows in the Deschutes River are high and wetlands are inundated with water. LiDAR does not penetrate the surface of the water. Therefore, the elevational data for the river and floodplains that would be necessary to conduct hydraulic modeling are not available at this time.

The Service has been working with partners to develop hydrological modeling to further inform our understanding of how water management influences wetlands along the Deschutes River. To date, hydrological modeling of Deschutes River flows and inundation of floodplain wetlands has been small-scale, primarily due to a lack of data, described above, and funding.

The Basin Study Work Group (BSWG), a large collaborative group focused on developing water solutions in the Deschutes Basin, funded a recent instream flow study that was completed by River Design Group (RDG) (RDG 2017). The BSWG directive for the instream flow study was to complete an analysis that evaluates the relationships between instream flow and adjacent wetland habitats. The study focused on two areas along the Deschutes River reach between Wickiup Dam and the Fall River where spotted frogs occur: Bull Bend and Dead Slough. Although this modeling effort only covers two spotted frog locations, it provides some useful information about the reach of the Deschutes River immediately downstream of Wickiup Dam that is primarily influenced by flows measured at the WICO gauge. The RDG modeling effort is discussed below that describes spotted frog habitat between Wickiup Dam and the Fall River.

Further downstream, another effort to model inundation of floodplain wetlands has been initiated by the USGS Oregon Water Science Center in collaboration with the Service but this effort is currently unfunded. The USGS water group conducted a data collection effort in 2016 within the reach of the Deschutes River between Benham Falls to Dillon Falls for use in floodplain inundation modeling efforts. The final data include water surface elevations from 15 water level loggers in the main channel between Benham and Dillon falls and two loggers placed in two of the off-channel ponds in that reach. The temporal scope of the final data ranges from March 26 to October 9, 2016. The data are published at https://doi.org/10.5066/F7DR2SP5. Due to a lack of funding, the USGS has not initiated hydraulic modeling studies in this reach of the river at this time.
Spotted Frog Population Monitoring

In addition to hydrological monitoring, breeding counts are conducted in early spring through a large, interagency collaborative effort. Egg masses are easy to detect relative to other life stages of the spotted frog (tadpole, juvenile, adult). As explained below, we use egg mass counts to gain a general idea of how many breeding adult frogs may be present within wetlands where they are known to occur. It should be noted that these surveys cannot be relied upon to determine trends in populations. However, in areas where breeding counts have been conducted over long periods of time (e.g., Sunriver) we can assess how management may be affecting the adults within the population. More intensive monitoring is needed to understand the population demographics of the spotted frog.

Breeding counts typically commence in mid-March and continue into early May, though the bulk of time is spent during the first few weeks in April when breeding occurs at many of the sites. Spotted frog breeding has been described as “explosive” whereby it occurs all at once (Pearl et al. 2010, p. 4). This rush of breeding can be completed within a couple of weeks. This rapid rate of breeding can hinder our ability to gather counts at all of the known sites across the entire landscape.

Breeding surveys are currently conducted via a multi-agency collaborative effort that includes a private researcher (i.e., J. Bowerman) and consultant (Biota Pacific). Currently, Reclamation is partnering in this effort through funding to the USGS. The Service coordinates with the U.S. Forest Service, USGS, Oregon Department of Fish and Wildlife and private individuals prior to each breeding season to ensure that many of the key spotted frog sites are being surveyed and that there is no duplication of effort as a protection measure for spotted frogs. ESA Section 10 permits have been issued to individuals conducting the survey work.

Despite the large coordinated effort to conduct breeding counts, it is nearly impossible to reach every site in a single year due to insufficient personnel, the large geographic area to be surveyed, and the abundance of snow that hinders accessibility of sites during the breeding season (e.g., Wickiup and Crane Prairie Reservoirs and high elevation sites).

Ongoing Studies

Information on most aspects of population biology, habitat use, and connectivity for spotted frogs in the Deschutes River Basin is lacking. The Service and USGS have recently received funding under a Scientific Support Partnership (SSP) to conduct a study that will assess the status and biology of spotted frog populations along the Deschutes River that are affected by the storage and release of water from Wickiup Dam. These studies focus on three sites: (1) East Slough Camp; (2) SW Slough Camp; and (3) Dead Slough.

The SSP study will address specific questions related to spotted frog population dynamics (size, growth, survival, etc.) and distribution within the managed water regime. The study underway with the USGS will build upon ongoing survey and monitoring efforts by utilizing mark-recapture and telemetry techniques. The work will characterize the redistribution of frogs as flows and water levels are reduced in late summer, as well as assess inter-site and cross-river
movements that have implications for population connectivity and colonization of restoration sites. The sampling efforts also will facilitate future landscape genetic analysis. Data collection began in the summer of 2016 prior to the receipt of funding for the project; that funding was confirmed in June of 2017.

Recent telemetry work has been conducted by USGS at the three core sites identified for the SSP study. Spotted frogs were tracked at these sites from September through December. This temporal window allowed USGS to document movements of frogs to their wintering areas within the lifespan of the telemetry batteries. Data were gathered from 23 frogs with transmitters at the three sites. These frogs were found using a range of conditions across all sites, including semi-terrestrial retreats at two sites and a mainly aquatic wintering site at Dead Slough. At least two frogs that were telemetered in the fall were observed in the 2017 breeding season. The USGS is currently preparing a manuscript paper for reporting these results.

5.1.2.2 Oregon Spotted Frog Sites above Wickiup Dam

Both Crane Prairie and Wickiup reservoirs and the Deschutes River in between the reservoirs are occupied by Oregon spotted frogs. Of the approximately 15,365 acres encompassing this area, approximately 15,213 acres are contained within the two reservoirs. Although the reservoirs represent a large portion of this geography, the habitat areas where spotted frogs have been detected represent much smaller acreages than the entirety of the reservoirs (Figure 4).
Figure 4. Oregon spotted frog breeding sites within Crane Prairie and Wickiup Reservoirs.

The reservoirs provide breeding, rearing and overwintering habitat for the OSF and facilitate an aquatic connection between populations. However, the quality of OSF habitat is influenced by current water management operations, water storage volumes and surface water elevations within the reservoirs. Currently, we have little understanding of where spotted frogs overwinter and how spotted frogs move between overwintering and breeding sites along the reservoir margins. We suspect that although current reservoir operations result in significant fluctuations in water levels within the reservoirs, the increasing water depth from November through March when water is being stored in the reservoirs provides OSF overwintering habitat.

Breeding survey efforts have been limited within the geography depicted in Figure 4, mostly due to the expansive area to be covered and difficulty in accessing these sites when roads are snowed in during the late spring. Our current understanding of the distribution and abundance of Oregon
spotted frogs within this geographic area is based on existing breeding surveys and summer observations, described below.

**Crane Prairie Reservoir**

**OSF Distribution and Abundance**

Crane Prairie reservoir supports one of the larger populations of the OSF in the Deschutes River Sub-basin as indicated by the results of breeding surveys in 2013, 2015 and 2017 (Table 13). Absent long-term data and additional population monitoring, the specific status of the OSF population at Crane Prairie cannot be characterized. However, we suspect that water management of the reservoir has had a major influence on OSF productivity and survival, as discussed below.

Within the reservoir, there are three main areas where breeding has been detected. Other wetlands and ponds draining or adjacent to the reservoir also serve as breeding sites for OSF. However, these habitats are less influenced by reservoir water management. The majority of spotted frog breeding occurs in wetlands along the north shore of Crane Prairie between the Cultus River and east of the confluence with the Deschutes River and the reservoir (i.e., Crane Prairie NW bay and Crane Prairie NE bay) (Figure 5). A small number of egg masses have recurrently been located along the south shore of the reservoir (Crane Prairie SE; Table 13). A pond adjacent to the reservoir (i.e., ODFW Goldfish Pond) also consistently serves as a breeding site for spotted frogs. Wetland oxbows adjacent to the Deschutes River (i.e., Cow Meadow Wetland and Oxbow N. FS 40 RD) also serve as consistent breeding sites for OSF. The approximate 8.5 mile stretch of the Deschutes River upstream of Crane Prairie provides connectivity for spotted frogs to move into Crane Prairie from other populations (Blue Pool, Little Lava Lake) located upstream of the reservoir.
Figure 5. Oregon spotted frog breeding sites at Crane Prairie Reservoir from 2013 to 2017.

Table 13. Egg mass counts at breeding locations at Crane Prairie Reservoir

<table>
<thead>
<tr>
<th>Breeding site</th>
<th>2012</th>
<th>2013</th>
<th>2014</th>
<th>2015</th>
<th>2016</th>
<th>2017</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crane Prairie Reservoir NE bay</td>
<td>-</td>
<td>100</td>
<td>-</td>
<td>168</td>
<td>18</td>
<td>82</td>
</tr>
<tr>
<td>Crane Prairie Reservoir NW Bay</td>
<td>-</td>
<td>95</td>
<td>-</td>
<td>118</td>
<td>10</td>
<td>292</td>
</tr>
<tr>
<td>Crane Prairie Reservoir SE shore</td>
<td>2</td>
<td>-</td>
<td>-</td>
<td>5</td>
<td>6</td>
<td>0</td>
</tr>
<tr>
<td>Crane Prairie Reservoir ODFW Gold fish pond</td>
<td>40</td>
<td>-</td>
<td>-</td>
<td>10</td>
<td>25</td>
<td>13</td>
</tr>
<tr>
<td>Deschutes River - Cow Meadow wetland</td>
<td>-</td>
<td>21</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>4</td>
</tr>
<tr>
<td>Deschutes River – Oxbow N. FS 40 RD</td>
<td>7</td>
<td>2</td>
<td>-</td>
<td>9</td>
<td>5</td>
<td>-</td>
</tr>
</tbody>
</table>

In 2016, a summer survey of spotted frogs detected predominately juvenile spotted frogs at various locations around the reservoir outside of known breeding locations (Biota Pacific 2016) (Figure 6). Summer observations indicate that the distribution of spotted frogs is throughout the entirety of the reservoir.
Figure 6. Summer observations of Oregon spotted frogs at Crane Prairie in 2016.

Influence of Hydrology on Spotted Frogs and Critical Habitat

Crane Prairie Reservoir is relatively shallow with a maximum physical capacity of 55,300 acre feet and storage water rights of 50,000 acre-feet. Crane Prairie Reservoir sits on permeable basalt which results in a large amount of seepage. Crane Prairie Reservoir storage and water elevations and exceedance values (80, 50 and 20 percent) from 1983 to 2009 are depicted in Figure 4-6 in the BA (p. 54 in the BA). In general, Crane Prairie Reservoir begins to fill in October and reaches maximum storage (36,560/46,350/54,050AF representing the 80/50/20 percent exceedance storage values) during the spotted frog’s breeding and rearing period in April or May. The reservoir draw down typically occurs in mid-April and continues to October when the reservoir reaches its lowest storage volume between 18,270 and 33,940 acre feet (20- and 80 percent exceedance storage values). Over the period of record analyzed in the BA (i.e., 1983 to 2009), the average difference between the annual maximum and minimum pool elevation for Crane Prairie Reservoir is 5.4 feet.

Under historical operations, the Crane Prairie Reservoir pool would often fall outside suitable Oregon spotted frog habitats within the emergent wetland vegetation along the shoreline which is predominately inundated when reservoir volumes are above 40,000 acre feet. However, when reservoir volumes exceed 50,000 acre feet, the water intersects more terrestrial vegetation that is less suitable habitat for Oregon spotted frog. As illustrated in Figure 7 (Figure 4-6 in the BA (p. 54)), from 1983 to 2009, peak storage in reservoir exceeded 50,000 acre-feet in half of the years.
Crane Prairie Reservoir stayed above 35,000 acre feet in only two of those years; therefore, it appears that historical operations affected the extent of available Oregon spotted frog habitat at different times of the year.

Figure 7. RiverWare modeled Proposed Action and Baseline for storage in Crane Prairie.

Reservoir management influences the quality of habitat for spotted frogs within the reservoir, and seasonal fluctuations in water surface elevations at Crane Prairie have had direct impacts to spotted frogs. Reservoir storage volumes in excess of 50,000 acre feet result in water expanding into unsuitable, upland habitat for spotted frogs. At these volumes, water may extend into lodgepole pine forest and is outside of the sedge vegetation that protects egg masses and rearing tadpoles. These effects to spotted frogs were observed in 2015 at reservoir volumes of 54,535 and 54,980 (Figure 8) at two locations along the north shore of Crane Prairie where large numbers of egg masses were located on March 30 and April 3, 2015. In some areas, egg masses were free floating in deep water and exposed to winds that swept egg masses towards the center of the reservoir, thereby exposing them to potential predation by fish. In other areas, egg masses were deposited in shallow water in the upland edges of the reservoir. As described above, these areas did not contain suitable vegetation to support the development of egg masses and tadpoles. Furthermore, some of the areas were heavily shaded, which slows the hatching of the eggs. On May 13, 2015, the breeding locations were revisited to determine whether or not they remained inundated at storage volumes of 48,286 acre feet. These areas were dry and a long distance from the water edges (Figure 9). Therefore, we assume that these breeding efforts were unsuccessful and emerging tadpoles perished under this water management scenario in the spring of 2015.
Figure 8. Crane Prairie NE Bay Breeding Site on March 30, 2015 at 54,535 acre feet of storage (left); Crane Prairie NW Bay breeding site on April 3, 2015 at 54,980 acre feet of storage (right).

Figure 9. Crane Prairie NE Bay Breeding Site re-visited on May 13, 2015 at 48,246 acre feet of storage shows areas where breeding sites are dry.

The overwintering period (October to February) for spotted frogs in the reservoirs is also one in which there may be limited habitat that results in reduced survival of juvenile, sub adult and adults spotted frogs. As reservoirs are drawn down through the summer and fall, the once inundated wetlands become devoid of water and frogs are exposed to predation by terrestrial animals such as sandhill cranes, which are often seen in the wetlands inhabited by spotted frogs at Crane Prairie. In late September and October when reservoir volumes are lowest, potential overwintering sites for spotted frogs are limited to the reservoir or along the tributaries where the rivers flow into the reservoir. What remains for overwintering habitat, particularly within the reservoir itself, is laden with nonnative predaceous fish resulting in reduced survival through this life stage.

Without knowing exactly where spotted frogs are overwintering, we must make assumptions regarding what they are selecting to overwinter in and use the breeding surveys to account for how many adults are in these habitats.

We believe that the heavy draw down of Crane Prairie to water volumes below 27,000 acre feet in August of 2015 combined with continued low storage volumes (<30,000 acre feet) until mid-
December 2015 reduced overwintering survival of spotted frogs. Spring breeding surveys in 2016 found low egg mass counts compared to the prior years of 2013 and 2015 (Table 13), and no spotted frogs were encountered near the breeding locations or within other suitable habitats within the reservoir. Furthermore, the breeding habitat at approximately 40,000 acre feet in mid-March was vastly reduced compared to past years.

In the fall/winter seasons (October 1 to March 15) that preceded the years of high breeding counts, the reservoir volumes at the beginning of the storage season (Oct 1) were approximately 30,000 acre feet and reached volumes of between 48,000 and 50,000 acre feet by early March.

Based on limited observations of site conditions and breeding surveys, reservoir operations were modified in 2016 to improve habitat conditions for spotted frogs and increase survival. However, the effectiveness of these conservation measures should be assessed to determine if these changes are beneficial to the species. Breeding conditions observed on April 21, 2017 at 46,630 acre feet were favorable for spotted frogs compared to prior years. Eggs were deposited in water depths more suitable for egg development (ranging from 5 to 12 inches) and oviposition sites were within wetland vegetation.

In 2017, water was not withdrawn from Crane Prairie until after July 15 to allow spotted frogs to metamorphose before drawing upon irrigation water in the reservoir. The Service visited Crane Prairie on July 17, 2017 to observe water levels in the wetlands at a storage volume of 46,038 acre feet. Wetlands were sufficiently inundated with water and the spotted frog habitat appeared to be highly suitable (Figure 10).

Figure 10. Crane Prairie reservoir wetlands at 46,038 acre feet of storage on July 17, 2017.
Wickiup Reservoir

Wickiup Reservoir encompasses an area of approximately 10,000 acres and although spotted frog surveys have been limited within this geographic area, there have been observations of Oregon spotted frogs at various locations within the reservoir over a number of years (Figure 4).

In 1996, Oregon spotted frogs were found in a toe-drain ditch at the base of Wickiup Reservoir, where flows enter the Deschutes River via the ditch below the dam (Hayes 1997, p. 8). In 2001, eggs, juveniles, and adult Oregon spotted frogs were moved to constructed ponds in nearby Dilman Meadow, a wetland that drains into the Deschutes River, 4.18 KM (2.6 miles) below the Wickiup Reservoir outflow (C. Pearl and J. Bowerman, pers. comm. 2005; Adams et al. 2006, p. 12). The original site at the base of the dam no longer provides viable habitat.

In 2013, six egg masses were located on the southern end of the reservoir. Prior to that detection, spotted frog observations were limited to the northeastern area of the reservoir with less than 10 egg masses observed over several years (C. Pearl, pers. comm. 2010). The expansiveness of the reservoir and the large distance between known oviposition sites indicate that spotted frogs could have a broad distribution in the reservoir. However, the small number of egg masses encountered indicates that the adult breeding population may be very small. We cannot be conclusive about population size within the reservoir without further surveys and investigation. We suspect that much of the habitat within the reservoir is unsuitable for spotted frogs to complete their lifecycle due to the large fluctuation of water volume and elevation for irrigation storage and release.

Influence of Hydrology on Spotted Frogs and Critical Habitat

Wickiup Reservoir has a maximum physical capacity of 200,000 acre-feet, and storage water rights for 200,000 acre-feet. All rights to store water in Wickiup Reservoir are held by NUID. Wickiup Reservoir storage and water elevations and exceedance values (80, 50 and 20 percent) from 1980 to 2009 are depicted in Figure 4-8 in the BA (p. 56). In general, Wickiup Reservoir begins to fill in October and reaches maximum storage (186,680/197,420/200,130 AF representing the 80/50/20 percent exceedance storage values) during the spotted frog’s breeding period in the spring. Storage releases typically commence in mid-April and the reservoir is drawn down to its minimum storage volume (between 27,580 and 104,840 acre-feet, representing the 20th- and 80th-percentile minimum storage values respectively) by October (Figure 4-8 in the BA; Figure 11).
Reservoir management influences the quality of habitat for spotted frogs within the reservoir. When the reservoir is at maximum volume (~200 K acre feet), optimal (i.e., shallow depths less than 12 inches within emergent vegetation) breeding habitat for spotted frogs is limited. If spotted frogs breed within the reservoir, developing larvae are at risk to the dropping water level within the reservoir as releases occur. The minimum volumes of water that remain in the reservoir from October into the winter provide what may be marginal overwintering habitat for spotted frogs since these areas are predominately unvegetated with little refugia from the abundance of non-native fish that reside in the reservoir. Figure 12 shows the vast reduction in surface area inundated at between the spring and fall seasons at Wickiup Reservoir.
Deschutes River Sites between Crane Prairie and Wickiup Reservoirs

The Deschutes River between the reservoirs also provides some habitat for OSF and may influence connectivity between Crane Prairie and Wickiup reservoirs. Few breeding surveys have been conducted in this reach of the Deschutes River for spotted frogs. A small seasonally wetted breeding site (~1.6 acres) was detected on the west side of the river in 2014 and had been consistently used as an oviposition site until 2017 (Figure 13). Egg mass surveys documented 7 egg masses in 2014, 28 egg masses in 2015, 5 egg masses in 2016, and 0 egg masses in 2017. However, observations of water levels and egg mass development at this site indicate that the breeding attempts are not successful. This is supported by the decline from 28 egg masses in 2015 to 5 egg masses in 2016, and finally, to 0 egg masses in 2017. The area does not remain inundated through the metamorphosis period and egg mass stranding has been observed in each year egg masses were found (i.e., 2014 – 2016).

Figure 13. Deschutes River spotted frog breeding location between Crane Prairie and Wickiup Reservoirs.

The seasonal wetting of the floodplain appears to be influenced by the storage of water in Wickiup Reservoir in combination with flow releases from Crane Prairie reservoir. Further hydrological evaluation of this site is needed to assess the timing and duration of habitat inundation.
5.1.2.3 Oregon Spotted Frog Sites below Wickiup Dam

Spotted frogs occur in riverine wetlands and oxbows along the Deschutes River between Wickiup Dam and the city of Bend, OR, though their distribution is relatively sparse within this 61-mile river reach. The sparse distribution of spotted frogs is likely the result of the seasonal storage and release of water from Wickiup Dam, which has dramatically altered hydrological regimes within the Deschutes River and floodplain wetlands and renders many of the wetlands unsuitable for spotted frogs to complete their lifecycle (explained below). Current water management results in transitory inundation of wetlands that under a historic condition remained inundated and provided connectivity between sites. Wetland habitats along this reach of the Deschutes River that provide consistent and concentrated breeding activity are used by a relatively small number of frogs.

Currently there are four known areas along this stretch of the Deschutes River where breeding activity is concentrated and consistent annually: La Pine State Park sloughs (including Dead Slough and La Pine S.P. SW Slough), Sunriver, Slough Camp (East and SW Slough Camp sites) and the Old Mill (Les Schwab Amphitheater (LSA) Marsh and Old Mill pond) (Figure 14). Dilman Meadow, which drains to the Deschutes River approximately 2.6 miles below Wickiup Dam (~224 RM), hosts a population of translocated spotted frogs that is unaffected by the storage and release of water from Wickiup Dam.

Due to a lack of genetic information, it is unclear if each of these concentrated locations of spotted frogs along the Deschutes River are distinct populations. Given the isolation between sites due to the large fluctuations in Deschutes River flows, we refer to the frogs at each of these sites as its own population for the purpose of this analysis. Future genetic work is necessary to shed light on the degree to which each of these groups function as an independent population.

In addition to the above-mentioned sites, occasional, small breeding efforts are detected within other wetland and oxbow areas along the Deschutes River where hydrological conditions are sufficient to support overwintering of adult spotted frogs prior to the breeding season. There are likely some small breeding areas on private land that are not yet known because private lands are mostly unsurveyed.

Wetlands along the river outside of breeding areas are important for dispersal and connectivity between populations. Summer surveys of these wetland habitats for Oregon spotted frogs are limited. However, in the few summer survey efforts conducted to date, adult and juvenile spotted frogs have been detected in wetlands adjacent to known sites and in small wetlands that are a substantial distance (~12 miles) from known sites (e.g., site in the Lava Island to COID Diversion reach). These findings underscore the importance of all wetlands along the Deschutes River in providing for conservation and recovery of spotted frogs. We suspect that the high irrigation flows during summer in the Deschutes River may provide conditions that facilitate this movement and dispersal. However, we expect that there is limited survival of dispersing animals since most of the riparian wetlands are de-watered at the onset of the storage season and remain dry through winter. Research that aims to better understand population demographics and survival in this reach of the Deschutes River is needed.
In order to describe spotted frog habitats downstream of Wickiup Dam, we have divided the Deschutes River into seven analysis reaches: Reach 1 is Wickiup Dam to its confluence with the Fall River, Reach 2 is the confluence with the Fall River to its confluence with the Little Deschutes River, Reach 3 is the confluence with the Little Deschutes River to Benham Falls, Reach 4 is Benham Falls to Dillon Falls, Reach 5 is Dillon Falls to Lava Island Falls, Reach 6 is Lava Island Falls to the COID diversion, and Reach 7 is the COID diversion to the Colorado Avenue Bridge (Figure 14). All reaches, except Reach 5, have known Oregon spotted frog sites. Table 14 depicts spotted frog sites within the analysis reaches and approximate location along the river by river mile (RM). These sites are described in detail below (Section x) by analysis reach. In the next section, we discuss the condition of the Deschutes River at the broad scale because it is the river that provides function for the spotted frog sites.

![Deschutes River Analysis Reaches](image)

**Figure 14.** Deschutes River analysis reaches for Section 7 consultation.
Historical and Current Condition of the Deschutes River below Wickiup Dam

In order to describe spotted frog habitat in the context of regulated storage and release of water, we must first describe the hydrogeology of the Upper Deschutes River basin and the physical changes to the river and adjacent wetlands that have occurred since the construction of Wickiup Dam in 1943. This fundamental explanation is necessary because it is the physical configuration of the river and the variation in the timing and duration of flow volumes within its channel (described in terms of cubic feet per second (CFS)) that support the ecological function of wetlands inhabited by spotted frogs.

A description of the river system must also include a discussion of unregulated (i.e., flows prior to dam construction) hydrology, since it was under that historical flow regime that the river and wetlands formed. Furthermore, there are limits to the amount of water that the basin can provide to the Deschutes River even in the absence of the reservoir system.

Prior to the construction of the reservoir system, the Deschutes River was described in a 1914 USGS report as “remarkably uniform” (USGS 1914, p. 12). The inherent volcanic geological nature of the Upper Deschutes River basin contributed to this consistent, relatively stable flow in the Deschutes River (USFS 1996, Gannett 2001). The Upper Deschutes River basin is primarily spring-fed, whereby snowmelt runoff is absorbed by pumice sands over porous volcanic rock, and infiltrates directly into the ground water system. As a result of large volumes of subsurface flow, the Upper Deschutes River basin has few tributaries most of which are spring-fed (USFS 1996, p. 132).

In between Wickiup Dam and Bend, OR, the Deschutes River has few tributaries: the Fall, Little Deschutes, and Spring Rivers. These tributaries augment flows in the Deschutes River downstream of the Fall River at approximate 205 RM. In the 22-mile reach of the Deschutes River between Wickiup Dam and the Fall River, flow is dependent on releases from the dam and

<table>
<thead>
<tr>
<th>River Reach</th>
<th>Sites within analysis reach</th>
<th>~ River Mile (RM)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1: Wickiup to Fall River</td>
<td>Bull Bend*</td>
<td>221</td>
</tr>
<tr>
<td></td>
<td>Dead Slough</td>
<td>208</td>
</tr>
<tr>
<td></td>
<td>La Pine SP SW Slough</td>
<td>205.5</td>
</tr>
<tr>
<td>2: Fall River to Little Deschutes</td>
<td>Private land*</td>
<td>202</td>
</tr>
<tr>
<td></td>
<td>Island Loop* (private)</td>
<td>195</td>
</tr>
<tr>
<td>3: Little Deschutes to Benham Falls</td>
<td>Sunriver</td>
<td>188 – 191.5</td>
</tr>
<tr>
<td>4: Benham to Dillon Falls</td>
<td>SW Slough Camp</td>
<td>180</td>
</tr>
<tr>
<td></td>
<td>East Slough Camp</td>
<td>179 - 180</td>
</tr>
<tr>
<td></td>
<td>S. Ryan Ranch*</td>
<td>179</td>
</tr>
<tr>
<td>6: Lava Island Falls to COID diversion</td>
<td>Private Preserve **</td>
<td>172</td>
</tr>
<tr>
<td>7: COID Diversion to Colorado Street Bridge</td>
<td>Old Mill - LSA Marsh***</td>
<td>167.5 - 168</td>
</tr>
</tbody>
</table>
it is within this reach that the effects of changes to the hydrological regime due to operation of the reservoir system are most extreme.

The change in hydrologic regime associated with the storage and release of irrigation water from Wickiup Reservoir has significantly altered flows in the Deschutes River and the way the river interacts with its floodplain. Storage of water in the reservoirs can result in winter flows as low as 20 cfs at the WICO gauge. Summer flow releases for irrigation can be as high as 1,800 cfs at the WICO gauge. Wetland inundation along the river corresponds to the fluctuating hydrograph resulting from storage and release operations. Wetlands are dewatered and riverbanks are exposed during the storage season. These habitats are then inundated during the summer irrigation season by large volumes of water. Figure 15 depicts the Deschutes River at approximate river mile 179 in the fall when wetlands are dewatered.

Figure 15. Photo depicts Deschutes River and adjacent wetlands in the Benham to Dillon Falls reach on October 12, 2016 with flows of 117 at WICO and 570 at BENO.

The hydrograph as a result of regulated flows is vastly different than that of the historical unregulated system that depicted relatively stable year round flows immediately downstream of Wickiup Dam (Figure 16; Figure 4-9 in the BA pp. 59-60). Estimates of the historical unregulated flow regime of the Upper Deschutes River vary between studies depending on the period of record, gauging location, the statistical approach used for analysis, and observational records (Golden and Alyward 2006; USGS 1914; LaMarche and Eklund 2003; Bureau of Reclamation in progress). For the purposes of this opinion, we use seasonal monthly averages and the hydrographs to characterize the magnitude of change in flow that has occurred since the reservoir systems have been in operation.
Figure 16. RiverWare-modeled unregulated versus regulated (measured) flows out of Wickiup Dam (WICO gauge). Gray lines represent single-year traces for the period spanning 1980 through 2009. Colored lines represent the daily 20\textsuperscript{th}, 50\textsuperscript{th}, and 80\textsuperscript{th}-percentile exceedance values for the same period.

The reservoir-regulated flows that release large volumes of water during the irrigation season and store it through winter have resulted in physical changes to the river channel geomorphology downstream of Wickiup Dam. The river channel, once a low-gradient system with relatively stable flows and well-established vegetation that stabilized the streambanks, has been scoured by the large volumes of water that it now conveys for irrigation. The streambanks, consisting of fine volcanic and glacial sediments held together with riparian vegetation, have been severely eroded, resulting in a channel that is now estimated to be 20 percent larger than it was prior to the change in flow regime (USFS 1996). The widened channel in many areas is unvegetated, a result of the erosive processes that have occurred in the past and continue as water is stored and released. The photos in Figure 17 depict low winter flows in the Deschutes River downstream of Wickiup Dam, the enlarged and eroding channel and mudflats.
Figure 17. Photos of the Deschutes River channel condition during low winter flows from Wickiup Dam.

The widening of the river channel affects the way water is distributed spatially on the landscape. Essentially, lower volumes of water do not reach areas that the same volumes would have reached via conveyance through the historical channel. Wetland habitats have shifted in distribution and the vegetative characteristics of these wetland and riparian areas is dependent on the volume, timing, and duration that water is present.

The reservoir regulated flow regime has increased the frequency and duration in which the river exceeds bankfull flows during summer. Irrigation season flows result in increased depth of inundation in slough habitats adjacent to the river. Because this occurs during the vegetation growing season, wetland vegetation is deeply inundated and unable to survive. Therefore, existing wetland habitats may exhibit large areas that are unvegetated and, at low flows (October through April), water intersects exposed sediment.

The area of spatial extent of inundation of sloughs along the river has increased due to high flows, as well. Under the current water management, high flows have created wetlands in areas where they may not have been in the past.

Influence of Hydrology of Spotted Frogs and Critical Habitat

All of the physical and hydrological changes to the river and adjacent wetland habitats, described above, influence the distribution and survival of spotted frogs within this reach of the Deschutes River. The regulated flows that affect the hydroperiod (i.e., the seasonal pattern of timing and inundation of water) of wetlands disrupt the spotted frog’s life cycle in several ways. Figure 18 (Figure 3-1 RDG 2017) depicts the average mean daily flows for 2000 to 2014 from Wickiup Dam within the context of the spotted frog life cycle.
At the onset of the irrigation water storage season in early October, Deschutes River flows may drop to as low as 20 cfs and wetlands without groundwater support are dewatered and unsuitable for the overwintering period of the spotted frog life cycle. The vast reduction in acreage as a result of the fall ramp down occurs at a time when frogs must move to overwintering habitat to survive the extremes of a central Oregon winter. The rate at which the flows drop during the storage season is abrupt and frogs are left stranded without water and hiding cover from predators. Low water during the winter storage season has the potential to reduce winter survival of juvenile, subadult, and adult frogs and impact connectivity among seasonally used habitats and between breeding populations. Brown trout that reside in the river may be concentrated into areas where spotted frogs seek overwintering habitat when the flows in the river are reduced.

High summer flows (up to 1,800 cfs) vastly increase the surface area of inundation in most wetlands along the Deschutes River. In areas where spotted frogs are breeding, the high flows intersect an abundance of emergent vegetation that provides excellent rearing habitat for spotted frog tadpoles. However, frogs that move into suitable habitat at high flow are more likely to be stranded as flows are reduced for the storage season.

Early irrigation season flows in April correspond with the breeding period for Oregon spotted frogs and often flows are not sufficient to inundate large areas and reach emergent vegetation. Therefore, the breeding efforts are concentrated into small areas. The preferred shallow water depths that spotted frogs tend to seek may be outside of emergent vegetation that provide cover for eggs and hatching tadpoles and may be so shallow that stranding of these life stages may occur. The eggs and hatching tadpoles also are exposed to weather conditions such as freezing and overheating.
Although we have described ongoing effects to spotted frogs and their habitat in a general sense, monitoring work continues to improve our understanding of the specific flows that have the greatest benefit or impact to spotted frogs. This monitoring is especially important as the Service works with irrigation districts to develop the Deschutes Basin HCP and an adaptive management strategy for water management that provides for spotted frog conservation into the future.

Deschutes River Flows and Ongoing Effects to Spotted Frogs and Critical Habitat

Wickiup Ramp Down Study (2014)

In October 2014, a monitoring opportunity provided insight into how specific flows affect riverine and wetland habitats along the Deschutes River between Wickiup Dam and Lava Island Falls (approximately 53 miles). A staged ramp down of the Deschutes River was conducted by Oregon Water Resources Department (OWRD) in cooperation with the Deschutes Board of Basin Control (DBBC) and partners within the community (Trout Unlimited, ODFW, Deschutes River Conservancy, etc.) to allow stranded fish to be salvaged from a side channel at Lava Island Falls (RM 174.5). The USFWS and Forest Service, as part of the collaborative effort, selected 20 locations along the river between Wickiup Dam and Lava Island Falls to conduct a photo monitoring study over the staged ramp down to determine how the system, including wetlands, responded to various flows (Figure 19). Water elevation surveys also were conducted by the Forest Service as part of the 2014 Wickiup Ramp Down study.

Figure 19. Photo monitoring locations along 53 miles of river between Wickiup Dam and Lava Island Falls.

The purpose of the monitoring effort was to make general observations of river discharge and assess the corresponding physical and ecological processes associated with decreasing flow rates. Methods for the ramp down study included six controlled flow releases from Wickiup Dam, each lasting two days to allow the river to equilibrate to Lava Island Falls (Gritzner. J., pers. comm. 2014). Flow rates chosen for the staged ramp down were intended to replicate various ecological
flows identified in previous studies (Hardin-Davis 1991; USFS 1994), as well as to determine approximate river flow rates required to maintain flows through the Lava Island side channel to avoid fish stranding during the fish salvage efforts. Approximate flow rates (+/−45 cfs) controlled at Wickiup Dam were 700, 500, 300, 200, 100, and 50 cfs.

The entire study area had been proposed for Oregon spotted frog critical habitat designation at the time of the 2014 Wickiup Ramp Down study. Therefore, the photo monitoring of the river, proposed critical habitat, and wetland and slough sites that were known to be inhabited by spotted frogs, allowed us to record the influence of various flows on spotted frog habitat. Select photos from the staged ramp down are indexed by river reach in Table 14 and included in the Appendix to exhibit the changes in these habitats at the onset of the irrigation storage season in the fall.

Table 15. Index of photos from Wickiup Experimental Ramp Down in 2014 at various flows recorded at the WICO and BENO gauges.

<table>
<thead>
<tr>
<th>River Reach</th>
<th>Site location</th>
<th>WICO</th>
<th>BENO</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wickiup Dam to Fall</td>
<td>Bull Bend</td>
<td>1168-47</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Bull Bend breeding</td>
<td>1168-47</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Dead Slough River</td>
<td>886-47</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Dead Slough Inlet</td>
<td>886-47</td>
<td></td>
</tr>
<tr>
<td></td>
<td>La Pine State Park SW Slough</td>
<td>1168-47</td>
<td></td>
</tr>
<tr>
<td></td>
<td>La Pine State Park SW Slough</td>
<td>47</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(panoramic)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fall River to Little</td>
<td>Silver Fox oxbow</td>
<td>975-47</td>
<td></td>
</tr>
<tr>
<td>Deschutes</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Little Deschutes to</td>
<td>Benham Wetland</td>
<td>886-229</td>
<td>1445-790</td>
</tr>
<tr>
<td>Benham Falls</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Benham to Dillon Falls</td>
<td>East Slough Camp pond</td>
<td>936-47</td>
<td>1442-586</td>
</tr>
<tr>
<td></td>
<td>East Slough Camp revisit 12/9/14</td>
<td>50</td>
<td>664</td>
</tr>
<tr>
<td></td>
<td>East Slough Camp revisit 2/11/15</td>
<td>127</td>
<td>941</td>
</tr>
</tbody>
</table>

Some general observations documented during the ramp down were that water receded from wetlands in the Wickiup to Fall River reach at higher flows than those downstream of the confluences with the Little Deschutes River. As the river dropped to 700 cfs at WICO, the flow exchange with the wetlands was towards the river and mudflats were beginning to be exposed (Gritzner pers. comm. 2014). This was an important observation since the wetlands without water cannot support spotted frogs through winter. Water receding from the vegetation towards the river degrades functional habitat for spotted frogs. Spotted frogs must move out of the vegetated cover of wetlands to remain in the water, which is primarily within the river channel as flows decrease. In the river channel and outside of vegetative cover, spotted frogs are at risk to predation.

At 500 cfs at WICO, water surface elevations are reduced by approximately 0.5 ft in the upper reaches above the confluence with the Little Deschutes River and 0.4 ft in the reaches below Benham Falls (Gritzner, pers. comm. 2014). More areas along the river and within slough habitats were exposed as mudflats, except the pond at East Slough, which lags due to slow permeability. The ramp down monitoring observed a large decrease in area inundated between
500 and 300 cfs. Below 500 cfs, water receded rapidly (i.e., within a 2 day period) from most
wetlands (Appendix). Although the ramp down study continued to monitor the river conditions
as flows dropped below 300 cfs, few wetlands with groundwater persisted below these flows. As
flows decreased, the river became the only place for spotted frogs to overwinter.

Ongoing Hydrological Monitoring of Spotted Frog Sites Downstream of Wickiup Dam

While the ramp down monitoring effort in 2014 highlighted the significant change in habitat
along 53 of the 61 miles of Deschutes River where spotted frogs occur during the fall, additional
site monitoring has been conducted to ascertain hydrological condition at other times of the year.
In order to further refine our understanding of the specific volumes of flow that are significant to
habitat function for spotted frogs throughout the year, hydrological monitoring, as described
above, is ongoing.

Table 15 outlines the flows at the WICO and BENO gauges that strongly influence the function
of wetlands inhabited by spotted frogs. The flows in Table 16 correlate with inundation area that
provides good habitat for spotted frogs. However, spotted frogs habitat does exist when flows
are below these thresholds.

Table 16. Known breeding sites by analysis reach along Deschutes River and flows that begin to
reduce habitat function (based on visual observation)

<table>
<thead>
<tr>
<th>River Reach</th>
<th>Site location</th>
<th>WICO</th>
<th>BENO</th>
<th>BENO minus COID diversion and 7% loss</th>
</tr>
</thead>
<tbody>
<tr>
<td>1: Wickiup Dam to Fall River</td>
<td>Bull Bend*</td>
<td>&lt;900</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Dead Slough</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>La Pine SP SW Slough</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2: Fall River to Little Deschutes</td>
<td>Private RM 202*</td>
<td>unk</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Island Loop* (private)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3: Little Deschutes to Benham Falls</td>
<td>Sunriver</td>
<td></td>
<td>Water begins to enter weirs above 1000 at WICO</td>
<td></td>
</tr>
<tr>
<td>4: Benham to Dillon Falls</td>
<td>SW Slough Camp</td>
<td>N/A</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>East Slough Camp</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>East Slough Camp (duck blind marsh)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>North East Slough Camp</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>East Slough (Lily Pad pond)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>East Slough Transducer Pond</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>S. Ryan Ranch*</td>
<td>unk</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6: Lava Island Falls to COID diversion</td>
<td>Private Preserve ** RM 172</td>
<td>unk</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7: COID Diversion to Colorado Street Bridge</td>
<td>Old Mill - LSA Marsh***</td>
<td></td>
<td>unk</td>
<td></td>
</tr>
</tbody>
</table>

Additional and specific hydrological details that pertain to how a site functions are included
below within spotted frog site descriptions. Spotted frog breeding sites are described below
within the context of the regulated water regime in analysis reaches of the Deschutes River identified in Figure 14.

**Deschutes River Spotted Frog Habitat between Wickiup Dam and the Fall River (Reach 1)**

In between Wickiup Dam and the confluence of the Fall River, the wetland and riverine habitats receive water directly via flow releases from Wickiup Dam, and only an occasional spring contributes water to the river channel along this 22 mile reach of the Deschutes River (USFS 1994). Therefore, flow releases from the dam have a direct influence on maintaining suitable habitat for spotted frogs. The effects of the dramatic change in the hydrograph are most profound in this reach of the river and wetland habitat is limited.

Currently, there are two known locations along this river reach, approximately 20 miles downstream of Wickiup Dam within La Pine State Park, where spotted frog breeding has been detected over several years: Dead Slough and La Pine State Park SW Slough. Another area, referred to as Bull Bend located 6 miles downstream of Wickiup Dam on National Forest land, may occasionally support spotted frogs as indicated by a single breeding effort in 2013 (Figure 20). Two recent studies, discussed below, highlight the effect that WICO flows have on these spotted frogs sites. A description of the sites and spotted frog habitat utilization within the sites are described in detail below.

The 2014 Wickiup Ramp Down study, described above, documented the change in habitat conditions with decreasing flows from approximately 700 to 50 cfs at the spotted frog sites mentioned above (Appendix). In general, the photographic sequence of the draw down study highlights the loss of suitable habitat for spotted frogs as water receded below the wetland vegetation line and towards the river. At 700 cfs, the recession of water from wetlands was already occurring within the Deschutes River reach between Wickiup Dam and the Fall River. Wetland oxbows that are spring supported or hold residual water through winter provide overwintering habitat for spotted frogs. However, these winter sites are devoid of cover and within open water that is mostly unvegetated. Although the river maintains water in the winter, even at flows of 29 cfs at the WICO gauge, there is little shelter from predators such as brown trout that reside in the river.

A recent instream flow study by River Design Group (RDG June 2017, 53 pp.) and funded by the Deschutes Basin Study Work Group modeled flows in the Bull Bend and Dead Slough areas of the Deschutes River to assess the relationship between streamflow and the adjacent wetland habitats. Habitat conditions for Oregon spotted frog and redband trout, both native aquatic species in this reach of the Deschutes River, were the subject species of these analyses. A 2-dimensional hydraulic and habitat model developed using suitability criteria for each species was used to look at a range of flows (20 to 1,800 cfs) along the two 1-mile stretches of river at Bull Bend and Dead Slough. The objectives of the study that pertain to Oregon spotted frogs were to (1) determine the potential increases or reductions in spotted frog overwintering and breeding habitats within the range of flows identified above; and (2) determine how flows, particularly high summer flows, effect emergent riparian vegetation.
Although the RDG study provided some useful information on a range of flow conditions within the Bull Bend and Dead Slough areas, we are careful in our interpretation of the modeled results, particularly the computed Weighted Useable Areas curves for spotted frog breeding and overwintering habitat in the RDG study, explained below. The riparian vegetation assessment portion of the study, however, is significant to understanding the current condition of the river and adjacent wetland habitat under the influence of the regulated flow regime that is high in the summer and low in the winter.

The utilization of an instream flow assessment methodology for Oregon spotted frog presents some challenges since the model is essentially using physical attributes (i.e., water depth, water velocity, substrate composition) to describe the quality of the habitat as per the suitability indexes. Yet, there are other habitat features that characterize the quality and suitability of habitat for Oregon spotted frogs such as the availability of year-round water within slough wetlands, presence of micro habitat features created by muskrats and beavers (e.g., lodges, channels, dens), shelter from predators, and close proximity between breeding and overwintering habitats. These temporal, spatial, and biological elements of habitat are not assessed within the model. Furthermore, the outputs of an instream flow model are highly dependent on well-developed habitat suitability criteria. As explained above, Oregon spotted frogs are not entirely dependent on the physical attributes used to develop habitat suitability criteria that is assessed through the instream flow methodology. We describe the relevant findings of the RDG study at both Bull Bend and Dead Slough below.

**Bull Bend**

Five pre-metamorphic spotted frogs were detected in the Bull Bend area (~RM 221)(Figure 20) in August 2013 (Bowerman, pers. comm. 2013a). Given that spotted frogs have limited mobility prior to gaining legs at metamorphosis, we conclude that frogs bred in this location in the spring of 2013. Breeding surveys conducted since 2013 at Bull Bend have not detected Oregon spotted frogs or evidence of breeding. We suspect that although wetlands appear to be suitable in this area during the summer, winter flows are too low to sustain a population of Oregon spotted frogs.

The detection of pre-metamorphic spotted frogs at Bull Bend in 2013 provides an example of occasional breeding efforts that occur along the river, described above, and indicates that there is potential for spotted frogs to utilize this area for breeding in spring seasons following wet winters\(^4\) when flow releases from Wickiup Dam increase flows in the Deschutes River. We assume that increased winter flows in 2012 to 2013, ranging from above 500 cfs to 300 cfs in December through March (Figure 21), may have facilitated movement of spotted frogs from Dilman Meadow to wetlands in the Bull Bend area, an approximate distance of 3 miles.

\(^4\) The winters of 2012 and 2013 were wet and flow releases from Wickiup Dam ranges between 500 and 300 cfs from December 2012 through March 2013. The Service suspects that the wet conditions may have provided better conditions for overwintering and movement and facilitated a breeding effort at the Bull Bend location.
Figure 20. Image of Dilman Meadow and Bull Bend spotted frog breeding locations within Reach 1 of the Deschutes River.

Figure 21. Hydrograph for flows at Wickiup Dam between October 1, 2012 and March 31, 2013.

The Bull Bend wetlands are typically dry during the spring breeding season from mid-March to mid-April (Figure 22). At this time, flow releases from Wickiup Dam are not sufficient to inundate wetlands, primarily due to the low demand for irrigation water by downstream users.

The 2014 Wickiup Ramp Down Study, described earlier, observed rapid changes in water levels in this area at the onset of the water storage season in October (Appendix). As flows dropped to 700 cfs surface water from wetlands began draining to the river and dropped outside of wetland
vegetation (Gritzner, pers. comm. 2014). Remaining overwintering habitat is within the Deschutes River, where spotted frogs are at risk of predation.

The RDG study (2017) discussed earlier, modeled flows out of Wickiup and found that flows greater than 800 cfs were necessary to inundate wetlands in the Bull Bend area (RDG 2017, p. 36). The characterization of suitable overwintering habitat for spotted frogs in the Bull Bend area in the RDG study resulted in WUA curve with a steep increase in overwintering habitat suitability between 20 and 100 cfs and then a flattening of the curve as flows approached 600 cfs (Figure 23 as depicted in Figure 4-4 in RDG 2017). However, we note that the overwintering habitat is primarily within the river channel at these flows and that overwintering suitability increases along the edges of the channel and in closer proximity to breeding habitat as flows increase from 20 to 500 cfs (Figure 24 as depicted in Figure 4-3 RDG 2017).
Figure 23. (From Figure 4-4 in RDG 2017). Oregon spotted frog Weighted Useable Area in the Bull Bend area.

Figure 24. (Figure 4-3 in RDG 2017). Oregon spotted frog overwintering habitat suitability in the Bull Bend study site, from left to right: 20 cfs, 300 cfs, and 500 cfs.

La Pine State Park Sloughs – Dead Slough and SW Slough

Wetlands sloughs adjacent to the Deschutes River in the vicinity of La Pine State Park (including some private ownership), from approximate river mile 208 to 205 are inhabited by Oregon spotted frogs (Figure 25). Two breeding locations, referred to as Dead Slough and La Pine S.P. SW Slough, were first documented in 2013 by the US Geological Survey (Table 16). Both sites experience an unnatural hydroperiod due to the regulated storage and release of flows from Wickiup Reservoir, described below. Another small site (i.e., “bath tub”), located upstream and across from Dead Slough on the north side of the river, is occasionally utilized by spotted frogs for breeding. This site appears to be a small spring-fed pool (Figure 25).
Table 16 depicts the egg mass counts for Dead Slough and La Pine SP SW Slough. Egg masses observed in the “bath tub” site are included with the Dead Slough counts. Egg mass counts indicate that Dead Slough has an approximate minimum adult breeding population of 130 spotted frogs based on the 2017 survey. Located approximately two miles downstream of Dead Slough, the La Pine SP SW Slough appears to support few breeding adult spotted frogs. No more than two egg masses have been located since 2013. A single egg mass was observed in La Pine SP SW Slough in 2017.

Table 17. Egg mass counts in Dead Slough and La Pine SP SW Slough from 2013 to 2017

<table>
<thead>
<tr>
<th>Breeding site</th>
<th>2013*</th>
<th>2014**</th>
<th>2015***</th>
<th>2016*</th>
<th>2017*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dead Slough (including “bath tub” site)</td>
<td>19</td>
<td>28 (2)</td>
<td>17</td>
<td>45</td>
<td>64</td>
</tr>
<tr>
<td>La Pine SP SW Slough</td>
<td>2</td>
<td>0</td>
<td>2</td>
<td>2</td>
<td>1</td>
</tr>
</tbody>
</table>

*USGS survey; ** Oregon Parks staff survey; ***USFWS, Forest Service and Oregon Parks staff survey

Influence of Hydrology on Spotted Frogs and Critical Habitat

Dead Slough and the La Pine SP SW Slough are strongly influenced by flow releases from Wickiup Dam. Both sloughs retain water through winter. Dead Slough is spring supported and maintains a connection to the Deschutes River throughout winter even at the lowest flows from Wickiup Dam. Flows from Dead Slough to the Deschutes River are approximately 1 cfs during
the winter months. Although the latter site retains water through winter, the source of winter water in the La Pine SP SW Slough is undetermined.

In the spring prior to irrigation season flow releases, spotted frogs breed in shallow water that is unvegetated. Egg masses are exposed to wind and high water temperatures in the shallow water. Adult breeding frogs are at risk of predation by herons and raccoons. Figure 26 depicts Dead Slough at 290 cfs and 550 cfs flows at the WICO gauge on March 6 and April 15, 2015, respectively and shows an increase in lateral inundation of habitat as flows increase. However, the water’s edge does not reach the vegetation until approximately 800 cfs (Figure 27). In instances where flows at Wickiup remain below 800 cfs at Dead Slough, emerging tadpoles are subject to predation by garter snakes and risk over exposure to environmental elements such as freezing and high water temperatures.

![Figure 26. Dead Slough prior to and during breeding period in 2015 at 290 cfs (left) and 550 cfs (right) flows at the WICO gauge.](image1)

![Figure 27. Emerging tadpoles at Dead Slough, at 796 cfs on May 2, 2016, without access to emergent vegetation that provides hiding cover and thermal protection.](image2)

The rise and fall of flows from WICO can impact spotted frogs during the breeding season as was observed in the spring of 2016. Egg masses were deposited near the outlet channel of Dead Slough at around 600 cfs. During warm weather, flows were ramped up to accommodate irrigation demands to approximately 725 cfs at WICO and egg masses moved into the outlet and toward the river. Flows were then dropped to nearly 600 cfs and egg masses and tadpoles were
stranded in the channel and remaining shallow pools (Figure 28). On May 2, 2016, the area was revisited at nearly 800 cfs and tadpoles were observed in isolated pools (Figure 29).

Figure 28. Outlet of Dead Slough on April 18, 2016 where egg mass and tadpole stranding was observed following a rise and drop in flows at the WICO gauge.

Figure 29. Outlet of Dead Slough on May 2, 2016 at 796 flows at WICO where tadpoles were observed in isolated pools near the river.
At the La Pine State Park SW Slough, there is minimal breeding habitat that is suitable for spotted frogs in the spring. Egg masses are deposited into pools of residual water from the previous winter where there is no wetland vegetation. The egg masses are exposed to wind and predation within the oxbow. Figure 30 depicts the typical site conditions within this site during the spring breeding season.

![Egg mass](image)

**Figure 30.** La Pine State Park SW Slough egg mass and the typical site conditions during the spring breeding season.

In the fall, the rapid rate of ramp down results in a drop in water levels in Dead Slough and the downstream slough within the State Park. The 2014 Ramp Down study, described above, documented the change in habitat conditions with decreasing flows from approximately 900 to 50 cfs at Dead Slough and from 1168 to 50 cfs at La Pine SP SW Slough (Appendix). The photo series from the 2014 ramp down study show a rapid drop (i.e., flow decreases at WICO occurred every two days) in water levels within these two sloughs. Water was no longer in contact with vegetation after the drop to approximately 700 cfs. The wetland area within the SW Slough was void of water by 500 cfs. At Dead Slough there was a dramatic decrease in inundated surface area below 500 cfs (Appendix).

The rapid change in water levels can increase the risk of predation by leaving frogs without water and vegetative cover to hide in. Frogs must find suitable overwintering locations that may be some distance away from where they are at the time of the ramp down. Figure 31 and 32 depict overwintering habitat conditions within the sloughs at La Pine State Park. Recent telemetry work in the fall of 2016, tracked spotted frogs to overwintering locations in Dead Slough. All of the chosen overwintering locations were inundated with water into the winter period (C. Pearl, pers. comm. May 30, 2017).
Figure 31. Overwintering habitat condition within sloughs at La Pine State Park at the onset of storage season in October.

Figure 32. Winter aerials of the Dead Slough (left) and La Pine SP SW Slough (right) prior to the onset of the breeding season on March 18, 2016 with WICO at 28 cfs.

The recent hydraulic modeling by River Design Group (2017) describes the change in inundation at Dead Slough at flows ranging from 20 to 1,800 cfs. The modeled characterization of suitable
overwintering habitat for spotted frogs in the Dead Slough resulted in a gradual increase in WUA (i.e., weighted useable area) for spotted frogs between 20 and 600 cfs at the WICO gauge with an inflection in the curve at 400 cfs when water in the slough receives water from the river (Figure 33; Figure 4-10 in RDG 2017). Figure 34 (Figure 4-9 in RDG 2017) spatially depicts Oregon spotted frog overwintering suitability at Dead Slough at modeled flows of 20, 300 and 500 cfs.

Figure 33. (Figure 4-10 in RDG 2017): Oregon spotted frog calculated Weighted Useable Area in the Dead Slough.

Figure 34. (Figure 4-9 in RDG 2017). Oregon spotted frog overwintering habitat suitability within the Dead Slough study site, from left to right: 20 cfs, 300 cfs, and 500 cfs.

Dead Slough represents the only population of Oregon spotted frogs within the Deschutes River reach between Wickiup Dam and the Fall River (~22 miles). Therefore, maintaining the Dead Slough population is important to survival and recovery of spotted frogs. The Service and USGS
are working together through a Science Support Partnership project to gain additional information about this population. A mark recapture effort is underway to assess how spotted frogs are utilizing the slough habitat and the river under the influence of the regulated storage and release operations for irrigation at Dead Slough. The USGS has also utilized telemetry to track spotted frogs at this site between September and December of 2016 in an attempt to better understand habitat selection for the overwintering period. Preliminary data from the telemetry study show that spotted frogs are using aquatic habitat within the slough for overwintering. The USGS will be preparing a manuscript on their findings in the near future.

Deschutes River Spotted Frog Habitat - Fall River to Little Deschutes outlet at Sunriver (Reach 2)

The Deschutes River reach between the outlet of the Fall River and the Little Deschutes River is primarily under private ownership. Therefore, there have been few breeding surveys conducted in this approximately 12-mile stretch of the river. Two small riverine sites have recent evidence of spotted frog breeding. However, given that this reach of the river has an abundance of oxbow habitats, we assume that there are additional small breeding sites on private land along this reach of the Deschutes River.

In 2016, a single egg mass was detected in a small slough on the west side of the river just downstream of the Fall River at approximately river mile 202. An aerial flight photo, taken on March 18, 2016, indicates that this riverine wetland had water through the winter of 2015-2016, even though flows at the WICO gauge were 28 cfs. No egg masses were detected at this site in 2017, despite improved water conditions of 100 cfs at WICO and a wet winter (Figure 35). We observed evidence of toad predation by raccoons at this location and we suspect that the combination of shallow water and lack of cover do not provide refuge from predators and good overwintering conditions for spotted frogs. The input of additional water from the Fall River (~120 cfs) may improve some habitat downstream from its confluence with the Deschutes River. However, the additional flow from the Fall River is not large enough to result in a significant improvement to habitat conditions for OSF.

Another small and occasional OSF breeding site within the Deschutes River reach between the Fall and Little Deschutes River outlets is located in an area known as Island Loop (approximate river mile 195). Island Loop is located approximately 2.5 miles upstream of the outlet with the Little Deschutes River and is essentially an old riverine oxbow that has been developed (Figure 36). Few egg masses have been detected at this location over the years. In 2015, a single egg mass was located but appeared to be at risk of stranding (Bowerman, pers. comm. 2016). According to J. Bowerman, there is a small seep that keeps this wetland moist despite the low flows in the river. In 2017, between 6 and 8 egg masses were located within this wetland (Bowerman, per. comm. 2017a) on private land.
Figure 35. Winter aerial with WICO at 28 cfs and 100 cfs in March 2016 (left) and 2017 (right), respectively.

Figure 36. Location of spotted frog breeding sites along the Deschutes River, near the outlet of the Little Deschutes River on private land.
Deschutes River Spotted Frog Habitat between Little Deschutes River Outlet and Benham Falls (Reach 3)

Reach 3 includes Sunriver and wetlands habitats along the Deschutes River extending to Benham Falls. This reach is approximately 11.5 miles long.

Sunriver

Sunriver, located just downstream of the confluence of the Deschutes River and the Little Deschutes River (approximate 187.5 to 191.5 RM), has the largest population of Oregon spotted frogs in the Upper Deschutes River sub-basin. Spotted frog habitat in Sunriver consists of excavated ponds and the Sun River, an old riverine oxbow along the Deschutes River that connects ponds and water features within the 3,300-acre community (Figure 37). Although these habitats are influenced by the storage and release of water from Wickiup Dam (i.e., the water levels drop and rise), a system of weirs has been managed by Sunriver Owners Association via assistance from the Sunriver Nature Center to maintain water levels within wetlands and ponds throughout winter for many years. Habitats in this area are geographically positioned to receive groundwater inputs via the Little Deschutes River, further improving the winter conditions for spotted frogs. Figure 38 depicts overwintering habitat in Sunriver when flows at the WICO gauge are 28 cfs and BENO flows are 744 cfs. The persistence of water through winter has been considered a key factor in the persistence of a robust population of Oregon spotted frogs in Sunriver.

Sunriver is the only population of spotted frogs in the Upper Deschutes River sub-basin with a long survey history (i.e., 2000 to 2017). The final listing rule (79 FR 51658) included an estimated minimum adult breeding population of 1,454 spotted frogs, based on 2012 egg mass surveys. Recent egg mass surveys (2014-2017) indicate that there has been a significant reduction in the adult breeding population in Sunriver (J. Bowerman data 2000-2017; Table 18). The total egg mass counts in 2016 and 2017, at 369 and 355 respectively, are among the lowest counts in the survey history. The lowest count in 2004 was attributable to failure of the weir system during the winter of 2001 to 2002. The recent reduction in egg mass numbers appears to be correlated to the increasing number of bull frogs in Sunriver (Bowerman, pers. comm. 2017b).
Bull frogs appear to be increasing in Sunriver, despite some active management to eliminate them. Bull frogs began to colonize Lake Aspen in Sunriver in 2008, and the first breeding population was confirmed in 2010.

In addition to egg mass counts, the Sunriver Nature Center has been collecting Oregon spotted frog spring and fall migration data in and out of Lake Aspen since 1999. The movement data provide important information about habitat utilization and the number of spotted frogs within the Sunriver waterways. Other biological data (i.e., sex, age class, weight, length) also is collected at the time of capture which provides additional demographic information on spotted frogs in Sunriver.

Table 18. Number of egg masses counted in Sunriver wetlands from 2000 to 2016 by Sunriver Nature Center staff.

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<tr>
<td># egg masses</td>
<td>619</td>
<td>1182</td>
<td>698</td>
<td>477</td>
<td>282</td>
<td>637</td>
<td>1163</td>
<td>631</td>
<td>797</td>
<td>1132</td>
<td>1031</td>
<td>740</td>
<td>727</td>
<td>880</td>
<td>579</td>
<td>644</td>
<td>369</td>
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Since 2010 the number of spotted frogs captured in migration surveys has vastly decreased compared to earlier years. The decline in captures indicates that bull frogs are likely having an effect on spotted frogs in Sunriver. Active management to remove bull frogs is necessary in order to conserve spotted frogs in Sunriver. Although Sunriver has been the largest population of spotted frogs downstream of Wickiup Dam, the rapid decline in egg masses as well as individuals counted in the migration surveys indicate that persistence of spotted frogs in Sunriver is threatened by bull frogs left untreated. This population of spotted frogs is essential to the conservation and recovery of spotted frogs downstream of Wickiup Dam.

Currently, there is no agreement with Sunriver Owners Association or the Nature Center to continue spotted frog conservation efforts. We rely on volunteer efforts to continue the important work that has been ongoing for many years. The Service is working to develop Safe Harbor Agreements with SROA and the Sunriver Resort to ensure spotted frog conservation work continues on these private lands along the Deschutes River.

_Wetlands between Sunriver and Benham Falls_

Wetlands between Sunriver and Benham Falls (~RM 188 to 181, respectively) have had few spotted frog breeding or summer surveys over the years and we do not know how spotted frogs may be using these habitats. When the water is high in the Deschutes River and wetlands are inundated during the summer, spotted frogs have been found using wetlands along the Deschutes River in the vicinity of Sunriver. Further downstream, many of the wetlands along this 6.5-mile reach of the river are only accessible via boat and are therefore difficult to access during breeding surveys when the river is low. These wetlands have also been difficult to
hydrologically assess for the same reason. Monitoring per the 2014 Ramp Down (e.g., Benham Wetland; Figure 39; Appendix) and aerial flights conducted since that time indicate that many of these wetlands are dewatered during the storage season. An 11-acre wetland referred to as the Benham Wetland, located just upstream of Benham Falls, is dewatered when flows at the BENO gauge drop below 1,100 cfs (Appendix). We assessed the hydrological condition of this wetland in the spring of 2016 to see if flow releases of 600 cfs from WICO could influence inundation of this site. We determined through an aerial flight that when flows are above 1,200 cfs at BENO, the site is inundated (Figure 40).

Figure 39. Wetlands showing potential Oregon spotted frog habitat along Deschutes River between Sunriver and Slough Camp.
Figure 40. Aerial flight photos of large wetland upstream of Benham Falls with flows at BENO gauge of 744 (left) and 1274 cfs (right) early in the spotted frog breeding season.

Other wetlands within this reach of the river should be assessed for winter inundation. Currently, we know that at least one of these off channel wetlands maintains water through winter (Figure 41). However, further studies are necessary to understand how flows in the river influence these habitats.

Figure 41. Winter inundation of wetland upstream of Benham Falls during low flows in Deschutes River.

We are in the process of evaluating the hydrological periods of inundation of these wetlands within the context of the regulated water for the Deschutes Basin HCP. This multi-agency monitoring effort is described in the BA (page 32). Reclamation has provided cameras to the Service to deploy within wetlands. Ideally, the camera installation will occur prior to the fall ramp down of irrigation water in 2017.
Although wetlands between Sunriver and Slough Camp do not currently have any known occurrences of spotted frogs, there are numerous ponds and wetlands that may provide for dispersing spotted frogs in the summer season when flows are high in the river (Figure 39). Therefore, these wetlands, an approximate 33 acres of suitable habitat, are important for spotted frogs that may disperse from Sunriver to Slough Camp or other suitable habitat along the river.

**Deschutes River Spotted Frog Habitat between Benham and Dillon Falls (Reach 4)**

Wetlands and riverine habitats along the approximate 3-mile reach (178 to 181 RM) of the Deschutes River between Benham and Dillon falls provide important habitat for Oregon spotted frogs. Lands along this reach of the river are on the Deschutes National Forest. The Slough Camp area wetlands currently support spotted frogs. The Ryan Ranch wetland, less than 0.5 mile downstream of Slough Camp, is a historic spotted frog site that is proposed for restoration in the near future (Figure 42). Spotted frogs within this reach of the Deschutes River are isolated by long distances from populations upstream at Sunriver (~7 river miles) and downstream at the Old Mill (~11.5 river miles). Water falls on either end of the reach may further reduce connectivity between populations along the Deschutes River. The wetlands inhabited by spotted frogs in this reach of the river exhibit a complex hydrology both naturally and under the regulated water management regime, described below.

![Figure 42. Oregon spotted frog wetland sites between Benham and Dillon Falls.](image-url)
Slough Camp

The Slough Camp area has two main wetlands inhabited by Oregon spotted frogs: a 9-acre marsh located on the west side of the river (i.e., SW Slough Camp) and a 47-acre wetland complex on the east side of the Deschutes River (i.e., East Slough Camp) (Figure 42). The SW Slough Camp spotted frog site is spring supported and is not affected by the regulated water management. Conversely, East Slough Camp wetlands experience dramatic fluctuations in the area of inundation due to the storage and release of water from Wickiup Reservoir. Hydrological variability within the East Slough Camp wetland complex is described in detail below.

Oregon spotted frogs were first detected at Slough Camp in 2010 on the east side of the river (East Slough). In September 2010, approximately 42 frogs were found (21 adults with 3 being positively identified as breeding females and 21 juveniles). Breeding was confirmed in 2011 when 33 egg masses were located by the Forest Service at East Slough and 5 were located in a wetland south of the parking area at Slough Camp (SW Slough). Surveys on both sides of the river in 2012 and 2013 yielded 14 and 41 egg masses, respectively. Table 19 shows annual egg mass counts since 2011 at SW Slough and East Slough. To date, the highest breeding counts observed were in 2017 at both sites (Table 19) (USGS 2017 data). Based on breeding counts to date, the Slough Camp population of spotted frogs is estimated to contain less than 260 breeding adults.

Table 19. Annual Slough Camp egg mass counts since 2011.

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<th></th>
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</thead>
<tbody>
<tr>
<td>SW Slough Camp</td>
<td>5</td>
<td>14</td>
<td>41</td>
<td>8</td>
<td>8</td>
<td>18</td>
<td>27</td>
</tr>
<tr>
<td>East Slough Camp</td>
<td>33</td>
<td>10</td>
<td>39</td>
<td>67</td>
<td>100</td>
<td></td>
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</table>

Breeding in the Slough Camp area has been observed as early as March 17 in the SW Slough Camp wetland on the west side of the river. Within the East Slough Camp complex the commencement of breeding has been observed as early as the first week in April and as late as the first week in May. Based on observations in the timing of the onset of egg mass depositions, we suspect that spotted frog breeding may sync with the availability of water at the East Slough wetland complex. The hydrology within the East Slough Camp complex is strongly influenced by the storage and release of water from Wickiup Dam combined with inputs from the Little Deschutes River, 12 miles upstream, and is often lacking water until late April. Therefore, breeding habitat is limited in early April when breeding season typically commences. Typically, areas that retain water through winter are the first places that spotted frogs are able to oviposit in. When the area wets up, we have observed spotted frog egg masses in areas that had been dry earlier in the season.

In some years, when there is a delay in the flow releases for irrigation, spotted frogs may deposit egg masses in shallow water from snowmelt that gradually dries up if the river is still low due to irrigation storage. Subsequently, egg masses can strand. Figure 43 shows a breeding pond in April 2014 where egg masses were deposited and then remained on mud flats prior to the release of irrigation water.
Figure 43. Breeding pond at East Slough on April 18, 2014 (left). Egg mass stranding on April 10, 2014 (right).

Figure 44 depicts the distribution of oviposition sites within the Slough Camp wetlands since 2012. The location of oviposition sites is likely also influenced by the spatial and temporal variability in inundation of these wetlands.

Figure 44. Oregon spotted frog oviposition sites within Slough Camp from 2012 to 2017.
Overwintering at this location may be difficult for Oregon spotted frogs due to the rapid drop in water elevation at the onset of the irrigation water storage season in October. Figure 45 (left) shows a large wetland area within the East Slough Camp wetland complex in the fall at the onset of the storage season, described below. In the fall of 2016, the OSF Technical Team for the HCP conducted visual observations at East Slough Camp to assess the rate of drawdown within the wetlands and observe potential stranding of spotted frogs. Juvenile spotted frogs were observed on mudflats along the Deschutes River, west of the draining marsh at East Slough (Figure 45, right). A gravid female (i.e., carrying eggs) spotted frog and numerous juveniles also were observed within a de-watered beaver channel on the south end of the wetland complex.

Figure 45. East Slough Camp marsh is de-watered in October as irrigation storage season begins (left). Juvenile spotted frogs are observed along Deschutes River mud flats as wetlands drain (right).

To gain a better understanding of how spotted frogs select overwintering locations within the Slough Camp area, the USGS is using telemetry to track spotted frogs in the fall season as water draws down (Figure 46). This ongoing study is the continuation of some preliminary telemetry work that was conducted in 2011 when spotted frogs were first discovered in the Slough Camp area.

Figure 46. Oregon spotted frog with USGS telemetry transmitter at East Slough Camp.
USGS is in the process of preparing a manuscript on the findings. Preliminary data indicate that spotted frogs in the East Slough Camp Marsh may seek overwintering sites within the large lava flow adjacent to the marsh (Figure 47). Spotted frogs also have been noted wintering beneath the thick cattails within the marsh. Based on these preliminary data, it appears that most adult spotted frogs within the Slough Camp area are using non riverine habitats for overwintering.

Hydrology of Slough Camp Wetlands and Influence on Spotted Frog Critical Habitat

The wetlands inhabited by spotted frogs in the Slough Camp area exhibit a complex hydrology both naturally and under the regulated water management regime. In order to understand this complex hydrology and how it influences spotted frog biology and habitat both temporally and spatially, a variety of monitoring techniques have been and continue to be implemented by the Service and agency partners. These efforts are described in general terms above and in detail below. The OWRD gauge at Benham Falls (BENO) is used to assess how flows in the river affect the wetlands in this reach of the river.

As stated above, the SW Slough Camp wetland, on the west side of the river (Figure 42), is supported by groundwater and retains water year round. This wetland is less influenced by the storage and release of water than other wetlands within this river reach. The East Slough Camp wetland has a complex hydrology and is strongly influenced by storage and release operations. Some ponds within the wetland complex retain water throughout the winter and others drain as the Deschutes River flows are reduced at the onset of the irrigation storage season at Wickiup Reservoir. The vast majority of wetlands are without water through the winter (Figure 47).

Figure 47. Aerial photo of East Slough Camp complex on March 18, 2016 with flows at WICO of 28 cfs and BENO at 744 cfs.
In order to better understand how the regulated flows affect these wetlands, the Service has been working with the Forest Service, USGS and DBBC consultant to conduct hydrological monitoring. Using photos, ground observations, and transducer equipment, data collected are compared with Benham gauge (BENO) flows to correlate changes in surface inundation of wetlands with river flows.

Photo monitoring of the East Slough Camp wetland conducted by the Service and Forest Service since 2012 has helped us to gain a better understanding of how Oregon spotted frog habitat is affected by the hydrograph of the river and inputs from the environment. This photo monitoring has been conducted on the ground during the irrigation ramp up in the spring, ramp down in the fall, and through the summer season. Time lapse cameras have been deployed throughout the East Slough Camp wetland complex to assess the timing of inundation relative to the spotted frog’s lifecycle.

The photo monitoring is important in that it captures when the water is above the ground surface and gives us an idea of the spatial extent of inundation within the wetlands. For example, Figure 48 shows the northern end of the East Slough Camp Marsh in mid-May prior to when the marsh is fully inundated (top) and after the marsh becomes full inundated (bottom). Through these observations we are able to determine the flows that are necessary to fully inundate the marsh. It appears that approximately 1,600 cfs at the BENO gauge is necessary to fully inundate the northern portion of East Slough. We also determine that the change in water level is rapid (approximately 24 hours) when the flow at BENO is at or above 1,600 cfs (Figure 48). A similar observation was observed at the East Slough Camp transducer pond in April 2015.
In 2016 and 2017, aerial flights were conducted before and after April 1 to observe spatial inundation of wetlands along the Deschutes River. Figure 47, above, shows the East Slough Camp wetland complex prior to the irrigation season on March 18, 2016 with flows at WICO of 28 cfs and BENO at 744 cfs. On April 7, 2016 another aerial flight observed the wetting of the large marsh at East Slough Camp (Figure 49) with flows at WICO of 604 and BENO at 1,274. These aerial photographs depict a large difference in spatial inundation within the East Slough Camp wetland complex before and after irrigation season begins in the spring which coincides with the spotted frog breeding season.
As previously described, transducers that monitor water elevations in the ground and at the surface of wetlands have been installed throughout the Slough Camp area (Figure 50). Preliminary data from the network of transducers within the Slough Camp wetlands further inform our understanding of the current hydrological condition (Vaughn 2017).

In general, the transducer data collected to date affirm that the water levels within the wetlands at East Slough Camp are predominately influenced by the flows in the Deschutes River and the
water levels within the wetland at SW Slough Camp are largely independent from river flow (Vaughn 2017). The data also corroborate our methods of tracking flows at the BENO gauge as a means of assessing the wetted condition of the East Slough Camp wetlands.

The network of transducers throughout the East Slough Camp wetland complex is important in helping us understand the variability of the hydrology within this large wetland complex. Transducers detect changes in water levels within the ground before water reaches the surface. Therefore, we are able to see where groundwater may be influencing the hydrological condition of the wetlands and where the rise in river flows influences the groundwater within the wetlands. We note that most of these wetlands do not have a direct surface connection to the river and the rise in water levels within the wetlands comes from below the ground surface.

Transducer data showed rise in groundwater levels in an Oregon spotted frog breeding pond (1065047) within five days of flows increasing at the BENO gauge following flow increases at Wickiup Dam (WICO gauge) (Vaughn 2017, p. 7). Transducer data indicate that water levels reached the estimated ground surface of the wetland (1065047) at 4040.83 feet (Vaughn 2017) on April 21, 2016 roughly 6 days after flows reached 1,430 at the BENO gauge. Our time lapse photos of the same location affirm that water is reaching the surface in this portion of the East Slough wetland at 1,400 cfs at BENO as indicated by the transducer data. However, the Service photographed this wetland on April 21, 2016 and the photo shows that the wetland is still minimally inundated (Figure 51). Although transducer data and time lapse photos show that water is reaching the surface, the water must rise in order to inundate a greater surface area of the wetland that will interface with the sedge vegetation to provide suitable habitat for Oregon spotted frogs.

Figure 51. East Slough Camp Oregon spotted frog breeding pond on April 21, 2016 shows spatial extent of surface water inundation. Transducer data indicate that water level is at the surface of the wetland.
Figure 52 shows the same pond on May 5, 2016 when flows at the BENO gauge are 1,560 cfs and the spatial extent of inundation has increased to intersect the emergent vegetation. The time delay in response of the water table to BENO gauge flows observed in the transducer data for this site would indicate that flows above 1,500 cfs (i.e., BENO flows 5 days earlier than the photo) will inundate emergent vegetation within this pond at East Slough Camp. We typically see these flows that inundate the pond towards the end of the breeding season in late April or early May at the BENO gauge.

![Figure 52. Increased spatial inundation within Transducer Pond 1 (1065047) on May 5, 2016 when flows at the BENO gauge are above 1,500 cfs.](image)

As described earlier, the spatial inundation of wetlands within the East Slough Camp wetland complex is vastly reduced from the fall through winter season. We assume that areas that remain inundated through winter are very important to spotted frog overwintering and survival. Data from four transducers (2051593, 2051581, 2051101 and 2051162) indicate that water remained within these wetlands through the winter of 2015 to 2016 within the East Slough Camp marsh (Vaughn 2017)(Figure 51). Aerial photos corroborate these results as shown in Figure 50, above. Aerial flights and on the ground photo monitoring provide us with some information regarding the spatial extent of inundation.

We use Arc GIS to calculate the acreage of East Slough Camp that is affected by storage and water release operations. The East Slough Camp wetland complex is approximately 47 acres based on our calculations within Arc GIS. However, we must estimate the acreage of inundated habitat that remains through winter and into spring before the water levels rise within the wetland complex as a result of irrigation releases from Wickiup Dam.
Using ArcGIS and aerial photos taken in March in 2016 and 2017, we estimate that less than 5 acres (approximately 10 percent) of the 47 acres remain inundated through winter. These acres represent residual water in the Lily Pad pond, small ponds where Transducers 1 and 2 are located, mid pond, and NE Slough Camp (Figure 53.). We know from several years of photo monitoring that the Lily Pad Pond and NE Slough Camp retain water in dry winters and that the areas where Transducers 1 and 2 are located dry up at the surface. Continued monitoring of this wetland complex combined with ongoing research by the USGS in coordination with the Service will further our understanding of how spotted frogs are persisting in this location along the Deschutes River.

**Ryan Ranch**

The Ryan Ranch wetland, located approximately 0.5 river-miles downstream of Slough Camp, was historically a slough basin floodplain of the Deschutes River that was occupied by Oregon spotted frogs (Hayes 1994). Specimens of spotted frogs were collected in 1949 from Ryan Ranch (Hayes 1994). However, the construction of a berm along the Deschutes River at Ryan Ranch in 1947 further limited river water from accessing the floodplain at this site and reduced the suitability of the wetland habitat for spotted frogs; that degraded condition has persisted to the present time. Reed canary grass, a threat to spotted frog habitat, is present within the Ryan Ranch wetland.

Recent surveys have not detected spotted frogs at Ryan Ranch. However, a dead spotted frog and a single egg mass were detected in a small wetland just south of Ryan Ranch and north of Slough Camp on the west side of the Deschutes River in 2013. Surveys conducted since 2013
have not detected spotted frogs or evidence of breeding at this small wetland adjacent to Ryan Ranch.

In 2016, the Forest Service began implementation of the Ryan Ranch Restoration project which aims to reconnect the Deschutes River with the Ryan Ranch floodplain and restore approximately 65 acres of freshwater emergent marsh habitat. Prior to implementation of the project, the inner basin of the Ryan Ranch wetland held a seasonal water table above the surface until late May or early June in most years. The limited duration of inundation within the wetland is influenced by the existing berm that prevents the Deschutes River from contributing surface water to the historic floodplain basin at this location. Therefore, the Ryan Ranch wetland may not provide suitable habitat for spotted frogs without implementation of the wetland restoration project proposed by the Forest Service. The lack of an aquatic connection to the river also reduces the feasibility of spotted frog movement into the Ryan Ranch wetland.

Before the restoration portion of the project is implemented, the Forest Service agreed to conduct a Pilot Study to test the amount of water seepage and evaporation loss to address concerns of the DBBC that the project could injure downstream water users. Monitoring of the hydrology in the basin during the pilot shows that the slough basin supported a surface pool of water throughout the irrigation season when connected with the river with limited seepage to deeper aquifers. In addition, a surface pool of water was maintained in the majority of the basin through the fall and winter storage seasons when the river dropped below levels necessary to contribute water to the slough floodplain (USFS 2017). As a result, it appears that Ryan Ranch would likely provide year round emergent freshwater marsh habitat if surface connections with the river were restored.

The close proximity of the Ryan Ranch Project to the Deschutes River within 0.5 river-miles of the Slough Camp spotted frog population and the documented presence of spotted frogs in the vicinity of Ryan Ranch referenced above indicates a high potential for Ryan Ranch to be occupied by spotted frogs in the future if hydrologic conditions were to be improved. Monitoring at East Slough Camp, conducted in the fall of 2016, showed juvenile spotted frogs present along the Deschutes River just upstream of Ryan Ranch when wetland habitats were dewatered (Figure 45 above) at the onset of the irrigation storage season. This project could provide a suitable refuge for spotted frogs that are displaced during the irrigation storage season when the East Slough Camp wetland is dewatered.

**Dillon Falls to Lava Island Falls (Reach 5)**

Currently we do not know of spotted frog use of wetlands in this reach of the Deschutes River. Although this reach of the river does not currently have any known breeding sites, there are numerous ponds and wetlands that may provide for dispersing spotted frogs in the summer season when flows are high in the river (Figures 54, 55 and 56). Therefore, these wetlands are important in the big picture of connectivity on the landscape. Most of these wetlands do not retain water when flows are reduced during the irrigation storage season. If these areas were to remain inundated year-round, these wetlands would provide approximately 34 acres of additional habitat for spotted frogs.
Figure 54. Ponds on wetlands adjacent to the Deschutes River between Dillon and Lava Island Falls that provide suitable habitat for OSF during the summer when flows are high in the river.

Arnold Irrigation District diversion occurs at approximate River Mile 174.5. Therefore flows in the summer in this reach include the flows at the BENO gauge minus the amount that is diverted for irrigation at this diversion. Aerial flight photos conducted in April of 2016 and 2017 indicate that many of these wetlands are inundated when flows are between 1,200 and 1,500 cfs (Figures 55 and 56). Additional hydrological evaluation is needed to determine the flow thresholds that influence inundation of wetlands in this reach.
Figure 55. Ponds adjacent to Deschutes River with flows of 1,274 at the BENO gauge on April 7, 2016.

Figure 56. Wetlands within the Dillon Falls to Lava Island Reach of the Deschutes River (Reach 5) with flows of 1530 at the BENO gauge on April 21, 2017.

Lava Island Falls to COID Diversion (Reach 6)

The stretch of river between Lava Island Falls and the COID Diversion (~174 and 171.3 RM) has limited habitat for spotted frogs and was not included in the critical habitat designation due
to it being a large distance (i.e., >10 km or 6.2 miles) from known populations at Slough Camp and the Old Mill. However, in September of 2016, four juvenile spotted frogs were located within a small wetland on private land upstream of the COID diversion (Bowerman pers. comm. 2017c) (Figure 57). This finding emphasizes the importance of seasonal wetland habitats along the river for dispersal between populations. We do not yet know if this site is inhabited year round by spotted frogs. It appears that the site was dewatered during the winter of 2016-2017. Therefore, the juvenile frogs that were present in September of 2016 may no longer reside in the wetland. The site will continue to be monitored by the Service and partners with permission from the private landowner.

![Figure 57. Yellow polygon depicts location of juvenile spotted frogs detected in September 2016 on private land near river mile 172.](image)

**Deschutes River COID Diversion to Colorado Bridge (Reach 7)**

**Old Mill Area of Deschutes River**

The downstream most extent of Oregon spotted frog distribution within the Upper Deschutes River sub-basin is located in the vicinity of the Old Mill District (~167.5 RM), in Bend, Oregon, approximately 11.5 miles downstream of Slough Camp and approximately 4.5 miles downstream of the site on private land where juveniles were located in 2016 (Figure 57 above). The Oregon spotted frog was historically known to occur 34 miles downstream of the Old Mill District where NW Lower Bridge Way crosses the Deschutes River (Hayes. 1997). In 2013, breeding surveys were conducted downstream from the Old Mill District between the Colorado Street Bridge and
Tumalo State Park, a distance of 7.8 miles (Biota Pacific and Smayda Environmenta 2013). Oregon spotted frogs were not detected during these surveys.

Spotted frogs were first discovered in this location in the Old Mill area in 2012 within a man-made storm water retention pond (i.e., Old Mill Pond). Shortly thereafter, spotted frogs were also detected in a riverine marsh (i.e., LSA Marsh), on the west side of the Deschutes River across from the Casting Pond (Figure 58).

![Figure 58. Oregon spotted frog breeding sites within the Old Mill District, Bend, OR.](image)

Breeding data indicate that spotted frogs have used both the pond and marsh for breeding. However, the pond has been less suitable for breeding in recent years. No egg masses were observed in the pond in 2015 and 2016. In 2017, two egg masses were detected in the pond. Egg mass counts were highest in 2013, the first spring after frogs were detected in the Old Mill area (Table 19).

Two known mortality incidents have occurred in recent years, one of which may account for the low breeding counts in 2015 and 2016. During the winter of 2012 and 2013, low water levels in the Casting Pond as a result of low precipitation combined with harsh winter conditions resulted in mortality of an approximated 29 frogs that had attempted to overwinter within rocks beneath a man-made walkway within the pond. Three frogs with radio transmitters and six frogs with PIT-tags installed the prior fall were among the aggregation of dead frogs. At least four live frogs
were also recovered from the excavation effort that discovered the overwintering hibernaculum within the Casting Pond (Bowerman, pers. comm. 2013b, 2013c and 2013d).

A second mortality incident occurred in May of 2015 when the LSA Marsh was accidentally dewatered during removal of a downstream dam. Water was restored to the marsh within days of the incident. However, the location where five egg masses had been deposited in April was void of water during the larval development phase and we suspect that there were no surviving recruits from that breeding effort. Juveniles from the 2014 breeding effort were concentrated in a nearby beaver channel and appeared to be unharmed (Bowerman, pers. Comm. 2015). Breeding counts in 2016 and 2017 are precariously low.

Table 20. Oregon spotted frog breeding counts in the Old Mill area

<table>
<thead>
<tr>
<th>Breeding site</th>
<th>2013</th>
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<th>2016</th>
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<tbody>
<tr>
<td>Casting Pond</td>
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<td>5</td>
<td>0</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>LSA Marsh</td>
<td>29</td>
<td>9</td>
<td>5</td>
<td>5</td>
<td>0</td>
</tr>
</tbody>
</table>

Trapping and pit tagging of spotted frogs, conducted in the Old Mill area since 2012, provides some information on population structure (i.e., size, sex, age). Initial fall trapping surveys in 2012 indicated that there were 30-50 adults and over 200 juveniles using the Casting Pond and LSA Marsh. Mark and recapture estimates and egg mass counts into 2013 indicated that there were over 100 breeding adults and approximately 945 juvenile spotted frogs using habitat within the LSA Marsh and Casting Pond (Bowerman, pers. comm. 2014a).

Telemetry and mark/recapture studies conducted between the winter of 2012-2013 and 2015 provide information on spotted frog seasonal habitat utilization within the Old Mill area. Data indicate that some spotted frogs move between the LSA Marsh and Casting Pond and that summer foraging territories exist within the riparian habitat on both sides of the river (Bowerman pers. comm. 2013e). The telemetry data also indicate that spotted frogs use the river during the winter (Bowerman, pers. comm. 2014b) and provide important information about overwintering site selection. In fact, it was the telemetry work that led to the discovery of the overwintering sites in 2013 within the Casting Pond and the unfortunate discovery of the mass of dead frogs, described above.

Hydrology in the Old Mill Area

Although this reach of the river is influenced by the storage and release of water from Wickiup Dam, the low end of the hydrograph is tempered by the damming effect of the Colorado Street Bridge. Hydrology data collected along the river in the Old Mill area to support the construction of the Bend Water Park provide useful information about the baseline hydrology at that location.

Following the incident that de-watered the LSA Marsh in 2015, a preliminary Operations and Maintenance Plan for the Colorado Avenue Safe Passage Project incorporated habitat conservation criteria for Oregon spotted frog that included maintaining water elevations in the marsh. A staff gauge was installed near the marsh by Bend Parks and Recreation District and daily staff gauge readings are recorded to comply with water level criteria designed to maintain spotted frog habitat year-round.
The BENO gauge is the nearest gauge to this part of the Deschutes River. However, the Arnold and Central Oregon diversions withdraw significant amounts of water downstream of the BENO gauge but upstream of the Old Mill area of the Deschutes River, and this section of the Deschutes River is also a losing reach, so it loses surface flows to ground water. It is important to take these items into account when discussing hydrology in this area. The Bend Parks and Recreation District calculated flows for the Old Mill area for 2016 and 2017 as part of the development of the Operations and Maintenance Plan for the Colorado Avenue Safe Passage Project. Flows were calculated by reducing the flow values at the BENO gauge by 7% for groundwater loss and subtracting out the withdrawals at the Arnold and Central Oregon diversions. Reclamation used the same approach and calculated daily flows from October 1, 2009, through May 20, 2017. Hydrographs showing the results by year are shown in Figure 59.

There is a fair amount of variability in average daily flows between years, particularly during the irrigation season. However, during most years, between 2010 and 2017, flows spent a significant amount of time around 500 cfs between December 1st and March 15th, when juvenile, subadult, and adult spotted frogs are overwintering. However, 2013 and to some degree 2012 were unique. In 2013, between December 1st and March 15th, flows ranged from 750 cfs to 1,162 cfs, with an average daily flow during that period of 1,027 cfs. In 2012, between December 1st and March 15th, flows ranged from 725 cfs to 1,284 cfs, with an average daily flow during that period of 970 cfs. For comparison, in 2014, between December 1st and March 15th, flows ranged from 413 cfs to 1,274 cfs, with an average daily flow during that period of 603 cfs. Table 21 displays the results for all of the water years considered.
Table 21. Minimum, maximum, and average daily flows between December 1st and March 15th, by water year.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>2010</td>
<td>331</td>
<td>665</td>
<td>557</td>
</tr>
<tr>
<td>2011</td>
<td>315</td>
<td>866</td>
<td>526</td>
</tr>
<tr>
<td>2012</td>
<td>725</td>
<td>1284</td>
<td>970</td>
</tr>
<tr>
<td>2013</td>
<td>750</td>
<td>1162</td>
<td>1027</td>
</tr>
<tr>
<td>2014</td>
<td>413</td>
<td>1274</td>
<td>603</td>
</tr>
<tr>
<td>2015</td>
<td>572</td>
<td>1032</td>
<td>724</td>
</tr>
<tr>
<td>2016</td>
<td>409</td>
<td>708</td>
<td>523</td>
</tr>
</tbody>
</table>

In Water Year 2017, the irrigation districts operated the system in a manner similar to the proposed action. In order to display how flows on the Deschutes River at the Old Mill area in Water Year 2017 compared to system operation between 2010 and 2016, a hydrograph was generated showing the average flows across water years 2010 through 2016, and displayed with the 2017 hydrograph (Figure 60).

Figure 60. Average estimated flows for the Deschutes River at the Old Mill District from 2010 through 2016, compared to Water Year 2017.

Additional monitoring within the LSA Marsh is necessary to determine if flow variability is affecting spotted frogs. Given that this population of spotted frogs has declined in recent years due to what we believe are circumstances outside of regulated flows, the Service and USGS would like to add this population to ongoing demographic studies at Slough Camp and Dead Slough. Funding for this proposed monitoring work has not been secured.
5.2 Status of the Spotted Frog in the Little Deschutes River Sub-basin

Oregon spotted frogs are distributed throughout wetland, pond, and riverine habitats along the Little Deschutes River which flows north for approximately 92 miles (148 km) from its headwaters in Klamath County to its convergence with the Deschutes River one mile (1.2 km) south of Sunriver and approximately 20 miles (32 km) south of Bend, Oregon. The Little Deschutes River sub-basin drains an area of approximately 1,020 square miles (2,600 square km) and includes two tributaries to the Little Deschutes River that are occupied by Oregon spotted frogs: Crescent Creek and Long Prairie Creek (also referred to as Long Prairie Slough).

The Little Deschutes River sub-basin geology is characterized by large areas of deposited ash and pumice from the eruption of Mt. Mazama (Crater Lake) about 6,800 years old. Lava flows from the Cascades Mountains to the west and Newberry Crater to the east formed the La Pine Basin with characteristically flat topography, highly permeable and rapidly draining soils with high water tables through which the Little Deschutes River flows. The floodplain of the Little Deschutes River is broad within an abundance of riverine oxbows and marsh habitat that is highly suitable for Oregon spotted frog.

At the time of listing (79 FR 51658), there were approximately 23 known breeding locations within five watersheds (10th Field Hydrologic Unit Code (HUC)) in the sub-basin: Upper, Middle, and Lower Little Deschutes River; Crescent Creek; and Long Prairie. Currently there are 27 locations through the expansive Little Deschutes River sub-basin where breeding has been detected (Figure 61; Tables 21 and 25). However, the number of breeding sites identified during listing and currently are considered to be an under representation of the distribution and abundance of spotted frog breeding sites as 70 percent of the Little Deschutes River sub-basin is in private ownership and only a portion of the lands have been surveyed for spotted frogs.

We refer to monitored sites or breeding locations rather than populations where these sites occur along Crescent Creek, Long Prairie, and the Little Deschutes River. We lack genetic work that would facilitate our understanding of population groupings. Therefore, we assume that there is connectivity between most of these breeding locations along these river corridors where they are in close proximity to each other and there is suitable habitat between them. Big Marsh, a large headwater wetland that drains into Big Marsh Creek and then into Crescent Creek, is the only site that we refer to as a population in our description of spotted frog sites in the Little Deschutes River sub-basin below.

5.2.1 General Threats

Threats to Oregon spotted frogs identified in the 2014 Listing (79 FR 51658) within the Little Deschutes River sub-basin include, but are not limited to, habitat loss and/or modification due to land conversions (primarily agriculture), hydrologic changes (e.g., dams, ditches, and water control structures), shrub encroachment, invasive reed canarygrass, and introduced predators (bullfrogs and cold water fish). Grazing may also pose a threat through trampling and reduced water quality when livestock are allowed access to water occupied by frogs. Climate change

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may play a role in this sub-basin overtime as the snow-dominant system changes to a mixed snow-rain-dominant system resulting in reduced peak spring streamflow, increased winter streamflow, and reduced late summer flow (Littell et al. 2009).

Tumalo Irrigation District operates Crescent Dam to store and release water in Crescent Lake for irrigation purposes. These water management operations affect a portion of the Little Deschutes River sub-basin where spotted frogs occur: Crescent Creek from the Crescent Lake Dam to the confluence with the Little Deschutes River and from the Little Deschutes River at the confluence with Crescent Creek to the outlet at the mainstem Deschutes River. Unregulated portions of the Little Deschutes River sub-basin contribute flow to areas that are affected by the storage and release operations at Crescent Dam. Of particular significance are Big Marsh Creek, which flows into Crescent Creek approximately 6 miles downstream of the dam, and the Upper Little Deschutes River located upstream of the confluence with Crescent Creek.

Figure 61, below, depicts the known spotted frog locations that are unaffected and affected by dam operations in yellow and green, respectively. The following sections describe the status of spotted frogs in the areas that are unaffected and affected by Crescent Lake Dam operations, respectively.
Figure 61. Oregon spotted frog breeding sites within the Little Deschutes River Sub-basin. Sites identified with green circles are those that are affected by ongoing irrigation storage and release operations. Sites identified with yellow circles are sites that are outside of the influence of storage and release operations.
5.2.2 Spotted Frog Sites/Populations in Areas Unaffected by the Proposed Action

Approximately 13 of the 27 monitored breeding locations are either upstream of or outside of the influence of managed flow releases from Crescent Lake Dam and are therefore not affected by the proposed action (Figure 61; Table 22). Two of these sites drain to Crescent Creek: Big Marsh and Black Rock Lava Pond. Six of these sites are located in the Upper Little Deschutes River watershed, upstream of the confluence with Crescent Creek. Long Prairie drains to the Little Deschutes River in the area of La Pine, OR and has approximately five known breeding sites.

The contribution of these spotted frogs sites to those within the area affected by water management is important. We assume that an aquatic connection and dispersal distances within 6.2 miles (10 kilometers) (based on distances described in critical habitat delineation) allow for the influx of individuals from populations within the Crescent and Little Deschutes system to immigrate into areas affected by water management. The Long Prairie breeding locations although close via distance are disconnected by drains and ditches that are associated with an irrigation system supplied by the Walker Basin Canal. Only the lowest reach of Long Prairie is connected to the Little Deschutes River.

Table 22. Spotted frog sites or populations by river mile locations within drainages that are not affected by the Deschutes Project.

<table>
<thead>
<tr>
<th>Watershed (HUC 10)</th>
<th>Waterbody or drainage</th>
<th>Site Name/Population</th>
<th>River Mile (RM)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crescent Creek</td>
<td>Big Marsh Creek</td>
<td>Big Marsh</td>
<td>7-12.5</td>
</tr>
<tr>
<td></td>
<td>Crescent Creek</td>
<td>Black Rock Lava Pond</td>
<td>14</td>
</tr>
<tr>
<td>Upper Little Deschutes River</td>
<td>Little Deschutes River</td>
<td>LD Marsh S. Shore</td>
<td>95.5</td>
</tr>
<tr>
<td></td>
<td>Hemlock Creek Marsh</td>
<td>Tributary enters at 88.5</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Hwy 58 area sites (Upper oxbow, Mowich log pond)</td>
<td>86.5-87.5</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Odell Pasture; 100 road mill pond and oxbows</td>
<td>70-71</td>
<td></td>
</tr>
<tr>
<td></td>
<td>LDR 62 road oxbow, floodplain pool, gravel pit, beaver</td>
<td>60-61.5</td>
<td></td>
</tr>
<tr>
<td>Long Prairie</td>
<td>Long Prairie Creek</td>
<td>Long Prairie marsh (La Pine HS)</td>
<td>0-0.5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Long Prairie Hwy 97 City Hall</td>
<td>1.5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Long Prairie Pond (Private)</td>
<td>2.5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Long Prairie upper BLM</td>
<td>6.5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Long Prairie Private site</td>
<td>6.5</td>
</tr>
</tbody>
</table>

The final rule included a minimum population estimate of approximately 6,628 adult breeding spotted frogs in the Little Deschutes River sub-basin based on limited breeding surveys conducted on public and private land in 2012 (Final Rule Vol. 79 No. 168 p.51666). However, the vast acreage of existing wetland complexes and suitable habitat for Oregon spotted frogs along the mainstem Little Deschutes River and Crescent Creek indicate that the frog population
within the un-surveyed areas may be well above this estimate. We note that the adult population at Big Marsh was estimated to be approximately 5,324 adults at that time, comprising 80 percent of the adult breeding population within the Little Deschutes River sub-basin at the time of listing.

Big Marsh, a 2,000-ac (809 ha) wetland located within headwaters at 4,760 feet (1,451 m) elevation on the Deschutes National Forest, has the largest monitored population of spotted frogs in the Little Deschutes River sub-basin and possibly range-wide. Table 23 depicts breeding surveys since 2002.

Table 23. Big Marsh Oregon spotted frog Egg Mass Survey Data, 2002 to 2015

<table>
<thead>
<tr>
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<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>490</td>
<td>694</td>
<td>173*</td>
<td>1,254</td>
<td>1,736</td>
<td>2,611</td>
<td>427*</td>
<td>25**</td>
<td>1,514</td>
<td>1,265</td>
<td>2,662</td>
<td>3,071</td>
<td>1,087</td>
<td>3,618</td>
</tr>
</tbody>
</table>

*Incomplete survey.  
**Incomplete late season survey.  Masses already hatched.

Several hydrological restoration efforts have occurred at Big Marsh over the years (i.e., 2000, 2004, 2006, and 2007) and we have seen a positive response in egg mass counts in the years that followed these efforts. Based on egg mass surveys the population has increased from a low estimated at 980 breeding individuals (male and female) in 2002 to a high of 6,142 breeding individuals in 2013 (Table 23). The positive response in the adult population of spotted frogs indicates that hydrological restoration efforts have been effective in improving habitat conditions for spotted frogs. The Service recently consulted on another proposed project at Big Marsh to continue the hydrological restoration work (USFWS 2015, p. 17).

Maintaining a healthy Big Marsh population is important to the conservation of the spotted frog because it may be a source population for downstream habitats within Big Marsh Creek, Crescent Creek, and the Little Deschutes River. Big Marsh is not affected by irrigation storage and release, which influences and in some cases adversely impacts habitat for spotted frogs along the entirety of Crescent Creek and approximately 60 miles of the Little Deschutes River downstream of its confluence with Crescent Creek.

Upstream of the confluence with Crescent Creek, the Little Deschutes River has approximately six locations where breeding has been monitored over the years. These sites have relatively short distances between them as indicated by river mile locations in Table 24. In some cases these areas cover 1-2 miles of the river floodplain where breeding has been detected. Large sites typically have higher breeding counts than the small areas located at the highest elevations in the watershed. However, conducting breeding surveys at the high elevations is difficult due to inaccessibility via the road system due to heavy snow that remains when the breeding season begins in April. Accordingly, the breeding counts that we have completed may be inaccurately low. The largest egg mass counts of these monitored sites have been observed at the LDR 62 Rd location, upstream of the Crescent Confluence by less than one mile. Breeding counts at this location in 2012 indicate there are approximately 300 breeding adult spotted frogs using this section of the Little Deschutes River on BLM administered lands (Table 24). Spotted frogs at this location contribute to spotted frog distribution and abundance in the area along the Little Deschutes River that is affected by the proposed action.
Table 24. Oregon spotted frog sites and breeding counts within Little Deschutes River sub-basin upstream of the confluence with Crescent Creek outside of affected area.

<table>
<thead>
<tr>
<th>River Mile</th>
<th>Site Name</th>
<th>Breeding Count</th>
<th>Approximate acreage</th>
<th>Ownership</th>
</tr>
</thead>
<tbody>
<tr>
<td>95.5</td>
<td>LD Marsh S. Shore</td>
<td>3 (2013)</td>
<td>1.14</td>
<td>US Forest Service</td>
</tr>
<tr>
<td></td>
<td>Tributary enters at 88.5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>88-89</td>
<td>5830 Road</td>
<td>2 (2012); 2 (2013); 11 (2016)</td>
<td>35</td>
<td></td>
</tr>
<tr>
<td>86.5-87.5</td>
<td>Hwy 58 area sites (Upper oxbow, Mowich log pond)</td>
<td>1 (2012); 7 (2013)</td>
<td>21.1</td>
<td></td>
</tr>
<tr>
<td>70-71</td>
<td>Odell Pasture; 100 road mill pond and oxbows</td>
<td>27 (2012); 26 (2013); 4 (2015); 53 (2016)</td>
<td>32.5</td>
<td></td>
</tr>
<tr>
<td>60-61.5</td>
<td>LDR 62 road oxbow, floodplain pool, gravel pit, beaver</td>
<td>164 (2012); 121 (2013); 3 (2016)</td>
<td>28</td>
<td>US Bureau of Land Management</td>
</tr>
</tbody>
</table>

Long Prairie Creek Sites

Historically, it was likely that Oregon spotted frogs existed over much of Long Prairie, a marshy tributary of the Little Deschutes River that is now bisected by Highway 97. In terms of river miles, the Long Prairie drainage is approximately 17 miles. However, the Long Prairie area has been drained and modified extensively. A system of irrigation ditches receives water via the Walker Basin Canal which diverts water from the Little Deschutes River downstream of the confluence with Crescent Creek. This irrigation delivery system is independent of the water storage and release operations being analyzed in this Opinion.

Currently, Oregon spotted frogs occur along the lower 6.5 miles of Long Prairie. There are five known breeding locations where spotted frogs have been monitored in recent years. Due to the abundance of private lands that have not been surveyed for spotted frogs, it is difficult to determine the status of spotted frogs inhabiting Long Prairie. Two of these sites both of which are in private or partially private ownership, Long Prairie Pond and Long Prairie marsh (La Pine HS), have had large breeding counts in recent years (Table 24), which indicates that spotted frogs are persisting and abundant in these locations.

Table 25. Oregon spotted frog sites and breeding counts outside of affected area within Long Prairie.

<table>
<thead>
<tr>
<th>River Mile</th>
<th>Site Name</th>
<th>Breeding Count</th>
<th>Approximate acreage</th>
<th>Ownership</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-0.5</td>
<td>Long Prairie Beaver pond marsh (La Pine HS)</td>
<td>1 (2006); 204 (2013); 157 (2017)</td>
<td>6.93</td>
<td>BLM (some private in 2013 and 2017)</td>
</tr>
<tr>
<td>1.5</td>
<td>Long Prairie Hwy 97 City Hall</td>
<td>4 (2017)</td>
<td>1.44</td>
<td>private</td>
</tr>
<tr>
<td>2.5</td>
<td>Long Prairie Pond</td>
<td>133 (2013)</td>
<td>25.5</td>
<td>private</td>
</tr>
<tr>
<td>6.5</td>
<td>Private site (RM 6.5)</td>
<td>2 (2012)</td>
<td>11</td>
<td>private</td>
</tr>
<tr>
<td>6.5</td>
<td>Long Prairie upper BLM</td>
<td>20 (2001)</td>
<td>4.47</td>
<td>BLM</td>
</tr>
</tbody>
</table>
Given that the Long Prairie area has been ditched and modified, we assume that these sites are not connected, except for the lowest end of the reach at the confluence with the Little Deschutes River. Bull frogs also have been detected in all known spotted frog sites on Long Prairie.

5.2.2 Spotted Frog Sites/Populations in Areas Affected by the Proposed Action

Approximately 14 monitored Oregon spotted frog breeding sites occur within the geographic area affected by the Proposed Action: five adjacent to Crescent Creek and nine along the Little Deschutes River downstream of its confluence with Crescent Creek (Table 26; Figure 61). These sites, located along Crescent Creek and the Little Deschutes River, are within the area that is hydrologically influenced by the storage and release of water from Crescent Lake Reservoir.

Table 26. Spotted frog breeding locations along Crescent Creek and the Little Deschutes River influenced by storage and release operations at Crescent Lake Dam.

<table>
<thead>
<tr>
<th>Watershed (HUC 10)</th>
<th>Waterbody or drainage</th>
<th>Site Name</th>
<th>River Mile (RM)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crescent Creek</td>
<td>Crescent Creek</td>
<td>Crescent Creek above Highway 58</td>
<td>22 – 22.5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Crescent Creek below Highway 58</td>
<td>21.5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Crescent Upper Oxbow (Private)</td>
<td>9-9.5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Crescent Creek 62 RD (Private)</td>
<td>3-7</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Crescent Creek BLM oxbows and adjacent private</td>
<td>0-2</td>
</tr>
<tr>
<td>Middle Little Deschutes River</td>
<td>Little Deschutes River</td>
<td>Middle Little Deschutes complex 1 (Private)</td>
<td>56-57</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Middle Little Deschutes complex 2 (Private)</td>
<td>49-51</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Leona Park</td>
<td>~35</td>
</tr>
<tr>
<td>Lower Little Deschutes River</td>
<td>Little Deschutes River</td>
<td>Oxbows behind La Pine High School (BLM/Private)</td>
<td>~30-31</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Rosland Park</td>
<td>~27-28</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Riverside oxbow (private)</td>
<td>~21</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Casey Tract</td>
<td>~13-15</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Thousand Trails (private)</td>
<td>~4-6</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Crosswater (N. driving range pond, bullfrog pond, Fairway 2) (private)</td>
<td>0-2</td>
</tr>
</tbody>
</table>

Monitoring of these sites has been mostly sporadic until recent years. Therefore, breeding counts are limited. In 2011 and 2012, the Service contracted with the USGS to conduct spotted frog breeding counts within this geography, primarily for the purposes of determining distribution of the species. At the time, the Service was working on the proposed listing and critical habitat determination for the species. With assistance from the USGS, we determined that spotted frogs were distributed throughout the entire reach of the Little Deschutes River downstream of the confluence with Crescent Creek and within approximately 25 of the 30 miles of Crescent creek. Spotted frogs have not been detected within the 5-mile reach of Crescent Creek directly
downstream of Crescent Lake Dam. Currently, known sites within Crescent Creek are
downstream of its confluence with Big Marsh Creek, an important tributary as we discuss
hydrological conditions below.

5.2.2.1 Ongoing Water Management and Hydrological Influences on Spotted Frog
Critical Habitat

Crescent Lake is operated as a reservoir to capture and store runoff in the Crescent Creek
watershed (upstream of RM 29) in the fall, winter and spring (typically October through June)
and release water from storage during the irrigation season (typically July through September).
Reservoir operations result in flows downstream of Crescent Dam that are lower than natural
(unregulated) conditions during the storage season (fall, winter and spring) and higher than
unregulated conditions during the irrigation season (summer). Figures 62 and 63 show the
average daily flows in Crescent Creek below the dam (CREO gauge) and in the Little Deschutes
River in La Pine, OR (LAPO gauge), respectively, under regulated (i.e., actual recorded flows)
and unregulated conditions (i.e., simulated flows for period between 1983 and 2014).

Figure 62. Comparison of unregulated, historical regulated and Proposed Action monthly
medians of daily average flows in Crescent Creek below Crescent Dam (source R2 and Biota
Pacific 2016).
There has been a significant change in the hydrographs within Crescent Creek and the Little Deschutes River (to a lesser extent) as a result of reservoir storage and release operations and these actions affect the timing of inundation in wetland habitat for Oregon spotted frog. The low winter flows have the potential to reduce the availability of overwintering habitat for Oregon spotted frogs. However, the spring-fed nature and high water table within the Little Deschutes River sub-basin likely buffers the effect of the reduction in flows due to storage. The greatest disparity between the unregulated and regulated hydrographs occurs in the summer when flows in the rivers are high due to irrigation flow releases at a time when under the unregulated condition flows would be lowest. The high summer flows in the rivers maintain water elevations in riverine oxbows and wetland habitats occupied by Oregon spotted frogs at higher levels than in the unregulated condition.

In addition to seasonal changes in flow, operation of the reservoir (which involves the release of water at a constant rate) moderates natural fluctuations in flow that occur on a daily or weekly basis due to precipitation events and snowmelt (Biota Pacific 2017). Consequently, the dynamic disturbance processes such as flood events that create oxbow habitat are reduced within the system downstream of the Crescent Lake dam on Crescent Creek. This effect of the dam is less evident in Crescent Creek below the Big marsh Creek confluence, and on the Little Deschutes River which is unregulated above the confluence with Crescent Creek.

In general, the effects of reservoir operation on Oregon spotted frogs in Crescent Creek and Little Deschutes River are those that occur directly or indirectly through changes in the timing and magnitude of flow on a daily, seasonal and year-to-year basis. Changes in flow have the potential to cause changes in water surface elevation (depth) in wetlands occupied by Oregon spotted frogs. Changes in water surface elevation influence conditions for breeding, summer rearing/feeding and overwintering in wetlands inhabited by spotted frogs. The hydrological effect of storage and release from Crescent Dam are described in the description below of spotted frog sites within Crescent Creek and the Little Deschutes River.
Crescent Creek Sites

Crescent Creek is approximately 30 miles in length between the outlet at the Little Deschutes River and the Crescent Lake Dam. Spotted frog breeding locations are concentrated on the lower 9 miles of Crescent Creek which is mostly on private land. A small riverine segment (~1 mile) of Crescent Creek on BLM administered lands has been monitored since 2013. Another one mile stretch of Crescent Creek (21.5 to 22.5 RM) that flows through lands administered by the Forest Service contains two small breeding locations that have been monitored consistently since 2013 (Figure 64). In addition to these five known breeding locations along the river, the Black Rock Lava Pond represents another breeding location that drains into Crescent Creek at approximately river mile 14. This site is outside of the area influenced by storage and release from Crescent Lake Dam.

Breeding surveys along Crescent Creek have been sporadic until recent years. The lower 18 miles of Crescent Creek are predominately private land. Therefore, we are unable to conduct breeding surveys within the mid to lower river reach unless we are granted permission to access private land. Currently, only three of these five sites along Crescent Creek are consistently monitored: two sites on national forest land upstream and downstream of Highway 58 (between RM 21.5 and 22.5) and another site located near the mouth of the creek on BLM land (RM 0-2) (Table 27).

Figure 64. Spotted frog breeding locations on national forest land along Crescent Creek between river miles 21.5 and 22.5.
Table 27. Crescent Creek Oregon spotted frog site breeding counts and acreages (calculated in ArcGIS).

<table>
<thead>
<tr>
<th>Breeding site on Crescent Creek</th>
<th>Acres</th>
<th>Total egg mass counts</th>
</tr>
</thead>
<tbody>
<tr>
<td>62 RD (Private) (RM 3-7)</td>
<td>233</td>
<td>2006  62</td>
</tr>
<tr>
<td>BLM oxbows and adjacent private (RM 0-2)</td>
<td>48</td>
<td>2006  42  2009  18  2011  9  2012  12</td>
</tr>
</tbody>
</table>

Most of the habitats where Oregon spotted frog breeding has been detected on or near the floodplain of Crescent Creek are characterized as oxbows and sloughs which typically form where the creek has a low gradient (Figure 65). On the lowest monitored reach of Crescent Creek, spotted frog egg masses have been observed within riverine emergent wetlands within the creek (Figure 66). Spotted frogs also have been observed basking on sandbars along the creek in mid-summer.

Figure 65. Slough habitat at Crescent Creek Highway 58 sites (22 and 21.5 RM)
Influence of Water Management on Crescent Creek Spotted Frog Sites

Upper Crescent Creek basin (above Crescent Dam) provides about 40 percent of the average annual flow in Crescent Creek (Biota Pacific 2017). Big Marsh Creek, the largest tributary to Crescent Creek, enters about 6 miles downstream of Crescent Dam at RM 23 and contributes another 26 percent to average annual flow. Much of the remaining 36 percent of the annual flow in Crescent Creek enters between Crescent Dam and Big Marsh Creek (Gannett et al. 2001). Reservoir operations influence approximately 40 to 50 percent of the total flow within Crescent Creek on an annual basis downstream of the confluence with Big Marsh Creek (Biota Pacific 2017). An important point to note here is that flows at the CREO gauge do not directly correspond to surface water levels and the extent of inundation of wetlands. Big Marsh Creek provides substantial volumes of water to Crescent Creek in the spring and there is currently no hydrological gauge to measure hydrological inputs to Crescent Creek from Big Marsh Creek. The hydrological response of wetlands to changes at the CREO gauge is most noticeable in the late summer and fall when flows out of Big Marsh Creek are low.

Water storage at Crescent Lake results in average monthly fall, winter, and spring flows at the Crescent Dam gauge (CREO) that are lower than unregulated flows (Figure 62) in October through May. Suitable habitat for Oregon spotted frog is reduced during this period. We assume that spotted frogs seek oxbow habitat that remains inundated through winter such as those at known breeding locations upstream and downstream highway 58 between river miles 21.5 and 22.5 on Crescent Creek (Figure 65). However, where spotted frogs utilize wetlands on the creek such as the BLM site at RM 1.5, overwintering may occur in Crescent Creek when wetlands are dewatered during the storage season. Utilization of the river for wintering increases the risk of
predation on spotted frogs by brown trout, which are abundant in the Little Deschutes River and in the lower reaches of Crescent Creek.

The abrupt change in inundation of wetlands that occurs at the onset of the storage season (Sept to Oct) can strand frogs in unsuitable habitat and leave them vulnerable to predation. Daily average flows in Crescent Creek and the Little Deschutes River can drop as much as 100 cfs in a matter of days when irrigation releases from Crescent Lake Reservoir cease for the season in late September or early October (Figures 62 and 63 above).

In the fall of 2015, the Tumalo Irrigation District slowed the ramp down rate and maintained flows of approximately 30 cfs from the fall through winter in an effort to lessen potential impacts to spotted frogs due to irrigation storage. In theory this is a good approach for facilitating movement to and maintaining overwintering habitat for spotted frogs. Figure 67 shows Crescent Creek spotted frog sites at RM 22.5 and RM 1.5 on October 25, 2015 when flows are reduced to approximately 30 cfs. Although water had receded from vegetation at the site near RM 22.5, the oxbow habitat remained inundated and juvenile spotted frogs were observed in the water. The spotted frog site at RM 1.5 also remained inundated at flows of approximately 30 cfs at the CREO gauge.

A network of transducers that monitor surface water elevations in wetlands were installed in the three monitored spotted frogs site locations (RM 22.8, RM 21.9 and RM 1.7 ) and within the river channel above and below the Crescent Creek confluence with Big Marsh Creek beginning in 2015. Transducer data improve our understanding of how the storage and release of water at Crescent Dam influences water surface elevation in wetlands occupied by spotted frogs.

Figure 67. Crescent Creek spotted frog sites at river miles 22.5 and 1.5 on October 25, 2015 when flows are reduced to approximately 30 cfs.

Rating curves for Crescent Creek at RM 22.8 and RM 1.7 were developed using transducer data and show that all of the monitored sites are influenced by the changes in flow at the CREO gauge (Biota Pacific 2017). However, the magnitude of the influence is variable seasonally. Hydrological data collected at monitored frog sites show that the largest influence of the flow releases from Crescent Dam is during the three summer months of July, August, and September. Biota Pacific estimated that median water surface elevations of wetlands adjacent to Crescent Creek can increase from 4.9 to 7.8 inches during these summer months. From October through
June, water surface elevations may be reduced by 0.3 to 2.3 inches (Biota Pacific 2017, p. 17-19).

Sites on Crescent Creek may experience low water during spring breeding season since water is held in Crescent Lake until July. Egg mass stranding was observed at the Forest Service site downstream of Highway 58 in 2013 when the flow below Crescent Dam was 10 cfs and at the BLM site on the lowest reach of Crescent Creek in 2014 when the flow below Crescent Dam was 7.5 cfs (Figure 68). In the later instance, the Tumalo Irrigation District allowed an additional 14 cfs past the dam to improve habitat for spotted frogs.

Stranding of egg masses is not entirely due to irrigation storage. Rather, the stranding at times is due to natural flood events (i.e., rain on snow or snowmelt upper watershed) that vastly inundate the floodplain causing spotted frogs to seek shallow areas on the floodplain to deposit eggs. The duration of flood water on the floodplain is often short-lived and egg masses or hatching tadpoles can strand at these shallow deposition sites. In cases where oxbows are deep enough to intersect the water table or base elevations of the adjacent river, egg masses can develop and metamorphose.

On April 24, 2014, Tumalo Irrigation District increased the flow below Crescent Dam to 22 cfs when informed of the stranding. Figure 69 shows improved hydrological condition in the wetland where frogs breed. Additional precipitation also helped to wet the area.

Figure 68. Oregon spotted frog egg mass stranding in Crescent Creek BLM wetland (1.5 RM) at 7.5 cfs on April 8, 2014.
Figure 69. Oregon spotted frog site on BLM land near RM 1.5 on April 24, 2014 when flows at CREO gauge were increased to 22 cfs from 7.5 cfs.

Although additional flow releases in the spring can improve breeding conditions, particularly after a dry winter, these additional dam releases could decrease breeding habitat suitability in the short-term, where natural flooding is occurring on the floodplains due to high amounts of precipitation. The Service observed high water levels and less suitable breeding and rearing conditions for spotted frogs along Crescent Creek during the spring of 2017 after a winter of high snowfall.

Summer irrigation flows vastly increase the volume of water in the river channel and within some wetlands and oxbows along Crescent Creek. In the unregulated condition, average monthly flows at the Crescent Dam gauge (CREO) were 20 cfs and below in July, August, and September. Average monthly flows within the regulated system are now between 100 and 140 cfs during summer months (Figure 62 above). The high summer flows create an abundance of inundated wetlands that are highly suitable for spotted frogs. Figure 70 shows a Crescent Creek oxbow at 65 cfs during summer and high quality habitat for Oregon spotted frog. Figure 71 shows the lower Crescent Creek site at RM 1.5 with flows of 115 cfs at the CREO gauge.

Although the summer flows create highly suitable habitat for spotted frogs, we do not know how suitable these areas are for spotted frogs when flows are reduced at the onset of the storage season. Habitat monitoring should be conducted in the fall to observe the change in wetland conditions at the onset of the storage season. Continued monitoring is necessary to determine how the timing and volumes of flow releases from Crescent Lake Dam may be affecting Oregon spotted frogs and their habitats. Furthermore, telemetry studies such as those described above by USGS could inform our understanding of spotted frog movement and habitat preferences in Crescent Creek.
Figure 70. Oregon spotted frog site on private land near RM 1.5 on July 7, 2014 when flows at CREO are 65 cfs.

Figure 71. Oregon spotted frog site on BLM land (RM 1.5) on September 15, 2015 when flows at CREO are 115 cfs.

**Little Deschutes River Sites Downstream of Crescent Creek Confluence**

The Little Deschutes River flows approximately 60 miles between the confluences with Crescent Creek and the mainstem Deschutes River near Sunriver, OR. This reach of the river is almost completely within private lands. Only two small blocks of BLM land are present within this reach of the Little Deschutes River where spotted frog monitoring has occurred. Another two parcels of lands administered by the City of La Pine have also been occasionally surveyed for spotted frogs.

The Service’s ability to monitor private lands along the Little Deschutes River is highly dependent upon our relationship with private landowners. We have had a long standing relationship with the owners of Crosswater Golf Course through a partnership with the Sunriver
Nature Center and Observatory. Breeding counts have been conducted on private property within Crosswater development since the early 2000s, similar to those at Sunriver, described above. Table 28 represents a portion of those breeding counts and those within other sites along the Little Deschutes River. The USGS has conducted most of the breeding counts within the Little Deschutes River system over the years.

Without thorough breeding surveys and other more rigorous population monitoring, it is difficult to assess the status of spotted frogs within the Little Deschutes River sub-basin. Therefore, in addition to breeding counts, continued habitat and threats assessment work is needed at all spotted frog sites.

Table 28. Breeding counts along the Little Deschutes River below Crescent Creek confluence.

<table>
<thead>
<tr>
<th>Breeding site</th>
<th>Egg mass counts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Middle Little Deschutes complex 1 (Private)</td>
<td></td>
</tr>
<tr>
<td>Middle Little Deschutes complex 2 (Private)</td>
<td></td>
</tr>
<tr>
<td>Leona Park (City of La Pine)</td>
<td></td>
</tr>
<tr>
<td>Oxbows behind La Pine High School (BLM/Private)</td>
<td>5</td>
</tr>
<tr>
<td>Rosland Park (City of La Pine)</td>
<td></td>
</tr>
<tr>
<td>Riverside oxbow (private)</td>
<td></td>
</tr>
<tr>
<td>Casey Tract</td>
<td></td>
</tr>
<tr>
<td>Thousand Trails (private)</td>
<td></td>
</tr>
<tr>
<td>Crosswater (private)</td>
<td>197</td>
</tr>
</tbody>
</table>

Spotted frog habitat is abundant along the Little Deschutes River system within riverine oxbows and sloughs. Figure 72 depicts the abundance of oxbow habitat in an aerial flight conducted on April 21, 2017 with flows at the LAPO gauge of 469 cfs. As described earlier, the Little Deschutes River is characterized as shallow gradient with a broad floodplain consisting of emergent vegetation and willows (*Salix* spp.), with mature lodgepole pine (*Pinus contorta*) on the surrounding uplands. The inherent geology results in a high water table (UDWC 2002). Beaver are active within the Little Deschutes River system and maintain inundated oxbows in many areas that enhance the suitability of these areas for Oregon spotted frogs. In addition to the natural habitats, Oregon spotted frog breeding sites also occur within man-made ponds on private lands (i.e., Crosswater and Thousand Trails) near Sunriver, OR.
5.2.3 Influence of Water Management on Little Deschutes River Spotted Frog Habitat

Average monthly fall, winter, and spring flows at the La Pine gauge (LAPO) are slightly lower compared to flows in an unregulated condition (Figure 63 above) due to water being held in Crescent Lake during the storage season (Oct – May). The fall ramp down may reduce inundation of wetlands between September and October at which point frogs may be vulnerable to predation. Frogs must either move to overwintering locations or remain in residual pools of water after ramp down.

We assume that spotted frogs overwinter in oxbows and ponds that hold water through winter. Given that the Little Deschutes River flows have been reduced by storage, the frogs are likely to be using the river, as well. Utilization of the river for wintering increases the risk of predation on spotted frogs by brown trout, which are abundant in the Little Deschutes River.
Sites on the Little Deschutes River, located downstream of the Crescent Creek confluence, do not typically experience low water during spring breeding season due to water being held in Crescent Lake until July because spring rains in the upper Little Deschutes system contribute significant flows to the system. The difference between the unregulated and regulated average monthly flows at the LAPO gauge is relatively small during the spring breeding period (March – April) (Figure 63). Egg mass stranding has been observed at sites along the Little Deschutes River during the spring. However, the stranding at times is due to natural flood events (i.e., rain on snow or snowmelt from the Upper Little Deschutes watershed) that vastly inundate the floodplain and spotted frogs are forced to seek shallow areas on the floodplain to deposit eggs. The duration of flood water on the floodplain is often short-lived and egg masses or hatching tadpoles can strand at these shallow deposition sites. In cases where oxbows are deep enough to intersect the water table or base elevations of the adjacent river, then egg masses can develop and metamorphose.

Summer irrigation flows vastly increase the volume of water in the river channel and within some wetlands and oxbows along the Little Deschutes River. In the unregulated condition, average monthly flows at the La Pine gauge (LAPO) were 50 cfs and below in July, August, and September. Average monthly flows within the regulated system are now between 100 and 150 cfs during summer months (Figure 63). In addition to storage and release of water from Crescent Lake, a large irrigation ditch (Walker Basin Canal) pulls water (~28 cfs) from the Little Deschutes downstream of the confluences with Crescent Creek and supplies irrigation water to Long Prairie. Irrigation water supplied via this canal is not within the action area.

Habitat monitoring is necessary to further elucidate the change in wetland conditions related to storage and release of water from Crescent Dam. To date, we do not have sufficient hydrological monitoring of spotted frog sites on the Little Deschutes River system.

5.2.4 Other Threats

Despite an abundance of habitat for spotted frogs in the Little Deschutes River system, there are prevalent threats in addition to the water management. Bull frogs and reed canarygrass appear to be increasing in abundance. Our assessment of these threats is currently only qualitative. During the ESA listing process in 2014, we identified where each of these threats were present within the 23 spotted frog breeding locations in the Little Deschutes River sub-basin (Threats Matrix).

The ESA listing identified bull frogs as a high threat to Oregon spotted frogs based on their presence at 8 of 23 (35 %) sites assessed. Currently, bull frogs are not present within spotted frogs breeding sites above river mile 35 on the Little Deschutes River. We assume that higher elevation sites maintain cool water temperatures that are not suitable for bull frogs.

Only 13 of the 23 spotted frog breeding sites were surveyed for reed canarygrass at the time of the ESA Listing. The invasive grass was observed at 8 of 13 spotted frog sites surveyed. Additional survey work is needed to assess the condition of spotted frog sites and the presence of reed canarygrass and bull frogs within spotted frog breeding sites on the Little Deschutes River. Treatment of these invasive species will be necessary to maintain suitable habitat for Oregon spotted frogs over time.
5.3 Conservation Role of the Action Area for Spotted Frogs

The Action Area encompasses a large portion of the range of the Oregon spotted frog and contains a significant portion of the known population and a significant portion of remaining habitat for this species.

The Action Area covers about 65 percent of the Upper Deschutes and Little Deschutes river sub-basins, which collectively encompass about 35 percent of the current range of the Oregon spotted frog. At the time of listing in 2014 (79 FR 51658), the Service attempted to quantify the number of breeding adults within each occupied sub-basin range-wide to provide some relative abundance information on the species. In the Final Rule, the minimum number of breeding adult spotted frogs that were enumerated within the Upper Deschutes and Little Deschutes river sub-basins accounted for about 50 percent of those enumerated within the range of the species, highlighting the importance of these two sub-basins for the conservation of the Oregon spotted frog with respect to its numbers and distribution.

The Oregon spotted frog is broadly distributed within the Action Area. However, the known numbers of individual spotted frogs in the Action Area are lower than those in portions of these sub-basins that are not affected by irrigation water storage and release operations associated with the Proposed Action. For example, Big Marsh, which is not within Action Area and is not affected by water storage and release operations, represents about 80 percent of the estimated minimum breeding adult population of the Oregon spotted frog within the Little Deschutes River sub-basin.

Habitat loss, degradation, and fragmentation threaten the continued existence of the Oregon spotted frog (79 FR 51658). The Action Area provides an abundance of habitat that is essential to ensuring a persistent spotted frog population in this portion of its range. Based on the principles of conservation biology (Groom et al. 2006), the Service concludes that maintaining and increasing population viability and expanding spotted frog distribution within the Action Area are essential to the recovery of the species.

Past and present irrigation water storage and release operations within the Action Area have degraded the condition of the Oregon spotted frog population by significantly altering habitat conditions to an extent that is causing incidental take of the species. Apart from the Proposed Action, which is short-term in duration, these operations are otherwise a non-Federal action. In accordance with the requirements of the ESA, the Districts are currently developing a HCP to address ongoing and future anticipated incidental take of the spotted frog caused by these operations. Given the range-wide significance of the Action Area, such a plan is vital to ensuring the persistence of the Oregon spotted frog in the Action Area and the continued existence of this species range-wide.

5.4 Status of Oregon Spotted Frog Critical Habitat

The Deschutes Project occurs within critical habitat units (CHU) 8 (Upper Deschutes River) and 9 (Little Deschutes River) of Oregon spotted frog critical habitat (Table 29). These CHUs
combined encompass approximately 35,065 acres of critical habitat for the Oregon spotted frog and represent 54 percent of the range-wide acreage of designated critical habitat (65,038 acres). Of these 35,065 acres, approximately 22,688 acres of critical habitat (35 percent of critical habitat acreage range-wide) are within the geographic area influenced by the Deschutes Project (Figure 73), including private irrigation district actions that store and release water for irrigation.

Figure 73. Oregon spotted frog critical habitat in the Upper Deschutes and Little Deschutes River CHUs likely to be affected by the Deschutes Project (in red) compared to unaffected critical habitat.

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6 Critical habitat acres and percentages of critical habitat do not include the approximately 30 miles of Oregon spotted frog critical habitat designated in Washington State.
Table 29. Oregon spotted frog critical habitat by unit and subunit within and outside of the area affected by the Deschutes Project.

<table>
<thead>
<tr>
<th>CH Unit</th>
<th>CH Subunit</th>
<th>CH Acres</th>
<th>Affected Acres</th>
<th>Percent (%) Affected</th>
<th>Unaffected Acres</th>
<th>Percent (%) Unaffected</th>
</tr>
</thead>
<tbody>
<tr>
<td>8. Upper Deschutes River</td>
<td>8A – Below Wickiup Dam</td>
<td>2,001</td>
<td>1,960</td>
<td>98</td>
<td>41</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>8B – Above Wickiup Dam</td>
<td>22,031</td>
<td>15,365</td>
<td>70</td>
<td>6,666</td>
<td>30</td>
</tr>
<tr>
<td></td>
<td>Upper Deschutes River Total</td>
<td>24,032</td>
<td>17,325</td>
<td>72</td>
<td>6,707</td>
<td>30</td>
</tr>
<tr>
<td>9. Little Deschutes River</td>
<td></td>
<td>11,033</td>
<td>5,362</td>
<td>49</td>
<td>5,671</td>
<td>51</td>
</tr>
</tbody>
</table>

The terminology adopted by National Wetland Inventory (NWI; Cowardin et al. 1979) was used to describe the wetland habitat types within delineated critical habitat in ArcGIS and to estimate acreages of habitat types included in the description of each CHU below. The wetland habitat types include freshwater emergent wetland, freshwater forested/shrub wetland, freshwater pond, lake, and riverine (Cowardin et al. 1979).

5.4.1 Critical Habitat Unit 8: Upper Deschutes River

This unit includes 24,032 ac (9,726 ha) located in Deschutes and Klamath counties, Oregon, in the Upper Deschutes River sub-basin. The Upper Deschutes River unit extends from headwater streams and wetlands draining to Crane Prairie and Wickiup reservoirs and to the main stem of the Deschutes River downstream to Bend, Oregon. This unit also includes Odell Creek and Davis Lake. Approximately 23,213 ac (9,394 ha) of CHU 8 are managed by the USFS Deschutes National Forest. A subset of the acreage managed by the Deschutes National Forest within Wickiup and Crane Prairie reservoirs is managed by the Districts in close coordination with the BOR.

The Upper Deschutes River CHU consists of two subunits: Below Wickiup Dam (Subunit 8A) and Above Wickiup Dam (Subunit 8B). These subunits are affected differently by the operation of the Deschutes Project. The description of each subunit and ongoing impacts to critical habitat by land management activities are described below for each subunit.

5.4.1.1 Critical Habitat Subunit 8A

Subunit 8A includes 2,001 ac (810 ha) of the Deschutes River and associated wetlands downstream of Wickiup Dam to Bend, Oregon, beginning at the outlet of an unnamed tributary draining Dilman Meadow. Approximately 875 acres of critical habitat (44 percent of subunit 8A) are within the Deschutes River corridor between river mile 167.5 and 228. The acres of critical habitat within this subunit affected by the operation of the Deschutes Project are 1,960 ac (793 ha), consisting of 468 ac (189 ha) of freshwater emergent wetland, 507 ac (205 ha) of freshwater forested/shrub wetland, 74 ac (30 ha) of freshwater pond, 37 ac (15 ha) of lake, and 875 ac (354 ha) of riverine habitat. The acres of critical habitat not affected within this subunit...
include 41 ac (17 ha) consisting of 37 ac (15 ha) of freshwater emergent wetland and 4 ac (2 ha) of freshwater forested/shrub wetland.

Within subunit 8A, approximately 1,182 ac (479 ha) are managed by the USFS Deschutes National Forest, 185 ac (75 ha) are managed by Oregon Parks and Recreation Department, 45 ac (18 ha) are managed by Deschutes County, and 589 ac (238 ha) are privately owned. Some private lands within Sunriver and at the Old Mill are excluded from critical habitat and the Service is actively working with these private landowners on conservation actions for spotted frogs. The entirety of subunit 8A is affected by the storage and release of water from Wickiup Dam by the Districts.

All of the following essential physical or biological features of spotted frog critical within this subunit are currently being impacted by hydrologic modification of river flows, reed canary grass, nonnative predaceous fish, and bullfrogs. The functional capability of critical habitat subunit 8A to support recovery of the Oregon spotted frog has been degraded or reduced by the storage and release of water caused by the Deschutes Project. Specific details regarding the condition of the PCEs within CHU 8A are provided in the “Historical and current condition of the Deschutes River below Wickiup Dam” section of the Environmental Baseline for the Oregon spotted frog.

Nonbreeding, breeding, rearing, and overwintering habitat (PCE 1) – Table 30 displays the habitat characteristics that define PCE1. Within this subunit, PCE 1 is degraded and breeding and overwintering habitats are adversely affected by the storage of water from October to April of each year caused by the Deschutes Project. Spotted frog breeding habitat is generally limited to a subset of critical habitat acres that hold water through the winter. A precise acreage of the habitat that remains during the storage season is not available. However, the Service has conducted aerial flights periodically and during different seasons to quantify the amount of critical habitat that is reduced by storage operations under the Deschutes Project.

Table 30. PCE 1 habitat characteristics for spotted frog nonbreeding, breeding, rearing, and overwintering habitat (81 FR 29335-29396).

<table>
<thead>
<tr>
<th>Habitat Type</th>
<th>Habitat Characteristics</th>
</tr>
</thead>
</table>
| Nonbreeding        | ● Total surface area with less than 50 percent vegetative cover  
|                    | ● An absence or low density of nonnative predators           |
| Breeding and Rearing | ● Inundated for a minimum of 4 months per year              
|                    | ● If ephemeral, areas are hydrologically connected by surface water flow to a permanent water body |
|                    | ● Shallow-water areas, less than or equal to 12 inches (30 cm), or water of this depth over vegetation in deeper water |
|                    | ● Herbaceous wetland vegetation (i.e., emergent, submergent, and floating-leaved aquatic plants), or vegetation that can structurally mimic emergent wetland vegetation through manipulation |
|                    | ● Shallow-water areas with high solar exposure or low (short) canopy cover |
|                    | ● An absence or low density of nonnative predators           |
| Overwintering      | ● Inundated from October through March                      |
A thorough description of habitat conditions within the action area is provided in the “Historical and current condition of the Deschutes River below Wickiup Dam” section above. In summary, flow releases from Wickiup Dam in early April have the potential to improve the condition of PCE 1 (i.e., breeding habitat) but the flows are often not sufficient to improve breeding conditions (i.e., to provide for shallow water areas in contact with emergent vegetation). Rearing habitats (PCE 1) can be improved when flow releases are above thresholds identified in Table 30. However, when the timing of flow releases are too late (i.e., weeks after the hatching of spotted frog eggs occurs), emerging tadpoles are not likely to be within emergent vegetation and are at a high risk of predation. Overwintering habitat (PCE 1) is limited to those wetlands that hold water throughout the winter that does not freeze solid. Many wetlands dry up or have greatly reduced water levels during the storage season when flows released from Wickiup Dam are as low as 20 cfs.

Aquatic movement corridors (PCE 2) – Habitat characteristics associated with PCE 2 include being less than or equal to 3.1 mi (5 km) linear distance from breeding areas and impediment-free relative to frog movement, including, but not limited to, hard barriers such as dams, impassable culverts, lack of water, or biological barriers such as abundant predators, or lack of spotted frog refugia from predators (81 FR 29335-29396). PCE 2 of critical habitat in Subunit 8A is degraded. The Deschutes River flows that convey water to wetlands that provide for adequate function of PCE 1 (breeding, rearing, overwintering, and nonbreeding habitat) are significantly reduced during the water storage season by the Deschutes Project. Landscape-level aquatic movement and within-site aquatic movement habitats for Oregon spotted frogs are limited for over six months of the year, every year, by the Deschutes Project. High summer flows may improve the connectivity within and between wetland habitats associated with the Deschutes River. However, under the Deschutes Project, the rapid change in flows that affects inundation of wetlands and the river corridor also adversely affect the function of PCE 2.

Refugia habitat (PCE 3) – Oregon spotted frog refugia habitat includes nonbreeding, breeding, rearing, or overwintering habitat or aquatic movement corridors with habitat characteristics that provide spotted frogs with refugia from predators (81 FR 29335-29396). Similar to PCEs 1 and 2, PCE 3 is degraded within Subunit 8A. During the water storage season of the Deschutes Project, refugia habitat is extensively reduced within critical habitat in this subunit. Spotted frog habitat that is available through the winter is limited to the Deschutes River and adjacent wetlands that either have springs or perched water that is sustained through the winter. Predators, such as the brown trout, occur within the Deschutes River and in areas where the only remaining spotted frog overwintering habitat is within the river, so there is little to no refugia habitat for spotted frogs to avoid exposure to predaceous fish.

Special management is necessary to improve existing spotted frog nonbreeding, breeding, rearing, and overwintering habitat, aquatic movement corridors, and refugia habitat in this subunit. In its current condition, the adverse effects to PCEs within subunit 8A due to the Deschutes Project, as described above, are ongoing and the capability of this subunit to properly function in support of spotted frog recovery is impaired.
5.4.1.2 Critical Habitat Subunit 8B

Subunit 8B includes 22,031 ac (8,916 ha) of land under USFS ownership. This subunit includes the following lakes, including associated wetlands, in the upper watersheds that flow into the Crane Prairie/Wickiup Reservoir system: Hosmer Lake, Lava Lake, Little Lava Lake, Winoopee Lake, Muskrat Lake, and Little Cultus Lake, Crane Prairie and Wickiup reservoirs, and Davis Lake. The following riverine waterbodies and associated wetlands are designated as critical habitat: the Deschutes River from Lava Lake to Wickiup Reservoir, Cultus Creek downstream of Cultus Lake, Deer Creek downstream of Little Cultus Lake, and Odell Creek from a spotted frog-occupied unnamed tributary to the outlet in Davis Lake. Approximately 15,213 acres of critical habitat in subunit 8B are within Crane Prairie and Wickiup reservoirs which are under USFS ownership but managed by the irrigation districts in close coordination with the BOR.

All of the essential physical or biological features of critical habitat in subunit 8B are currently being impacted by the storage and release of water for irrigation by the Deschutes Project, vegetation succession, nonnative predaceous fish, and reed canary grass within and between the reservoirs in this unit.

The area affected by Deschutes Project operations in the reservoirs and in the Deschutes River and associated wetlands between the reservoirs includes approximately 15,365 acres (6,218 ha) of critical habitat (70 percent of subunit 8B). Wetland habitat types within these acres include approximately: 3,029 ac (1,226 ha) of freshwater emergent wetland, 809 ac (327 ha) of freshwater forested/shrub wetland, 3 ac (1 ha) of freshwater pond, 11,514 ac (4,660 ha) of lake, and 11 ac (4 ha) of riverine habitat.

Crane Prairie Reservoir encompasses about 4,982 acres of Oregon spotted frog critical habitat. Within the large reservoir acreage, there are approximately 629 acres of emergent wetland habitat that are important physical and biological features of the critical habitat within the reservoir. Wickiup Reservoir encompasses approximately 10,231 acres of critical habitat. There are approximately 2,376 acres of emergent wetland habitat that are important physical and biological features of the critical habitat within the reservoir. The surface area inundated by the reservoirs fluctuates with storage and release of irrigation water; those fluctuations strongly influence the condition and recovery support function of PCEs 1, 2 and 3 within this subunit.

There are approximately 6,666 ac (2,698 ha) acres of spotted frog critical habitat that are not affected by the Deschutes Project or other anthropogenic activities within this unit: 1,180 ac (477 ha) of freshwater emergent wetland, 392 ac (159 ha) of freshwater forested/shrub wetland, 39 ac (16 ha) of freshwater pond, 4,959 ac (2,007 ha) of lake, and 96 ac (39 ha) of riverine habitat.

The capability of this subunit to function in support of spotted frog recovery has been reduced by the storage and release of water by the Deschutes Project, which causes significant fluctuations in reservoir levels during frog breeding and rearing periods. Specific details regarding the condition of the critical habitat within CHU 8B are provided in the “Oregon spotted frog sites above Wickiup Dam” section of the Environmental Baseline section for the spotted frog presented below.
Nonbreeding, breeding, rearing, and overwintering habitat (PCE 1) – Table 30 displays the habitat characteristics that define PCE 1. Crane Prairie and Wickiup reservoirs provide important spotted frog breeding, rearing, and overwintering habitat within critical habitat subunit 8B. However, these habitats change seasonally and spatially due to storage and release operations of the Deschutes Project. For example, breeding habitats within the reservoirs shift depending on water elevations in the spring; ideally, spotted frog breeding areas should be located in less than 12 inches of water within emergent vegetation.

The current system of reservoir management under the Deschutes Project results in significant fluctuations in water levels within the reservoirs. For that reason, PCE 1-related frog habitats within this subunit are currently sub-optimal for spotted frogs. Water levels may be high during the spring breeding season and suitable breeding habitats may not be present within the reservoirs. As described above, Crane Prairie Reservoir volumes that exceed 50,000 acre-feet result in suboptimal spotted frog breeding habitat due to shallow water areas extending into upland vegetation rather than into emergent vegetation that is inundated at these volumes.

Under the Deschutes Project, increasing water levels during the storage season (November to March) provides spotted frog overwintering habitat within the reservoirs. However, in instances when storage volumes are so low that water levels are below emergent vegetation, the habitat available to spotted frogs for overwintering may lack adequate cover for spotted frogs to successfully survive the winter. Under the Deschutes Project, water levels in Wickiup Reservoir, in particular, fluctuate abruptly and extensively resulting in lower quality PCE 1 habitats for all life stages of the spotted frog.

Aquatic movement corridors (PCE 2) – As described above, habitat characteristics associated with PCE 2 include being less than or equal to a 3.1-mi (5 km) linear distance from spotted frog breeding areas and free of impediments to movement. The reservoirs provide an aquatic connection for the species within the larger subunit, allowing for dispersal of juveniles and adults between populations of Oregon spotted frogs. PCE 2 of critical habitat in Subunit 8B is degraded. The extensive reduction in water levels, particularly in Wickiup Reservoir, in the fall decreases connectivity with wetlands along the margins of the reservoirs. Landscape- level aquatic movement by spotted frogs and within-site aquatic movement habitats for spotted frogs are limited in the fall every year due to the extensive reduction in water levels caused by the Deschutes Project.

Refugia habitat (PCE 3) – Spotted frog refugia habitat includes habitat for all life stages or aquatic movement corridors with habitat characteristics that provide refugia for spotted frogs from predators. Similar to PCEs 1 and 2, PCE 3 is degraded within Subunit 8B. Both reservoirs and the Deschutes River between the reservoirs contain populations of nonnative predaceous fish, so there is little to no refugia for spotted frogs from predaceous fish, particularly when the surface area (acreage) of inundation is reduced as reservoir water levels are lowered at the end of the irrigation season.

The physical or biological features that are essential to the conservation of Oregon spotted frog
within the reservoirs require special management considerations or protections to ensure that wetland habitats that support the life history requirements of the frog are subject to sufficient water levels from the breeding period through metamorphosis and are connected to overwintering habitat. Some of these areas within the reservoir may require the restoration and improvement of habitat features. Water releases from Wickiup Dam should be timed to coincide with the spotted frog breeding period and winter flow releases should improve overwintering conditions for Oregon spotted frogs that utilize the Deschutes River and adjacent wetlands in this subunit. Regardless, improving PCEs within the reservoirs could negatively affect critical habitat in subunit 8A, downstream of Wickiup Dam, and releasing flows to improve critical in subunit 8A could negatively affect critical habitat in subunit 8B. Therefore, the entire CHU 8 must be considered when implementing actions that are designed to improve the function of critical habitat in support of spotted frog recovery.

5.4.2 Critical Habitat Unit 9: Little Deschutes River

The Little Deschutes River unit encompasses 11,033 ac (4,465 ha) in Klamath and Deschutes counties, Oregon. The Little Deschutes River CHU includes the Little Deschutes River and associated wetlands from its headwaters to the confluence with the Deschutes River, 1 mi (1.6 km) south of Sunriver and approximately 20 mi (32.2 km) south of Bend, Oregon. This unit includes the following tributaries, including adjacent wetlands: Big Marsh Creek, Crescent Creek, and Long Prairie Creek.

Within this unit, currently 5,288 ac (2,140 ha) are managed by the USFS Deschutes National Forest and Prineville BLM, 14 ac (6 ha) are managed by the State of Oregon, 80 ac (32 ha) are managed by Deschutes and Klamath counties, and 5,651 ac (2,287 ha) are privately owned. Private lands within the Crosswater Golf Course and Resort are excluded from the critical habitat designation (81 FR 29366 - 29368). The essential physical or biological features found in this CHU are impacted by storage and release of water from Crescent Lake, irrigation withdrawals, nonnative predaceous fish, reed canary grass, and bullfrogs (81 FR 29335-29396). Specific details regarding the condition of spotted frog critical habitat in this CHU are provided in section 6.2.2 of this document:” Little Deschutes River sub-basin spotted frog sites that are affected by the proposed action.”

The portion of CHU 9 that is affected by water management operations by the Tumalo Irrigation District (TID) includes the Little Deschutes River from its mouth upstream to its confluence with Crescent Creek and Crescent Creek from its mouth upstream to Crescent Lake Dam. A total of 5,363 ac (2,171 ha) of critical habitat within this CHU is affected by the Deschutes Project. These acres consists of 2,306 ac (933 ha) of freshwater emergent wetland, 2,790 ac (1,129 ha) of freshwater forested/shrub wetland, 13 ac (5 ha) of freshwater pond, 88 ac (36 ha) of wetlands not overlapping with NWI-classified wetlands, and 166 ac (67 ha) of riverine habitat. The critical habitat affected by the Deschutes Project largely consists of wetlands associated with low-gradient meandering reaches of the Little Deschutes River and Crescent Creek which interact extensively with their floodplains.

The portion of the CHU not likely to be affected by the ongoing operations of the Deschutes Project and the proposed action includes the Little Deschutes River upstream of its confluence.
with Crescent Creek, Big Marsh Creek, and Long Prairie Creek for a total of 5,670 ac (2,294 ha). The acres that are not affected by TID water management operations include approximately: 2,442 ac (988 ha) of freshwater emergent wetland, 3,052 ac (1,235 ha) of freshwater forested/shrub wetland, 7 ac (3 ha) of freshwater pond, 62 ac (25 ha) of wetlands not overlapping with NWI wetlands, and 73 ac (30 ha) of riverine habitat.

Nonbreeding, breeding, rearing, and overwintering habitat (PCE 1) – Table 30 displays the habitat characteristics that define PCE 1. In CHU 9, PCE 1 is degraded due to the storage and release of water from Crescent Lake dam. Much of the critical habitat that is currently being affected by the Deschutes Project is privately owned and many “lots and subdivisions are in sensitive areas near the Little Deschutes River, impacting riparian and wetland habitats that are important for fish and wildlife habitat” (Upper Deschutes Watershed Council 2002). The Upper Deschutes Watershed Council (2002) also documented that the Little Deschutes River from river mile 0 to river mile 63 has an altered flow regime, high water temperatures, and degraded riparian conditions.

Aquatic movement corridors (PCE 2) – Habitat characteristics associated with PCE 2 include being less than or equal to a 3.1-mi (5 km) linear distance from spotted frog breeding areas and free of movement impediments (81 FR 29335-29396). PCE 2 in CHU 9 is degraded because Crescent Creek and Little Deschutes River flows are altered by the storage and release of water from Crescent Lake under the Deschutes Project.

Refugia habitat (PCE 3) – Refugia habitat includes spotted frog nonbreeding, breeding, rearing, or overwintering habitat or aquatic movement corridors with habitat characteristics that provide protection from predators (81 FR 29335-29396). Similar to PCEs 1 and 2, PCE 3 is degraded within CHU 9. During the water storage season, spotted frog refugia habitat is reduced within the critical habitat. Brown trout, which prey on spotted frogs, are present in the Little Deschutes River and at least the lower portion of Crescent Creek below Highway 61, so there is little to no refugia habitat for spotted frogs to use to avoid exposure to predaceous fish.

5.5 Conservation Role of the Action Area for Spotted Frog Critical Habitat

The intended conservation role of critical habitat in the Action Area for the recovery of the Oregon spotted frog is to provide sufficient levels of the following habitats to support a resilient and persistent population of the species in this portion of its range: (1) spotted frog non-breeding, breeding, rearing, and overwintering habitat; (2) aquatic habitat to facilitate unimpeded movements of the frog; and (3) refugia habitat for protection against predatory fish.

The Upper Deschutes River and Little Deschutes River sub-basins encompassed by CHUs 8 and 9 contain approximately 35,065 acres of critical habitat, representing 54 percent of the 65,038 acres of critical habitat designated range-wide. The Action Area encompasses approximately 22,688 acres of critical habitat within these two CHUs, and represents 35 percent of the critical habitat designated range-wide. The conservation function of critical habitat within the action area has been significantly altered due to past and ongoing water management associated with the Deschutes Project and other threats. Given the large extent of designated critical habitat in the Action Area, it is expected to play a significant role in the conservation/recovery of the
species. Improving the conservation function of critical habitat in the Action Area is essential to meeting the recovery needs of the Oregon spotted frog.

5.6 Climate Change

Our analyses under the Endangered Species Act include consideration of ongoing and projected changes in climate. The terms “climate” and “climate change” are defined by the Intergovernmental Panel on Climate Change (IPCC). The term “climate” refers to the mean and variability of different types of weather conditions over time, with 30 years being a typical period for such measurements, although shorter or longer periods also may be used (IPCC 2007a, p. 78). The term “climate change” thus refers to a change in the mean or variability of one or more measures of climate (e.g., temperature or precipitation) that persists for an extended period, typically decades or longer, whether the change is due to natural variability, human activity, or both (IPCC 2007a, p. 78).

Global climate projections are informative, and, in some cases, the only or the best scientific information available for us to use. However, projected changes in climate and related impacts can vary substantially across and within different regions of the world (e.g., IPCC 2007a, pp. 8–12). Therefore, we use “downscaled” projections when they are available and have been developed through appropriate scientific procedures, because such projections provide higher resolution information that is more relevant to spatial scales used for analyses of a given species (see Glick et al. 2011, pp. 58–61, for a discussion of downscaling). With regard to our analysis for the Oregon spotted frog, downscaled projections are available.

The climate in the Pacific Northwest (PNW) has already experienced a warming of 0.8 degrees Celsius (C) (1.4 degrees Fahrenheit (F)) during the 20th century (Mote et al. 2008, p.3). Using output from eight climate models the PNW is projected to warm further by 0.6 to 1.9 degrees C (1.1 to 3.4 degrees F) by the 2020s, and 0.9 to 2.9 degrees C (1.6 to 5.2 degrees F) by the 2040s (Mote et al. 2008, pp. 5–6). Additionally, the majority of models project wetter winters and drier summers (Mote et al. 2008, p.7), and of greatest consequence, a reduction in regional snowpack, which supplies water for ecosystems during the dry summer (Mote et al. 2003). The small summertime precipitation increases projected by a minority of models do not change the fundamentally dry summers of the PNW and do not lessen the increased drying of the soil column brought by higher temperatures (Mote et al. 2003, p. 8).

Snowmelt-dominated watersheds, such as White Salmon in Washington and the Upper Deschutes, Little Deschutes, and Klamath River sub-basins in Oregon, will likely become transient, resulting in reduced peak spring streamflow, increased winter streamflow, and reduced late summer flow (Littell et al. 2009, p. 8). In snowmelt-dominated watersheds that prevail in the higher altitude catchments and in much of the interior Columbia Basin, flood risk will likely decrease and summer low flows will decrease in most rivers under most scenarios (Littell et al. 2009, p. 13).

Climate change models predict that water temperatures will rise throughout Oregon as air temperatures increase into the 21st century. A decline in summer stream flow may exacerbate water temperature increases as the lower volume of water absorbs solar radiation (Chang and
Analyses of the hydrologic responses of the upper Deschutes basin (including the Upper and Little Deschutes River sub-basins) and the Klamath Basin to climate change scenarios indicates that the form of precipitation will shift from predominately snow to rain and cause decreasing spring recharge and runoff and increasing winter recharge and runoff (Waibel 2011, pp., 57–60; Mayer and Naman 2011, p. 3). However, there is spatial variation within the Deschutes sub-basins as to where the greatest increases in recharge and runoff will occur (Waibel 2011, pp., 57–60). Changes in seasonality of stream flows may be less affected by climate change along the crest of the Cascades in the upper watersheds of the Deschutes, Klamath, and Willamette River basins in Oregon, where many rivers receive groundwater recharge from subterranean aquifers and springs (Chang and Jones 2010, p. 107). Summer stream flows may thus be sustained in High Cascade basins that are groundwater fed (Chang and Jones 2010, p. 134). Conversely, Mayer and Naman (2011 p. 1) indicate that streamflow into Upper Klamath Lake will display absolute decreases in July-September base flows in groundwater basins as compared to surface-dominated basins. This earlier discharge of water in the spring will result in less streamflow in the summer (Mayer and Naman 2011, p. 12).

Although predictions of climate change impacts do not specifically address Oregon spotted frogs, short- and long-term changes in precipitation patterns and temperature regimes will likely affect wet periods, winter snow pack, and flooding events (Chang and Jones 2010). These changes are likely to affect amphibians through a variety of direct and indirect pathways, such as range shifts, breeding success, survival, dispersal, breeding phenology, aquatic habitats availability and quality, food webs, competition, spread of diseases, and the interplay among these factors (Blaustein et al. 2010 entire; Hixon et al. 2010, p. 274; Corn 2003 entire). Amphibians have species-specific temperature tolerances, and exceeding these thermal thresholds is expected to reduce survival (Blaustein et al. 2010, pp. 286–287). Earlier spring thaws and warmer ambient temperatures may result in earlier breeding, especially at lower elevations in the mountains where breeding phenology is driven more by snow pack than by air temperature (Corn 2003, p. 624). Shifts in breeding phenology may also result in sharing breeding habitat with species not previously encountered and/or new competitive interactions and predator/prey dynamics (Blaustein et al. 2010. pp. 288, 294). Oregon spotted frogs are highly aquatic and reductions in summer flows may result in summer habitat going dry, potentially resulting in increased mortality or forcing frogs to seek shelter in lower quality wetted areas where they are more susceptible to predation.

Amphibians are susceptible to many types of pathogens including trematodes, copepods, fungi, oomycetes, bacteria, and viruses. Changes in temperature and precipitation could alter host-pathogen interactions and/or result in range shifts resulting in either beneficial or detrimental impacts on the amphibian host (Blaustein et al. 2010, p. 296). Kiesecker et al. (2001a, p. 682) indicate climate change events, such as El Nino/Southern Oscillation, that result in less precipitation and reduced water depths at egg-laying sites results in high mortality of embryos because their exposure to UV-B and vulnerability to infection (such as Saprolegnia) is increased. Warmer temperatures and less freezing in areas occupied by bullfrogs is likely to increase bullfrog winter survivorship, thereby increasing the threat from predation. Uncertainty about climate change impacts does not mean that impacts may or may not occur; it means that the risks
of a given impact are difficult to quantify (Schneider and Kuntz-Duriseti 2002, p. 54; Congressional Budget Office 2005, entire; Halsnaes et al. 2007, p. 129). Oregon spotted frogs occupy habitats at a wide range of elevations, and all of the occupied sub-basins are likely to experience precipitation regime shifts; therefore, the Oregon spotted frog’s response to climate change is likely to vary across the range and the population-level impacts are uncertain. The interplay between Oregon spotted frogs and their aquatic habitat will ultimately determine their population response to climate change. Despite the potential for future climate change throughout the range of the species, as discussed above, we have not identified, nor are we aware of any data on, an appropriate scale to evaluate habitat or population trends for the Oregon spotted frog or to make predictions about future trends and whether the species will be significantly impacted.

6.0 EFFECTS OF THE ACTION: OREGON SPOTTED FROG AND OREGON SPOTTED FROG CRITICAL HABITAT

The following analysis evaluates the direct and indirect effects of the OSF Proposal on the Oregon spotted frog and its designated critical habitat. The action area is within the Upper Deschutes River basin which includes the Upper Deschutes River and Little Deschutes River subbasins. The effects analysis is organized by subbasin. The Upper Deschutes River subbasin is analyzed first and is followed by the analysis for the Little Deschutes River subbasin in each section below.

As described in the environmental baseline, the area affected by the OSF Proposal within the Upper Deschutes River subbasin includes Crane Prairie Reservoir, the Deschutes River between Crane Prairie and Wickiup reservoirs, Wickiup Reservoir, and the Deschutes River downstream of Wickiup Reservoir to the city of Bend, Oregon. The area affected by the OSF Proposal within the Little Deschutes River subbasin includes Crescent Creek downstream of Crescent Lake Dam to its confluence with the Little Deschutes River and the Little Deschutes River from its confluence with Crescent Creek downstream to its confluence with the Deschutes River. These areas are all within designated critical habitat. Given that the proposed action represents a minor change to water management, effects to spotted frogs and their critical habitat as described in the environmental baseline are anticipated to continue. The following analysis emphasizes effects that vary from those described in the environmental baseline. Effects of interrelated and interdependent activities are also evaluated herein.

6.1 The OSF Proposal

For the reasons discussed below, implementation of the OSF Proposal is likely to have adverse effects to the spotted frog and its critical habitat. These effects are likely to vary depending on geography. In some portions of the action area, implementation of the OSF Proposal is likely to have some beneficial effects to the spotted frog and its critical habitat compared to current, pre-OSF Proposal operations, by improving its habitat during important life stages. However, in other portions of the action area, water management operations as per the OSF Proposal is likely to maintain current, degraded habitat conditions caused by ongoing irrigation management operations. The timing of the change in operations may in fact be likely to further degrade the habitat suitability for spotted frogs at important life stages compared to pre-OSF Proposal
operations in some portions of the action area.

The objective of the OSF Proposal is to reduce impacts to the Oregon spotted frog and its habitat caused by ongoing operation and maintenance of Crane Prairie, Wickiup, and Crescent Lake reservoirs. The term of this action extends through July 31, 2019. We are working towards issuing the section 10(a)(1)(B) permit for the Deschutes Basin HCP, assuming the issuance criteria are met. The primary components of the OSF Proposal that are likely to affect the Oregon spotted frog and its critical habitat include changes in: storage at Crane Prairie Reservoir; minimum flow releases from Wickiup Reservoir; ramping rates at Wickiup Dam before and after the irrigation season; minimum flow releases from Crescent Lake Reservoir; and moderated flows released from Crescent Lake at the beginning and end of the irrigation season. In addition, Reclamation’s ROM and SEED programs are likely to adversely affect spotted frogs and their habitat.

6.1.1 Methods used to Analyze Effects

The complexity of analyzing the effects of changes in water management over a broad geography representing approximately 22,688 acres of designated critical habitat, requires the use of multiple analytical tools. In this analysis, four primary tools were used to analyze the effects likely to be caused by the OSF Proposal: (1) the hydrological monitoring results as described in the Environmental Baseline; (2) outputs of the RiverWare model; (3) 2017 Water Year hydrograph data; and (4) ArcGIS outputs. In addition, for those components of the OSF Proposal that are the same as implemented under pre-OSF Proposal operations, these effects are briefly discussed below with reference to the more detailed description in the Environmental Baseline section above.

As described in the Environmental Baseline, the Service and partners have been conducting hydrological monitoring to assess how changes in flows may impact spotted frogs and their critical habitat. This work has been extensive on the Deschutes River downstream of Wickiup Dam and on Crane Prairie Reservoir. Therefore, within these geographic areas our effects analysis may be more precise in determining flows and volumes of water that support conservation of spotted frogs and function of critical habitat, and more robust in the description of the effects likely to be caused by the OSF Proposal.

Although there has been hydrological evaluation on Crescent Creek pertaining to frog habitat, there is additional assessment work that is needed to better understand how these habitats may be affected by irrigation water management operations throughout the year. The Little Deschutes River downstream of the confluence with Crescent Creek also is lacking in baseline hydrological information at spotted frog sites. Therefore, our effects analysis is more general for that geographic area.

The RiverWare model provides a useful tool for assessing the future effects of the proposed action compared to the environmental baseline (i.e., current condition or pre OSF Proposal) across the expansive geography within the action area. This tool helps describe how changes in water management may affect the flows at river gauges. So, in the coarse analysis of the proposed action, the RiverWare model generated flows were relied upon in our effects analysis,
described below. Due to inherent rule sets in the model and natural variability between years, the modeled flows may not always represent what the actual flow is likely to be as the proposed action is implemented. Given that the Proposed Action (OSF Proposal) was implemented as per the Settlement Agreement starting in October 2016, the hydrograph for the 2017 Water Year was also used for our analysis because, in some cases, we have made on-the-ground observations during that time period that are useful in articulating effects to the species.

Finally, ArcGIS was used to calculate acres of area impacted by the OSF proposal. Each spotted frog breeding site within the Upper Deschutes and Little Deschutes River sub-basins, have been delineated using ArcGIS to create polygons. These polygons represent approximate locations used by spotted frogs for breeding and rearing. We have detected spotted frogs outside of these polygons in some locations during the summer when river flows are high and habitat is suitable, which are not represented in the polygons and the Tables and Figures cited above. Since these polygons are nested within the designated critical habitat polygons for the Upper and Little Deschutes River sub-basins (CHUs 8 and 9), we use acreages calculated in the Critical Habitat Effects section to further describe the acreages that are affected by the Proposed Action. Section 6.1.4.1 also includes an estimation of the wetlands that are likely to be affected by the proposed action by river reaches.

6.1.1.1 RiverWare-modeled Hydrology

To analyze effects to spotted frogs and spotted frog habitat due to implementation of the OSF Proposal, we compared RiverWare-modeled outputs for current conditions (Environmental Baseline) to outputs for the OSF Proposal. These comparisons were assessed temporally by spotted frog life stage within the geographic area affected. The effects analysis looks at four periods during the year that are particularly important to certain life stages, including: the overwintering period (October 16 – March 14); the breeding period (March 15 – April 30); the period providing tadpole rearing and habitat use by juveniles, subadults, and adults (April 17 – August 1); and the period leading up to overwintering (September 1 – October 15). In order for spotted frogs to successfully carry out their life cycle, particular habitat characteristics are necessary during each of these periods. For overwintering, spotted frogs need a body of water with at least a portion of the surface that remains ice free with sufficient depth to not freeze solid. For breeding, adults need a depth of 12 inches or less with emergent vegetation. For tadpole rearing and use by juveniles, subadults, and adults they require access to emergent vegetation that is inundated with water at variable depths for cover and foraging. For the period leading up to overwintering, it is important that spotted frog summer habitat is adequately connected to suitable overwintering habitat.

Effects occurring in Crane Prairie and Wickiup Reservoirs are analyzed based on water levels or storage volumes during these periods under the OSF Proposal. The elevation of the water surface in the reservoirs determines the extent and quality of spotted frog habitat available along the shoreline and in adjacent wetlands, correlating largely to degree of inundation.

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7 The majority of tadpole rearing occurs after April 15. However, Oregon spotted frogs have been observed breeding as early as March 15, so for analysis purposes April 1 was considered as the start of the tadpole rearing stage.
Effects occurring in the rivers downstream of the reservoirs were analyzed using modeled flow rates under the OSF Proposal. The CRAO modeled flows are used to assess the effects of the proposed action on spotted frogs and critical habitat adjacent to the Deschutes River between Crane Prairie and Wickiup Reservoirs. The WICO and BENO modeled flows were used to assess the effects of the proposed action on spotted frogs and critical habitat between Wickiup Dam and Bend, OR. The CREO and LAPO modeled flows were used to assess the effects of the proposed action on spotted frogs and critical habitat along Crescent Creek and the Little Deschutes downstream of the confluence with Crescent Creek.

In connecting the hydrological effects of the OSF Proposal to the effects on Oregon spotted frogs, it is helpful to understand the number of days during important time periods in the frog’s life cycle that flows are above certain levels, because flow levels play a significant role in determining the amount and quality of Oregon spotted frog habitat available in adjacent wetlands. Therefore, for each river reach analyzed, the narrative describes the median number of days that modeled OSF Proposal flows exceeded certain discharges temporally for water years over the period of record (1980-2009) to analyze effects to particular life stages as defined in the preceding paragraph, and compares them to the median number of days that modeled pre-OSF Proposal flows exceeded the same discharges for water years over the same period.

6.1.2 Effects in the Upper Deschutes River Sub-basin

6.1.2.1 Effects Above Wickiup Dam

Crane Prairie Reservoir

Crane Prairie Reservoir provides breeding, rearing, and overwintering habitat for Oregon spotted frogs. It also provides connectivity between upstream populations unaffected by the OSF Proposal and populations downstream that are affected by the proposed action. For the reasons discussed below, the OSF Proposal will likely have significant beneficial effects on all life stages of Oregon spotted frogs within Crane Prairie Reservoir compared to the pre-OSF operations.

The OSF Proposal limits reservoir storage volumes to between 35,000 and 50,000 acre-feet. Under the OSF Proposal, the Crane Prairie Reservoir water volume reaches at least 45,000 acre feet by March 15th and may increase to 50,000 acre feet between May 1 and May 15th. From May 15th to July 15th, Crane Prairie Reservoir will be operated to minimize fluctuations in water depth. No stored water will be released from the reservoir prior to July 15th. From July 16th to July 31st, storage in excess of 35,000 acre-feet will be released at a rate that would result in a drop in reservoir elevation of no more than 0.05 feet per day.

During overwintering, the pre-OSF Proposal operations (i.e., period of 1980 to 2009) resulted in reservoir volumes that dropped to just below 30K acre feet of storage in late September and October but gradually increased to approximately 40K acre feet by January. During 2016 operations (WY 2016), reservoir volumes dropped to below 30K acre feet and remained low until mid-January (Figure 1). During 2016 operations, we observed a low breeding count and no spotted frogs in the spring following the low reservoir conditions and we determined that the low
reservoir volumes resulted in frog mortality. Implementation of the OSF Proposal will maintain reservoir volumes in excess of 35k acre feet to reduce mortality to spotted frogs resulting from low reservoir volumes. Reservoir operations in WY 2017 maintained reservoir volumes above 35k acre feet and the 2017 spring breeding counts at Crane Prairie were the largest on record. The high breeding count and observations of suitable habitat in the spring of 2017 indicate that there is likely to be a conservation benefit to Oregon spotted frogs at Crane Prairie through the maintenance of higher reservoir volumes during the winter. Continued monitoring will be necessary to evaluate the effectiveness of this spotted frog conservation measure.

![RiverWare modeled reservoir volumes](image)

Figure 74. RiverWare modeled reservoir volumes at Crane Prairie representing “current condition” and the proposed action, including WY 2017 (Oct 1 2016 up to June 5, 2017) representing actual implementation of the OSF proposal and WY 2016 (October 1, 2015 to Sept 30, 2016).

During the spotted frog breeding season, the pre-OSF Proposal operations resulted in storage exceeding 50,000 acre-feet in half of the years from 1983 to 2009 which resulted in water expanding into unsuitable, upland habitat outside of the sedge vegetation that protects egg masses and rearing tadpoles. As described above, the Proposed Action requires storage volumes to reach 45,000 acre-feet by March 15th and will increase up to 50,000 acre-feet between May 1st and May 15th if Wickiup Reservoir holds 180,000 acre feet or more. Storage between 45,000 and 50,000 acre-feet will ensure quality breeding habitat for Oregon spotted frogs within Crane Prairie. Under those conditions, the water’s edge will be within emergent sedge vegetation which will provide juveniles and breeding adults access to cover from predators, will allow egg masses to be deposited within cover so they will not drift into open water, and will allow tadpoles to emerge into quality habitat providing cover from predators and foraging opportunities.

During tadpole rearing, juvenile rearing, and subadult and adult habitat use between April 1 and
August 1, under pre-OSF Proposal operations, the Crane Prairie pool reached maximum 20th/50th/80th percentile values of 36,560/46,350/54,050 acre feet in April or May and the drawdown occurred until the pool reached minimum 20th and 80th percentile values in October. Figure 4-6 in the BA shows that the 20th/50th/80th percentile August 1 pool values are approximately 27,000/33,000/43,000 acre feet. Under the OSF Proposal, the Crane Prairie pool reaches at least 45,000 acre feet by March 15th and may increase to 50,000 acre feet between May 1 and May 15th. From May 15th to July 15th, Crane Prairie Reservoir would be operated to minimize fluctuations in water depth. No stored water would be released from the reservoir prior to July 15th. From July 16th to July 31st, storage in excess of 35,000 acre-feet would be released at a rate that would result in a drop in reservoir elevation of no more than 0.05 feet per day. The OSF Proposal brings significantly more stability to water levels in Crane Prairie between April 1 and August 1 than pre-OSF Proposal operations. As a result, tadpoles will have constant access to cover and abundant forage provided by the emergent sedge community along the shoreline and juveniles, subadults, and adults will have constant access to cover from predators as well as abundant foraging opportunities amidst the emergent sedge vegetation. These habitat benefits provided by the OSF Proposal in Crane Prairie from April 1 to August 1 are likely to significantly increase the survival of Oregon spotted frog tadpoles, juveniles, subadults, and adults.

During the period leading up to winter (September 1 – October 15) when juvenile, subadult, and adult Oregon spotted frogs are preparing to access overwintering habitat, the OSF Proposal will maintain higher storage volumes than the current condition. Under pre-OSF Proposal operations the reservoir reached its lowest storage volume between 18,270 and 33,940 acre feet (20th and 80th percentile minimum storage values) in October. Under the OSF Proposal, the reservoir will not be drawn below 35,000 acre feet. As a result, the OSF Proposal is likely to provide spotted frogs with improved access to overwintering habitat which should allow Oregon spotted frog adults, subadults, and juveniles to locate and use higher quality habitat than they were able to under pre-OSF Proposal operations. This will likely increase overwinter survival of adult, subadult, and juvenile spotted frogs. However, it is anticipated that the abundant predaceous, non-native fish in the reservoir will continue to prey on overwintering juvenile, subadult, and adult Oregon spotted frogs.

Although, the OSF Proposal has significant benefits to Oregon spotted frogs in Crane Prairie Reservoir, holding water in the reservoir also affects spotted frog populations downstream. Therefore, effectiveness of the action must be monitored. Habitat utilization studies of spotted frog are necessary to determine how spotted frogs are using the reservoir, particularly during the winter. Such studies would facilitate the development of conservation measures and an adaptive management strategy for the Deschutes Basin HCP.

Deschutes River from Crane Prairie Dam to Wickiup Reservoir

Oregon spotted frog use of the Deschutes River from Crane Prairie Dam to Wickiup Reservoir is limited to one monitored location where the Deschutes River meets Wickiup Reservoir at full pool. However, this reach provides important connectivity between upstream and downstream populations.
Under pre-OSF Proposal operations, flows at the CRAO gauge during winter (January to mid-March) are in the range of 100 to 150 cfs at the CRAO gauge (Figure 75). Under the OSF Proposal, modeled flows are anticipated to drop in January to 40 cfs and gradually increase to 150 cfs in mid-March. The sudden drop in water in January is likely to adversely impact overwintering spotted frogs. As mentioned earlier, the OSF Proposal operations were implemented upon the Settlement Agreement (October 28, 2016). Therefore, we were able to observe a change in condition in the spring of 2017 under the new operations.

Frogs were not found at the monitored wetland site during 2017 breeding surveys, despite there being no change in spring habitat inundation conditions. In reviewing the hydrograph for WY 2017, we noted that in the fall of 2016, flows out of Crane Prairie were high compared to pre-Proposal conditions. It is likely that the high water conditions caused spotted frogs to seek another location for overwintering. We also noted that there was a sudden drop in flow in January during the 2017 water year and that winter flows remained lower than pre-OSF Proposal conditions until mid-February. The modeled output for the Proposed Action depicts even higher flows at the outlet of Crane during the fall movement period for spotted frogs and lower winter flows when spotted frogs are sheltering within winter habitat. The change from high flows in the fall to low flows in the winter is likely to result in mortality of spotted frogs. High flows in fall will cause spotted frogs to seek overwintering habitats that become unsuitable as flows drop in the winter and it is likely that spotted frogs will not survive the winter. Further evaluation and monitoring within additional wetland habitats along the reach of the Deschutes River between the reservoirs is necessary to observe where conditions may remain suitable for spotted frogs through implementation of the Proposed Action.

Under pre-OSF Proposal operations, discharge at the CRAO gauge which measures flows in the Deschutes River between Crane Prairie Dam and Wickiup Reservoir during breeding (March 15

![Figure 75. RiverWare modeled flows at CRAO gauge representing “current condition” and the proposed action and Water Year 2017 (Oct 1, 2016 to June 5, 2017) representing actual implementation of the OSF proposal.](image)
– April 30) start out under 100 cfs and increase rapidly to 500 cfs in mid-April as irrigation releases start. Under the OSF Proposal, flows at the CRAO gauge during breeding range between 130 and 200 cfs the entire period. It is unknown what kind of effect any of these flows have on breeding habitat since we suspect that the hydrology of this particular location is dependent on a combination of these flows and surface water elevations in Wickiup Reservoir. Figure 76 depicts the modeled surface water elevations of Wickiup Reservoir for pre-OSF Proposal and the OSF Proposal, including operations for 2016 to 2017. Implementation of the OSF Proposal will result in lower surface water elevations in Wickiup Reservoir. Therefore the combined effects of reducing flows out of Crane Prairie and lower surface water elevations in Wickiup Reservoir are likely to result in less suitable breeding conditions for spotted frogs at this location. Past observations of breeding at this site have observed stranding and we suspect that most breeding efforts have not been successful in producing young of the year. Continued monitoring of spotted frogs and breeding habitat at this location will be necessary to better understand site suitability as the OSF Proposal is implemented.

Under pre-OSF Proposal operations, flows at the CRAO gauge during tadpole rearing, juvenile rearing, and subadult and adult habitat use from April 1 to August 1, start out less than 100 cfs until mid-April, then spike to more than 500 cfs until May 1, and then drop down to between 280 and 400 cfs for the rest of the period. Under pre-OSF Proposal conditions flows are relatively stable from May through September (Figure 75) and range from 280 to 300 cfs. Under the OSF Proposal, modeled flows are lower during the month of April, and range from 150 to 200 cfs with a drop to less than 100 cfs during the first half of May. Modeled flows are lower than pre-OSF Proposal flows from mid-May to mid-July when flows will spike to 400 cfs when the irrigation drawdown begins on Crane Prairie Reservoir (Figure 75). The 400 cfs is essentially a spike in the hydrograph and is not maintained. There appears to be significant changes in the modeled hydrographs for the pre-OSF Proposal operations and the OSF Proposal.

The changes in flow conditions are likely to affect the way spotted frogs utilize wetland habitat adjacent to the Deschutes River between the reservoirs. The changes will not necessarily eliminate habitat for spotted frogs along this reach of the river, even though we anticipate that the known breeding location will become less suitable. We anticipate that there may be a shift in habitat utilization depending on how suitable other wetland habitats are during the implementation of the OSF Proposal. Continued hydrological and biological monitoring is necessary to assess habitat conditions and determine spotted frog presence throughout the two-year implementation of the OSF Proposal.

**Wickiup Reservoir**

As described above and depicted in Figure 76 below, RiverWare modeled storage volumes for Wickiup Reservoir indicate that the OSF Proposal is likely to result in lower surface water elevations in Wickiup Reservoir from October 1 to September 30. There are approximately 2,961 acres of wetlands within the 10,231 acres of Wickiup Reservoir that extend into the floodplain of the Deschutes River that is between Crane Prairie and Wickiup reservoirs. We do not know precisely the storage volume within the reservoir that creates the most suitable habitat conditions for spotted frogs within this geography.
In past observations of wetland habitats within Wickiup Reservoir in the spring, we have observed unsuitable breeding conditions in the spring when reservoir storage volumes are close to maximum capacity. Therefore, if Wickiup is not as full in the spring as predicted in the modeled volumes for the Proposed Action, breeding conditions may be more suitable for spotted frogs. Long-term monitoring of wetland habitats, spotted frogs and conducting habitat utilization studies would elucidate whether or not these changes in condition are beneficial for spotted frogs.

Table 31 (Table 16 in the BA) depicts the percent change in storage volumes of Wickiup Reservoir during critical time periods for the Proposed Action compared to the current condition during low, medium and high flow years. We note that the change in condition between the Proposed Action and current condition is most extreme in late summer and early fall as the reservoir volume is drawn down for irrigation.

![RiverWare modeled water volumes at Wickiup Reservoir](image)

Figure 76. RiverWare modeled water volumes at Wickiup Reservoir representing “current condition” and the proposed action and Water Year 2017 (Oct 1, 2016 to June 5, 2017) representing actual implementation of the OSF proposal and WY 2016 (October 1, 2015 to Sept 30, 2016).

In past monitoring efforts of Wickiup Reservoir during the late summer/early Fall time frame, we have observed that the drawdown of Wickiup Reservoir results in very little overwintering habitat for spotted frogs. Remaining bodies of water contain an abundance of non-native predatory fish and therefore there are little refugia habitats for spotted frogs to overwinter in. Based on the current condition, we are reasonably certain that the implementation of the OSF Proposal will result in the continued drawn down of Wickiup Reservoir in the late summer and fall, resulting in a low residual volume of water for spotted frogs to overwinter in.
The Proposed Action will maintain Wickiup Reservoir in this degraded condition, and there will be little suitable year-round habitat for spotted frogs due to the large change in surface water volumes of the reservoir as irrigation water is released for irrigation.

Table 31. Modeled storage volumes in Wickiup Reservoir for the current conditions versus the Proposed Action in low, medium and high flow years.

<table>
<thead>
<tr>
<th>Critical Time Windows</th>
<th>Current Condition (ac-ft)</th>
<th>Proposed Action (ac-ft)</th>
<th>% Δ</th>
<th>Current Condition (ac-ft)</th>
<th>Proposed Action (ac-ft)</th>
<th>% Δ</th>
<th>Current Condition (ac-ft)</th>
<th>Proposed Action (ac-ft)</th>
<th>% Δ</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low Flow Year (80% exceedance)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>March 16 - March 31</td>
<td>170,070</td>
<td>136,510</td>
<td>-20%</td>
<td>194,700</td>
<td>157,320</td>
<td>-19%</td>
<td>199,060</td>
<td>177,500</td>
<td>-11%</td>
</tr>
<tr>
<td>April 1 - April 15</td>
<td>175,780</td>
<td>131,220</td>
<td>-25%</td>
<td>193,850</td>
<td>152,570</td>
<td>-21%</td>
<td>196,190</td>
<td>177,980</td>
<td>-9%</td>
</tr>
<tr>
<td>April 16 - April 30</td>
<td>169,150</td>
<td>116,340</td>
<td>-31%</td>
<td>184,330</td>
<td>140,830</td>
<td>-24%</td>
<td>188,670</td>
<td>173,070</td>
<td>-8%</td>
</tr>
<tr>
<td>May</td>
<td>149,900</td>
<td>96,550</td>
<td>-36%</td>
<td>172,170</td>
<td>128,070</td>
<td>-26%</td>
<td>179,780</td>
<td>165,680</td>
<td>-8%</td>
</tr>
<tr>
<td>June</td>
<td>118,660</td>
<td>64,900</td>
<td>-45%</td>
<td>147,420</td>
<td>107,260</td>
<td>-27%</td>
<td>171,100</td>
<td>155,240</td>
<td>-9%</td>
</tr>
<tr>
<td>July</td>
<td>84,800</td>
<td>30,440</td>
<td>-64%</td>
<td>119,530</td>
<td>72,590</td>
<td>-39%</td>
<td>153,620</td>
<td>133,100</td>
<td>-13%</td>
</tr>
<tr>
<td>August</td>
<td>50,130</td>
<td>14,690</td>
<td>-71%</td>
<td>89,570</td>
<td>37,540</td>
<td>-58%</td>
<td>132,540</td>
<td>111,110</td>
<td>-16%</td>
</tr>
<tr>
<td>September</td>
<td>24,990</td>
<td>14,660</td>
<td>-41%</td>
<td>74,240</td>
<td>20,440</td>
<td>-72%</td>
<td>127,700</td>
<td>105,110</td>
<td>-18%</td>
</tr>
<tr>
<td>October</td>
<td>29,050</td>
<td>21,840</td>
<td>-25%</td>
<td>86,610</td>
<td>29,280</td>
<td>-66%</td>
<td>144,170</td>
<td>124,770</td>
<td>-13%</td>
</tr>
<tr>
<td>November</td>
<td>62,460</td>
<td>50,720</td>
<td>-19%</td>
<td>121,380</td>
<td>62,800</td>
<td>-48%</td>
<td>166,940</td>
<td>144,470</td>
<td>-13%</td>
</tr>
<tr>
<td>December</td>
<td>98,860</td>
<td>79,510</td>
<td>-20%</td>
<td>148,270</td>
<td>94,350</td>
<td>-36%</td>
<td>180,830</td>
<td>158,640</td>
<td>-12%</td>
</tr>
<tr>
<td>January</td>
<td>131,290</td>
<td>101,020</td>
<td>-23%</td>
<td>168,950</td>
<td>116,970</td>
<td>-31%</td>
<td>189,180</td>
<td>166,060</td>
<td>-12%</td>
</tr>
<tr>
<td>February</td>
<td>151,240</td>
<td>117,760</td>
<td>-22%</td>
<td>183,340</td>
<td>138,660</td>
<td>-24%</td>
<td>192,990</td>
<td>171,870</td>
<td>-11%</td>
</tr>
<tr>
<td>March 1 - March 15</td>
<td>162,130</td>
<td>129,490</td>
<td>-20%</td>
<td>189,280</td>
<td>150,000</td>
<td>-21%</td>
<td>195,960</td>
<td>175,090</td>
<td>-11%</td>
</tr>
</tbody>
</table>

There have been observations of Oregon spotted frogs at various locations within the reservoir over a number of years within the wetland habitat along the edge of the reservoir. Though due to the expansive area of the reservoir, there have been few surveys of spotted frogs over the years. It is likely the spotted frogs will use a portion of the 2,961 acres of wetlands within the reservoir and attempt to overwinter in residual pools over the course of the Proposed Action. We assume that Wickiup Reservoir provides an important function in terms of aquatic connectivity between spotted frog populations. However, survival of spotted frogs is limited within the reservoir due to the large change in surface area inundation over a broad geography, which reduces the ability of spotted frogs to move between habitats that are suitable for breeding, rearing and overwintering over the annual life cycle.

6.1.2.2 Effects Below Wickiup Dam

Water management-related effects to the spotted frog and its habitat along the Deschutes River
between Wickiup Dam and Bend, Oregon are strongly influenced by storage and release operations at Wickiup Dam. River flows out of Wickiup Dam are measured using the WICO gauge (OWRD Gauge 14056500).

As described in the BA, the minimum instream flow at the WICO gauge will be 600 cfs from March 31st through September 15th, and 100 cfs from September 16th through March 30th. Modeling of the OSF Proposal operations using the period of record from 1980 through 2009 shows that flows will be greater than 600 cfs from mid-April through late September due to releases of irrigation storage and that the lowest the flow could go is 600 cfs during this time period (Table 1 in Proposed Action section; Table 17 in the BA). Flows will generally be 100 cfs from November to mid-March, unless an extreme runoff event, while both reservoirs are nearly full, requires additional releases. From September 16th through October 31st, flows are above 100 cfs at WICO as irrigation releases are ramping down, and after mid-March, flows are above 100 cfs as flows are ramping up to achieve the 600 cfs minimum by March 31st. The BA explains that, under the OSF Proposal, from March 31st through April 30th, the flow at the WICO gauge could be increased, but not allowed to decrease at any time, even if it were above 600 cfs. The maximum flow would be 800 cfs until April 15, after which the flow could exceed 800 cfs if needed to meet irrigation demands. Whenever the flow is at or below 800 cfs, the maximum rate of increase in flow would be 0.1 feet per 4-hour period and the maximum rate of decrease in flow would be 0.2 feet per 12-hour period.

The range of flows that inundate wetlands adjacent to the Deschutes River downstream of Wickiup Dam is variable over the annual life cycle of the spotted frog. As described earlier in the environmental baseline, the river channel morphology in combination with the regulated hydrograph influences the function of the wetland habitats that spotted frogs must use to complete their life cycle. The Deschutes River channel is approximately 20 percent larger now than it was in a pre-Wickiup Dam condition due to the erosional processes that have occurred via storage and release operations. Therefore, larger volumes of water are needed to reach wetland habitats than under pre-Wickiup Dam river conditions. Spring flows released from the dam often do not provide optimal conditions for spotted frogs to breed and rear in. Additionally, high volumes of water released in spring and summer flood emergent vegetation to a depth that does not allow for recruitment of riparian vegetation during the growing season, further reducing the suitability of wetland habitats for Oregon spotted frogs.

At the onset of the irrigation storage season in October, the flows of the Deschutes River are reduced and many wetlands adjacent to the river drain. The habitats that sustain water through winter are the only suitable overwintering areas for spotted frogs. Despite the spring-fed hydrology of the upper Deschutes River Basin, wetland habitats that remain inundated at some level through the winter are limited. In some areas, the river channel may provide the only place for frogs to spend the winter. Within the river, spotted frogs are at risk to predation by brown trout that are concentrated into the reduced wetted area. Therefore, overwintering habitat for spotted frogs is severely limited downstream of Wickiup Dam.

Table 32 outlines the flows at the WICO and BENO gauges that strongly influence the function of wetlands inhabited by spotted frogs as described in the Environmental Baseline. The flows in Table 32 correlate with inundation area that provides suitable habitat for spotted frogs and we
use these flows as thresholds in the effects analysis below. River Reaches 1 through 7 were
delineated for the purposes of our effects analysis. All reaches, except Reach 5, have known
occurrences of spotted frogs.

Table 32. Known Oregon spotted frog breeding sites by analysis reach along the Deschutes
River and flows that begin to reduce habitat function (based on visual observation).

<table>
<thead>
<tr>
<th>River Reach</th>
<th>Site location</th>
<th>WICO</th>
<th>BENO</th>
<th>BENO minus Arnold and COID diversions and 7% loss</th>
</tr>
</thead>
<tbody>
<tr>
<td>1: Wickiup Dam to Fall River</td>
<td>Bull Bend*</td>
<td>&lt;900</td>
<td>7%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Dead Slough</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>La Pine SP SW Slough</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2: Fall River to Little Deschutes</td>
<td>Private RM 202*</td>
<td>unk</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Island Loop* (private)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3: Little Deschutes to Benham Falls</td>
<td>Sunriver</td>
<td></td>
<td></td>
<td>Water begins to enter weirs above 1,000 at WICO</td>
</tr>
<tr>
<td>4: Benham to Dillon Falls</td>
<td>SW Slough Camp</td>
<td>N/A</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>East Slough Camp</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>East Slough Camp (duck blind</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>marsh)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>North East Slough Camp</td>
<td></td>
<td></td>
<td>&lt;1,200</td>
</tr>
<tr>
<td></td>
<td>East Slough (Lily Pad pond)</td>
<td></td>
<td></td>
<td>&lt;1,600</td>
</tr>
<tr>
<td></td>
<td>East Slough Transducer Pond</td>
<td></td>
<td></td>
<td>1,400-1,600</td>
</tr>
<tr>
<td></td>
<td>S. Ryan Ranch*</td>
<td>unk</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5: Dillon Falls to Lava Island Falls</td>
<td>No known spotted frog sites</td>
<td>1,200</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>but wetlands with suitable</td>
<td>1,500</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>habitat are present</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6: Lava Island Falls to COID diversion</td>
<td>Private Preserve ** RM 172</td>
<td>unk</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7: COID Diversion to Colorado Street Bridge</td>
<td>Old Mill - LSA Marsh***</td>
<td>unk</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Occasional breeding detected; ** New site juveniles only; *** Old Mill Pond not affected by flows;
unk - Unknown

Our hydrological analysis of the OSF Proposal using RiverWare-modeled hydrology is grouped
into Reaches 1 and 2 (Wickiup Dam to the Little Deschutes River) and Reaches 3 through 5
(Little Deschutes River to Lava Island Falls). Using the RiverWare-modeled hydrological data,
we assessed how implementation of the OSF Proposal compares to the current condition in
timing and duration of habitat inundation in Reaches 1 through 5 using thresholds identified in
Table 32, above. The RiverWare-modeled hydrology was not used for the effects analysis in
Reaches 6 and 7. As explained in the Environmental Baseline, Reach 6 has little suitable
wetland habitat (i.e., 7 acres) for spotted frogs and the large portion of this reach was not
included in the critical habitat designation for the lack of habitat and known spotted frog
occurrences. Our biological and hydrological monitoring efforts were not focused on Reach 6
until spotted frog juveniles were detected in a small wetland on private lands in November of
2016. We currently do not have a flow threshold identified for maintaining suitable habitat in
Reach 6. Hydrological conditions in Reach 7 are more complex, described below, and we are
not able to use the RiverWare-modeled hydrology for our analysis of this reach. Site-specific studies are underway to develop appropriate flow thresholds for spotted frog habitat in Reach 7.

Deschutes River between Wickiup Dam and the Little Deschutes River (Reaches 1 and 2)

The following narrative addresses two reaches of the Deschutes River that stretch between Wickiup Dam and the Little Deschutes River: Reach 1 (Wickiup Dam to Fall River) and Reach 2 (Fall River to the Little Deschutes River). Spotted frog breeding locations within these reaches are identified in Table 33.

As described in the Environmental Baseline, the only known area in Reach 1 where spotted frog breeding activity is concentrated and consistent (annually) is at Dead Slough within La Pine State Park (including La Pine S.P. SW Slough), approximately 20 miles downstream of Wickiup Dam. Bull Bend, located approximately 6 miles downstream of Wickiup Dam and 13 miles upstream from Dead Slough, represents an area where we suspect that spotted frogs bred in 2013 due to the detection of pre-metamorphic spotted frogs. The spotted frogs were found in riverine wetlands near Bull Bend after a wet winter in central Oregon, and flow releases from Wickiup Dam ranged between 300 and 500 cfs. In most years, winter flows are too low to support spotted frogs in this area. Therefore, it is unlikely that wetlands without spring support in Reach 1 can sustain a population of Oregon spotted frogs under the current flow regime.

Reach 2 of the Deschutes River receives additional flows of up to 120 cfs from the Fall River. However, those flows are insufficient to maintain adequate habitat conditions for the spotted frog through the winter irrigation storage season. Reach 2 includes two small spotted frog breeding locations on private land. The Private RM 202 site, located approximately 2.5 miles downstream of La Pine SP SW Slough, is likely to retain some water through the winter irrigation storage season but the habitat conditions are likely to be sub-optimal for spotted frogs in that there is little cover from predators. We do not currently know how the changes in river flows under the OSF proposal are likely to affect the Island Loop site on private land, which is spring supported.

As described in the Environmental Baseline, hydrological conditions of spotted frog habitat within Reaches 1 and 2 are most influenced by the storage and release of water from Wickiup Dam. Therefore, our hydrological monitoring work to date has attempted to calibrate the observed water levels in wetlands with the flows at the WICO gauge. To date, most of the hydrological monitoring has occurred on Federal and State lands in River Reach 1.

<table>
<thead>
<tr>
<th>River Reach</th>
<th>Spotted Frog Breeding Site location</th>
<th>~ River Mile (RM)</th>
<th>Ownership</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Wickiup Dam to Fall River</td>
<td>Bull Bend**</td>
<td>221</td>
<td>Forest Service</td>
</tr>
<tr>
<td></td>
<td>Dead Slough</td>
<td>208</td>
<td>Oregon State Parks</td>
</tr>
<tr>
<td></td>
<td>La Pine SP SW Slough</td>
<td>205.5</td>
<td></td>
</tr>
<tr>
<td>2. Fall River to Little</td>
<td>Private RM 202*</td>
<td>202</td>
<td>Private</td>
</tr>
<tr>
<td>Deschutes River</td>
<td>Island Loop* (private)</td>
<td>195</td>
<td></td>
</tr>
</tbody>
</table>

* Occasional breeding detected; **suspected breeding due to presence of pre-metamorphic frogs in single year.
Spotted frogs begin breeding in late March to early April when flows are typically in the range of 200 to 600 cfs at the WICO gauge (Figure 79). At Dead Slough and La Pine State Park SW Slough, egg masses and emerging tadpoles are outside of riparian vegetation and at risk of predation until flows reach approximately 800 cfs. Figure 77 shows egg masses in shallow open water at Dead Slough on April 2, 2015 with flows of 381 cfs at the WICO gauge. Our site observations indicate that most wetland vegetation is not inundated with water when flows are below approximately 900 cfs at the WICO gauge (Appendix). As described in the Environmental Baseline, the lack of vegetation within inundated areas is primarily a result of the high summer flows that prevent establishment of the sedge vegetation within the wetlands that is preferred by spotted frogs during most portions of their lifecycle. When flows are below this threshold, there is little cover for spotted frogs. We emphasize that the 900 cfs flow is not what is needed to inundate areas where frogs breed, nor was this flow common during the spring breeding period under the historical unregulated hydrological condition (Figure 16 in Environmental Baseline). Rather 900 cfs flows provide more suitable habitat for spotted frogs in the current condition. When flows are below this threshold, spotted frogs of all life stages are at risk to predation and thermal highs and lows that impact the early life stages (eggs, tadpoles). Figure 78 shows a spotted frog breeding location within Dead Slough at 893 cfs in September to illustrate how water intersecting with sedge vegetation provide more suitable habitat than mudflats.

![Figure 77. Egg masses in shallow, open water at Dead Slough on April 2, 2015 with flows of 381 cfs at the WICO gauge.](image)

In most years, flows at the WICO gauge are between 600 and 1,400 cfs during the spotted rearing period (tadpole through metamorphosis). Flows may reach 900 cfs by mid-April according to the RiverWare-modeled hydrographs (Figure 79), described in more detail below. Therefore, water extends into the vegetated emergent marsh edges of Dead Slough for this important period of the spotted frog life cycle.
As water drains out of the wetlands at the onset of the irrigation storage season, Dead Slough maintains a significant residual pool of water, partially fed by groundwater springs. This provides suitable overwintering conditions for spotted frogs, which is a very critical period in the spotted frog’s life cycle. The year-round site conditions at Dead Slough, although altered by storage and release operations, provide suitable but not necessarily optimal habitat for spotted frogs.

Implementation of the OSF Proposal is likely to result in the continuation of adverse effects to spotted frogs with some improvement in spotted frog habitat conditions at Dead Slough. Adverse effects to spotted frogs are most likely to occur during the spring breeding period when flows are below 900 cfs and adults, eggs and tadpoles are exposed to increased predation by birds, snakes and raccoons when they are without the cover of emergent vegetation. Juvenile, subadult and adult spotted frogs also are adversely impacted during the irrigation draw-down period in the fall when wetlands drain of water, restricting movement of frogs to overwintering locations and increasing predation when they are without the cover of emergent vegetation.

RiverWare-modeled Flow Comparison of the OSF Proposal and Current Conditions at the Wickiup Dam (WICO) Gauge

As described earlier, we used the RiverWare-modeled hydrology to assess implementation of the OSF Proposal versus the “current condition”, representing average flows from 1980 to 2009. Additionally, we monitored the hydrographs of the water years for 2016 and 2017 (partial hydrograph: data included to early June 2017) since elements of water management under the OSF proposal were already being implemented. For example, 600 cfs was reached by April 1 of the 2017 water year as per the settlement agreement. Using the thresholds identified above, we can assess how the implementation of the OSF Proposal compares to the current condition in timing and duration of habitat inundation.
Figure 79 depicts the RiverWare modeled flows out of Wickiup Dam for the current condition and the proposed action (i.e., the OSF Proposal). Hydrographs for Water Year 2017 (Oct 1, 2016 to June 5, 2017) representing actual implementation of the OSF proposal and WY 2016 (October 1, 2015 to Sept 30, 2016) also are included in Figure 79. As modeled, implementation of the OSF Proposal will result in flows reaching 600 cfs earlier in the breeding season compared to the current condition which would typically have flows reaching 600 cfs by mid-April.

The modeled flows for both the proposed action and the current condition show a steep increase in mid-April to between 1,300 and 1,400 cfs. The actual flows in mid-April during the water years of 2016 and 2017 remained close to 600 cfs until May and then rose to approximately 900 cfs by mid-May. The modeled flows for the proposed action and the current condition drop from high flows above 1,200 cfs in late April to as low as 400 and 600 cfs in early May before rising again to reach approximately 1,400 cfs again in late May. The OSF Proposal implementation also shows that flows will be lower than current conditions in August through September.

Our interpretation of these hydrographs is that there is a large variation in the modeled hydrographs for the current condition and the proposed action when compared to the actual hydrographs for water years 2016 and 2017. These differences in the hydrographs occur in mid to late April, in early May and in June (Water Year 2017 not included). This difference in hydrographs is worth noting here as water management in 2017 reflects similar water management to be implemented via the OSF Proposal.
The analysis presented below assumes that the RiverWare-modeled flows for the OSF Proposal will occur at the WICO gauge as per reflected in the hydrographs in Figure 79. Since water operations below Wickiup Dam are expected to remain similar to past years, we also relied on the analysis presented in the Environmental Baseline section above to describe ongoing effects to the Oregon spotted frog and its critical habitat.

**RiverWare-modeled Flow Comparison of Duration at the WICO Gauge for the OSF Proposal and Current Condition (Reaches 1 and 2)**

To assess a change in hydrological condition via implementation of the OSF Proposal in Reaches 1 and 2, we compared the duration of RiverWare-modeled flows at the WICO gauge for the OSF Proposal and the current condition (referred to as pre-OSF Proposal). This comparison between modeled flows was done for the breeding, rearing and overwintering periods of the spotted frog life cycle and is represented in Tables 34, 35 and 36. Juvenile, subadult, and adult spotted frogs are using the habitat during all seasons.

Table 34 shows the median number of days that flows are greater than 600, 700, and 800 cfs during the spotted frog breeding period for the OSF Proposal and pre-OSF Proposal. Table 35 shows the median number of days that flows are greater than 600, 700, 800, 900, 1000, 1100, 1200, 1300, 1400 and 1500 cfs for the period of time tadpoles are rearing for the OSF Proposal compared to the current condition. The minimum flow value of 600 cfs used for breeding and rearing was selected because this flow represents conservation criteria in the OSF Proposal and a flow where monitoring has been conducted to observe changes to habitat quantity and quality. Table 35 depicts the median number of days that flows are greater than 300, 400, 500, 600, 700, 800, 900, and 1000 cfs for the period of time particularly important to juveniles, subadult and adult spotted frogs prior to overwintering (September 1 to October 15).

Table 34. Median number of days exceeding particular flow thresholds at the WICO gauge during Oregon spotted frog breeding (March 15-April 30).

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<tbody>
<tr>
<td>600 cfs</td>
<td>28</td>
<td>60%</td>
<td>17</td>
<td>36%</td>
<td>+11</td>
</tr>
<tr>
<td>700 cfs</td>
<td>13</td>
<td>28%</td>
<td>15</td>
<td>32%</td>
<td>-2</td>
</tr>
<tr>
<td>800 cfs</td>
<td>12</td>
<td>26%</td>
<td>13</td>
<td>28%</td>
<td>-1</td>
</tr>
</tbody>
</table>

During the overwintering period under the OSF Proposal, flows are at 100 cfs in the Deschutes River below Wickiup Dam the majority of the time and would likely only exceed 100 cfs during extreme runoff events when both reservoirs are full, while under pre-OSF Proposal operations, flows are at 20 cfs the majority of the time, resulting in an increase of 80 cfs in the Deschutes River during the overwintering period. However, this increase in 80 cfs is insufficient to affect water levels in adjacent wetlands, so there is no improvement in overwintering habitat quantity or quality in adjacent wetlands.
As described above, breeding can occur between March 15th and April 30th, for a total of 47 days. During this time, modeled flows of the OSF Proposal and the pre-OSF Proposal, show that the median number of days that flows are greater than 600 cfs in the Deschutes River below Wickiup Dam are 28 days (60% of the time) and 17 days (36% of the time), respectively. Modeling predicts that flows will be greater than 700 cfs at the WICO gauge for a median of 13 days (28% of the time) under the OSF Proposal versus 15 days (32% of the time) under current conditions. Modeling predicts that flows under the OSF Proposal, the median is 12 days (26% of the time) below Wickiup, with flows greater than 800 cfs, while under pre-OSF Proposal operations, the median was 13 days (28% of the time) with flows greater than 800 cfs.

In summary, the RiverWare modeling predicts that the OSF Proposal provides flows over 600 cfs for 11 more days than the pre-OSF Proposal operations during the Oregon spotted frog breeding period. The modeling also shows that there will be fewer days where flows will be at 700 and 800 cfs under the OSF Proposal compared to pre-OSF Proposal operations. During breeding the OSF Proposal gets to 600 cfs more quickly than the pre-OSF operations and takes slightly longer to get to 700 cfs and 800 cfs.

Under the OSF Proposal, flows will reach 600 cfs by April 1, improving breeding conditions over the current condition by increasing the wetted area in wetlands earlier in the breeding season. However, we know from observations at Dead Slough and other breeding sites within this reach, that flow of 600 cfs are not sufficient to inundate wetland vegetation that provides cover from predators for spotted frogs. Therefore, continued breeding counts and habitat monitoring during the breeding period are needed to observe whether or not the increase in flows provides improvements to spotted frog breeding in not only Reaches 1 and 2 but further downstream where the WICO flows are combined with flows from the Little Deschutes River (BENO gauge).

Based on aerial flights conducted prior to and after the April 1 flow releases of 600 cfs, we concluded that habitat conditions are improved over a broad geographic area. But given that these are short-term changes and that flows are consistently very low in the winter and prior to the breeding season, we do not know if such a change will result in improved viability for the spotted frog.
Table 35. Median number of days exceeding particular flow thresholds at the WICO gauge during Oregon spotted frog tadpole rearing (April 1-August 1).

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<tbody>
<tr>
<td>600 cfs</td>
<td>123</td>
<td>100%</td>
<td>106</td>
<td>86%</td>
<td>+17</td>
</tr>
<tr>
<td>700 cfs</td>
<td>91</td>
<td>74%</td>
<td>100</td>
<td>81%</td>
<td>-9</td>
</tr>
<tr>
<td>800 cfs</td>
<td>82</td>
<td>67%</td>
<td>87</td>
<td>71%</td>
<td>-5</td>
</tr>
<tr>
<td>900 cfs</td>
<td>71</td>
<td>58%</td>
<td>78</td>
<td>63%</td>
<td>-7</td>
</tr>
<tr>
<td>1,000 cfs</td>
<td>62</td>
<td>50%</td>
<td>68</td>
<td>55%</td>
<td>-6</td>
</tr>
<tr>
<td>1,100 cfs</td>
<td>56</td>
<td>46%</td>
<td>57</td>
<td>46%</td>
<td>-1</td>
</tr>
<tr>
<td>1,200 cfs</td>
<td>47</td>
<td>38%</td>
<td>51</td>
<td>41%</td>
<td>-4</td>
</tr>
<tr>
<td>1,300 cfs</td>
<td>37</td>
<td>30%</td>
<td>37</td>
<td>30%</td>
<td>0</td>
</tr>
<tr>
<td>1,400 cfs</td>
<td>26</td>
<td>21%</td>
<td>30</td>
<td>24%</td>
<td>-4</td>
</tr>
<tr>
<td>1,500 cfs</td>
<td>13</td>
<td>11%</td>
<td>15</td>
<td>12%</td>
<td>-2</td>
</tr>
</tbody>
</table>

As described above, tadpole rearing can begin as early as April 1st and extend to August 1st, for a total of 123 days. During this time, modeled flows of the OSF Proposal and the pre-OSF Proposal, show that the median number of days that flows at the WICO gauge are greater than 600 cfs is 123 days (100% of the time) and 106 days (86% of the time), respectively. However, implementation of the OSF Proposal results in a reduction in the median number of days that flows for all flows above 700 cfs, except 1,300 cfs (Table 35). As described above, flows above 900 cfs are more likely to come in contact with emergent vegetation that provides cover for rearing tadpoles, juveniles and adults. The WICO gauge flows are typically above 1,200 cfs during the warm months of the irrigation season (i.e., late June to early September) under the current condition and under the OSF Proposal (Figure 79). The RiverWare-modeled hydrographs indicate that the reduction of flow thresholds below 900 cfs, which places the spotted frogs outside of the cover of vegetation in Dead Slough, will occur in May during the early tadpole phase of the lifecycle (Figure 79). Therefore, we conclude that ongoing impacts to spotted frogs, discussed in the environmental baseline, will continue during the early rearing period, since rearing tadpoles are without cover and subject to predation by birds and snakes.

The period of time from September 1st to October 15th leading up to overwintering is particularly important for newly post-metamorphic juveniles, subadult and adult Oregon spotted frogs. As described in the Environmental Baseline, storage operations typically commence in early October at which time flows in the Deschutes River are reduced and wetlands are drained. Currently, irrigation districts begin reducing water deliveries in September in preparation for the storage season which can be seen in the hydrograph for operations from 1980 to 2009 (i.e., current condition and pre-OSF Proposal) (Figure 79). We assume that spotted frogs that have endured the regulated water operations in the Deschutes since the construction of Wickiup Dam approximately 70 years ago may have synced their movement to overwintering habitat with the ramping down of the irrigation system. We also suspect that this is a period of time in the regulated system that results in significant mortality to spotted frogs as the habitats that provide...
shelter for frogs are voided of water. Spotted frogs are left to seek overwintering habitats that remain inundated through winter which are vastly reduced during the ramp down period.

The RiverWare-modeled hydrographs for the current condition indicate that flows drop from approximately 1,400 cfs in early September to slightly under 100 cfs by mid-October. The Riverware-modeled hydrograph for implementation of the OSF Proposal results in WICO flow less than 1,100 cfs in early September dropping to 100 cfs in mid-October.

Table 36 compares the median number of days that RiverWare-modeled flows exceed 300 to 1,000 cfs at the WICO gauge from September 1 to October 15 under the OSF Proposal versus the pre-OSF Proposal. Under the OSF Proposal, flows begin ramping down sooner than under pre-OSF Proposal operations, resulting in an earlier decrease in flow volumes and wetland water levels that connect rearing habitat to overwintering habitat. The higher flows above 900 cfs are reduced by approximately one week under the OSF Proposal compared to the pre-OSF Proposal. Under the current water management operations, flows are above 900 cfs at the WICO gauge for approximately 50 percent of the time during the period of September 1 to October 15. Under the OSF Proposal, flows are above 900 cfs at the WICO gauge for approximately 33 percent of the time during this period.

Table 36. Median number of days exceeding particular flow thresholds at the WICO gauge for period immediately preceding Oregon spotted frog overwintering (September 1 – October 15).

<table>
<thead>
<tr>
<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td>300 cfs</td>
<td>42</td>
<td>93%</td>
<td>42</td>
<td>93%</td>
<td>0</td>
</tr>
<tr>
<td>400 cfs</td>
<td>36</td>
<td>80%</td>
<td>38</td>
<td>84%</td>
<td>-2</td>
</tr>
<tr>
<td>500 cfs</td>
<td>35</td>
<td>78%</td>
<td>37</td>
<td>82%</td>
<td>-2</td>
</tr>
<tr>
<td>600 cfs</td>
<td>33</td>
<td>73%</td>
<td>35</td>
<td>78%</td>
<td>-2</td>
</tr>
<tr>
<td>700 cfs</td>
<td>31</td>
<td>69%</td>
<td>32</td>
<td>71%</td>
<td>-1</td>
</tr>
<tr>
<td>800 cfs</td>
<td>22</td>
<td>49%</td>
<td>29</td>
<td>64%</td>
<td>-7</td>
</tr>
<tr>
<td>900 cfs</td>
<td>15</td>
<td>33%</td>
<td>23</td>
<td>51%</td>
<td>-8</td>
</tr>
<tr>
<td>1,000 cfs</td>
<td>9</td>
<td>20%</td>
<td>15</td>
<td>33%</td>
<td>-6</td>
</tr>
</tbody>
</table>

Deschutes River between the Little Deschutes River and the Colorado Street Bridge (Reaches 3 to 7)

The following narrative includes five reaches of the Deschutes River that stretch between Little Deschutes River and the Colorado Street Bridge in Bend, OR: Reach 3 (Little Deschutes to Benham Falls), Reach 4 (Benham Falls to Dillon Falls), Reach 5 (Dillon Falls to Lava Island Falls), Reach 6 (Lava Island Falls to COID diversion) and Reach 7 (COID diversion to Colorado Street Bridge). Reaches 3, 4 and 7 contain known areas along this stretch of the Deschutes River where breeding activity is concentrated and consistent annually: Sunriver, Slough Camp (East and SW Slough Camp sites) and the Old Mill (Les Schwab Amphitheater (LSA) Marsh and Old Mill pond). Individual frogs were detected in Reach 6 in 2016 (i.e., Private Preserve RM 172) but breeding at this location has not been confirmed. No spotted frogs have been confirmed in
Reach 5. However, this reach of the Deschutes River located between Dillon Falls and Lava Island Falls has had little monitoring within the wetland habitats that are suitable during portions of the year.

As described in the Environmental Baseline, hydrological conditions of spotted frog habitat within these reaches is influenced by the combined storage and release of water from Wickiup Dam, flows from the unregulated tributaries of the Fall and Spring Rivers, and Little Deschutes River flows. Therefore, our hydrological monitoring work to date has attempted to calibrate the observed water levels in wetlands with the flows at the BENO gauge. Most of the hydrological monitoring has occurred in the Slough Camp area on Federal lands in Reach 4, an important area for spotted frog conservation. Hydrological monitoring data in Reaches 6 and 7 are limited. Furthermore, Reach 7 hydrological conditions are not directly related to flows at the BENO gauge. Rather flows in Reach 7 must be calculated by deducting withdrawals at Central Oregon and Arnold Irrigation District diversions and a 7% groundwater loss of from flows at the BENO gauge. Therefore, our RiverWare modeling analysis of flow conditions, below, only includes Reaches 3 through 5 where we can correlate wetland conditions to flows at the BENO gauge.

Table 37. Analysis of reaches with spotted frog sites between the Little Deschutes River and the Colorado Street Bridge.

<table>
<thead>
<tr>
<th>River Reaches with spotted frogs</th>
<th>Site location</th>
<th>~ River Mile (RM)</th>
<th>Ownership</th>
</tr>
</thead>
<tbody>
<tr>
<td>3: Little Deschutes to Benham Falls</td>
<td>Sunriver</td>
<td>188 – 191.5</td>
<td>Private</td>
</tr>
<tr>
<td>4: Benham to Dillon Falls</td>
<td>SW Slough Camp</td>
<td>180</td>
<td></td>
</tr>
<tr>
<td>East Slough Camp</td>
<td>East Slough Camp (duck blind marsh)</td>
<td>179 - 180</td>
<td>US Forest Service</td>
</tr>
<tr>
<td>East Slough (Lily Pad pond)</td>
<td>East Slough Transducer Pond</td>
<td></td>
<td></td>
</tr>
<tr>
<td>S. Ryan Ranch*</td>
<td></td>
<td>179</td>
<td></td>
</tr>
<tr>
<td>6: Lava Island Falls to COID diversion</td>
<td>Private Preserve ** RM 172</td>
<td>172</td>
<td>Private</td>
</tr>
<tr>
<td>7: COID Diversion to Colorado Street Bridge</td>
<td>Old Mill - LSA Marsh***</td>
<td>167.5 - 168</td>
<td>Private</td>
</tr>
</tbody>
</table>

* Occasional breeding detected; ** New site juveniles only; *** Old Mill Pond not affected by flows; unk – Unknown

River flows also influence habitat to varying degrees within the analysis reaches. For example, spotted frog habitat in Sunriver, located on private land in Reach 3, is managed artificially with weirs. Therefore, Sunriver wetlands are buffered from the winter low flows and maintain water through winter. Due to the weir elevations, Sunriver wetlands do not receive surface water from the Deschutes River until flows out of Wickiup Dam exceed 1,000 cfs at the WICO gauge. We have observed a positive effect to spotted frogs when irrigation flow releases inundate wetlands in Sunriver and increase area of inundation within the rearing habitat in Sunriver. When flows at
WICO are below 1,000 cfs and water from the river is not inundating wetland habitats where spotted frogs breed in the spring, stranding of egg masses is likely to occur. Further hydrological assessment is needed within the Sunriver area wetlands to more precisely assess the influence of storage and release operations and determine flow thresholds in the Deschutes River that may affect spotted frogs in the managed weir system.

RiverWare-modeled flow comparison of the OSF Proposal and Current Condition at the Benham Falls (BENO) gauge (Reaches 3, 4 and 5)

Figure 80 depicts the RiverWare modeled flows at the BENO gauge for the current condition and the proposed action (i.e., the OSF Proposal). Hydrographs for Water Year 2017 (Oct 1, 2016 to June 5, 2017) representing actual implementation of the OSF proposal and WY 2016 (October 1, 2015 to Sept 30, 2016) also are included in Figure 80.

As modeled, implementation of the OSF Proposal will result in flows reaching approximately 1,300 cfs at BENO in early April compared to approximately 1,100 cfs under the current condition (Figure 80). The modeled flows for both the proposed action and the current condition show a steep increase in mid-April to between approximately 2,200 cfs. During the water years of 2016 and 2017, the actual flows from mid-April to mid-May ranged between 1,500 and 1,700 cfs. The modeled flows for the proposed action and the current condition drop from high flows above 2,000 cfs in late April to below 1,500 in early May before rising again to above 2,000 in mid-May. The OSF Proposal implementation also shows that flows will be lower than current conditions in mid-July through September at the BENO gauge.

Again, we note that there is a variation in the modeled hydrographs for the current condition and the proposed action when compared to the actual hydrographs for water years 2016 and 2017. These differences in the hydrographs occur in mid to late April, in mid to late May and in June (Water Year 2017 not included). This difference in hydrographs is worth noting here as water management in 2017 reflects similar water management to be implemented via the OSF Proposal.
Assuming that the RiverWare-modeled flows for the OSF Proposal will occur at the BENO gauge as reflected in the hydrographs presented in Figure 80, we conduct our analysis below for the modeled hydrographs. Since water operations below Wickiup Dam are expected to remain similar to past years, we also refer to our Environmental Baseline to describe ongoing effects to the Oregon spotted frog and its habitat.

RiverWare-modeled Flow Comparison of Duration at the BENO Gauge for the OSF Proposal and Current Condition

To assess a change in hydrological condition via implementation of the OSF Proposal in Reaches 3 through 5, we compared the duration of RiverWare-modeled flows at the BENO gauge for the OSF Proposal and the current condition (referred to as pre-OSF Proposal). This comparison between modeled flows was done for the breeding, rearing and prior to overwintering periods of the spotted frog life cycle and is represented in Tables 38, 39 and 40. Juvenile, subadult, and adult spotted frogs are using the habitat during all seasons.

The median number of days that RiverWare-modeled flows are greater than 1100, 1200, 1400, 1600, and 1800 cfs for the OSF Proposal compared to the current condition (pre-OSF Proposal) are shown in Table 38 for the spotted frog breeding period, Table 39 for the tadpole rearing period and Table 40 for the period of time particularly important to juveniles, subadult and adult spotted frogs prior to overwintering (September 1 to October 15). The minimum flow value of 1,100 cfs was selected because this is the flow at Benham Falls in which changes to habitat quantity in adjacent wetlands is noticeable.
Table 38. Median number of days exceeding particular flow thresholds at the Benham Falls gauge during the Oregon spotted frog breeding season (March 15-April 30).

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<tbody>
<tr>
<td>1,100 cfs</td>
<td>30</td>
<td>64%</td>
<td>30</td>
<td>64%</td>
<td>0</td>
</tr>
<tr>
<td>1,200 cfs</td>
<td>29</td>
<td>62%</td>
<td>18</td>
<td>38%</td>
<td>+11</td>
</tr>
<tr>
<td>1,400 cfs</td>
<td>19</td>
<td>40%</td>
<td>13</td>
<td>28%</td>
<td>+6</td>
</tr>
<tr>
<td>1,600 cfs</td>
<td>15</td>
<td>32%</td>
<td>13</td>
<td>28%</td>
<td>+2</td>
</tr>
<tr>
<td>1,800 cfs</td>
<td>12</td>
<td>26%</td>
<td>9</td>
<td>19%</td>
<td>+3</td>
</tr>
</tbody>
</table>

The RiverWare modeled flows show that the median number of days that flows exceed 1,100 to 1,800 cfs at the BENO gauge is greater under the OSF Proposal compared to the current condition during the breeding period. It appears that the earlier flow releases from Wickiup Dam (i.e., 600 cfs by April 1) combined with inputs from the unregulated tributaries (Fall and Spring rivers) and the Little Deschutes River result in higher flows during the breeding period that are above the identified thresholds in Table 38.

Based on our ongoing hydrological monitoring, we have observed a significant increase in surface area inundation of wetlands adjacent to the Deschutes River in reaches 3, 4 and 5 when flows exceed 1,200 cfs at the BENO gauge. Aerial flights conducted before and after flow releases from Wickiup Dam on April 1 show that a large wetland upstream of Benham Falls (Figure 40), the large East Slough Camp marsh (referred to as duck blind marsh) (Figure 43) and wetlands between Dillon and Lava Falls become inundated when flows at BENO are above 1,200 cfs (Figures 55 and 56). Spotted frog breeding was detected earlier in 2017 than in past years within the East Slough Camp marsh which may indicate that the earlier flow releases affect the timing at which spotted frogs breed. The majority of East Slough Camp wetlands are inundated at flows between 1,500 and 1,600 cfs at the BENO gauge. Therefore, we anticipate that there will be a short duration of improvement to spotted frog breeding habitat within the East Slough Camp Complex through implementation of the OSF Proposal.

The median number of days that RiverWare-modeled flows are greater than 1100, 1200, 1400 and 1,600 cfs at the BENO gauge will increase through implementation of the OSF Proposal during the rearing period (Table 39). As explained above, we anticipate improvements to spotted frog habitat within the East Slough Camp complex and other wetlands adjacent to the Deschutes River at flows above 1,200 cfs. RiverWare-modeled flows for the OSF Proposal show that the median number of days that flows exceed 1,200 cfs will occur 98 percent of the time during the rearing period versus 89 percent of the time under the current condition. The median number of days that flows will exceed 1,800 cfs will decrease from 65 to 62 days (3 percent decrease) under the OSF Proposal. However, we do not anticipate that this change is significant since the wetland habitat is fully inundated at flows less than 1,800 cfs at the BENO gauge in important habitat for spotted frogs such as the East Slough Camp complex.
Table 39. Median number of days exceeding particular flow thresholds at the Benham Falls gauge during the Oregon spotted frog tadpole rearing period (April 1-August 1).

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<tbody>
<tr>
<td>1,100 cfs</td>
<td>122</td>
<td>99%</td>
<td>120</td>
<td>98%</td>
<td>+2</td>
</tr>
<tr>
<td>1,200 cfs</td>
<td>121</td>
<td>98%</td>
<td>109</td>
<td>89%</td>
<td>+12</td>
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<td>1,600 cfs</td>
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<td>68%</td>
<td>82</td>
<td>67%</td>
<td>+2</td>
</tr>
<tr>
<td>1,800 cfs</td>
<td>62</td>
<td>50%</td>
<td>65</td>
<td>53%</td>
<td>-3</td>
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The RiverWare modeling predicts that implementation of the OSF Proposal will result in fewer days in September and early October where flows at the BENO gauge will exceed 1,200, 1,400, 1,600 and 1,800 cfs compared to current condition (Table 39) and same number of days where flows exceed 1,100 cfs during this period of time. The reduction in flows under the OSF Proposal during this period is likely to reduce the surface area of inundation within wetlands, thereby reducing connectivity between rearing habitats and overwintering habitats for spotted frogs. Future monitoring work will inform our assumptions about the importance of connectivity between rearing and overwintering habitat under storage and release operations in the Deschutes River system. At East Slough Camp, the USGS and the Service will be working together under a Scientific Support Partnership to assess the timing of movement and habitat utilization during this critical time period.

Table 40. Median number of days exceeding particular flow thresholds at the Benham Falls gauge for the period immediately preceding Oregon spotted frog overwintering (September 1 – October 15) under the OSF Proposal and Pre-OSF water management operations.

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<tbody>
<tr>
<td>1,100 cfs</td>
<td>34</td>
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<td>34</td>
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<tr>
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<td>34</td>
<td>76%</td>
<td>-1</td>
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<tr>
<td>1,800 cfs</td>
<td>1</td>
<td>2%</td>
<td>8</td>
<td>18%</td>
<td>-7</td>
</tr>
</tbody>
</table>

Summary of RiverWare-modeled Flow Comparisons in the Deschutes River

Reaches 1 and 2 include wetlands adjacent to the Deschutes River between Wickiup Dam and the Little Deschutes River from approximately RM 224 (upstream) to RM 192.5 (downstream). In these river reaches, the hydrological analysis of RiverWare-modeled flows at the WICO gauge indicates that implementation of the OSF Proposal results in fewer days during all life cycle
periods analyzed where flows are above suitable habitat thresholds described in the Environmental Baseline (e.g., 900 cfs).

There are at least five spotted frog breeding areas within Reaches 1 and 2 where these effects are likely to occur. However, the Dead Slough site represents the only population of spotted frogs between Wickiup Dam and the Fall River and is therefore very important to maintain in the context of recovery in these reaches.

Although under the OSF Proposal, flows at the WICO gauge are reaching 600 cfs slightly earlier in the spotted frog breeding period, there are fewer days that flows are intersecting vegetation and reaching thresholds that provide high quality suitable habitat during the breeding period. The RiverWare model also predicts that there will be fewer days where flows exceed the 900 cfs threshold during the spotted frog rearing period. The model results for the OSF Proposal show that there are a median of 71 days (58% of the time) versus 78 days (63% of the time) in which flows exceed 900 cfs from April 1 to August 1 during tadpole rearing, juvenile rearing, and adult habitat use when compared to the baseline conditions (Table 39). This shows that the OSF proposal reduces the amount of time that habitat in Reaches 1 and 2, including Dead Slough, are providing functional habitat from April 1 to August 1 by approximately 1 week or 5%.

The modeled hydrographs for the OSF Proposal versus current conditions at the WICO gauge (Figure 79) indicate that these lower flows will occur on the early end of the rearing period in April when eggs are hatching out. We know from site observations described in the Environmental Baseline that there are adverse effects occurring to the spotted frog during this time period in mid-April because spotted frogs, eggs and tadpoles are at increased risk of predation when they are without the protective cover of emergent vegetation. The model results indicate that these effects are likely to continue as described in the Environmental Baseline.

The RiverWare model also predicts that flows at the WICO gauge from September 1 to October 15 will drop below the 900 cfs threshold approximately 8 days earlier through implementation of the OSF Proposal. As described above, this is an important period of movement for spotted frogs as they prepare to seek overwintering habitat, which becomes very limited during the irrigation storage season. The Wickiup experimental ramp down study documented the loss of wetland and riverine function as flows in the river decreased at the onset of the storage season (Appendix). An earlier ramp down may reduce the ability of spotted frogs to reach suitable overwintering habitats and increase the risk of predation on spotted frogs as they move to overwintering sites.

Reaches 3, 4 and 5 include wetlands adjacent to the Deschutes River between its confluence with the Little Deschutes River (~ RM 192.5) and Lava Island Falls (~ RM 174). In these river reaches, the hydrological analysis of RiverWare-modeled flows at the BENO gauge indicates that the OSF Proposal is likely to result in flows greater than 1,200 cfs for more days during the spotted frog breeding and rearing period more often than under the conditions created by the Pre-OSF Proposal operations. Given that we have identified 1,200 cfs at BENO as a flow that improves hydrological conditions in wetlands in these reaches, we anticipate that spotted frog breeding and rearing life stages will be slightly improved through implementation of the OSF Proposal. Spotted frog habitat within these reaches will be wetted earlier in the breeding season.
due to the earlier flow releases at Wickiup Dam combined with flows from upstream tributaries (i.e., Fall, Spring, and Little Deschutes rivers). Under the OSF Proposal, wetlands within these reaches are likely to remain above inundation thresholds slightly longer during the spotted frog rearing period.

The only spotted frog populations that occur within these reaches are Sunriver in Reach 3 and Slough Camp (including East Slough Camp) in Reach 4. As described above, Sunriver is less affected by storage and release operations because it is managed with weirs; the WICO gauge is used to assess spotted frog habitat conditions at the Sunriver site. Based on local observations, spotted frog rearing conditions improve at Sunriver when flows exceed 1,000 cfs at the WICO gauge. When WICO flows are below 1,000 cfs during the spring breeding period, egg masses and emerging tadpoles are likely to strand if wetlands are not inundated by river flows. The hydrological analysis of RiverWare-modeled flows indicates there may be a slight decrease in the number of days that flows exceed 1,000 cfs at WICO during the spotted frog rearing period with implementation of the OSF Proposal. The modeled hydrographs for the OSF Proposal versus current conditions at the WICO gauge (Figure 79) indicate that these lower flows will occur on the early end of the rearing period in April when eggs are hatching out. Therefore, there it is likely that spotted frog egg masses or emerging tadpoles will strand in wetlands in Sunriver when flows are below 1,000 cfs at WICO.

The RiverWare-modeled hydrology at the BENO gauge indicates that East Slough Camp, which is most affected by storage and release operations, may benefit slightly during the spotted frog breeding through rearing periods with implementation of the OSF Proposal. However, the RiverWare model predicts that implementation of the OSF Proposal may result in a decrease in flows that fully inundate the wetlands (i.e., 1,600 cfs) earlier in the late summer and early Fall than Pre-OSF Proposal operations. An earlier ramp down as predicted by the model is likely to have adverse effects to spotted frogs at East Slough during the period of time that they begin to seek overwintering habitats. Based on our field observations, the reduction in flows under the OSF Proposal during this period is likely to reduce the surface area of inundation within wetlands, thereby reducing aquatic connectivity between rearing habitats and overwintering habitats for spotted frogs.

The RiverWare model was not used to assess hydrological conditions in Reaches 6 and 7. We have limited information for Reach 6 due to the limited amount of habitat and private land present in this area, as discussed further below.

*Deschutes River from the COID Diversion to the Colorado Street Bridge (Reach 7)*

As noted in the environmental baseline, flows in the Deschutes River at the Old Mill District are affected by losses to groundwater and irrigation season withdrawals of water at the Central Oregon and Arnold diversions. Flows at this location were calculated for 2010 through May 2017 using flows at the BENO gauge minus a 7% groundwater loss and withdrawals at Central Oregon and Arnold diversions. Since Water Year 2017 was operated in a manner similar to the proposed action, this analysis displays the estimated 2017 flows against the calculated average of flows for 2010 through 2016 as depicted in Figure 81 below.
Since the data available for Water Year 2017, at the time this Opinion was prepared, is limited to eight months of the year, it is only possible to make a direct comparison between estimated 2017 flows and estimated average 2010 through 2016 flows during the periods of spotted frog overwintering, breeding, the first half of tadpole rearing, and the latter one-third of the period leading up to overwintering.

There are two notable discrepancies between the 2017 water year and the average 2010 through 2016 flows. First, during the overwintering period of 2017, flows were between 500 and 600 cfs, while the average 2010 through 2016 flows were between 700 and 800 cfs. The reduction of flow within the river by approximately 200 cfs is likely to result in a reduction of suitable overwintering habitat within the Les Schwab Amphitheater (LSA) Marsh. During breeding period in 2017, the flows increased to greater than 1,200 cfs at the onset of breeding, while the average 2010 through 2016 flows did not reach 1,200 cfs until the latter part of the breeding period. Since the LSA Marsh is located within the Deschutes River, the higher flows prior to and during the breeding period are likely to have resulted in less suitable breeding conditions for Oregon spotted frogs, which typical choose shallow, still waters for breeding.

During the early stages of tadpole rearing and juvenile, subadult, and adult habitat use, flows are fairly similar between 2017 and the average 2010 through 2016 daily flows. However, during the latter part of the period leading up to overwintering, estimated 2017 flows dropped more quickly and to a lower level than the 2010 through 2016 daily flows. This sudden drop in flows likely made it more difficult for juvenile, subadult, and adult spotted frogs to locate suitable overwintering habitat. Assuming 2017 flows represent implementation of the OSF Proposal, it is reasonable to expect a significant disruption of juvenile, subadult, and adult spotted frog overwintering behaviors. Furthermore, spotted frogs are likely to avoid breeding within the LSA Marsh if flows are too high in the spring.
The population of spotted frogs within the Old Mill District has declined since it was first discovered in 2012. There are several factors that contributed to the decrease in spotted frogs in this reach of the Deschutes River, as described in the Environmental Baseline. The Service is working with property owners in the Old Mill District under a Candidate Conservation Agreement with Assurances and the Bend Parks and Recreation Department to improve monitoring of spotted frog habitat in the Old Mill District. Future work is needed to determine how changes in flow may affect the suitability of habitats over the life cycle of the spotted frog in the Old Mill area.

6.1.3 Effects in the Little Deschutes River Sub-basin

Under the proposed action, the minimum instream flow in Crescent Creek below Crescent Dam (as measured at the CREO gauge) will be 30 cfs from March 15th through November 30th, and 20 cfs from December 1st through March 14th. Releases of additional water from Crescent Lake Reservoir will continue during the summer to meet TID's irrigation needs, but they will be lower than historical releases, because the release of additional water during winter would reduce the amount of storage available for release in summer. TID will accommodate the reduced availability of Crescent Lake storage water through a combination of reduced deliveries to patrons and transfers of water from other Deschutes Basin Board of Control (DBBC) districts on the Deschutes River, as described above with the 5,600 acre feet of storage in Wickiup Reservoir. The net effect may cause a delayed-start of summer releases from Crescent Lake Reservoir (historically beginning in early July), early cessation of releases (historically, these releases extended into early or mid-September), and lower overall rates of flow during peak summer releases. Outside the irrigation season, flows below Crescent Lake Dam would not likely exceed the specified minimums of 20 to 30 cfs. The minimum instream flows would only be exceeded during the fall, winter, and spring if reservoir capacity was exceeded (i.e., under flood conditions).

The BA explains that from the end of the irrigation season until November 30th, the minimum instream flow below Crescent Dam would be 30 cfs. From December 1st through March 14th, the minimum would be 20 cfs. The transition from 30 cfs to 20 cfs is intended to coincide with seasonal increases in runoff from Crescent Creek tributaries downstream of Crescent Dam (particularly Big Marsh Creek) that reduce the need for the release of storage to maintain riparian wetlands. In case of a dry fall, when 30 cfs might be needed after November 30th, the transition from 30 cfs to 20 cfs would be delayed until the flow in the Little Deschutes River at the LAPO gauge is at least 110 cfs.

The ESA Listing Rule for the Oregon spotted frog included a minimum population estimate of approximately 6,628 adult breeding spotted frogs in the Little Deschutes River sub-basin based on limited breeding surveys conducted on public and private land in 2012 (Final Rule Vol. 79 No. 168 p.51666). Since much of the spotted frog habitat along the Little Deschutes River and Crescent Creek is located on private land, we are unable to conduct breeding surveys unless we are granted permission to access the land. As a result, the number of surveys and consistency of surveys is limited in the Little Deschutes River sub-basin. However, given that spotted frogs are distributed throughout the Little Deschutes River sub-basin and that there are vast wetland complexes that provide suitable habitat for spotted frogs along the mainstem Little Deschutes
River and Crescent Creek, we assume that the frog population within the un-surveyed areas may be well above our minimum adult population estimate in the ESA Listing Rule.

In the Environmental Baseline of this Opinion, we describe that Big Marsh, which is outside of the area affected by the Proposed Action, provides habitat for approximately 80% (i.e., 5,324) of the estimated number of adult Oregon spotted frogs occupying the Little Deschutes River subbasin. Big Marsh drains to Crescent Creek via Big marsh Creek and provides an important source population to the area affected by the Proposed Action.

As described in the *Environmental Baseline* section, Crescent Lake dam is the only water storage structure within the Little Deschutes River sub-basin. The remainder of the sub-basin is unregulated. Runoff in the sub-basin is driven by a snowmelt hydrology in which the highest flows occur in June and low flows occur at the end of summer (R2 and Biota Pacific 2016). Big Marsh Creek is the largest contributor of flow to Crescent Creek, doubling the flow in Crescent Creek at certain times (R2 and Biota Pacific 2016). Although storage and release of water from Crescent Lake dam has an influence on Crescent Creek, this influence is moderated by the significant contribution of flow from Big Marsh Creek. The influence of water storage and release from Crescent Lake on flows in the Little Deschutes River is further moderated by unregulated flows contributed upstream of its confluence with Crescent Creek. These unregulated flows account for the shape of the hydrograph at the LAPO gauge for the majority of the year (Figure 83). Most notable of the hydrograph for LAPO are the peaks that occur in the fall, winter and spring while flows at the CREO gauge at Crescent Dam are constant (Figures 82 and 83). These peaks are natural hydrological events that shape the habitat for Oregon spotted frogs in the Little Deschutes River system.

As depicted in the *Environmental Baseline* section, the most obvious influence of Crescent Lake dam releases on flows at the CREO and LAPO gauges is during the summer months of July, August and September when releases are increased to deliver irrigation water. The RiverWare-modeled current condition represented in Figures 82 and 83, below, shows that release operations may result in an increase in the hydrograph during these summer months at the CREO gauge but the rise in the hydrograph at the LAPO gauge is less apparent during the summer months. When comparing the OSF Proposal to the current condition, it appears that the OSF proposal is likely to result in significantly lower flows during the summer months at the CREO gauge. Similarly, the OSF Proposal may result in lower flows during the summer at the LAPO gauge, particularly in August and September (Figure 83). During the winter months, the RiverWare-modeled hydrographs show that the OSF Proposal may result in significantly higher flows at the CREO gauge but little change at the LAPO gauge, with the exception of October when flows are planned to be higher under the OSF Proposal (Figures 82 and 83). The OSF Proposal appears to have the largest increase in flows over the current condition in mid-April at the CREO gauge (Figure 82). This is an interesting point to note since the Tumalo Irrigation District has been increasing winter flows to benefit the Oregon spotted frog for the past two seasons, represented by the hydrographs for Water Years 2016 and 2017.

The magnitude of influence that the storage and release of water from Crescent Lake dam has on flows within occupied spotted frog habitat on Crescent Creek and the Little Deschutes River is difficult to determine due to the location of the gauges in the Little Deschutes River sub-basin.
The CREO gauge measuring flows on Crescent Creek at Crescent Lake dam is approximately 6 miles upstream of Crescent Creek’s confluence with Big Marsh Creek which does not have a gauge measuring flows. The LAPO gauge measuring flows on the Little Deschutes River near La Pine, OR is greater than 20 river miles downstream of its confluence with Crescent Creek.

Hydrological monitoring within the Crescent Creek system has been focused on attempting to understand the influence of flow releases at Crescent Dam on changes in water levels within the creek and to a lesser extent the adjacent wetlands (R2 and Biota Pacific 2016 and Biota Pacific 2017). As described above, Big Marsh Creek provides significant inputs to the Crescent system but does not have a hydrological gauge. The upper, unregulated watershed of the Little Deschutes River is also without a gauge. Due the naturally dynamic hydrological inputs and lack of river gauges, we are not yet able to establish absolute thresholds in terms of flow releases at the Crescent Lake dam (CREO gauge) that affect spotted frog habitat within Crescent Creek or the Little Deschutes River.

Despite having precise flow thresholds that provide high quality spotted frog habitat, flows at the CREO and LAPO gauges that we believe influence spotted frog habitat were selected for the following hydrological analysis using the RiverWare model. Our hydrological analysis for Crescent Creek and the Little Deschutes River, below, uses the RiverWare-modeled hydrology to compare flows at the CREO and LAPO gauges during the breeding, rearing and prior to overwintering phases of the spotted frog life cycle. Juvenile, subadult, and adult spotted frogs are using the habitat during all seasons. Additional habitat monitoring at select spotted frog sites will be necessary over the period of time in which this proposed action is implemented to properly assess the effects to spotted frogs and their habitat resulting from storage and release at the Crescent Dam.
Figure 82. RiverWare modeled flows for Crescent Creek at Crescent Lake, OR (CREO) representing “current condition” and the proposed action and Water Year 2017 (Oct 1, 2016 to June 5, 2017) representing actual implementation of the OSF proposal and WY 2016 (October 1, 2015 to Sept 30, 2016).

Figure 83. RiverWare modeled flows for Little Deschutes River near La Pine, OR (LAPO) representing “current condition” and the proposed action and Water Year 2017 (Oct 1, 2016 to June 5, 2017) representing actual implementation of the OSF proposal and WY 2016 (October 1, 2015 to Sept 30, 2016).
6.1.3.1 RiverWare-modeled Flow Comparison of the OSF Proposal and Current Condition at the Crescent Lake Dam (CREO) Gauge

Under the OSF Proposal, flows will be maintained between 20 and 35 cfs in Crescent Creek below Crescent Lake Dam during the overwintering period the majority of the time, while under pre-OSF Proposal operations, flows were at 11 cfs or less the majority of the time. Therefore, implementation of the OSF Proposal is likely to result in an increase of between 9 and 24 cfs in Crescent Creek during the spotted frog overwintering period. It is likely that this increase in flow during the overwintering period will increase the quantity and improve the quality of overwintering habitat available to Oregon spotted frogs. However, during the winter of 2016-2017 these higher flows were maintained in Crescent Creek as per the Settlement Agreement. We note that these higher flows from the dam combined with heavy snows resulted in very high water in spotted frogs sites during the spring breeding period, discussed below.

Using the RiverWare-modeled hydrology, the median number of days that flows at the CREO gauge exceed 20, 30, 40 and 50 cfs during the spotted frog breeding period were compared for the OSF Proposal and pre-OSF Proposal (Table 41). The OSF Proposal provides flows over 20, 30, 40, and 50 cfs for 32, 37, 15, and 13 more days, respectively, compared to pre-OSF Proposal operations. The overall increase in flows under the OSF Proposal may lead us to believe that there is a significant improvement in breeding habitat for spotted frogs during this period. However, our observations in the spring of 2017 indicate that more water during the breeding season is not necessarily beneficial to spotted frogs when there has been a significant amount of precipitation in the form of snow and rain during the winter prior to the breeding season. The combined effects of flow releases from the dam and precipitation are likely to result in high flows in Crescent Creek and the riverine wetlands where spotted frogs seek still, shallow water to deposit their eggs after winters with high precipitation.

Table 41. Median number of days exceeding particular flow thresholds in Crescent Creek below Crescent Lake Dam during the Oregon spotted frog breeding period (March 15-April 30).

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<tr>
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<td>13</td>
<td>28%</td>
<td>0</td>
<td>0%</td>
<td>+13</td>
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Table 42 shows the median number of days that flows are greater than 30, 40, 50, 60, 70, 80 and 90 cfs for the period of time tadpoles are rearing under the OSF Proposal compared to the current condition. Similar to the breeding period, the OSF Proposal appears to provide additional days that are above these flows. The OSF Proposal may result in a significantly greater number of days exceeding flows of 30, 40, 50, 60 and 90 cfs compared to the pre-OSF Proposal operations while tadpoles are rearing. However, pre-OSF Proposal operations have resulted in a
significantly greater number of days exceeding flows of 70 and 80 cfs during tadpole rearing. As shown in the RiverWare-modeled hydrographs (Figure 82), above, it appears that the OSF Proposal may result in a decrease in flows compared to the current condition in the later part of May and through June. Therefore, less rearing habitat may be available to spotted frogs in late May and June. Habitat effects during this period of time should be monitored during implementation of the Proposed Action.

Table 42. Median number of days exceeding particular flow thresholds in Crescent Creek below Crescent Lake Dam during the Oregon spotted frog tadpole rearing period (April 1-August 1).

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<tr>
<td>90 cfs</td>
<td>20</td>
<td>16%</td>
<td>7</td>
<td>6%</td>
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Table 43 depicts the median number of days under past operations and under the proposed OSF Proposal that flows are greater than 30 to 100 cfs for the period of time particularly important to juvenile, subadult and adult spotted frogs prior to the overwintering period (September 1 to October 15). Leading up to the overwintering period, there is no difference in the median number of days in which flows exceed 30, 40, 50, 60 and 100 cfs between the OSF Proposal and pre-OSF Proposal operations. However, under the proposed action, the median number of days over the period of record that flows are greater than 70 and 80 cfs in Crescent Creek below Crescent Lake Dam will be reduced by approximately 3 to 4 weeks. We anticipate that the earlier reduction in flows under the OSF Proposal is likely to have adverse effects to spotted frogs during a critical movement period to overwintering habitat. The reduction in suitable habitat may hinder movement to overwintering habitat and increase the risk of predation to spotted frogs.

Big Marsh Creek flows are typically lower during September to mid-October. Therefore, there is little supplemental flow to spotted frog habitat in Crescent Creek from Big Marsh Creek at this time. Based on historical conditions, precipitation increases in November in the Crescent Creek system. However, the lack of a hydrological gauge on Big Marsh Creek makes it difficult to assess how the reduction of flows at the dam (as measured at the CREO gauge) are affecting spotted frog habitat from the fall through the winter in the Crescent Creek habitats.
Table 43. Median number of days exceeding particular flow thresholds in Crescent Creek below Crescent Lake Dam for period immediately preceding the Oregon spotted frog overwintering period (September 1 – October 15).

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</tbody>
</table>

Effectiveness monitoring of the modifications to flows are essential in determining whether or not the implementation of flow changes result in benefits to spotted frogs at key periods in their life cycle.

6.1.3.2 RiverWare-modeled Flow Comparison of the OSF Proposal and Current Conditions in the Little Deschutes River at the La Pine, OR (LAPO) Gauge

The following narrative describes the effects of the OSF Proposal by comparing RiverWare-modeled flows for the OSF Proposal to modeled pre-OSF Proposal flows in the Little Deschutes River at the LAPO gauge. Specifically, the median number of days over the period of record that flows are greater than 200, 300, and 400 cfs for the period of time frogs are breeding (Table 44) and tadpoles are rearing (Table 45), and the median number of days over the period of record that flows are greater than 100, 150, and 200 cfs prior to the overwintering period (Table 46), are compared between the pre-OSF Proposal operations and the OSF Proposal.

The OSF Proposal provides flows over 200, 300, and 400 cfs for 9, 5, and 2 more days than the pre-OSF Proposal operations (Table 44). As described above, the overall increase in flows under the OSF Proposal may lead to an improvement in breeding habitat for spotted frogs during this period. However, the Little Deschutes River system receives substantial contributions of flow from upper, unregulated watersheds and our observations in the spring of 2017 indicate that more water during the breeding season is not necessarily beneficial to spotted frogs during wet winters.
Table 44. Median number of days exceeding particular flow thresholds in the Little Deschutes River at the LAPO gauge during the Oregon spotted frog breeding period (March 15 - April 30).

<table>
<thead>
<tr>
<th></th>
<th></th>
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<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>200 cfs</td>
<td>44</td>
<td>94%</td>
<td>35</td>
<td>74%</td>
<td>+9</td>
</tr>
<tr>
<td>300 cfs</td>
<td>22</td>
<td>47%</td>
<td>17</td>
<td>36%</td>
<td>+5</td>
</tr>
<tr>
<td>400 cfs</td>
<td>9</td>
<td>19%</td>
<td>7</td>
<td>15%</td>
<td>+2</td>
</tr>
</tbody>
</table>

While tadpoles are rearing, the OSF Proposal provides two more days above 200 cfs and 10 more days above 300 cfs compared to the pre-OSF Proposal operations at the LAPO gauge (Table 45). However, there are two less days of flows above 400 cfs under the OSF Proposal. Although these results indicate that there may be minimal change between the OSF Proposal and current conditions, the comparison of hydrographs above indicate that prior to implementation of the OSF Proposal, flows at the LAPO gauge are higher in August (Figure 83). Under the OSF Proposal, lower flows in August could reduce the amount of rearing habitat for spotted frogs. However, habitat monitoring in the post-breeding season and during the rearing period is necessary to determine how implementation of the OSF Proposal is likely to affect spotted frogs within the Little Deschutes River sites.

Table 45. Median number of days exceeding particular flow thresholds at the LAPO gauge during the Oregon spotted frog tadpole rearing period (April 1-August 1).

<table>
<thead>
<tr>
<th></th>
<th></th>
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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>200 cfs</td>
<td>92</td>
<td>75%</td>
<td>90</td>
<td>73%</td>
<td>+2</td>
</tr>
<tr>
<td>300 cfs</td>
<td>70</td>
<td>57%</td>
<td>60</td>
<td>49%</td>
<td>+10</td>
</tr>
<tr>
<td>400 cfs</td>
<td>48</td>
<td>39%</td>
<td>50</td>
<td>41%</td>
<td>-2</td>
</tr>
</tbody>
</table>

Prior to the spotted frog overwintering period (September 1 to October 15), there is little difference between the median number of days that flows are above 100, 150 and 200 cfs when comparing implementation of the OSF Proposal to the current condition (Table 46). However, we once again note the comparisons of RiverWare-modeled hydrographs above that show higher August flows under the current condition compared to the OSF Proposal. Basing our analysis only on the RiverWare-modeled hydrology, we assume that there is no change in the connectivity of spotted frog rearing habitats with overwintering habitats with implementation of OSF Proposal. We emphasize that there is a need to conduct appropriate habitat monitoring at all life cycle stages within spotted frog breeding sites in the Little Deschutes River sub-basin as the OSF Proposal is implemented. Information gathered through monitoring efforts will be essential for the Deschutes Basin HCP that is under development.
Table 46. Median number of days exceeding particular flow thresholds at the LAPO gauge for period immediately preceding the Oregon spotted frog overwintering period (September 1 – October 15).

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>100 cfs</td>
<td>36</td>
<td>80%</td>
<td>33</td>
<td>73%</td>
<td>+3</td>
</tr>
<tr>
<td>150 cfs</td>
<td>18</td>
<td>40%</td>
<td>18</td>
<td>40%</td>
<td>0</td>
</tr>
<tr>
<td>200 cfs</td>
<td>4</td>
<td>9%</td>
<td>6</td>
<td>13%</td>
<td>-2</td>
</tr>
</tbody>
</table>

6.1.4 Acres of Spotted Frog Habitat Affected in the Upper Deschutes River and Little Deschutes River Sub-basins

This section of the effects analysis focuses on describing the acreages of Oregon spotted frog habitat that are affected by the Proposed Action. To avoid redundancy in describing effects, we refer to the Environmental Baseline and Effects Analysis above to articulate the ongoing effects from irrigation storage and release in the Deschutes Basin and the effects resulting from the Proposed Action, respectively.

Currently, spatial hydraulic models are not available to estimate the difference in change of acreages of inundation in wetlands as a result of storage and release operations over the broad geographic area that is affected by the Proposed Action. Therefore, we used ArcGIS to estimate the acreages of spotted frog habitat that are impacted by the Proposed Action. These acreage estimates have been calculated at the site and waterbody or river reach scale for the Upper and Little Deschutes River sub-basins (see Tables 47-50). Spotted frog breeding site polygons represent the approximate areas used by spotted frogs for breeding and rearing. These polygons are nested within the broader waterbody or river reach scale. The broader waterbody and river reach scale acreages include areas where we have detected spotted frogs during the summer or periodically. The broad acreages also include areas with suitable habitat that have not been surveyed due to access issues (e.g., private lands or difficult to access) but are within the known geographic range of spotted frogs.

National Wetland Inventory (NWI) maps were used to delineate the estimated wetland acreages and open water habitats that may be affected by the Proposed Action at the waterbody or river reach scale. We utilized NWI maps in an attempt to account for the change in fluctuating water conditions. The wetland habitat types recognized by the NWI that are utilized by spotted frogs include freshwater emergent wetland, freshwater forested/shrub wetland, freshwater pond, lake, and riverine. The lake and riverine types account for open water acreages. Freshwater pond, freshwater forested/shrub wetland and freshwater emergent wetland habitat types are included in the wetland acreages. For the purposes of our GIS analysis, we assumed that the open water acreages are close to what remains inundated during low water conditions (i.e., during the
storage season in rivers and the end of irrigation season in reservoirs). However, we know that the open water acreages are an over-estimate of the habitat that is available for spotted frogs during low water conditions based on our aerial flights and on-the-ground observation. Likewise, a large acreage of wetland habitats are not completely without water during the low water conditions. For example, we know that during the winter irrigation storage season there are Deschutes River floodplain wetlands that retain water through this period.

Tables 47, 48 and 50 provide approximate acreages by population or site name for the site scale. The Upper Deschutes River sub-basin acreages above and below Wickiup Dam are represented in Tables 47 and 48, respectively. The Little Deschutes River sub-basin acreages are presented in Table 50. We note that these acreages are slightly different than those presented for critical habitat because some of these wetland acreages were excluded in the final critical habitat rule.

Table 47. Oregon spotted frog sites, habitat acreages and estimated minimum adult population size above Wickiup Dam.

<table>
<thead>
<tr>
<th>Waterbody or River</th>
<th>Population/Sub-popn/Site Name</th>
<th>Polygon Acreage of OSF Site</th>
<th>Estimated Wetland Acreage of Waterbody</th>
<th>Estimated Open Water Acreage</th>
<th>Minimum Adult Population Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crane Prairie Reservoir</td>
<td></td>
<td>4,982</td>
<td>583*</td>
<td>4,238</td>
<td>700 - 800</td>
</tr>
<tr>
<td>Deschutes River</td>
<td>Deschutes River Arm of Wickiup</td>
<td>2</td>
<td>2,961</td>
<td>7,180</td>
<td>10 - 20</td>
</tr>
<tr>
<td>Wickiup Reservoir</td>
<td></td>
<td>10,231</td>
<td></td>
<td></td>
<td>unknown</td>
</tr>
</tbody>
</table>

*Freshwater emergent marsh acres only.

Table 48. Oregon spotted frog sites, habitat acreages and estimated minimum adult population size below Wickiup Dam.

<table>
<thead>
<tr>
<th>Waterbody or River</th>
<th>Population/Sub-popn/Site Name</th>
<th>Polygon Acreage of Breeding Site</th>
<th>Estimated Wetland Acreage***</th>
<th>Estimated Open Water Acreage</th>
<th>Minimum Adult Population Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deschutes River</td>
<td>Dead Slough</td>
<td>17</td>
<td>1,200</td>
<td>985</td>
<td>130</td>
</tr>
<tr>
<td></td>
<td>La Pine SP SW Slough</td>
<td>11</td>
<td></td>
<td>2-4</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Private land* RM 202</td>
<td>3</td>
<td></td>
<td>2</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Island Loop* RM 195 (private)</td>
<td>2</td>
<td></td>
<td>16</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Sunriver**</td>
<td>115</td>
<td></td>
<td>700-800</td>
<td></td>
</tr>
<tr>
<td></td>
<td>East Slough Camp</td>
<td>47</td>
<td></td>
<td>200</td>
<td></td>
</tr>
<tr>
<td></td>
<td>S. Ryan Ranch*</td>
<td>1</td>
<td></td>
<td>2</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Old Mill - LSA Marsh</td>
<td>8</td>
<td></td>
<td>10-30</td>
<td></td>
</tr>
</tbody>
</table>

** Partial effects; *** includes breeding site acreages.
6.1.4.1 Acres of Oregon Spotted Frog Habitat Affected in the Upper Deschutes River Sub-basin

The timing and duration of spotted frog habitat impacts differ above and below Wickiup Dam. Above Wickiup Reservoir, the reservoirs provide habitat for spotted frogs during the irrigation storage season (winter) and into the early parts of the irrigation season (spring). However, when water is drawn upon for irrigation, the wetlands along the margins of the reservoirs drain and become less suitable habitat for Oregon spotted frogs. Downstream of Wickiup Dam, much of this habitat is devoid of water during the storage season and does not provide suitable habitat for spotted frogs, as described in the Environmental Baseline and Effects Analysis above. During the irrigation season, these wetland habitats are inundated and provide suitable habitat for Oregon spotted frogs. When wetlands are drained during the irrigation storage season, it is reasonably certain that spotted frogs will experience a restriction in movement, reduction in cover, and stranding, all of which increase the likelihood of predation and mortality.

Acres Affected Above Wickiup Dam

Crane Prairie Reservoir, including adjacent habitat, encompasses approximately 4,982 acres (Table 47). In ArcGIS, there are an estimated 4,238 acres of open water within Crane Prairie Reservoir that extend into approximately 583 acres of freshwater emergent marsh along the shoreline. Breeding and rearing areas for spotted frogs occur within these shoreline marsh habitats which are inundated with water when reservoir volumes exceed 40,000 acre feet. Implementation of the OSF Proposal is likely to increase the duration of inundation within the marsh habitats that provide important breeding and rearing habitat for spotted frogs.

The Proposed Action results in reservoir storage volumes ranging between 35,000 and 50,000 acre-feet. Water management of the reservoir under the OSF Proposal aims to reach a reservoir storage volume of approximately 45,000 acre feet by mid-March to provide suitable spotted frog breeding habitat within the emergent vegetation. Reservoir volumes between 45,000 and 50,000 acre feet will be maintained during the spotted frog rearing period until July 15 when the reservoir is draw down to deliver irrigation water downstream. Since the change in acreage of inundation between 35,000 and 50,000 acre feet is not discernable using ArcGIS, we estimate that there will be an improvement to approximately 583 acres of wetlands along the shoreline of Crane Prairie Reservoir to support spotted frogs during the breeding and rearing periods of the Oregon spotted frog life cycle.

Under the Proposed Action, from July 16th to July 31st, storage in excess of 35,000 acre-feet will be released at a rate that would result in a drop in reservoir elevation of no more than 0.05 feet per day. The slow rate of decrease is intended to provide spotted frogs the ability to move towards the residual pool of water without stranding. Since the metamorphosis period may not be complete when the reservoir draw down period begins, there is potential for some pre-metamorphic spotted frogs to strand as wetlands are voided of water within the approximate 583 acres of shoreline wetlands.

The Proposed Action requires that the residual reservoir pool remain at 35,000 acre feet, which is above what is typically maintained under pre-Proposed Action conditions. The maintenance of higher water surface elevations through winter lessens the distance between the potential...
wintering sites and spring breeding habitats which reduces the energy expenditure of spotted frogs during this time in the life cycle and the potential for predation of spotted frogs by fish. Given that fish are abundant in Crane Prairie, spotted frogs that choose to overwinter within the reservoir at volumes of 35,000 acre feet remain at risk to predation.

Crane Prairie Reservoir supports an important population of spotted frogs within the Upper Deschutes River sub-basin. Spotted frog populations occur upstream of Crane Prairie within at least three tributaries: (1) the Deschutes River; (2) Deer Creek; and (3) Cultus Creek. This distribution pattern provides an opportunity for genetic exchange between spotted frog populations which is important in maintaining the viability of the species. Overall, implementation of the OSF Proposal is likely to improve survival of spotted frogs in Crane Prairie Reservoir by providing more adequate water levels at the right time to support spotted frog life history requirements.

Wickiup Reservoir encompasses approximately 10,231 acres. In ArcGIS, there are an estimated 7,180 acres of open water within Wickiup Reservoir and approximately 2,961 acres of wetlands that includes where the Deschutes River flows into the reservoir. The small, two-acre spotted frog breeding site between the reservoirs (i.e., the Deschutes River arm of Wickiup Reservoir) is included with the wetland acreage for Wickiup Reservoir.

As described in the hydrological analysis using RiverWare above, we anticipate that implementation of the OSF Proposal may have adverse effects to the small, two-acre spotted frog breeding site between the reservoirs due to changes in flow at the CRAO gauge resulting from a change in management at Crane Prairie Reservoir combined with reduced volumes of water within Wickiup Reservoir into spring. As described earlier, although water management may improve conditions for spotted frogs in one location (e.g., Crane Prairie), there may be adverse effects to spotted frogs at another location (e.g., Deschutes River Arm of Wickiup).

We also assume no change in the degraded baseline condition for Wickiup Reservoir as a result of the Proposed Action. The Proposed Action will continue to drain the 2,961 acres of wetlands in Wickiup Reservoir and result in a small storage volume at the end of the irrigation season within which spotted frogs must overwinter with predaceous fish. Spotted frog breeding surveys should be implemented within wetland habitats throughout the expansive reservoir to determine if habitats provide increased suitability for spotted frogs with lower reservoir volumes that are anticipated through implementation of the OSF Proposal.

Acres Affected Below Wickiup Dam

As described in the hydrological effects above, the Proposed Action does little to provide year-round improvement to spotted frog habitats, including designated critical habitat, adjacent to the Deschutes River downstream of Wickiup Dam. The degraded conditions, described in the Environmental Baseline, will continue for the duration of the Proposed Action which extends to July 31, 2019.

Low river flows throughout the irrigation storage season provide little suitable habitat for spotted frogs to overwinter. As a result of this annual reduction of habitat, there are approximately four
areas where spotted frogs are known to persist below Wickiup Dam where adult breeding counts indicate that a population is being sustained in the short-term: (1) Dead Slough; (2) Sunriver; (3) Slough Camp; and (4) the Old Mill District. Although spotted frog breeding areas occur in other locations along the river system (e.g., Island Loop), breeding counts indicate that the abundance of spotted frogs is very minimal at these sites and these populations may not persist without intervention. Therefore, the areas where populations of spotted frogs persist are very important for conservation and recovery of spotted frogs in the Upper Deschutes River sub-basin in the short-term and long-term. The small spotted frog breeding sites located sparsely between the known larger populations are important for providing genetic flow and conservation of the overall species population within this sub-basin. Habitat enhancement opportunities within these habitats should be evaluated for implementation within the anticipated Deschutes Basin HCP.

Connectivity is limited between existing spotted frog populations by distance as a result of the annual dewatering of habitats by irrigation water management operations. During the irrigation season, wetlands adjacent to the river are inundated with water and spotted frogs have been detected in various locations along the Deschutes River during this period of time when flows are high in the river. Spotted frogs that disperse into riverine wetlands that are then dewatered likely do not survive through the winter. At the onset of the fall ramp down period in October, spotted frogs become vulnerable to predation when they are exposed as water recedes from vegetated wetlands that provide cover.

Long-term improvements to winter water conditions below Wickiup Dam will improve connectivity between existing spotted frog sites and provide additional opportunities for spotted frog conservation at individual sites and throughout floodplain wetlands downstream of Wickiup Dam. A long term strategy to increase water within the Deschutes River and adjacent wetlands for the Deschutes Basin HCP will support survival and recovery of spotted frogs.

Approximately 1,200 acres of wetland habitats adjacent to the Deschutes River and 985 acres of river channel are likely to be affected by implementation of the OSF Proposal between Wickiup Dam and Bend. Known spotted frog breeding areas within this area represent approximately 204 acres (1.7 percent) within the total wetland acres that are influenced by storage and release operations at Wickiup Dam. More than half of the spotted frog breeding habitat acres are in Sunriver (115 acres; 56%). The small acreage associated with the breeding and rearing areas compared to the large acreage of suitable habitat within the river reaches underscores the importance of maintaining these areas in a functioning condition for spotted frogs throughout the entire life cycle (Table 48).

Approximately 633 acres of wetlands (53 percent) between Wickiup Dam and Bend occur within Reaches 1 and 2 of the Deschutes River (Table 49). However, the degraded condition of the river and the ongoing effect of storage and release operations render most of the wetlands unsuitable for spotted frogs to complete their life cycle. Within these acres, spotted frogs are reasonably certain to experience a restriction in movement, reduction in cover, and stranding, all of which increase the likelihood of predation and mortality.

Dead Slough, located approximately 20 miles downstream of Wickiup Reservoir, provides habitat for the only known population of spotted frogs between Wickiup Dam and Sunriver,
approximately 32 RM in Reaches 1 and 2. This 17-acre slough is hydrologically supported by a spring which facilitates the persistence of spotted frogs within the slough during the low water period in winter. Implementation of the OSF Proposal results in impacts to this population in the winter, spring, and fall season when water inundation is outside of emergent vegetation and frogs are at increased risk to predation by fish, snakes, raccoons and other predators. The RiverWare model indicates that although flows may reach 600 cfs at the WICO gauge sooner in the breeding period than the current condition, flows will take longer to reach 800 and 900 cfs during the breeding and rearing period. Therefore, the amount of time that water is within emergent vegetation is less under the OSF Proposal and the benefit of reaching 600 cfs at the WICO gauge by April 1 under the Proposed Action is negated by the water taking longer to reach higher flows.

Table 49. Acres of wetlands and river in seven reaches of the Deschutes River between Wickiup Dam and Bend, OR.

<table>
<thead>
<tr>
<th>River Reach</th>
<th>Wetland acres</th>
<th>River acres</th>
</tr>
</thead>
<tbody>
<tr>
<td>1: Wickiup Dam to Fall River</td>
<td>325</td>
<td>321</td>
</tr>
<tr>
<td>2: Fall River to Little Deschutes</td>
<td>308</td>
<td>226</td>
</tr>
<tr>
<td>3: Little Deschutes to Benham Falls</td>
<td>286*</td>
<td>200</td>
</tr>
<tr>
<td>4: Benham to Dillon Falls</td>
<td>198</td>
<td>61</td>
</tr>
<tr>
<td>5: Dillon Falls to Lava Island Falls</td>
<td>95</td>
<td>67</td>
</tr>
<tr>
<td>6: Lava Island Falls to COID diversion</td>
<td>7</td>
<td>49</td>
</tr>
<tr>
<td>7: COID Diversion to Colorado Street Bridge</td>
<td>8**</td>
<td>64</td>
</tr>
</tbody>
</table>

*115 acres in Sunriver; ** all wetlands are within the Old Mill District.

The presence of small-scale breeding efforts (e.g., at La Pine State Park SW Slough and Private Land RM 202) and summer spotted frog detections in riverine wetlands downstream of Dead Slough indicate that there is a potential for out-migrating frogs from Dead Slough to redistribute or disperse into downstream habitat. However, as described above and in the Environmental Baseline section, spotted frog habitat is limited during the irrigation storage season and spotted frogs are likely to be concentrated into small areas in the river and adjacent habitat with predaceous fish such as the brown trout. As a result, it is likely that spotted frog survival is reduced during the winter period.

Studies have shown that amphibian population connectivity is predominantly affected through juvenile dispersal (Madison, 1997; Preisser et al., 2001; Guerry and Hunter, 2002; Rothermel, 2004). Numerous studies indicate that post-metamorphic dispersal contributes more to regional persistence than adult dispersal (Sinsch, 1992, 1997; Sinsch and Seidel, 1995). The loss of wetland habitats for juvenile spotted frogs to disperse into during the irrigation storage season limits population connectivity along the Deschutes River.

Further downstream, implementation of the OSF Proposal may provide a short-term improvement to spotted frog habitat below the confluence of the Deschutes River with the Little Deschutes River as indicated by the hydrological analysis conducted using the RiverWare model.
RiverWare modeling of the OSF Proposal predicts that there will be a slight increase in the duration of flows that inundate habitats downstream of the confluence of the Little Deschutes River in Reaches 3, 4 and 5 during the spotted frog breeding and rearing periods. However, RiverWare modeling also predicts that flows in the Deschutes River will be reduced earlier compared to the current condition in the fall season preceding the overwintering period. Therefore, there is likely to be no net benefit to the early increases in flows without lengthening the fall ramp down period into mid-October so that spotted frogs can move to overwintering habitat that is extremely limited during the irrigation storage season.

Within Reach 3 (Little Deschutes River to Benham Falls) of the analysis area, there are approximately 286 acres of wetlands and 200 acres of river. Approximately 115 acres of these wetland acres are within the managed water bodies in Sunriver that support the largest population of spotted frogs downstream of Wickiup Dam. Although the hydrological analysis using the RiverWare model predicts that there will be habitat improvements in these reaches during the spotted frog breeding and rearing periods, we do not anticipate that the Proposed Action will improve conditions in Sunriver for the reasons discussed below.

As described above, Sunriver wetlands do not receive surface water from the Deschutes River until flows out of Wickiup Dam exceed 1,000 cfs at the WICO gauge due to existing weir elevations. The RiverWare model-predicted flows at the WICO gauge indicate that flows above 1,000 cfs will be reduced by approximately one week under the OSF Proposal during the spotted frog breeding and rearing periods. We anticipate that the one-week reduction in flows of 1,000 cfs at WICO will result in egg mass stranding in Sunriver wetlands. As stated earlier, spotted frog habitat in Sunriver is buffered from some of the effects of irrigation storage due to weirs that maintain water in the habitat through the winter season. Furthermore, spotted frog habitat in Sunriver is uniquely positioned below the confluence of the Little Deschutes and Deschutes rivers. The combined influence of the weirs and unregulated winter flows on the Little Deschutes River improve the hydrological function of the habitat in Sunriver. Therefore, we do not expect that spotted frog wintering habitat will be affected by the Proposed Action. Additional hydrological monitoring is needed in Sunriver to determine precisely when the storage and release operations at Wickiup Dam affect the spotted frog and its habitat.

Maintaining suitable spotted frog habitat within Sunriver is very important to the conservation and recovery of spotted frogs downstream of Wickiup Dam because it is the largest population in the Deschutes River downstream of Wickiup Dam. In recent years, the population of spotted frogs in Sunriver has declined. Increasing numbers of bull frogs and the expansion of reed canarygrass within the Sunriver habitats are suspected to be contributors to this decline. The Service has begun working with the Sunriver Resort and the Sunriver Owners Association to address the increasing threats to spotted frogs in Sunriver habitat and to develop appropriate ways to conduct hydrological measurements at the weirs.

Spotted frogs have been observed adjacent to the Deschutes River in areas that are not managed by the weir system in the Sunriver area. In Reach 3, there are approximately 171 acres of wetlands outside of the area that is maintained by the Sunriver weirs that provide important habitat for spotted frogs that disperse from the Sunriver spotted frog population. At the onset of the irrigation storage season the majority of the wetlands are dewatered and the aquatic
connectivity of habitat is reduced. Although there are ponds within Reach 3 that maintain some water during the winter, the reduction in flow prevents spotted frogs from reaching these habitats. Spotted frogs are reasonably certain to experience a restriction in movement, reduction in cover, and stranding, all of which increase the likelihood of predation and mortality. Continued hydrological monitoring observations are needed within Reach 3 to assess habitat suitability at various flows and through winter to determine future options for increasing habitat for spotted frogs under the Deschutes Basin HCP.

Based on RiverWare-modeled hydrology at the BENO gauge, we anticipate a minimal benefit to spotted frog habitat during the breeding period in Reach 4 at East Slough Camp where wetland habitats that support spotted frogs are inundated earlier via the Proposed Action compared to the current condition. There are approximately 198 acres of wetlands within Reach 4. East Slough Camp, a 47-acre wetland complex of pond and marsh habitat supporting spotted frogs, is impacted by storage and release operations at Wickiup Dam. There is some indication based on preliminary data that spotted frogs may breed earlier here if water is available. An earlier breeding effort may lead to earlier metamorphosis of spotted frogs which may provide juveniles with improved movement capability into the fall. However, if the fall ramp down period occurs earlier under the OSF Proposal then the benefit of an earlier breeding period to spotted frogs is likely to be negated.

The ongoing impacts caused by the irrigation water storage season are likely to continue in Reach 4 under the Proposed Action. Based on aerial flight photos and ArcGIS acreage calculations, the East Slough Camp wetland is reduced to less than 4 acres of inundated habitat during the storage season. In the fall of 2016, juvenile spotted frogs were observed along mudflats of the Deschutes River adjacent to East Slough Camp. The proposed action will result in similar impacts to spotted frogs in Reach 4, and is reasonably certain to restrict movement, reduce cover, and increase stranding, all of which increase the likelihood of predation and mortality.

Immediately downstream (less than ¼-mile) from East Slough Camp, the US Forest Service has begun to restore the Ryan Ranch wetland, a 65-acre historic spotted frog habitat that was drained and disconnected from the Deschutes River via a berm after the construction of Wickiup Dam. The Ryan Ranch wetland is now holding water year-round and the near-future completion of restoration actions is expected to provide refuge to spotted frogs that are emigrating from the East Slough Camp wetland in the fall and at other times during the year. If implemented in its entirety, the Ryan Ranch wetland restoration project could provide overwintering habitat for spotted frogs that are displaced from East Slough Camp during the irrigation water storage season.

In Reach 5, there are approximately 95 acres of wetlands and 67 acres of river. Although improvements to habitat are expected earlier in the breeding period within this reach, there are no known spotted frog populations that will benefit from the improved habitat conditions. Given that there has been little emphasis on monitoring this reach of the Deschutes River, spotted frog breeding surveys and habitat monitoring should be conducted during the spring to evaluate if the improved flow conditions result in a change from the current baseline.
In Reach 6, implementation of the Proposed Action is not expected to change the current baseline condition. Wetlands are limited to approximately 7 acres in the 3 miles of Reach 6 and the river accounts for 49 acres. This reach of the Deschutes River was not included in the final critical habitat determination due to the lack of suitable habitat and a greater than 6.2-mile distance from known spotted frog populations. However, in September of 2016, four juvenile spotted frogs were detected in a small pond on private land that was inundated during irrigation season and dewatered during the storage season which likely resulted in mortality. It is reasonable to expect similar mortality of spotted frogs with implementation of the proposed action.

As stated earlier, this detection of spotted frogs underscores the importance of maintaining suitable wetland habitats along the river system for spotted frog dispersal between populations. Ideally, there should be areas that maintain water throughout the irrigation water storage season so that spotted frogs may persist and recover. This site on private land will be monitored by a private researcher in coordination with the Service to determine whether or not there is an opportunity to provide year-round habitat at this site that is suitable for spotted frogs.

Wetland habitats that are suitable for spotted frogs are limited in Reach 7 to approximately 8 acres, the majority of which are within the LSA marsh, a known spotted frog site. This area is under evaluation as the hydrology is dynamic and not easily monitored. Currently, a staff gauge has been installed within the marsh to monitor and identify appropriate water levels that provide habitat conditions to support breeding and overwintering spotted frogs.

Given the low number of breeding adults in recent years within the LSA Marsh, abrupt changes in the hydrological system will likely have negative consequences on spotted frogs using this habitat within the river. Surface water elevations in the river are likely to be reduced, significantly restricting movement to overwintering habitat. Continued population and habitat monitoring will be necessary to ensure that spotted frogs persist at the downstream most end of the species’ distribution in the Deschutes River Basin.

6.1.4.2 Acres of Oregon Spotted Frog Habitat affected by the Proposed Action in the Little Deschutes River Sub-basin

In the Little Deschutes River sub-basin, the Proposed Action influences an area that includes approximately 5,204 acres of wetland habitat and 166 acres of open water, riverine habitat in Crescent Creek and the Little Deschutes River. As described in the Environmental Baseline, spotted frog surveys are limited in the Little Deschutes River sub-basin because most of the habitat occurs on private land. Table 50 below provides approximate acreages by breeding site name for the site scale and estimated wetland and open water acreages at the creek or river scale within the area affected by the Proposed Action. Due to an abundance of private land along Crescent Creek and the Little Deschutes River, spotted frog breeding surveys are limited. Therefore, the acreages for breeding sites, calculated in ArcGIS, are an under-estimate of the habitat utilized by spotted frogs. The floodplains of these river systems provide an abundance of suitable wetlands habitat for Oregon spotted frog. Given the close proximity between known breeding sites, we expect that there is a broad distribution of spotted frogs within suitable wetland habitats along these two rivers.
Although the storage and release of irrigation water from Crescent Lake Dam has an ongoing effect to spotted frogs in Crescent Creek and to a lesser extent within the Little Deschutes River, the magnitude of the effect is much less than that described for the Deschutes River downstream of Wickiup Dam. The impact of storage and release at Crescent Dam is buffered by natural hydrological inputs from unregulated portions of the Little Deschutes River sub-basin, mainly Big Marsh Creek and the Upper Little Deschutes River. These unregulated tributaries support and maintain spotted frog habitat at periods of time where flows may be low as a result of irrigation storage (i.e., winter into spring).

Based on the RiverWare-modeled flows, the summer rearing and fall movement prior to overwintering periods appear to be most affected by implementation of the Proposed Action. However, the magnitude of the impact is difficult to describe precisely given the natural variability in the system and the lack of seasonal habitat monitoring that correlates to hydrological conditions.

Table 50. Approximate ArcGIS acreages of spotted frog breeding habitat in Crescent Creek and the Little Deschutes River.

<table>
<thead>
<tr>
<th>Waterbody or drainage</th>
<th>Breeding Site Name</th>
<th>Polygon Acreage of breeding site</th>
<th>Estimated wetland Acreage***</th>
<th>Estimated open water acreage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crescent Creek</td>
<td>Crescent Creek above Highway 58</td>
<td>9.6</td>
<td>1,882</td>
<td>48</td>
</tr>
<tr>
<td></td>
<td>Crescent Creek below Highway 58</td>
<td>4.44</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Crescent Upper Oxbow (Private)</td>
<td>20</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Crescent Creek 62 RD (Private)</td>
<td>233</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Crescent Creek BLM oxbows and adjacent private</td>
<td>48</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Little Deschutes River</td>
<td>Middle Little Deschutes complex 1 (Private)</td>
<td>40.3</td>
<td>3,322</td>
<td>118</td>
</tr>
<tr>
<td></td>
<td>Middle Little Deschutes complex 2 (Private)</td>
<td>146</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Leona Park</td>
<td>7.54</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Oxbows behind La Pine High School (BLM/Private)</td>
<td>12.21</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Rosland Park</td>
<td>32.3</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Riverside oxbow (private)</td>
<td>24.1</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Casey Tract</td>
<td>91</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Thousand Trails (private)</td>
<td>70.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Crosswater (N. driving range pond, bullfrog pond, Fairway 2) (private)</td>
<td>8.35</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*** Includes breeding site acreages.

Site-monitoring was conducted in August 2017 at the lower Crescent Creek BLM site to observe site conditions when the CREO gauge is at 89 cfs (Figure 84). Figure 84 shows that water is intersecting with sedge vegetation at 89 cfs and the affected habitat is very suitable for juvenile spotted frogs that were observed utilizing the wetland margins of the creek, including lightly vegetated sandbars within the creek.
The analysis conducted using the RiverWare modeled flows indicates that the Proposed Action may result in a greater number of days that flows will be below the 90 cfs threshold in Crescent Creek in August and September compared to current conditions. Based on our observations at 89 cfs, and results of the RiverWare model, we expect that spotted frogs in approximately 1,182 acres of wetland habitats along Crescent Creek will be exposed to increased avian and terrestrial predation when cover is lost as wetlands drain. When spotted frogs move to Crescent Creek as a result of a reduction in flows, they are subject to increased predation from brown trout along approximately 30 miles. Therefore, monitoring the decrease in flows during the fall period of ramp down is necessary to determine where suitable habitat for spotted frogs persists after ramp down.

Figure 84. Lower Crescent Creek on August 10, 2017 with flows of 89 cfs at the CREO gauge.

In the Little Deschutes River downstream of the confluence with Crescent Creek, the RiverWare model also indicates an earlier ramp down of flows in August. Since we do not have flow thresholds established for flows at the LAPO gauge that inundate habitat along the Little Deschutes, we have based our analysis only on the RiverWare-modeled hydrology combined within the inherent characteristics of the Little Deschutes River that includes an abundance of oxbows that provide habitat for spotted frogs. We believe that although the RiverWare model shows that there may be an earlier ramp down in August, it is unlikely that there will be a measurable change in the 3,322 acres of wetlands along the Little Deschutes River through implementation of the Proposed Action. We assume that there is a change in the aquatic connectivity between spotted frog rearing and overwintering habitats with implementation of OSF Proposal. However, the abundance of habitat will likely provide habitat that is suitable for spotted frogs as the Proposed Action is implemented.

We emphasize that there is a need to conduct appropriate habitat monitoring at all life cycle stages within spotted frog breeding sites in the Little Deschutes River sub-basin as the OSF Proposal is implemented. Information gathered through monitoring efforts will be essential for the Deschutes Basin HCP that is under development.
6.2 The ROM and SEED Programs

The ROM and SEED programs will not be implemented in the Little Deschutes River sub-basin, as Crescent Lake Dam is owned by the irrigation districts. Therefore, the following analysis addressed the implementation of these programs within the Upper Deschutes River sub-basin only.

The primary mechanism for effects to the Oregon spotted frog and its habitat from implementation of the ROM and SEED programs is a short-term reduction in flows downstream of the structure where the activity is being implemented. In order to minimize these effects, these activities are scheduled in close coordination with the Districts and the Service. The activities that require flows to be significantly reduced or completely shut down are implemented every 3 years at each of the dams. Duration of these activities at Crane Prairie range from 2 to 6 hours, except for the gate full-open/full-close examination which results in a complete shutdown for a few minutes and then a flow increase to 500 cfs for approximately 5 minutes. In addition, rock debris will be removed from the outlet works in a one-time event that will result in a complete shutdown for 3 hours. Activities will occur in the fall between mid-October and mid-December, except for the gate full-open/full-close examination which will occur in early-summer when flows are higher.

At Wickiup Dam, none of the activities require a complete shutdown of flows. However, for dive inspections flows will be reduced to between 25 and 40 cfs for 6 to 8 hours, while for the tube valve inspection flows will be reduced to between 35 and 50 cfs for 2 days. Activities will occur in the fall between mid-October and mid-December. In addition, concrete will be patched at two locations on Wickiup Dam that will result in flows being reduced from 25 to 40 cfs for one week while repairs are made at one location and flows being reduced to 35 to 50 cfs for 2 days at the other location.

All but one of the activities will occur between mid-October and mid-December, so most of the effects will occur during the overwintering period. However, the gate full-open/full-close examination at Crane Prairie Dam will occur during early-summer when tadpoles are rearing and juveniles, subadults, and adults are using the habitat for cover and foraging.

6.2.1 Crane Prairie Reservoir

Due to the short-term nature of the activities associated with the ROM and SEED programs, the effects to spotted frogs within Crane Prairie Reservoir are likely to be relatively minor. It is likely that when the actions are implemented between mid-October and mid-December that reservoir volume will be between 35,000 and 40,000 acre-feet and spotted frogs will be seeking or already occupying overwintering habitat. The only effect to the habitat within Crane Prairie from completely shutting down releases from the reservoir for 2 to 6 hours is that the level of the reservoir will increase at a slightly greater rate during that period because inflows will continue, but releases will be shut down. Since spotted frogs will be seeking or already occupying overwintering habitat and the actions will increase the rate of filling for a 2 to 6 hour period and not decrease the lake level, the activities associated with the ROM and SEED programs are likely
to have no effect on Oregon spotted frogs within Crane Prairie Reservoir.

In addition, the short duration of 5 minutes for the gate full-open/full-close examination is likely to have minimal effect on rearing tadpoles, juveniles, subadults, and adults. It is unlikely that the effect on the water level in the reservoir will even be observable given the volume of water in the reservoir and wave action along the shoreline of the lake. As a result, it is likely that all life stages of the spotted frog using the reservoir will be able to respond to any change associated with the lake surface without experiencing any adverse effects.

6.2.2 Deschutes River from Crane Prairie Dam to Wickiup Reservoir

The activities associated with the ROM and SEED programs are likely to result in short-term adverse effects to the spotted frog during their implementation. As noted above, most of these activities will occur between October 15th and December 15th, while juvenile, subadult, and adult Oregon spotted frogs are seeking or already occupying overwintering habitat. Currently, the extent of spotted frog use of the Deschutes River between Crane Prairie Dam and Wickiup Reservoir is unknown. Egg masses have been observed at the confluence of the Deschutes River and Wickiup Reservoir. It is most likely that overwintering occurs in the pool of Wickiup Reservoir since they prefer low water velocities while overwintering, but it is possible that individuals overwinter in the Deschutes River between the reservoirs.

Complete shutdown of releases from Crane Prairie for a period of 2 to 6 hours is likely to dewater significant portions of the river channel between Crane Prairie Dam and Wickiup Reservoir during that period. Spotted frogs already within overwintering habitat that retains water (i.e., within Wickiup Reservoir or a residual pool in the channel) during this period should not be at risk. However, frogs within overwintering habitat that is dewatered will be at increased risk of displacement, predation, or exposure to the elements.

In addition, the short duration of 5 minutes for the gate full-open/full-close examination is likely to have minimal effect on rearing tadpoles, juveniles, subadults, and adults. The effect on the Deschutes River between the reservoirs will be observable following both the full opening and the full closing of the gate. In the early spring, between 100 and 400 cfs will be being released from Crane Prairie, so the rapid increase of flow to 500 cfs when the gate is fully opened has potential to displace juveniles, subadults, or adults that may be present along the margins of the Deschutes River. Displacement will likely increase the risk of predation for several minutes until flows normalize and individuals can access cover. Juveniles, subadults, and adults have potential to be stranded on land for up to 5 minutes during the full-close portion of the examination. This is likely to put them at risk of increased predation for several minutes. However, tadpoles will not be using the channel of the Deschutes River; they will likely be in the area influenced by Wickiup Reservoir or an adjacent wetland so the risk of exposure is expected to be small.

6.2.3 Wickiup Reservoir

Due to the short-term nature of the activities associated with the ROM and SEED programs, the effects of these programs on the spotted frog within Wickiup Reservoir is likely to be relatively
minor. It is likely that when the actions are implemented between mid-October and mid-December, spotted frogs will be seeking or already occupying overwintering habitat. The only effect to the habitat within Wickiup Reservoir from greatly reducing releases from the reservoir for 6 hours to 1 week is that the level of the reservoir will increase at a slightly greater rate during that period because inflows will continue, but releases will be decreased. Since spotted frogs will be seeking or already occupying overwintering habitat and the actions will increase the rate of filling for a 6 hour to 1 week period and not decrease the lake level, the activities associated with the ROM and SEED programs are likely to have no effect on Oregon spotted frogs within Wickiup Reservoir.

6.2.4 Deschutes River from Wickiup Dam to the Little Deschutes River

The activities implemented at Crane Prairie Dam associated with the ROM and SEED programs will not affect the Deschutes River below Wickiup Dam because Wickiup Reservoir will absorb the changes in Crane Prairie Dam releases without releases from Wickiup Dam being changed. However, activities implemented at Wickiup Dam are likely to have a short-term effect on flows in the Deschutes River between Wickiup Dam and the Little Deschutes River (Reaches 1 and 2). Sites used by spotted frogs within Reach 1 include the La Pine State Park sloughs, SW Slough, and Dead Slough. Reach 2 contains at least two locations where breeding has been observed on private land. Private land in this reach contains suitable habitat and we assume wetlands are used by Oregon spotted frogs at various life stages. All of the activities that will occur at Wickiup Dam will be implemented between mid-October and mid-December when flows at the WICO gauge will be 100 cfs under the OSF Proposal. Each of the ROM and SEED activities that occur once every 3 years will maintain releases between 25 and 50 cfs from Wickiup Dam and extend from 6 hours to 2 days, while the two one-time concrete repair activities scheduled for 2017 or 2018 will also maintain releases between 25 and 50 cfs and extend from 2 days to 1 week.

The activities associated with the ROM and SEED programs are likely to result in short-term adverse effects to spotted frogs during their implementation. Flows from Fall River will moderate effects to some degree in Reach 2. During implementation, juvenile, subadult, and adult Oregon spotted frogs will be seeking or already occupying overwintering habitat. Currently, the extent of use in the Deschutes River between Wickiup Dam and the Little Deschutes River is unknown. It is most likely that overwintering occurs in wetlands adjacent to the river since they prefer low water velocities while overwintering, but it is possible that some individuals overwinter in the Deschutes River in reaches 1 and 2.

Decreased releases from Wickiup for a period of 6 hours to 2 days or 2 days to 1 week for one-time activities are likely to dewater the edge of the channel during that period. Spotted frogs already within overwintering habitat that retains water (i.e., adjacent wetlands or wetted channel) during this period should not be at risk. However, frogs overwintering along the edge of the river where it is dewatered will be at increased risk of displacement, predation, or exposure to the elements. It is expected that few frogs overwinter in the river in this reach. However, additional study and monitoring is necessary to determine where spotted frogs are overwintering.
6.2.5 Deschutes River from the Little Deschutes River to Colorado Street Bridge

The Deschutes River from the Little Deschutes River to the Colorado Street Bridge consists of five reaches (3-7). Reach 3 extends from the Little Deschutes River to Benham Falls, Reach 4 extends from Benham Falls to Dillon Falls, Reach 5 extends from Dillon Falls to Lava Island Falls, Reach 6 extends from Lava Island Falls to the COID diversion, and Reach 7 extends from the COID diversion to the Colorado Street Bridge.

Activities implemented at Wickiup Dam under the ROM and SEED programs are likely to have a short-term effect on flows in the Deschutes River between the Little Deschutes River and the Colorado Street Bridge. Habitat known to be occupied by spotted frogs is present in reaches 3 and 7, while the extent of spotted frog use is unknown in reaches 4, 5, and 6. Reach 3 contains the Slough Camp wetland complex which provides habitat for all Oregon spotted frog life stages and Reach 7 contains a wetland along the Deschutes River near the Les Schwab Amphitheater and the casting pond at the Old Mill District which provide habitat for all life stages. Flows at the BENO gauge will be between 600 and 800 cfs during implementation of the programs, compared to 100 cfs at the WICO gauge, due to contributions from the Fall River, Spring River, and Little Deschutes River. Rather than flows being reduced 50 to 75% as they are in Reach 1 by these activities, flows in Reach 3 will be reduced 6 to 12.5%. Although considerably lower in magnitude, the activities associated with the ROM and SEED programs are still likely to result in some short-term adverse effects to spotted frogs during their implementation. During program implementation, juvenile, subadult, and adult Oregon spotted frogs are likely to be seeking or already occupying overwintering habitat. It is likely that most overwintering occurs in wetlands adjacent to the river since they prefer low water velocities while overwintering, but some individuals likely overwinter in the Deschutes River in Reach 3.

Decreased releases from Wickiup Dam for a period of 6 hours to 2 days or 2 days to 1 week for one-time activities are likely to dewater a small portion of the channel’s edge during that period. Spotted frogs already within overwintering habitat that retains water (i.e., adjacent wetlands or wetted channel) during this period should not be at risk. However, frogs overwintering along the edge of the river where it is dewatered will be at increased risk of displacement, predation, or exposure to the elements. Additional study and monitoring is necessary to determine where spotted frogs are overwintering in Reach 3.

6.3 Effects to Oregon Spotted Frog Critical Habitat PCEs

Within the Upper Deschutes River Basin, spotted frog critical habitat consists of Unit 8 in the Upper Deschutes River sub-basin and Unit 9 within the Little Deschutes River sub-basin. Unit 8 is divided into subunits: 8A is the area upstream of Wickiup Dam and 8B is the area downstream of Wickiup Dam. These subunits are affected differently by the OSF Proposal. The description of each subunit and the impacts to critical habitat are described below by subunit. The effects analysis, above, that described the anticipated effects from implementation of the OSF Proposal, overlaps with the effects to critical habitat described below since nearly all of habitat where spotted frogs occur are within designated critical habitat.
Approximately 98 percent of critical habitat within subunit 8A, 70 percent of critical habitat within subunit 8B, and 49 percent of critical habitat within Unit 9, is within the area affected by the OSF Proposal (Table 51).

Table 51. Critical habitat by unit and subunit within and outside of the area affected by the Deschutes Project.

<table>
<thead>
<tr>
<th>CH Unit</th>
<th>CH subunit</th>
<th>CH acres</th>
<th>Affected Acres</th>
<th>Percent (%) Affected</th>
</tr>
</thead>
<tbody>
<tr>
<td>8. Upper Deschutes River</td>
<td>8A – Below Wickiup Dam</td>
<td>2,001</td>
<td>1,960</td>
<td>98</td>
</tr>
<tr>
<td></td>
<td>8B – Above Wickiup Dam</td>
<td>22,031</td>
<td>15,365</td>
<td>70</td>
</tr>
<tr>
<td></td>
<td>Upper Deschutes River Total</td>
<td>24,032</td>
<td>17,325</td>
<td>72</td>
</tr>
<tr>
<td>9. Little Deschutes River</td>
<td></td>
<td>11,033</td>
<td>5,362</td>
<td>49</td>
</tr>
</tbody>
</table>

6.3.1 Effects of the OSF Proposal on Critical Habitat PCEs

As described in the Environmental Baseline, critical habitat within the action area, consists of freshwater emergent wetland, freshwater forested/shrub wetland, freshwater pond, lake, and riverine habitat. Each of these habitat types will be affected differently by the OSF Proposal. The Environmental Baseline describes how the pre-OSF Proposal operations have affected critical habitat and some of these effects will continue with the OSF Proposal, while the magnitude or timing of others will change under the OSF Proposal.

6.3.1.1 Effects of the OSF Proposal on Spotted Frog Critical Habitat Subunit 8A

The majority of critical habitat within subunit 8A is affected by the OSF Proposal (i.e., 1,960 acres). Subunit 8A includes 2,001 ac (810 ha) of the Deschutes River and associated wetlands downstream of Wickiup Dam to Bend, Oregon, beginning at the outlet of an unnamed tributary draining Dilman Meadow. Approximately 875 acres of critical habitat (44 percent of subunit 8A) are within the Deschutes River corridor between river mile 167.5 and 228. Operation of the Deschesutes Project affects 1,960 acres (793 ha) of critical habitat within subunit 8A. These acres consist of 468 acres (189 ha) of freshwater emergent wetland, 507 acres (205 ha) of freshwater forested/shrub wetland, 74 acres (30 ha) of freshwater pond, 37 acres (15 ha) of lake, and 875 acres (354 ha) of riverine habitat. Anticipated effects to the PCEs of spotted frog critical habitat are discussed below.

PCE 1 – Spotted Frog Nonbreeding, Breeding, Rearing, and Overwintering Habitat

For the reasons discussed below, the OSF Proposal is likely to maintain the functioning at risk rating for spotted frog nonbreeding, breeding, rearing, and overwintering habitat in Subunit 8A. Flow releases from Wickiup Dam in early April can improve spotted frog breeding and rearing habitat in this subunit. However, the RiverWare model analysis above indicates that habitat conditions in only a portion of CHU 8A may be improved by increased flows and the increased
duration of inundation associated with these flows may be slight.

Based on the results of the RiverWare model hydrological analysis, the OSF Proposal is likely to provide flows over 600 cfs for 11 more days than the pre-OSF Proposal operations within CHU 8A between Wickiup Dam and the Little Deschutes River during the spotted frog breeding period. Although implementation of the OSF Proposal results in WICO flows reaching 600 cfs earlier in the breeding season than the pre-OSF operations, flows will take longer to get to 700 cfs and 800 cfs during the breeding period. Table 2, above, shows that good spotted frog habitat in adjacent wetlands between Wickiup Dam and the Little Deschutes River is provided by flows above 900 cfs at the WICO gauge. Therefore, the increase in days with flows greater than 600 cfs under the Proposed Action is likely of limited benefit to the proper functioning of PCE1 breeding habitat in the portion of CHU 8A upstream of the confluence with the Little Deschutes River.

Likewise, implementation of the OSF Proposal results in less days where flows at the WICO gauge exceed 900 cfs during the spotted frog rearing period. Therefore, there is a potential for implementation of the OSF Proposal to reduce the proper function of PCE 1 rearing habitat in CHU 8A upstream of the confluence with the Little Deschutes River.

Within CHU 8A, the benefits to spotted frog breeding habitat under the OSF Proposal are associated with slightly improved conditions downstream of the confluence of the Little Deschutes River with the Deschutes River. The RiverWare model predicts that flows at the Benham Falls gauge (BENO) may exceed the number of days at each flow threshold under the OSF Proposal compared to pre-OSF Proposal operations during the spotted frog breeding season. Table 2, above, shows that flows between 1,200 and 1,600 cfs improve spotted frog habitat in wetlands below the confluence of the Little Deschutes and Deschutes rivers. At the BENO gauge, the model predicts the OSF Proposal may provide 11, 6, 2, and 3 more days of flows over 1,200, 1,400, 1,600, and 1,800 cfs compared to current conditions. Therefore, we anticipate that spotted frog breeding conditions in Subunit 8A downstream of the confluence of the Little Deschutes and Deschutes rivers may be improved over a slightly longer duration compared to current operations.

Likewise, implementation of the OSF Proposal results in more days where flows at the BENO gauge exceed 1,200, 1,400, and 1,600 cfs during the spotted frog rearing period. As noted above, flows between 1,200 and 1,600 cfs provide good spotted frog habitat in wetlands below the confluence of the Little Deschutes and Deschutes rivers. Therefore, there is a potential for implementation of the OSF Proposal to improve the proper function of PCE 1 rearing habitat in CHU 8A downstream of the confluence of the Little Deschutes and Deschutes rivers.

The period of time from September 1 to October 15, leading up to overwintering, is particularly important for juvenile, sub-adult, and adult Oregon spotted frogs. Under the OSF Proposal, flows begin ramping down sooner than under pre-OSF Proposal operations. The effect of this change may further reduce the proper function of CHU 8A during this time period.

During the spotted frog overwintering period under the OSF Proposal, flows are at 100 cfs in the Deschutes River below Wickiup Dam the majority of the time and would likely only exceed 100
cfs during extreme runoff events when both reservoirs are full. Under pre-OSF Proposal operations, flows are at 20 cfs the majority of the time. Therefore, implementation of the OSF Proposal may result in an increase of 80 cfs in the Deschutes River below Wickiup Dam during the spotted frog overwintering period. However, this increase of 80 cfs is insufficient to affect water levels in adjacent wetlands, which is necessary to improve spotted frog overwintering habitat quantity or quality in those adjacent wetlands.

PCE 2 – Spotted Frog Aquatic Movement Corridors

The OSF Proposal does affect PCE 2 aquatic movement corridors within Subunit 8A by changing the timing and extent to which certain habitats are wetted. The RiverWare model analysis predicts that during the spotted frog breeding (March 15-April 30) and rearing (April 1-August 1) periods, the OSF Proposal will benefit spotted frog aquatic movement corridors above the Little Deschutes River by increasing flows above 600 cfs for 11 and 17 more days than under pre-OSF Proposal operations, but will also degrade these movement corridors to some level by providing fewer days with flows exceeding thresholds that are necessary to facilitate such movement. However, below the confluence of the Little Deschutes and Deschutes rivers, the model predicts the OSF Proposal will benefit spotted frog aquatic movement corridors during the breeding and rearing periods by providing more days with flows that exceed the threshold levels for facilitating such movement compared to pre-OSF Proposal operations.

The model analysis also predicts the OSF Proposal will further reduce the currently degraded function of PCE 2 within Subunit 8A during the period leading up to the spotted frog overwintering period (September 1-October 15) by providing fewer days with flows that exceed thresholds at the WICO and BENO gauges that are likely to benefit spotted frog habitat. This effect is due to an earlier ramp down in flows compared to pre-OSF Proposal operations.

PCE 3 – Spotted Frog Refugia Habitat

Based on the results of the RiverWare model analysis, the OSF Proposal will further degrade the functioning at risk rating for spotted frog refugia habitat in Subunit 8A during the time period leading up to the overwintering period (September 1 – October 15) by providing fewer days with flows that exceed thresholds at the WICO and BENO gauges that are likely to benefit spotted frog habitat. The dewatering of habitats during this period of time reduces the amount of refugia habitat and shortens the time at which these habitats are functioning as refugia habitat for spotted frogs. Although the OSF Proposal increases the WICO flows to 100 cfs during the spotted frog overwintering period under the OSF Proposal, flows are insufficient to affect water levels that provide overwintering habitat in adjacent wetlands. Much of the remaining water through the winter period (i.e., the irrigation storage season) in Critical Habitat subunit 8A is within the Deschutes River, which is inhabited by predatory brown trout. There is little spotted frog refugia habitat remaining through the winter period.

6.3.1.2 Effects of the OSF Proposal on Spotted Frog Critical Habitat Subunit 8B

The area affected by the OSF Proposal encompasses Crane Prairie and Wickiup reservoirs and the Deschutes River and associated wetlands between the reservoirs, and includes approximately
15,365 acres (6,218 ha) of critical habitat (70 percent of subunit 8B). Wetland habitat types within these acres include approximately: 3,029 ac (1,226 ha) of freshwater emergent wetland, 809 ac (327 ha) of freshwater forested/shrub wetland, 3 ac (1 ha) of freshwater pond, 11,514 ac (4,660 ha) of lake, and 11 ac (4 ha) of riverine habitat. For the reason discussed below, implementation of the OSF Proposal improves the function of CHU 8B in a portion of the subunit while the remainder of the CHU is maintained in a degraded condition.

PCE 1 – Spotted Frog Nonbreeding, Breeding, Rearing, and Overwintering Habitat

For the reasons discussed below, the OSF Proposal is likely to provide significant benefits to spotted frog nonbreeding, breeding, rearing, and overwintering habitat within Crane Prairie Reservoir which represents approximately 32 percent (4,982 acres) of CHU 8B. Within the large reservoir acreage, there are approximately 629 acres of emergent wetland habitat that are important physical and biological features of the critical habitat within the reservoir.

At Crane Prairie Reservoir, spotted frog breeding habitat under pre-OSF Proposal operations has been functioning at risk due to storage volumes exceeding 50,000 acre-feet which resulted in water expanding into unsuitable, upland habitat outside of the sedge vegetation that protects egg masses and rearing tadpoles. The OSF Proposal will result in reservoir storage volumes of 45,000 to 50,000 acre-feet during the breeding and rearing period that are likely to improve the function of PCE 1 in the portion of CHU 8B that includes Crane Prairie Reservoir. On an annual basis, the duration of improvements to PCE 1 rearing habitat under the OSF proposal will continue until at least July 15th when the reservoir can be drawn upon for irrigation water. The OSF Proposal may also provide some improvement to the function of spotted frog overwintering habitat by maintaining reservoir volumes above 35,000 acre feet compared to the pre-OSF Proposal operations (i.e., the period of 1980 to 2009) which resulted in reservoir volumes that dropped to just below 30K acre feet of storage in late September and October. The larger reservoir volume that will be maintained through the overwintering period under the OSF Proposal inundates a larger surface area of the reservoir than modeled-pre-OSF Proposal operations and shortens the distance between overwintering and breeding habitats, which improves the function of PCEs.

Maintaining reservoir volumes in Crane Prairie Reservoir has downstream consequences in the portion of CHU 8B that includes the Deschutes River between the reservoirs. The hydrology of this portion of CHU 8B is dependent on a combination of natural precipitation, CRAO flows and surface water elevations in Wickiup Reservoir. Based on the hydrological analysis above using the RiverWare model, there will be a slight reduction in the function of PCE 1 in this area of CHU 8B through implementation of the OSF Proposal due to a reduction in flows at the CRAO gauge and predicted lower reservoir storage volumes at Wickiup Reservoir.

Under current conditions and implementation of the OSF Proposal, CHU 8B at Wickiup Reservoir will continue to have limited suitable year-round habitat for spotted frogs due to the large change in surface water depth and spatial extent of inundation that results from reservoir drawdown for irrigation water supply. RiverWare modeled storage volumes for Wickiup Reservoir indicate that the OSF Proposal is likely to result in lower surface water elevations in Wickiup Reservoir compared to pre-OSF Proposal operations. At lower storage volumes of
water, breeding habitat will be shallower than the current condition described in the Environmental Baseline. As the irrigation season commences on April 1, the reservoir will be drawn down for irrigation and expansive areas of shallow water that provide breeding and rearing habitat will be drained of water over a large spatial area reducing the function of these PCEs. At the end of the irrigation season, the remaining storage volumes of water within the reservoir that provide overwintering habitat for spotted frog are likely to be further reduced under the OSF Proposal.

The minimum volumes of water that remain in the reservoir from October into the winter provide what may be marginal spotted frog overwintering habitat since these areas are predominately unvegetated with little refugia from the abundance of non-native fish that reside in the reservoir. On that basis, the function of PCE 1 is likely to remain degraded with implementation of the OSF Proposal.

PCE 2 – Spotted Frog Aquatic Movement Corridors

As described above for PCE 1, implementation of the OSF Proposal is likely to improve the function of PCE 2 at Crane Prairie Reservoir via a longer duration of inundation and higher residual pool through the winter that should improve the connectivity of spotted frog breeding, rearing and overwintering habitats within the reservoir.

With implementation of the OSF Proposal, the function of PCE 2 may be reduced within the portion of CHU 8B that includes the Deschutes River between Crane Prairie and Wickiup reservoirs. This geographic area of CHU 8B provides important connectivity between upstream and downstream spotted frog populations. Storage of water in Crane Prairie for a longer duration and lower reservoir volumes in Wickiup Reservoir as a result of the Proposed Action, are likely to change the timing and duration of water levels and impact habitat connectivity within riverine habitat conditions in wetlands adjacent to the Deschutes River. For those reasons, the function of PCE 2 in Wickiup Reservoir is likely to be maintained in a degraded condition with implementation of the OSF Proposal.

PCE 3 – Spotted Frog Refugia Habitat

The OSF Proposal is likely to maintain the functioning at risk rating for refugia habitat in Subunit 8B. However, the condition of PCE 3 (refugia habitat) in Crane Prairie Reservoir is likely to be improved under the OSF Proposal by providing spotted frogs with increased access to cover throughout the year as a result of higher water levels being maintained in the reservoir for a longer period of time compared to current operations. Under the OSF Proposal, spotted frog refugia habitat within the Deschutes River between the Crane Prairie and Wickiup reservoirs is likely to be maintained in its current degraded condition because water levels are unstable within wetland habitats during the breeding and rearing periods, leaving egg masses and rearing tadpoles at risk of desiccation and adult spotted frogs without cover from predators such as cranes, herons, raccoons, minks, snakes and other natural predators. The OSF Proposal is likely to result in lower winter water levels and overwintering habitats coincide with predatory brown trout in the Deschutes River.
6.3.1.3 Effects of the OSF Proposal on the Recovery Support Function of Spotted Frog Critical Habitat Unit 9

A total of 5,363 ac (2,171 ha) of critical habitat within this CHU are likely to be affected by the Proposed Action. The affected critical habitat consists of 2,306 ac (933 ha) of freshwater emergent wetland, 2,790 ac (1,129 ha) of freshwater forested/shrub wetland, 13 ac (5 ha) of freshwater pond, 88 ac (36 ha) of wetlands not overlapping with NWI-classified wetlands, and 166 ac (67 ha) of riverine habitat. The critical habitat affected by the Proposed Action largely consists of wetlands associated with low-gradient meandering reaches of the Little Deschutes River and Crescent Creek which interact extensively with their floodplains. As described in the Environmental Baseline, the Little Deschutes River receives unregulated (natural) hydrological inputs from the upper basin above the confluence with Crescent Creek. For that reason, irrigation water storage and release has less of an effect on CHU 9 than CHU 8, as described above.

PCE 1 – Spotted Frog Nonbreeding, Breeding, Rearing, and Overwintering Habitat

The OSF Proposal is likely to maintain the degraded condition of spotted frog nonbreeding, breeding, rearing, and overwintering habitat in CHU 9 for the following reasons.

The OSF Proposal appears to increase the median number of days that flows are above the thresholds necessary to provide for functional spotted frog habitat conditions compared to the current condition. However, the results of habitat monitoring within this unit are not yet sufficient to assert with certainty that the thresholds identified for the RiverWare hydrological analysis are likely to result in improvements to spotted frog habitat conditions on the ground. The assessment of hydrological conditions is further confounded by the lack of river gauges on Big Marsh Creek and the Upper Little Deschutes River that measure the natural hydrological contributions of flow to the system.

During the overwintering period, the OSF Proposal is likely to increase flows in Crescent Creek between 9 and 24 cfs, which is likely to increase the availability and quality of spotted frog overwintering habitat in Crescent Creek. However, there is less certainty that the increased flows in the winter will improve habitat conditions in the Little Deschutes River for the following reasons. The reach of the Little Deschutes River that is affected by the Proposed Action within CHU 9 is approximately 60 miles long with one hydrological gauge (LAPO) located in La Pine, OR. We do not have baseline monitoring that calibrates surface water elevations that influence function of PCEs within critical habitat within this area. Therefore, the RiverWare model that informs our effects analysis is our best attempt to articulate a change in flows under implementation of the Proposed Action versus the current condition (baseline).

During the spotted frog overwintering period, it is unclear whether the OSF Proposal improves habitat in the Little Deschutes River because the results of the RiverWare model analysis suggest that it increases the median number of days flows at the LAPO gauge are greater than 100 cfs, but maintains the median number of days flows are greater than 150 cfs, and reduces the median number of days flows are greater than 200 cfs. Since we do not have flow thresholds for the LAPO gauge, there is no way of knowing how a change in water management along this reach of
river within CHU 9 will affect PCEs under the Proposed Action. We are reasonably certain, however, that the function of PCEs is reduced at the onset of the irrigation storage season throughout CHU 9.

PCE 2 – Spotted Frog Aquatic Movement Corridors

The OSF Proposal is likely to maintain the functioning at risk rating of aquatic movement corridors in CHU 9, as a whole. Implementation of the OSF Proposal that provides an increase in flows from Crescent Dam in the fall are likely to slightly improve wetland conditions that will facilitate spotted frog movement to overwintering habitat within a portion of CHU 9.

PCE 3 – Spotted Frog Refugia Habitat

The OSF Proposal is likely to maintain the degraded condition of refugia habitat in CHU 9 because the irrigation storage season that results in the lowering the water levels throughout the wetlands and in the river reduce the amount of overwintering habitat for spotted frogs that is without predatory fish.

6.3.2 Effects of the ROM and SEED Programs on Critical Habitat PCEs

6.3.2.1 Effects of the ROM and SEED Programs on Spotted Frog Critical Habitat Subunit 8A

The effects analysis, above, that described the anticipated effects from implementation of the ROM and SEED programs, overlaps with the effects to critical habitat described below since nearly all of the habitat where spotted frogs occur is within designated critical habitat. Approximately 98 percent of critical habitat within subunit 8A and 70 percent of critical habitat within subunit 8B is within the area affected by the OSF Proposal. None of the critical habitat within Unit 9 is affected by implementation of the ROM and SEED programs, because Reclamation does not own Crescent Lake Dam and is not responsible for maintaining that facility.

The majority of critical habitat within subunit 8A is affected by the ROM and SEED programs. Operation of the Deschutes Project affects 1,960 acres (793 ha) of critical habitat within subunit 8A. Anticipated effects to the PCEs of spotted frog critical habitat are discussed below.

PCE 1 – Spotted Frog Nonbreeding, Breeding, Rearing, and Overwintering Habitat

For the reasons discussed below, implementation of the ROM and SEED programs is likely to maintain the functioning at risk rating for spotted frog nonbreeding, breeding, rearing, and overwintering habitat in Subunit 8A.

The activities implemented at Crane Prairie Dam associated with the ROM and SEED programs will not affect the Deschutes River below Wickiup Dam as described above. However, activities implemented at Wickiup Dam will have a short-term effect on flows in the Deschutes River
between Wickiup Dam and the Colorado Street Bridge. All of the activities that will occur at Wickiup Dam will be implemented between mid-October and mid-December when flows at the WICO gage will be 100 cfs under the OSF Proposal. Therefore, overwintering habitat is the only component of PCE 1 that will be affected. Each of the ROM and SEED activities that occur once every 3 years will maintain releases between 25 and 50 cfs from Wickiup Dam and extend from 6 hours to 2 days, while the two one-time concrete repair activities scheduled for 2017 or 2018 will also maintain releases between 25 and 50 cfs and extend from 2 days to 1 week.

The activities associated with the ROM and SEED programs are likely to result in short-term reduced flows in the Deschutes River during their implementation. Decreased releases from Wickiup for a period of 6 hours to 2 days or 2 days to 1 week for one-time activities are likely to dewater the edge of the channel during that period. However, overwintering habitat within adjacent wetlands will not be affected by the reduction of flows from 100 to 25 cfs, because the wetlands are already disconnected from the river at 100 cfs.

The Fall River, Spring River, and the Little Deschutes River contribute a significant amount of additional water, progressively lessening the magnitude of effect as you move downstream. Nonetheless, the activities associated with the ROM and SEED programs are likely to dewater the edge of the Deschutes River channel to some degree during their implementation all the way to the Colorado Street Bridge.

**PCE 2 – Spotted Frog Aquatic Movement Corridors**

Implementation of the ROM and SEED programs will have a slight effect on PCE 2 during the period frogs are moving into overwintering habitat by dewatering the edge of the channel for a period of 6 hours to 2 days or 2 days to 1 week for one-time activities. The distance to access overwintering habitat within the Deschutes River is likely to increase up to several feet during these periods. The remainder of the year, the ROM and SEED programs will have no effect on PCE 2 in subunit 8A.

**PCE 3 – Spotted Frog Refugia Habitat**

Implementation of the ROM and SEED programs will have a slight effect on PCE 3 during the period frogs are moving into overwintering habitat by dewatering the edge of the channel for a period of 6 hours to 2 days or 2 days to 1 week for one-time activities. The distance to access overwintering habitat that might also function as refugia habitat within the Deschutes River is likely to increase up to several feet. Also, the short-term decrease in flows is likely to result in a slight increase in the concentration of predacious fish within the Deschutes River. The remainder of the year, the ROM and SEED programs will have no effect on PCE 3.

**6.3.2.2 Effects of the ROM and SEED Programs on Spotted Frog Critical Habitat Subunit 8B**

The area affected by implementation of the ROM and SEED programs encompasses Crane Prairie and Wickiup reservoirs and the Deschutes River and associated wetlands between the reservoir and includes approximately 15,365 acres (6,218 ha) of critical habitat within subunit 8B. Anticipated effects to the PCEs of spotted frog critical habitat are discussed below.
For the reasons discussed below, implementation of the ROM and SEED programs is likely to maintain the functioning at risk rating for spotted frog nonbreeding, breeding, rearing, and overwintering habitat in Subunit 8B.

Due to the short-term nature of the activities associated with the ROM and SEED programs the effects within Crane Prairie Reservoir will be minor. It is likely that when the actions are implemented between mid-October and mid-December that reservoir volume will be between 35,000 and 40,000 acre-feet. The only effect to the habitat within Crane Prairie from completely shutting down releases from the reservoir for 2 to 6 hours is that the level of the reservoir will increase at a slightly greater rate during that period because inflows will continue, but releases will be shut down. In addition, the short duration of 5 minutes for the gate full-open/full-close examination is likely to have minimal effect on the water level within the reservoir. It is unlikely that the effect on the water level in the reservoir will even be observable given the volume of water in the reservoir and wave action along the shoreline of the lake.

The activities associated with the ROM and SEED programs are likely to result in short-term adverse effects to the Deschutes River between Crane Prairie Dam and Wickiup Reservoir during their implementation. Most of the activities associated with these programs will occur between October 15th and December 15th, so the effects will primarily be to overwintering habitat. Complete shutdown of releases from Crane Prairie for a period of 2 to 6 hours is likely to dewater significant portions of the Deschutes River channel between Crane Prairie Dam and Wickiup Reservoir during that period. The effect of the 5-minute gate full-open/full-close examination on the Deschutes River between the reservoirs will be observable following both the full opening and the full closing of the gate. In the early spring, between 100 and 400 cfs will be being released from Crane Prairie, so the rapid increase of flow to 500 cfs when the gate is opened will inundate portions of the channel along the margins of the Deschutes River that were previously dry. While the closure of the gate will dry portions of the channel for a short period until the gate is reopened.

Due to the short-term nature of the activities associated with the ROM and SEED programs the effects within Wickiup Reservoir will be relatively minor. The only effect to the habitat within Wickiup Reservoir from greatly reducing releases from the reservoir for 6 hours to 1 week is that the level of the reservoir will increase at a slightly greater rate during that period because inflows will continue, but releases will be decreased.

Implementation of the ROM and SEED programs will have short-term adverse effects to PCE 2 within subunit 8B by affecting the Deschutes River between Crane Prairie Dam and Wickiup Reservoir during implementation of activities associated with Crane Prairie. Complete shutdown of releases from Crane Prairie for a period of 2 to 6 hours is likely to dewater significant portions of the channel between Crane Prairie Dam and Wickiup Reservoir during that period. The effect of the 5-minute gate full-open/full-close examination on the Deschutes River between the
reservoirs will be observable following both the full opening and the full closing of the gate. In the early spring, between 100 and 400 cfs will be being released from Crane Prairie, so the rapid increase of flow to 500 cfs when the gate is opened will inundate portions of the channel along the margins of the Deschutes River that were previously dry. While the closure of the gate will dry portions of the channel for a short period until the gate is reopened.

**PCE 3 – Spotted Frog Refugia Habitat**

Implementation of the ROM and SEED programs will have a slight effect on PCE 3 within subunit 8B during the period frogs are moving into overwintering habitat by dewatering the edge of the channel of the Deschutes River between Crane Prairie Dam and Wickiup Reservoir for a period of 2 to 6 hours. The distance to access overwintering habitat that might also function as refugia habitat within the Deschutes River is likely to increase up to several feet. Also, the short-term decrease in flows is likely to result in a slight increase in the concentration of predacious fish within the Deschutes River. The effect of the 5-minute gate full-open/full-close examination on the Deschutes River between the reservoirs will be observable following both the full opening and the full closing of the gate. In the early spring, between 100 and 400 cfs will be being released from Crane Prairie, so the rapid increase of flow to 500 cfs when the gate is opened will inundate portions of the channel along the margins of the Deschutes River that were previously dry. While the closure of the gate will dry portions of the channel for a short period until the gate is reopened.

**6.3.2.3 Effects of the ROM and SEED Programs on Spotted Frog Critical Habitat Unit 9**

Crescent Lake Dam is owned by the irrigation districts, so the ROM and SEED programs will not be implemented in the Little Deschutes River subbasin. Therefore, these programs will have no effect on designated critical habitat in Unit 9.

**6.3.4 Summary of Effects to Critical Habitat Units 8 and 9**

Overall, the implementation of the Proposed Action is likely to maintain the degraded condition of designated critical habitat in Units 8 and 9. We anticipate partial improvements to PCEs within portions of each unit.

In Subunit 8A, implementation of the Proposed Action is likely to maintain the degraded function of critical habitat. The function of critical habitat within this subunit is disrupted annually by the seasonal storage and release of water for irrigation. The majority of critical habitat within subunit 8A is adversely affected by the implementation of the OSF Proposal (i.e., 1,960 acres) which continues water operations that dewater most of the wetlands adjacent to the Deschutes River in the fall and winter during the irrigation storage season. All PCEs are adversely affected during this time period.

In subunit 8B, the Proposed Action will improve the condition of PCEs and the function of critical habitat at Crane Prairie reservoir, which represents approximately 32 percent (4,982 acres) of CHU 8B. In the remainder of CHU 8B, the Proposed Action will maintain critical
habitat in a degraded condition whereby the duration of function is limited due to the seasonal changes in water levels that reduce PCE condition within critical habitat.

In Unit 9, implementation of the OSF Proposal is likely to maintain the degraded function of critical habitat, since the function of critical habitat within this subunit is disrupted annually by the seasonal storage and release of water for irrigation. A total of 5,363 ac (2,171 ha) of critical habitat within this CHU are likely to be affected by the OSF Proposal. A portion of CHU 9 that includes Crescent Creek and adjacent wetlands will be partially improved by implementation of the OSF Proposal (Table 52).

Given the lack of on the ground habitat monitoring and hydrological gauges within the Little Deschutes River sub-basin, it is difficult to determine precisely what the magnitude of the effect is to critical habitat. However, we are reasonably certain that the function of PCEs is reduced at the onset of the irrigation storage season throughout CHU 9.

Through our analyses, we have determined that the portion of critical habitat that is within the Crescent Creek system (i.e., 1,182 acres) is more affected by storage operations than the portion of critical habitat that is within the Little Deschutes River and adjacent wetlands downstream of the confluence with Crescent Creek, primarily due to the Little Deschutes River receiving natural hydrological inputs from the upper Little Deschutes River watershed and Big Marsh Creek. Additionally, there is an abundance of oxbow habitat adjacent to the Little Deschutes River that provides quality breeding, rearing and overwintering habitat, despite storage and release operations. For these reasons, the critical habitat within the Crescent Creek system is most likely to be partially improved by implementation of the OSF Proposal.

During the overwintering period, the Proposed Action will increase flows in Crescent Creek, which is likely to increase the availability and quality of spotted frog overwintering habitat in the portion of CHU 9 that includes Crescent Creek. The Proposed Action is likely to maintain the functioning at risk rating of aquatic movement corridors in CHU 9, as a whole. However, the Proposed Action increases flows from Crescent Dam in the fall which is likely to slightly improve wetland conditions that will facilitate spotted frog movement to overwintering habitat within a portion of CHU 9. The Proposed Action is likely to maintain the degraded condition of refugia habitat in CHU 9 because the irrigation storage season that results in the lowering the water levels throughout the wetlands and in the river reduce the amount of overwintering habitat for spotted frogs that is without predatory fish.
Table 52. Summary of effects to PCEs of designated critical habitat within CHUs 8 and 9

<table>
<thead>
<tr>
<th>CH Unit</th>
<th>CH subunit</th>
<th>PCE 1 – Breeding, rearing, overwintering, nonbreeding</th>
<th>PCE 2 – Aquatic movement corridor</th>
<th>PCE 3 – Refugia habitat</th>
</tr>
</thead>
<tbody>
<tr>
<td>8. Upper Deschutes River</td>
<td>8A – Below Wickiup Dam</td>
<td>Maintain degraded</td>
<td>Maintain degraded</td>
<td>Maintain degraded</td>
</tr>
<tr>
<td></td>
<td>8B – Above Wickiup Dam</td>
<td>Partial improvement/ Maintain degraded</td>
<td>Partial improvement/ Maintain degraded</td>
<td>Partial improvement/ Maintain degraded</td>
</tr>
<tr>
<td>9. Little Deschutes River</td>
<td></td>
<td>Partial Improvement/ Maintain degraded</td>
<td>Partial improvement/ Maintain degraded</td>
<td>Maintain degraded</td>
</tr>
</tbody>
</table>

6.4 Effects of Interrelated and Interdependent Actions

Regulations implementing the ESA require that the Service consider the effects of activities which are interrelated and interdependent to the proposed Federal action (50 CFR §402.02) as part of the effects of the proposed Federal action (see the regulatory definition of “effects of the action” at 50 CFR §402.02). The ESA defines interrelated activities as those which are part of a larger action and depend upon the larger action for their justification, and interdependent activities as those projects which have no independent utility apart from the action that is under consideration. Both interrelated and interdependent activities may be assessed by applying the "but for" test, which asks whether any action and its associated impacts would occur "but for" the proposed Federal action. No interdependent or interrelated activities were identified in this consultation. Therefore, we anticipate no effects to Oregon spotted frogs or their designated critical habitat from such activities.

6.5 Summary of Effects of the Proposed Action

The current baseline condition for the spotted frog and designated critical habitat in the Action Area is highly degraded. Implementation of the Proposed Action over the next two years is not likely to further degrade that condition for two reasons: (1) improvements to spotted frog habitat at Crane Prairie reservoir are likely to increase survival of all life stages of spotted frogs over the term of the Proposed Action within the Upper Deschutes River sub-basin; and (2) increased fall and winter flows from Crescent Lake in the Little Deschutes River sub-basin are likely to increase spotted frog survival within critical habitat along Crescent Creek by extending the period of time in which spotted frog habitat is inundated.

The effects of the action on the spotted frog and its critical habitat vary geographically within the Action Area. Depending on where water is stored or delivered and the timing of these operations in the context of the Oregon spotted frog life cycle (i.e., breeding, rearing, pre-overwintering movement period, and overwintering), spotted frog habitat may be either improved or degraded. In some areas of the Action Area, the Proposed Action may slightly improve habitat conditions in one area while slightly degrading habitat in another area (e.g., Deschutes River reaches below Wickiup Dam).
Over the broad Action Area, Table 53, below, identifies the locations where the Proposed Action is likely to improve or slightly improve habitat conditions for the spotted frog, or maintain degraded or further degrade habitat conditions as described in the Environmental Baseline section above.

A summary of the anticipated effects to spotted frogs and designated critical habitat from implementation of the Proposed Action are described below for each sub-basin.

Table 53. Effects of the Proposed Action on the Oregon spotted frog during key life history stages, by location, compared to baseline conditions.

<table>
<thead>
<tr>
<th>Upper Deschutes River Sub-basin</th>
<th>Breeding Period</th>
<th>Rearing Period</th>
<th>Pre-Overwintering Period</th>
<th>Overwintering Period</th>
</tr>
</thead>
<tbody>
<tr>
<td>Above Wickiup Dam</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Crane Prairie Reservoir</td>
<td>Likely to Improve Baseline Conditions</td>
<td>Likely to Improve Baseline Conditions</td>
<td>Likely to Improve Baseline Conditions</td>
<td>May Improve Degraded Baseline Conditions</td>
</tr>
<tr>
<td>Crane Prairie Dam to Wickiup</td>
<td>Likely to Maintain Degraded Baseline Conditions</td>
<td>Likely to Increase Degraded Baseline Conditions</td>
<td>Likely to Maintain Degraded Baseline Conditions</td>
<td>Likely to Increase Degraded Baseline Conditions</td>
</tr>
<tr>
<td>Wickiup Reservoir</td>
<td>Likely to Maintain Degraded Baseline Conditions</td>
<td>Likely to Maintain Degraded Baseline Conditions</td>
<td>Likely to Maintain Degraded Baseline Conditions</td>
<td>Likely to Maintain Degraded Baseline Conditions</td>
</tr>
<tr>
<td>Below Wickiup Dam</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wickiup Dam to Little Deschutes River (Reaches 1 and 2)</td>
<td>Likely to Maintain or Slightly Improve Degraded Baseline Conditions</td>
<td>Likely to Maintain or Slightly Improve Degraded Baseline Conditions</td>
<td>Likely to Increase Degraded Baseline Conditions</td>
<td>Maintain degraded</td>
</tr>
<tr>
<td>Little Deschutes River to Lava Island Falls (Reaches 3-5)</td>
<td>Likely to Maintain or Slightly Improve Degraded Baseline Conditions</td>
<td>Likely to Maintain or Slightly Improve Degraded Baseline Conditions</td>
<td>Likely to Increase Degraded Baseline Conditions</td>
<td>Likely to Maintain Degraded Baseline Conditions</td>
</tr>
<tr>
<td>Lava Island Falls to COID Diversion (Reach 6)</td>
<td>Likely to Maintain Degraded Baseline Conditions</td>
<td>Likely to Maintain Degraded Baseline Conditions</td>
<td>Likely to Maintain Degraded Baseline Conditions</td>
<td>Likely to Maintain Degraded Baseline Conditions</td>
</tr>
</tbody>
</table>
6.5.1 Upper Deschutes River Sub-basin

Crane Prairie Reservoir

In the Upper Deschutes River sub-basin, we anticipate improvements to spotted frog habitat that are likely to increase spotted frog survival at Crane Prairie reservoir. Although the Proposed Action results in improvements to spotted frog habitat at Crane Prairie by maintaining suitable surface water elevations during the breeding and rearing periods and increasing the winter storage volumes, we anticipate that spotted frogs will continue to perish when reservoir volumes are drawn down for irrigation beginning sometime between July 16 and July 31st of each year. Spotted frogs that are not fully metamorphosed when the reservoir draw down begins will be stranded and desiccated as water levels recede from emergent wetland vegetation. During the drawdown period, adult and juvenile spotted frogs that are stranded out of water will attempt to move to overwintering sites and will be at increased risk of predation by avian and terrestrial predators. There are approximately 583 acres of shoreline wetlands along Crane Prairie where we anticipate that spotted frogs will be stranded and preyed upon during the ramp down period due to de-watering. The extent of these impacts is likely to be exceeded if the drawdown for irrigation occurs prior to July 16 and/or if the drawdown rate exceeds that under the Proposed Action.

The Proposed Action maintains reservoir storage of at least 35,000 acre-feet through winter. Spotted frogs that overwinter within the reservoir are likely to be preyed upon by fish within the reservoir. The extent of this impact is likely to be exceeded if the winter storage volume is lower than 35,000 acre-feet, which will further concentrate the predatory fish population. Precise overwintering locations for spotted frogs at Crane Prairie have not been identified and it will be necessary to determine where these important habitats are within the reservoir to determine if the
residual volume of water storage through winter (i.e., 35,000 acre feet) is sufficient to increase overwintering survival of spotted frogs. Fall telemetry studies are necessary to determine spotted frog movement to and selection of overwintering sites within Crane Prairie reservoir.

Deschutes River and Wetlands between the Reservoirs

Maintaining water levels within Crane Prairie reservoir may have adverse downstream consequences to spotted frogs in the Deschutes River between the reservoirs. Currently, there is only one monitored spotted frog breeding location within this reach of the Deschutes River. Prior to implementation of the Proposed Action, we observed spotted frogs using habitat adjacent to the river for breeding over a few years. In the spring of 2017 when the OSF Proposal was being implemented as per the Settlement Agreement, no spotted frogs or breeding were observed at this location despite no change in spring habitat inundation condition. We assessed the hydrographs for the CRAO gauge for the fall and winter that preceded the breeding season of 2017 and observed high flows in the fall of 2016 and a large drop in flows in January 2017. Lows at the CRAO gauge remained lower than pre-OSF Proposal operation until mid-February. The modeled output for the Proposed Action depicts even higher flows at the outlet of Crane during the fall movement period for spotted frogs and lower winter flows when spotted frogs are sheltering within winter habitat. The change from high flows in the fall to low flows in the winter is likely to result in mortality of spotted frogs. High flows in fall will cause spotted frogs to seek overwintering habitats that become unsuitable as flows drop in the winter and it is likely that spotted frogs will not survive the winter. Further evaluation and monitoring within additional wetland habitats along the reach of the Deschutes River between the reservoirs is necessary to observe where conditions may remain suitable for spotted frogs through implementation of the Proposed Action.

Wickiup Reservoir

The Proposed Action is likely to result in lower surface water elevations in Wickiup Reservoir from October 1 to September 30 according to the RiverWare-modeled hydrographs. There are approximately 2,961 acres of wetlands within the 10,231 acres of Wickiup Reservoir that extend into the floodplain of the Deschutes River between Crane Prairie and Wickiup reservoirs, as described above. These wetlands are dewatered as the reservoir is drawn down from maximum storage volumes of 200,000 acre-feet during the irrigation season, and do not provide year-round suitable habitat for spotted frogs. As the water recedes from these wetlands, spotted frogs are without cover from terrestrial and avian predators and are at an increased risk of predation. The Proposed Action will continue the annual draw down of Wickiup Reservoir and the RiverWare model predicts that the residual volume of water that remains in the reservoir will be lower than current conditions. Spotted frogs that overwinter within the reservoirs will continue to be preyed upon as they are concentrated into the residual pool of the reservoir with an abundance of predatory fish and no refugia habitat for protection against predatory fish.

Given that spotted frog habitat is currently degraded within Wickiup Reservoir, the change in reservoir condition that is anticipated under the Proposed Action is likely to maintain the degraded existing habitat conditions for spotted frog and designated critical habitat. We do not know precisely the storage volume within the reservoir that creates the most suitable habitat
conditions for spotted frogs. Monitoring of wetland habitat along the margins of Wickiup Reservoir will be necessary to determine spotted frog use of these wetlands for breeding.

**Deschutes River below Wickiup Dam**

Flows in the Deschutes River below Wickiup Dam are slightly modified by the Proposed Action. Earlier flow releases below Wickiup Dam in the spring may provide some benefit to spotted frogs during the breeding and rearing periods by flooding emergent wetlands along and adjacent to the River sooner. However, implementation of the Proposed Action is likely to perpetuate the ongoing adverse effects of irrigation water storage and release operations by the Districts such that the currently degraded condition of wetlands adjacent to the Deschutes River downstream of Wickiup Dam, as described in the Environmental Baseline section above, are likely to be maintained. Furthermore, the results of RiverWare modeling indicate that implementation of the OSF Proposal is likely to result in an earlier ramp down (and its associated de-watering effect on frog habitat) in the fall, which will further impact spotted frogs during the important movement period to overwintering habitat. Approximately 1,227 acres of wetlands and designated critical habitat are adversely affected by the Proposed Action along 57 miles of the Deschutes River. Within these acres, spotted frogs are reasonably certain to experience a restriction in movement, a reduction in cover, and stranding, all of which increase the likelihood of spotted frog predation and mortality.

The Proposed Action is not likely to result in any improvement in Deschutes River wetlands that support spotted frogs or designated critical habitat with an increase in winter flows to 100 cfs based on the results of the Wickiup Ramp Down Study in 2014 (Appendix). Under this study, flows of approximately 100 cfs were established within the Deschutes River along approximately 53 of 61 miles of spotted frog critical habitat and habitat conditions were assessed. An illustrated account of the Deschutes River and adjacent wetland habitat conditions at various reductions in flow, including 100 cfs, are provided in the Appendix of this biological opinion. Winter flows of 100 cfs do not inundate the floodplain wetlands of the Deschutes River which is the preferred habitat for spotted frogs. Flows of 100 cfs at WICO provide insufficient suitable overwintering habitat for spotted frogs because the area of inundation at this flow level is contained within the river channel where there is limited overwintering habitat for spotted frogs that could serve as cover to protect spotted frogs from being predated by brown trout.

Table 54 below summarizes the wetland acreages by river mile that are likely to be adversely affected by the Proposed Action and the flow thresholds at the WICO and BENO gauges below which reductions in spotted frog habitat quality and quantity have been observed by Service staff during on-the-ground monitoring of spotted frog habitat. Most of this monitoring work was conducted in Deschutes River Reaches 1 through 4. Therefore, the flow thresholds that are included in Table 54 only apply to Reaches 1 through 4. Although we have not yet developed flow thresholds for Reaches 5 through 7, we include acreages of habitat that are adversely affected by the Proposed Action in Table 54, below. Designated critical habitat acres that are likely to be adversely affected by the Proposed Action due to reduced flows and associated de-watering of adjacent wetlands are also included in Table 54. The critical habitat acres exclude wetland habitat in Sunriver because those acres were excluded in the Final Critical Habitat Designation (81 FR 29336); the Sunriver wetland habitat also includes acreage associated with
the Deschutes River that functions as an aquatic movement corridor for spotted frogs.

The Proposed Action is likely to adversely affect approximately 633 acres of wetland habitat along 36 miles of the Deschutes River in Reaches 1 and 2 as the river ramps down in the fall at the onset of the irrigation storage season. When flows at the WICO gauge drop below 900 cfs, water drains from the emergent wetland vegetation that provides spotted frogs with cover from predators. As flows continue to drop to 100 cfs at the WICO gauge, the surface area that is inundated by water is vastly reduced. Since ramp down operations occur during a movement period for spotted frogs between summer rearing and overwintering habitats, the reduction of water from their habitat impedes movement and increases the risk of avian and terrestrial predators. As stated above, limited overwintering habitat is available for spotted frogs at flows of 100 cfs at the WICO gauge and frogs are likely to be preyed upon by brown trout as they are concentrated in areas still subject to inundation from October to April 1.

Although the Proposed Action will increase flows from WICO to 600 cfs by April 1, there is limited improvement to habitat conditions and critical habitat in Reaches 1 and 2 since water does not inundate emergent vegetation at this flow level. When water is outside of emergent vegetation, spotted frogs do not have shelter from predators as they breed. Egg masses and emerging tadpoles are at increased risk of predation, freezing and overheating without cover. Compared to pre-OSF Proposal flow conditions, the Proposed Action is likely to result in fewer days across all spotted frog life cycle periods where flows are above 900 cfs; flows above 900 cfs provide high quality habitat for spotted frogs.

In Reach 3, the Proposed Action is likely to adversely affect approximately 115 acres of spotted frog breeding and rearing habitat in Sunriver when river flows are below 1,000 cfs at WICO for a slightly longer period than under current (pre-OSF Proposal) conditions. Egg masses and emerging tadpoles are at increased risk of stranding when river flows are below 1,000 cfs at WICO and not flowing into habitat at Sunriver.

The Proposed Action may slightly improve spotted frog habitat conditions within approximately 171 acres of wetlands in Reach 3 that are outside the area of inundation that is maintained by the Sunriver weirs; that slight improvement over current conditions is likely to be caused when flows at the BENO gauge exceed 1,200 cfs at the BENO gauge for a slightly longer period during the spotted frog breeding period. However, this benefit to spotted frogs is negated as the majority of the wetlands are dewatered and the aquatic connectivity of habitat is reduced during the irrigation storage season. Spotted frogs are reasonably certain to experience a restriction in movement, a reduction in cover, and stranding, all of which increase the likelihood of their predation and mortality within these 171 acres. Continued monitoring of hydrological conditions is needed within Reach 3 to assess spotted frog habitat suitability at various flow levels and through the winter period to determine future options for increasing habitat for spotted frogs under the Deschutes Basin HCP.

The Proposed Action is likely to adversely affect approximately 198 acres of spotted frog habitat, including designated critical habitat, along the 3 miles of Deschutes River in Reach 4. Two thresholds for flows at the BENO gauge (1,200 and 1,600 cfs) are used below to describe anticipated effects of the Proposed Action on spotted frogs and its critical habitat due to the
complex hydrology of this reach of the river.

In the spring, when flows are below 1,200 cfs, most of the 198 acres of wetland habitat within Reach 4 is not being inundated by the river. As flows in the river rise above 1,200 cfs at the BENO gauge, the groundwater within wetlands that are not completely connected to the river via surface water also begins to rise. However, the groundwater is not visible within the wetlands until flows reach approximately 1,400 cfs at the BENO gauge. At 1,600 cfs at the BENO gauge the entire wetland acreage is inundated and suitable for all life stages of spotted frogs. Therefore, when flows are below 1,600 cfs during the spring breeding and early rearing period, egg masses and emerging tadpoles are at increased risk of stranding and spotted frogs are exposed to increased predation as they utilize areas without vegetated cover for breeding.

Table 54. Summary of spotted frog habitat acres below Wickiup Dam that are reasonably certain to be adversely affected by the Proposed Action.

<table>
<thead>
<tr>
<th>River Reach</th>
<th>Gauge flow thresholds below which de-watering of spotted frog habitat is likely to occur</th>
<th>Wetland acreages affected</th>
<th>River location affected by River Mile</th>
<th>River acres affected</th>
<th>Spotted Frog Critical Habitat</th>
</tr>
</thead>
<tbody>
<tr>
<td>1: Wickiup Dam to Fall River (includes monitored spotted frog sites at Bull Bend, Dead Slough and La Pine SP SW Slough)</td>
<td>900 cfs at WICO</td>
<td>325</td>
<td>RM 224 to RM 204.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2: Fall River to Little Deschutes (includes monitored spotted frog sites on private land at RM 202 and 195)</td>
<td></td>
<td>308</td>
<td>RM 192.5 to RM 188</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3: Little Deschutes to Benham Falls (includes Sunriver)</td>
<td>1000 cfs at WICO; 1,200 at BENO</td>
<td>286*</td>
<td>RM 188 to RM 181</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4: Benham to Dillon Falls (includes monitored spotted frog sites at East Slough Camp and S. Ryan Ranch)</td>
<td>1,600 to 1,200 at BENO</td>
<td>198</td>
<td>RM 181 to RM 178</td>
<td>985</td>
<td>1,960</td>
</tr>
<tr>
<td>5: Dillon Falls to Lava Island Falls</td>
<td>unknown</td>
<td>95</td>
<td>RM 178 to RM 174</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6: Lava Island Falls to COID diversion (includes monitored spotted frog site on private land at RM 172)</td>
<td>unknown</td>
<td>7</td>
<td>RM 174 to RM 171</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7: COID Diversion to Colorado Street Bridge (includes LSA Marsh in Old Mill)</td>
<td>unknown</td>
<td>8**</td>
<td>RM 171 to RM 167.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Total acreages and miles of river length affected</strong> <strong>1,227</strong> 56.5 linear miles</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*115 acres in Sunriver; ** all wetlands are within the Old Mill District.

In Reach 4, the Proposed Action will increase the duration of time that flows are above 1,200 cfs during the spring breeding period and above 1,600 cfs during the spotted frog rearing period, which is likely to improve conditions for these life stages. However, the Proposed Action will result in a decreased number of days where flows are above 1,600 cfs during the spotted frog
movement period in the fall. The reduction in flows during this period is likely to impede spotted frog movement between rearing and overwintering habitats by reducing aquatic connectivity.

Therefore, although the Proposed Action is likely to improve spotted frog breeding and rearing habitat conditions in Reach 4, the earlier ramp down period that reduces flows below levels that maintain suitable habitat conditions is likely to negate the spring season benefit of higher flow levels to spotted frogs. The Proposed Action is reasonably certain to restrict spotted frog movement, reduce cover, and increase stranding of spotted frogs when flows at the BENO gauge are below 1,600 and 1,200 cfs, all of which increase the likelihood of predation and mortality.

Flow thresholds below which de-watering of spotted frog habitat is likely were not identified for Reaches 5 through 7 along the Deschutes River in Table 54 because there is less certainty as to the specific flow thresholds that provide suitable year-round habitat for spotted frogs in these reaches due to the lack of on-the-ground monitoring and the complex hydrology of the river. Based on aerial flight photos for portions of Reach 5 (Dillon Falls to Lava Island Falls) and photos taken during the 2014 Wickiup Ramp Down Study, we are reasonably certain that the Proposed Action is likely to maintain the degraded condition of wetland habitats and designated critical habitat in Reaches 5 through 7 during the irrigation storage season. Since we do not have any monitored spotted frog sites within Reach 5, we cannot be reasonably certain that spotted frogs will be adversely impacted within the 95 acres of wetland habitat along this reach of the river. Future monitoring of wetlands within Reach 5 is necessary to determine when flows are adequate to inundate wetlands that are within designated critical habitat for the spotted frog.

Reach 6 has limited wetland habitat (approximately 7 acres) and was not included in the Final Critical Habitat designation. However, in September of 2016 juvenile spotted frogs were detected within wetlands on private land within this reach. The wetland habitat where frogs were observed was drained of water during the irrigation ramp down period and we are reasonably certain that spotted frogs at this location did not survive. It is likely that spotted frogs will occur in these wetlands during the course of the Proposed Action but perish during ramp down operations in the fall due to de-watering of wetland habitat; i.e., this area will serve as a “sink” for spotted frogs. Monitoring of wetlands at this location is necessary to determine flow rates that will avoid or reduce mortality of frogs due to de-watering of wetland habitat.

Reach 7 includes approximately 8 acres of wetlands (LSA Marsh) that occur within the Deschutes River channel at the Old Mill District. The Proposed Action is likely to adversely affect spotted frogs within this 8-acre marsh by further decreasing flows in the winter and increasing flows in the spring, both actions are likely to affect spotted frog habitat use at this site during key periods of the spotted frog life cycle. Our determination of effects is based on a comparison between the hydrographs for this site for the 2017 water year (when the OSF Proposal was implemented under the Settlement Agreement) and average hydrographs for water years 2000 to 2016.

Assuming 2017 flows represent implementation of the OSF Proposal, it is reasonable to expect a significant disruption of juvenile, subadult, and adult spotted frog overwintering behaviors at LSA Marsh as winter flows are decreased and render some of the habitat unsuitable for
overwintering spotted frogs. Furthermore, spotted frogs are likely to avoid breeding within the LSA Marsh if flows are too high in the spring.

Monitoring of surface water elevations that provide suitable habitat for spotted frogs is necessary to determine appropriate flow thresholds for maintaining suitable wetland habitat conditions for spotted frogs in Reach 7. As described in the Environmental Baseline and Effects of the Action sections of this biological opinion, the determination of flow thresholds is confounded by a complex hydrology that includes a reduction in flows at irrigation diversions upstream of wetlands and a 7 percent water loss within this river reach. This area is under evaluation as the hydrology is dynamic and not easily monitored. Currently, a staff gauge has been installed within LSA Marsh to monitor and identify appropriate water levels that provide habitat conditions to support breeding and overwintering spotted frogs.

The Proposed Action is likely to maintain overwintering habitat for spotted frogs in a degraded condition along 57 miles of the Deschutes River (not including the adjacent wetlands discussed above). As wetlands are drained prior to the onset of the irrigation storage season, spotted frogs are likely to move to the Deschutes River and the likelihood of survival is low. Overwintering habitat conditions at flows of 100 cfs at WICO are sub-optimal for spotted frogs because, under these conditions, spotted frogs are likely to be preyed upon by brown trout that reside in the river.

NOTE: The Deschutes River Basin HCP being prepared by the Districts needs to adequately address improved winter water conditions in the Deschutes River downstream of Wickiup Dam. As winter flows in the river increase above 500 cfs (as measured by the WICO gauge), there are likely to be opportunities to restore the function of the river and adjacent wetlands to provide suitable habitat for Oregon spotted frogs. Although the idea of engineered wetlands to create habitat for spotted frogs is reasonable, the feasibility of creating or restoring wetlands that provide year-round water for spotted frogs will not be realized until there is additional flow in the Deschutes River during the winter season.

Continued hydrological and biological monitoring of the Deschutes River and adjacent wetlands, particularly in the Reaches that have not been monitored intensively (e.g., Reaches 5, 6 and 7), is also needed to further inform conservation of Oregon spotted frogs and the proper function of spotted frog critical habitat between Wickiup Dam and Bend, OR. As described earlier in this Opinion, the flow thresholds that provide suitable habitat for spotted frogs based on our field monitoring of flow and habitat conditions are meant to serve as a way of describing the effects to spotted frogs over a very large action area. There is a need to further refine and define a range of flow conditions within the river that are likely to improve spotted frog survival over its annual life cycle.

NOTE: The flow thresholds that have been articulated in this Opinion for the WICO and BENO gauges within the Deschutes River below Wickiup Dam are not intended as flow targets for managing the river system. Rather, these flow thresholds have been used as a means to describe the effects to spotted frogs and critical habitat that are likely to occur as a result of the Proposed Action. As described in the Environmental Baseline section above, the Deschutes River below Wickiup Dam has widened and scoured since water storage and release operations began
approximately 70 years ago. Under those conditions, higher flows from Wickiup Dam (WICO) are needed to inundate wetland habitats on the floodplain. Such high flows may not be feasible due to insufficient natural production of water (i.e., precipitation in the form of rain and snow) in the upper basin and/or operationally. Therefore, a long-term approach to restoring habitat within the Upper Deschutes River for spotted frogs will require changes to the hydrograph (i.e., increasing winter and lowering summer flows) and channel restoration (e.g., restoring a narrower channel).

6.5.2 Little Deschutes River Sub-basin

In the Little Deschutes River sub-basin, the Proposed Action influences an area that includes approximately 5,204 acres of wetland habitat and 166 acres of open water, riverine habitat in Crescent Creek and the Little Deschutes River. The analysis of the Proposed Action conducted using the RiverWare model indicates that changes in hydrological conditions caused by the Proposed Action are most significant in the area that includes Crescent Creek, and that the timing of these changes are likely to occur during the fall period of movement for spotted frogs when the Proposed Action results in a ramp down in river flow that is earlier than current conditions. As discussed above, flow ramp downs de-water spotted frog habitat and exposes spotted frogs to increased levels of predation.

The Proposed Action is likely to impact approximately 1,182 acres of wetland habitats along Crescent Creek. Based on the analysis conducted using the RiverWare model, we anticipate that the Proposed Action will result in a greater number of days (compared to current conditions) where flows will be below the 90 cfs threshold for maintaining suitable habitat conditions for spotted frogs in Crescent Creek during August and September. Based on our observations of habitat conditions at 89 cfs, and the results of the RiverWare model, we expect that spotted frogs in wetland habitats along Crescent Creek will be exposed to increased avian and terrestrial predation when cover is lost as wetlands drain. When spotted frogs move to Crescent Creek as a result of a reduction in flows, they are subject to increased predation from brown trout along approximately 30 miles of the Creek. Monitoring the decrease in flows during the fall period of ramp down is necessary to determine where suitable habitat for spotted frogs persists after ramp down.

In the Little Deschutes River downstream of the confluence with Crescent Creek, the Proposed Action influences the hydrological condition of approximately 3,322 acres of wetlands and riverine oxbows that provide an abundance of suitable habitat for spotted frogs. Based on outputs from the RiverWare model, the Proposed Action is likely to result in an earlier ramp down of flows in August. Since we have not conducted enough monitoring of wetlands where spotted frogs occur to develop thresholds for flows at the LAPO gauge that are sufficient to maintain suitable habitat conditions for spotted frogs, we are unable to determine with certainty whether the Proposed Action is likely to decrease flows to an extent that is likely to expose spotted frogs to increased levels of predation. Although a decrease in the aquatic connectivity between spotted frog rearing and overwintering habitats is likely to occur with implementation of OSF Proposal, the change in habitat inundation conditions is not likely to be measureable. For that reason, there is a strong need to conduct appropriate habitat monitoring during all spotted
frog life cycle stages within spotted frog breeding sites in the Little Deschutes River sub-basin as the OSF Proposal is implemented. It will also be essential to incorporate such information into the initial development and long-term implementation of the Deschutes Basin HCP through the adaptive management process.

7.0 CUMULATIVE EFFECTS

Cumulative effects include the effects of future State, Tribal, local or private activities on the spotted frog and its critical habitat that are reasonably certain to occur within the Action Area considered in this biological opinion. Future Federal actions in the Action Area that are unrelated to the Proposed Action are not considered in this section because they require separate consultation pursuant to section 7 of the ESA.

During the two-year term of the Proposed Action, there are no future State, Tribal, local or private activities, other than those likely to be implemented by the Districts as part of the Federal action considered herein, that are reasonably certain to occur within the Action Area and that may affect the spotted frog and its critical habitat.

As discussed in the background section of this biological opinion, the Service anticipates that the Districts will request an incidental take permit for the spotted frog from the Service in conjunction with submitting a draft HCP that addresses future irrigation water management activities within the Action Area pursuant to the requirements of section 10(a)(1)(B) of the ESA. The scoping process under the National Environmental Policy Act for this permit action has begun. It is the Service’s expectation that the HCP will include conservation measures for the Oregon spotted frog that significantly improve the environmental baseline conditions for the spotted frog and its critical habitat in the Action Area. The Service will complete a formal consultation and prepare a biological opinion on the effects of the proposed incidental take permit action on the spotted frog and its critical habitat pursuant to our duties and responsibilities under section 7(a)(2) of the ESA.

8.0 CONCLUSION

After reviewing the current status of the Oregon spotted frog and its designated critical habitat, the environmental baseline for the action area, the effects of Reclamation’s OSF Proposal and the cumulative effects, it is the Service's biological opinion that the OSF Proposal is not likely to jeopardize the continued existence of the Oregon spotted frog, and is not likely to destroy or adversely modify Oregon spotted frog critical habitat. The Service reached these conclusions for the following reasons.

The current condition of the Oregon spotted frog and its critical habitat in the action area is highly degraded due to the impacts of past and ongoing irrigation water storage and delivery activities conducted by the Districts, in coordination with Reclamation, that have radically altered the natural hydrology of this portion of the Deschutes River Basin. Synchronizing and modifying, as needed, water management activities within the action area to ensure the proper
function of habitats that support all spotted frog life stages and to ensure connectivity within suitable habitat areas and between spotted frog populations are vital to the survival and recovery of this species. Implementation of the OSF Proposal over a two-year period is a first step in that direction, and should help inform the development of the Deschutes River Basin HCP by the Districts. That HCP effort represents a highly significant opportunity to conserve the Oregon spotted frog by aligning irrigation water management in the Basin to closely conform to and support the life history requirements of the spotted frog and the proper function of its critical habitat.

Implementation of the OSF Proposal is likely to result in some temporary improvements to Oregon spotted frog habitat during critical periods of the spotted frog life cycle. These improvements are most evident at Crane Prairie Reservoir, a key location for maintaining genetic exchange between spotted frog populations located above the reservoir. Under the proposed action, some temporary improvements to spotted frog habitat along the Deschutes River, downstream of Wickiup Dam, are also likely to occur during the spotted frog breeding period. In particular, the earlier release of water from Wickiup Dam by April 1 may facilitate an earlier initiation of breeding by spotted frogs at East Slough Camp. An earlier breeding effort facilitates an earlier (and longer) period of metamorphosis which is likely to result in more mobile spotted frogs in the early Fall when the irrigation storage season begins and wetlands supporting spotted frogs are drained. Overall, these temporary beneficial effects may improve the condition of the spotted frog population and function of spotted frog critical habitat in the action area to support recovery of this species. However, as summarized in Tables 53 and 54 above, on balance, implementation of the OSF Proposal is likely to maintain, but not appreciably deepen, the currently highly degraded baseline for the spotted frog and its critical habitat in the action area because irrigation water management activities are likely to be out of synch with the life history requirements of the spotted frog and the proper function of its habitat to address those requirements.

**INCIDENTAL TAKE STATEMENT**

Section 9 of the ESA and Federal regulations pursuant to section 4(d) of the ESA prohibit the take of endangered and threatened species, respectively, without special exemption. Take is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or attempt to engage in any such conduct. Harm is further defined by the Service as an act which actually kills or injures wildlife. Such acts may include significant habitat modification or degradation that results in death or injury to listed species by significantly impairing behavioral patterns, including breeding, feeding, or sheltering. Harass is defined by the Service as intentional or negligent actions that create the likelihood of injury to listed species to such an extent as to significantly disrupt normal behavior patterns which include, but are not limited to, breeding, feeding, or sheltering. Incidental take is defined as take that is incidental to, and not the purpose of, carrying out an otherwise lawful activity. Under the terms of section 7(b)(4) and 7(o)(2), taking that is incidental to and not intended as part of the agency action is not considered to be
prohibited taking under the ESA provided that such taking is in compliance with the terms and conditions of this incidental take statement [50 CFR §402.14(i)(3)] .

The measures described below are non-discretionary, and must be undertaken by Reclamation so that they become binding conditions of any grant or permits issued to others conducting the work, as appropriate, for the exemption in section 7(o)(2) to apply. Reclamation has a continuing duty to regulate the activity covered by the incidental take statement. If Reclamation (1) fails to assume and implement the terms and conditions or (2) fails to require their grantees or permittees to adhere to the terms and conditions of the incidental take statement through enforceable terms that are added to the permit or grant document, the protective coverage of section 7(o)(2) may lapse. In order to monitor the impact of incidental take, Reclamation must report the progress of the action and its impact on the species to the Service as specified in the incidental take statement [50 CFR §402.14(i)(3)].

FORM AND AMOUNT OR EXTENT OF TAKE ANTICIPATED

Form of Take

Based on the findings presented above in the Effects of the Action section, incidental take of the Oregon spotted frog is anticipated in the form of harm and harass as a result of altered habitat conditions (including increased exposure of spotted frog life stages to predation by birds, snakes, small terrestrial mammals such as mink or raccoons, and fish) caused by the Proposed Action.

Amount or Extent of Take

Detection of killed or injured individual eggs, tadpoles, juveniles, sub-adults, and adult Oregon spotted frogs will be very difficult to detect due to their small size, cryptic coloration, dependence on aquatic environments, and the nature of the take impact (e.g., consumption by predatory fish). For those reasons, it is not practical to monitor take impacts in terms of individual spotted frogs.

Pursuant to the authority of section 402.14(i)(1)(i) of the implementing regulations for section 7 of the ESA (80 FR 26832), a surrogate can be used to express the amount or extent of anticipated take if the following criteria are met: (1) the causal link between the surrogate and take is described; (2) an explanation is provided as to why it is not practical to express the amount or extent of take or to monitor take-related impacts in terms of individuals of the listed species; and (3) a clear standard is set for determining when the level of anticipated take has been exceeded.

For purposes of this incidental take statement, a combination of affected wetland acres, storage volumes, and gauge flow rates in specific geographic areas are used as surrogates for establishing the extent of Oregon spotted frog take likely to be caused by the Proposed Action. The causal link (criterion 1) between each of these surrogates and take of the spotted frog is described in detail for specific geographic areas in the Effects of the Action section above. Each of these surrogates was specifically relied upon to determine the biological effects of the Proposed Action on the spotted frog. Criterion 2 is met as discussed above. The basis for compliance with regulatory criterion 3 is described below. NOTE: For some reaches, it was not
possible to establish a surrogate for the amount or extent of take or to define a take exceedance criterion due to complex and variable hydrological and other site-specific conditions. As discussed above, because monitoring of take impacts in terms of individual spotted frogs is not practical, exempting a specific (estimated) number of individual spotted frogs for those reaches was not done in this incidental take statement. In those cases, the level of exempted take in that reach was all spotted frogs exposed to the Proposed Action-induced stressor(s), such as de-watering of habitat likely to be occupied by spotted frogs. For purposes of this incidental take statement, the sites for which a surrogate and a take exceedance trigger could be defined serve collectively as the standard for determining when the level of exempted take under this incidental take statement has been exceeded (see Table 55 below).

In the Upper Deschutes River sub-basin, the surrogates for quantifying take are a combination of storage volumes and wetland habitat acres in the reservoir system in the area above Wickiup Dam. In the area below Wickiup Dam the surrogates for quantifying take are a combination of river flow rates and wetland habitat acres by river reach.

Above Wickiup Dam, reservoir storage volumes influence the level of inundation within wetlands (approximately 583 acres) that provide habitat for spotted frogs. Within Crane Prairie reservoir we know that a reservoir storage volume of 45,000 acre-feet inundates a large area of the wetlands within the reservoir. The Proposed Action implements reservoir operations that require that storage volumes in Crane Prairie will reach at least 45,000 acre-feet by March 15. Between May 1st and May 15th, additional water may be stored in Crane Prairie Reservoir until the total volume reaches 50,000 acre-feet and covering the full surface area of wetlands within the reservoir with water that spotted frogs are likely to utilize. Beginning on July 16, reservoir storage (greater than 35,000 acre-feet) will be drawn down until reaching 35,000 acre feet at the end of the irrigation season. During this period when the wetlands are draining (July 16 to October 15), pre-metamorphic, juvenile, adult and sub-adult spotted frogs are likely to be harmed through desiccation and predation. Reservoir storage volumes will remain either at 35,000 acre-feet or increase until reaching 45,000 acre-feet by March 15 the following year. At low storage volumes, spotted frogs that overwinter within the reservoir are likely to be harmed by fish that prey upon them.

Downstream from Crane Prairie, there are approximately 2,961 acres of wetlands within the 10,231 acres comprising Wickiup Reservoir that extend into the floodplain of the Deschutes River between Crane Prairie and Wickiup reservoirs, described above. The floodplain wetlands along the Deschutes River are influenced by both flow releases from Crane Prairie Dam and storage volumes in Wickiup Reservoir. Wetlands within Wickiup Reservoir are influenced mainly by the storage volumes that are high (up to 200,000 acre-feet) in the spring and rapidly drain as storage volumes decrease during the irrigation season. These extreme changes in hydrological condition likely preclude the establishment of a persistent spotted frog population within Wickiup Reservoir. This area currently functions as a “sink” for spotted frogs; small, incipient populations are likely established within the wetlands at Wickiup Reservoir annually from upstream source areas only to be eliminated by the rapid de-watering of these wetlands during the irrigation season. Operation of the reservoir via the Proposed Action will perpetuate this cycle. During the irrigation season and extending into the irrigation water storage season (April 1 through October 15), all or most of the spotted frogs in various life stages (embryos,
tadpoles, juvenile, sub-adults and adults) that are present within the reservoir are likely to be stranded, desiccated and preyed upon as water drains from the wetlands as a result of the Proposed Action. Spotted frogs that overwinter within the residual storage volume of water within Wickiup Reservoir and the Deschutes River between the reservoirs are likely to be exposed to predation by brown trout that are concentrated in the residual reservoir pool.

Below Wickiup Dam, a surrogate for the amount or extent of spotted frog take can be expressed in terms of the extent of wetland acres (likely to be occupied by spotted frogs) that are de-watered when river flows, as measured by hydrological gauges at WICO and BENO, drop below specific flow thresholds identified in Table 54. In general, the timing of the take impact occurs in the fall when the river is ramped down in September and October so that storage of water may begin in the reservoirs upstream. As water drains from the wetlands, juvenile, subadult and adult spotted frogs are likely to be harmed by avian and terrestrial predators due to the lack of cover provided by water and emergent vegetation. Low flows of 100 cfs that remain in the river through winter under the Proposed Action are also likely to harm spotted frogs that are forced to overwinter in the river channel where habitat quality and quantity is vastly reduced. Spotted frogs overwintering within the Deschutes River are likely to be preyed upon by brown trout since refugia habitat becomes scarce when the wetland habitats are drained. Overall, spotted frogs are reasonably certain to experience a restriction in movement, a reduction in cover, and stranding that exposes them to predation within approximately 1,227 acres of wetlands adjacent to 57 miles of the Deschutes River downstream of Wickiup Dam.

Under the Proposed Action, when Deschutes River flows are managed below 900 cfs as measured at the WICO gauge during the breeding and early rearing period (March 15 to April 30), most spotted frogs within 633 acres of wetlands in Deschutes River Reaches 1 and 2 are exposed to habitat loss and degradation (due to a reduction in cover) that increases their exposure to avian and terrestrial predation. Egg masses and emerging tadpoles also are at increased risk of predation and exposure to freezing and overheating due to the lack of cover and shallow water depths. As flows are reduced below 900 cfs in September, juvenile, subadult and adult spotted frogs are once again at increased risk of predation as wetlands are dewatered. Movement between rearing and overwintering habitat is restricted and spotted frogs are subject to predation. The Proposed Action is likely to harm spotted frogs between September 15 and April 30 of the following year when Deschutes River flows are well below 900 cfs and there is limited habitat available to them from fall, through winter and into spring.

In Deschutes River Reach 3, when Deschutes River flows are below 1,000 cfs, as measured at the WICO gauge, some spotted frog egg masses and emerging tadpoles are likely to strand due to the delay in inundation of 115 acres of wetlands on private land that is managed by weirs in Sunriver. The timing of this stranding is likely to occur between March 15 and April 30. On approximately 171 acres outside of the area managed by weirs, spotted frog movement is also likely to be restricted and spotted frogs are likely to be stranded and preyed upon as water drains from wetlands as the irrigation storage season begins under the Proposed Action. The timing of this impact is likely to occur in September and extend until the following April during which time the flows at the BENO gauge are reduced below 1,200 cfs.

In Reach 4, some spotted frogs within approximately 198 acres of wetland habitat along 3 miles of river are likely to be subject to restricted movement and exposed to an increased risk of
stranding due to de-watering of habitat as flows at the BENO gauge are reduced below 1,600 cfs in September and further reduced shortly thereafter to below 1,200 cfs. As flows are reduced below these thresholds, most juvenile, subadult and adult spotted frogs using these wetlands are exposed to an increased risk of predation by aquatic and terrestrial predators.

In the spring, when flows are below 1,200 cfs, most of the 198 acres of wetland habitat within Reach 4 are not inundated by the river. Until flows reach 1,600 cfs at the BENO gauge in the spring, spotted frogs within these wetlands are concentrated into small areas and egg masses and emerging tadpoles are at increased risk of stranding and desiccation. Spotted frogs in Reach 4 are also exposed to increased predation as they utilize areas without vegetated cover for breeding.

In Reach 6, all spotted frogs within 7 acres of wetlands are likely to be killed when flows are reduced for the irrigation storage season. The timing of this impact is likely to occur in September under the Proposed Action. Based on limited field observations by Service staff, this area is likely functioning as a sink for spotted frogs.

In Reach 7, some spotted frogs within 8 acres of the LSA Marsh in the Old Mill District are likely to be subject to a significant disruption of their breeding, feeding, and sheltering behavior to an extent that creates the likelihood of injury. This impact will be caused by a reduction in the quality of spotted frog overwintering and breeding habitat caused by lower winter flows under the Proposed Action that are likely to affect spotted frog selection of overwintering sites. The Proposed Action is also likely to result in higher flows during the spotted frog spring breeding period which are likely to restrict spotted frog use of a portion of the marsh for breeding.

Table 55. Extent of anticipated take caused by the Proposed Action.

<table>
<thead>
<tr>
<th>Location</th>
<th>Surrogate</th>
<th>Form of take</th>
<th>Conditions that reflect take exceedance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Upper Deschutes River Sub basin Above Wickiup Dam</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Crane Prairie Reservoir</td>
<td>583 acres of dewatered wetlands between July 16 and October 15 (drawdown period)</td>
<td>Harm and harass</td>
<td>Storage volumes below 45,000 acre-feet on March 15; Storage volumes below 45,000 acre-feet between March 15 and July 15; Earlier drawdown than July 15; Storage volumes are &lt;35,000 acre-feet at any time of the year</td>
</tr>
<tr>
<td>Wickiup Reservoir, including Deschutes River wetlands between reservoirs</td>
<td>2,961 acres of dewatered wetland acres between April 1 and October 15 as storage volumes are reduced below 200,000 acre feet (i.e., maximum storage volume).</td>
<td>Harm and harass</td>
<td>All spotted frogs within the reservoir are anticipated to be taken annually.</td>
</tr>
</tbody>
</table>
### Upper Deschutes River Sub basin Below Wickiup Dam

<table>
<thead>
<tr>
<th>Reach</th>
<th>Description</th>
<th>Acres</th>
<th>Take Activity</th>
<th>Take Thresholds</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Wickiup Dam to Fall River (includes monitored spotted frog sites at Bull Bend, Dead Slough and La Pine SP SW Slough)</td>
<td>633</td>
<td>Harm and harass</td>
<td>Flows at WICO gauge &lt;900 cfs between June 30 and September 14</td>
</tr>
<tr>
<td>2</td>
<td>Fall River to Little Deschutes (includes monitored spotted frog sites on private land at RM 202 and 195)</td>
<td>115</td>
<td>Harm and harass</td>
<td>Flows at WICO gauge &lt;1,000 cfs between June 30 and September 14 Flows at BENO are &lt;1,200 cfs between May 1 and September 14</td>
</tr>
<tr>
<td>3</td>
<td>Little Deschutes to Benham Falls (includes Sunriver)</td>
<td>198</td>
<td>Harm and harass</td>
<td>Flows &lt;1,200 cfs at the BENO gauge between May 1 and September 14 Flows &lt;1,600 cfs at the BENO gauge between May 1 and September 14</td>
</tr>
<tr>
<td>4</td>
<td>Benham to Dillon Falls (includes monitored spotted frog sites at East Slough Camp and S. Ryan Ranch)</td>
<td>7</td>
<td>Harm</td>
<td>All spotted frogs within 7 acres are anticipated to be taken annually.</td>
</tr>
<tr>
<td>6</td>
<td>Lava Island Falls to COID diversion (includes monitored spotted frog site on private land at RM 172)</td>
<td>8</td>
<td>Harass</td>
<td>N/D</td>
</tr>
<tr>
<td>7</td>
<td>COID Diversion to Colorado Street Bridge (includes LSA Marsh in Old Mill)</td>
<td>1,182</td>
<td>Harm and harass</td>
<td>N/D</td>
</tr>
</tbody>
</table>

**Little Deschutes River Sub basin**

<table>
<thead>
<tr>
<th>Reach</th>
<th>Description</th>
<th>Acres</th>
<th>Take Activity</th>
<th>Take Thresholds</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crescent Creek</td>
<td>1,182 acres when flows at CREO gauge are &lt;90 cfs between October 15 to November 30.</td>
<td>Harm and harass</td>
<td>N/D</td>
<td></td>
</tr>
</tbody>
</table>

**ND = Not defined.** Based on best available information, take exceedance thresholds for these reaches could not be defined. **NOTE:** Take is not reasonably certain to occur within 95 acres of wetlands in Reach 5 because spotted frogs have not been detected in this reach. Take is not reasonably certain to occur within the 3,322 acres of the...
Little Deschutes River downstream of the confluence of Crescent Creek because these acres are not as likely to be affected by the CREO gauge, flow thresholds for wetland inundation have not been established through monitoring, natural hydrological inputs from the upper Little Deschutes River watershed is likely to support habitat and there is an abundance of suitable habitat that remains through the winter for spotted frogs in this reach of the Little Deschutes River.

In the Little Deschutes River sub-basin, the Proposed Action is likely to harm some spotted frogs as a result of de-watering within 1,182 acres of wetland habitats along approximately 30 miles of Crescent Creek. The timing of this impact is most likely to occur in the fall (September) as flows at the CREO gauge are reduced below 90 cfs during an important period of spotted frog movement to overwintering habitat. Spotted frogs in wetland habitats along Crescent Creek are likely to be exposed to increased avian and terrestrial predation when cover is lost due to the de-watering of wetlands as flows at the CREO gauge are reduced below 90 cfs. When spotted frogs move to Crescent Creek from adjacent wetlands as a result of a reduction in flows under the Proposed Action, they are also subject to increased predation from brown trout along approximately 30 miles of the creek.

Given the abundance of off-channel oxbows along Crescent Creek that maintain water (although at lower levels) through the fall drawdown and into the winter when increased precipitation results in increasing water levels in oxbows, spotted frogs are likely to persist in overwintering habitats that receive additional flows (i.e., approximately 24 cfs) from the CREO gauge under the Proposed Action. Therefore, the take exemption for spotted frogs in wetlands adjacent to Crescent Creek within the Little Deschutes River sub-basin applies only for the period of September 15 to November 30 (annually).

10.2 EFFECT OF THE TAKE

In the accompanying biological opinion, the Service determined that this level of anticipated take is not likely to result in jeopardy to the species or destruction or adverse modification of designated critical habitat.

11. REASONABLE AND PRUDENT MEASURES

The Service believes the following reasonable and prudent measures are necessary and appropriate to minimize the impacts of incidental take on the Oregon spotted frog as described in this incidental take statement, which is based on the analysis of the Effects of the Action in the accompanying biological opinion.

1. Reclamation and the Districts shall monitor storage volumes at Crane Prairie Reservoir and flow rates at the WICO, BENO, and CREO hydrological gauges in order to provide advance notice to the Service of irrigation water storage and release operations that are likely to exceed the take levels exempted in this incidental take statement. Reclamation and the Districts will identify opportunities to adjust Project operations to avoid that exceedance.
2. Reclamation and the Districts shall monitor hydrological conditions within Wickiup Reservoir, the Deschutes River between Wickiup and Crane Prairie reservoirs, Deschutes River Reaches 5-7, and the Little Deschutes River to determine the storage volumes and flow rates that are necessary to inundate wetland habitats whose proper function are key to supporting a well distributed and viable population of the spotted frog in the Action Area.

3. Reclamation and the Districts shall conduct biological monitoring to determine the effectiveness of the Proposed Action in reducing spotted frog take impacts at Crane Prairie Reservoir.

4. Reclamation and the Districts shall continue to provide funding or other support to ongoing inter-agency efforts to conduct annual spotted frog breeding counts within the Action Area.

5. Reclamation and the Districts shall, in coordination with the Service, develop an adaptive management plan that relies on the monitoring programs set forth under measures (1) and (2) above to address operational situations that may cause exceedance of the exempted levels of spotted frog take and modifications of those operations to avoid that exceedance. The plan shall also address opportunities for modifying Project operations under hydrological conditions where additional benefits to spotted frog reproduction, numbers, and distribution within the Action Area can be accrued.

6. Reclamation and the Districts shall work with the Service and other inter-agency partners to validate the RiverWare model as a tool for analyzing how Project operations are affecting spotted frogs and its habitat with respect to the timing, volume, and duration of river flows.

7. During the irrigation season, Reclamation and the Districts shall coordinate with the Oregon Water Resources Department and the Service on adjusting ramp-up and ramp-down operations to maximize the minimization of spotted frog take impacts.

8. Reclamation and the Districts shall increase winter flows in the Deschutes River, where feasible (e.g., as described in the Proposed Action during extreme run off events), to improve winter habitat conditions and survival of spotted frogs in the Action Area.

9. Reclamation and the Districts shall prepare an annual report summarizing all Project-related monitoring activities specified under this incidental take statement. The report shall be submitted to the Service by February 1 of each calendar year 2018, 2019, and 2020.

12. TERMS AND CONDITIONS

In order to be exempt from the prohibitions of section 9 of the ESA, Reclamation must comply with the following terms and conditions, which implement the reasonable and prudent measures (RPMs) described above, including required monitoring and reporting requirements. These terms and conditions are non-discretionary.
The following terms and conditions are necessary for the implementation of Reasonable and Prudent Measure (RPM) 1:

1. Monitor storage volumes at Crane Prairie Reservoir to determine when water management operations may be approaching take thresholds as identified in Table 55. Notify the Service if there are operational issues associated with managing the reservoir to reach targeted storage volumes as identified in the Proposed Action.

2. Notify the Service when drawdown of the Crane Prairie reservoir is anticipated to commence.

3. Monitor Deschutes River flow rates, as measured by the WICO and BENO gauges, to determine when water management operations may be approaching take thresholds as identified in Table 55.

4. In coordination with the Service, develop opportunities to observe on-the-ground habitat conditions at and below the flow thresholds identified for take. For example, flows of 900 could be observed over a couple of days on the ground through Reaches 1 and 2.

The following terms and conditions are necessary for the implementation of RPM 2:

5. Conduct hydrological and biological monitoring within the Deschutes River floodplain wetlands between the reservoirs to assess influence of operational changes at the CRAO gauge with habitat condition and spotted frog presence.
   a. Hydrological monitoring methods shall be coordinated with qualified hydrologists and the Service as approaches will vary depending on the location within the action area. Approaches to gathering hydrological information will resemble those outlined in the monitoring section, above, and may include additional tools and methods.

6. Monitor Wickiup Reservoir wetlands to determine storage volumes that provide suitable wetland habitat conditions for spotted frogs.

7. Determine what flow volumes are likely to inundate wetlands in Reaches 5, 6 and 7 and identify how best to measure these volumes.

8. In the Little Deschutes River system (Crescent Creek and Little Deschutes River), develop an approach to determining flows rates and methods for monitoring those flow rates that inundate spotted frog habitat. Assessment methods shall be designed by a qualified hydrologist and approved by the Service.

The following terms and conditions are necessary for the implementation of RPM 3:

9. Reclamation and the Districts shall fund a qualified party to prepare and implement a study to assess spotted frog habitat utilization at Crane Prairie Reservoir in 2018 and 2019, inclusive of conducting radio telemetry work, to elucidate spotted frog overwinter habitat
selection preferences at the reservoir. The study shall be developed in coordination with and
the approval of the Service by January 15, 2018. A funding agreement or other appropriate
legal instrument to implement the study shall be executed between Reclamation, the

The following terms and conditions are necessary for the implementation of RPM 4:

10. Reclamation and the Districts shall fund a qualified party (e.g., USGS in 2015 and 2016),
approved by the Service, to conduct annual breeding surveys for spotted frogs in the Action
Area in 2018 and 2019. The survey plan shall be developed in coordination with and the
approval of the Service by January 15, 2018.

11. Reclamation and Districts shall participate in and provide resources to interagency
efforts to conduct spotted frog breeding surveys that begin in mid-March. Coordination
meetings will be initiated by the Service in February, prior to the breeding season.

The following terms and conditions are necessary for the implementation of RPM 5:

12. Reclamation and the Districts shall prepare, in coordination with and the approval of
the Service, and implement the adaptive management plan by December 1, 2018.

The following terms and conditions are necessary for the implementation of RPM 6:

13. The RiverWare model has limitations in precisely predicting flows at the various
gauges that were relied upon for assessing take of spotted frogs in this opinion. The Effects
Analysis, above, provided examples of where the modeled output for the Proposed Action
did not reflect water operations that occurred during the 2017 Water Year when the OSF
Proposal was being implemented as per the Settlement Agreement. For this reason,
Reclamation must meet with irrigation district managers, the Water Resources Department,
and the Service to review the modeled hydrographs to assess where there may be
inaccuracies in how the model is predicting river flows since the RiverWare model is likely
be relied upon as a tool for assessing the flow scenarios for the Deschutes Basin HCP.

The following terms and conditions are necessary for the implementation of RPM 7:

14. In coordination with OWRD, Reclamation and Districts shall provide the Service with a
ramp down schedule for Wickup Dam by the end of the third week in September.

15. During the spring irrigation season ramp up at Wickiup Dam that coincides with the
spotted frog breeding season, Reclamation and Districts, in coordination with OWRD, shall
communicate weekly plans to increase flows in the Deschutes River above 600 cfs in the
month of April.

The following terms and conditions are necessary for the implementation of RPM 8:

16. Reclamation and the Districts shall convene a meeting with the Service annually in the month
of November in calendar years 2017, 2018, and 2019 to discuss the feasibility of increasing winter flow conditions in the Deschutes River. A joint feasibility determination shall be made at that meeting.

The following terms and conditions are necessary for the implementation of RPM 9:

17. The format of the report shall be developed in coordination with and approval by the Service.

**Reporting Requirements**

If a dead, injured, or sick endangered or threatened species is located, initial notification must be made to the Service’s Division of Law Enforcement in Oregon at (503) 682-6131. Instruction for proper handling and disposition of such specimens will be issued by the Division of Law Enforcement. Care must be taken in handling sick or injured Oregon spotted frogs to ensure effective treatment and care must be taken in handling dead specimens to preserve biological material in the best possible state for later analysis of cause of death. In conjunction with the care of sick or injured Oregon spotted frogs, or the preservation of biological materials from a dead Oregon spotted frogs, Reclamation has the responsibility to ensure that information relative to the date, time, and location of the frog when found, and possible cause of injury or death of each Oregon spotted frogs be recorded and provided to the Service Law Enforcement.

13.0 CONSERVATION RECOMMENDATIONS

Section 7(a)(1) of the ESA directs Federal agencies to utilize their authorities to further the purposes of the ESA by carrying out conservation programs for the benefit of endangered and threatened species. Conservation recommendations are discretionary agency activities designed to minimize or avoid adverse effects of a proposed action on listed species or critical habitat, to help implement recovery plans, or to develop information.

The Service recommends that Reclamation and/or the Irrigation Districts implement the following conservation measures:

1. Continue the close coordination with the Service in monitoring the status of the spotted frog in the area affected by the Deschutes Project.

2. Continue working towards developing a means of improving winter flow conditions in the Deschutes River downstream of Wickiup Dam from an operational and legal perspective. For example, consider converting the junior instream water rights of 300 cfs held by Oregon Department of Fish and Wildlife to a senior water right over time.

3. If the Deschutes Basin HCP is not in place when this Biological Opinion expires, the Service recommends increasing winter flows out of Wickiup dam (WICO gauge) to 200 cfs until the HCP is completed in an effort to make progress toward improving winter flow conditions that will support spotted frog.

4. The Deschutes Basin HCP should include conservation measures for spotted frogs that increase winter flows within the Deschutes River below Wickiup Dam.
5. Support on-farm water conservation to reduce demands on the Deschutes River flows.

6. Continue and expand water leasing opportunities to address flow needs in the Deschutes River.

7. Finalize and implement the Deschutes Basin HCP. In the context of natural hydrological water yield from the Upper Deschutes Basin, the Service recommends that the HCP mean winter flows of up to 600 cfs at WICO as early as possible with the following benchmarks:
   - Year 5: 300 cfs
   - Year 15: 500 cfs
   - Year 20: 600 cfs

8. The irrigation districts, in cooperation with Oregon Water Resources Department, should consider installation of hydrological gauges that account for the natural volumes of water that feed into the Action Area within the Little Deschutes River subbasin (i.e., Big Marsh Creek and Upper Little Deschutes River).

9. Given that there is no means of calculating the acres of wetland habitat that remain inundated through winter (during the irrigation storage season), the Service recommends that Reclamation fund LiDAR imagery for the Deschutes Basin at low flows (i.e., October flights before the snow) or “green” (bathymetric) LiDAR. Currently available LiDAR spatial layers for the Basin have been flow during high flows (irrigation season) and cannot be used for assessing winter conditions. Furthermore, the currently available LiDAR that has been flown during the summer irrigation season limits the ability to develop hydraulic modeling products that can assess the change in spatial inundation on the landscape over the changing hydrograph that occurs through storage and release operations.

10. Treat reed canarygrass within the project area and re-establish a diversity of native wetland vegetation in treated areas.

11. Assist with bullfrog control within lands occupied by spotted frogs.

12. Coordinate with Federal Energy Regulatory Commission on the Wickiup Hydro Project to reduce or eliminate the potential for entrainment of nonnative predatory fish into the Deschutes River.

In order for the Service to be kept informed of actions minimizing or avoiding adverse effects or that benefit listed species or their habitats, the Service requests notification of the implementation of any conservation recommendations.

14.0 REINITIATION NOTICE

This concludes the Service’s biological opinion addressing the effects of the Proposed Action on the Oregon spotted frog and its critical habitat. As provided in 50 CFR §402.16 re-initiation of formal consultation is required where discretionary Federal agency involvement or control over the action has been retained or is authorized by law and if: (1) the amount or extent of incidental take is exceeded; (2) if new information reveals effects of the action that may affect listed species or critical habitat in a manner or to an extent not considered in this consultation opinion;
(3) the agency action is subsequently modified in a manner that causes an effect to the listed species or proposed critical habitat that was not considered in this opinion; or (4) a new species is listed or critical habitat designated that may be affected by this action. In instances where the amount or extent of incidental take is exceeded, any operations causing such take must cease pending re-initiation.


Phillipsen, I.C., J. Bowerman, and M. Blouin. 2010. Effective number of breeding adults in

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**PERSONAL COMMUNICATIONS**


Bowerman, Jay. Sunriver Nature Center, September 18, 2013a, email communications with Jennifer O’Reilly, USFWS Bend Field Office, regarding spotted frog locations in Dillman Meadow.

Bowerman, Jay. Sunriver Nature Center, April 7, 2013b, email communications with Jennifer
O’Reilly, USFWS Bend Field Office, regarding Old Mill spotted frog population.

Bowerman, Jay. Sunriver Nature Center, April 9, 2013c, email communications with Jennifer O’Reilly, USFWS Bend Field Office, regarding Old Mill spotted frog population.


Bowerman, Jay. Sunriver Nature Center, October 17, 2013e, email communications with Jennifer O’Reilly, USFWS Bend Field Office, regarding update and summary of Old Mill spotted frogs.

Bowerman, Jay. Sunriver Nature Center, May 12 2014a, email communications with Jennifer O’Reilly, USFWS Bend Field Office, regarding Old Mill spotted frog breeding locations within the LSA Marsh.

Bowerman, Jay. Sunriver Nature Center, January 01, 2014b, email communications with Jennifer O’Reilly, USFWS Bend Field Office, regarding frog overwinter locations.


Bowerman, Jay. Sunriver Nature Center, August 29, 2016, email communications with Jennifer O’Reilly, USFWS Bend Field Office, regarding Island Loop breeding locations.

Bowerman, Jay. Sunriver Nature Center, April 26, 2017a, voicemail communications with Jennifer O’Reilly, USFWS Bend Field Office.


Engler, Joe. USFWS Conboy Lake National Wildlife Refuge, July 22, 1999, written communication with Dr. L. Karolee Owens, USFWS Western Washington Fish and Wildlife Office, regarding comments on Oregon spotted frog proposed rule.


APPENDIX

Wickiup Ramp Down 2014
Deschutes River and Wetland Monitoring
In October 2014, a monitoring opportunity provided insight into how specific flows affect riverine and wetland habitats along the Deschutes River between Wickiup Dam and Lava Island Falls (approximately 53 miles). A staged ramp down of the Deschutes River was conducted by Oregon Water Resources Department in cooperation with the Deschutes Board of Basin Control and partners within the community (Trout Unlimited, Oregon Department of Fish and Wildlife, Deschutes River Conservancy) to allow stranded fish to be salvaged from a side channel at Lava Island Falls (RM 174.5). The USFWS and Forest Service, as part of the collaborative effort, selected 20 locations (photo below) along the river between Wickiup Dam and Lava Island Falls to conduct a photo monitoring study over the staged ramp down to determine how the system, including wetlands, responded to various flows. The following photos represent a subset of this effort and correspond to the map and index below.

Figure xx: Photo monitoring locations along 53 miles of river between Wickiup Dam and Lava Island Falls.

<table>
<thead>
<tr>
<th>River Reach</th>
<th>Site location</th>
<th>WICO</th>
<th>BENO</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wickiup to Fall River</td>
<td>Bull Bend</td>
<td>1168-47</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Bull Bend breeding</td>
<td>1168-47</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Dead Slough River</td>
<td>886-47</td>
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<tr>
<td></td>
<td>Dead Slough Inlet</td>
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<td>La Pine State Park SW Slough</td>
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<tr>
<td></td>
<td>La Pine State Park SW Slough (panoramic)</td>
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<tr>
<td>Fall River to Little Deschutes</td>
<td>Silver Fox oxbow</td>
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<td>Little Deschutes to Benham Falls</td>
<td>Benham Wetland</td>
<td>886-229</td>
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<td>Benham to Dillon Falls</td>
<td>East Slough Camp pond</td>
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<td>1442-586</td>
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<td></td>
<td>East Slough Camp revisit 12/9/14</td>
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<td>664</td>
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<td></td>
<td>East Slough Camp revisit 2/11/15</td>
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<td>941</td>
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</table>
Site location: Bull Bend

WICO: 1168

WICO: 683
Site location: Bull Bend

- WICO: 528
- WICO: 315
- WICO: 229
Site location: Bull Bend

- 683 cfs – Mudflat are becoming evident; side channel with 0.5 feet of water; water line about 0.5 feet below sedge root zone.
- 528 cfs – water drop approximately 0.4 feet; lateral movement of water from edge of bank is approximately 10 feet; 0.25 feet of water remaining over river substrate; wetted side channel inundation retreated ~40 feet toward river.
- 315 cfs – Significant lateral movement of water towards river and riverbed exposure. No riverine water in wetlands. Instream wood is no longer in the water.
- 229 cfs – Entire mudflat exposed. Slumping banks and water level below root zone of WICO: 47

WICO: 47
Site location: Bull Bend breeding
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Site location: Bull Bend breeding

- 683 cfs – Mudflats are exposed; water no longer within wetland where spotted frogs had been observed in 2013. No potential overwintering habitat off channel. Beaver channel on far bank is connected.
- 528 cfs – Water level drop of ~0.5 feet; 40 percent of mudflat exposed. Mid-channel depositional feature becoming exposed. Banks that are not dominated by sedge have roots totally exposed and are greater than 1 foot from water surface. Beaver channel on far bank is disconnected from river.
- 315 cfs – Significant lateral movement of water’s edge away from bank and riverbed exposure. Remaining water is within river channel only. Most of the instream wood is partially out of the water.
- 229 cfs – Entire mudflat exposed. Submerged aquatic vegetation is out of the water. Bank erosion is evident. Greater than 50 percent of the riverbed is exposed. Majority of instream wood is out of the water.
- 102 cfs – Increased exposure of riverbed and banks.
- 47 cfs – Riverbed is largely exposed (80 percent), including fish spawning gravels.
Site location: Dead Slough River

WICO: 886

WICO: 683
Site location: Dead Slough River

WICO: 528

WICO: 315
Site location: Dead Slough River
Site location: Dead Slough River

- 683 cfs – Mudflat 75 percent exposed. Riverbed, including gravels and wood, becoming exposed. North channel from Dead Slough barely connected and draining to river. South channel to Dead Slough flowing towards river.
- 528 cfs – North channel to Dead Slough cut off from river. Residual pools will small fish are isolated. Increased gradient towards river observed in south channel. No vegetation connected to water. Exposed submerged aquatic vegetation.
- 315 cfs – Continued lateral movement of water toward river and riverbed exposure. Wood increasingly exposed with a drop in flows. South channel to Dead Slough becoming incised.
- 229 cfs – Riverbed exposure increases to ~50 percent.
- 102 cfs – Increased incision of south channel flowing (~2 cfs) from Dead Slough.
- 47 cfs – Continued exposure of riverbed and habitat features as described above.
Site location: Dead Slough Inlet
Site location: Dead Slough Inlet
Site location: Dead Slough Inlet
Site location: Dead Slough Inlet

- 683 cfs – Water outside of sedge vegetation and draining towards the slough.
- 528 cfs – Increased lateral movement of water away from the edge of sedge vegetation. Water extremely shallow.
- 315 cfs – Large increase in exposed mudflat. Residual channel flowing toward river.
- 229 cfs – Remaining pool within Dead Slough does not drop with decrease in flows below ~300 cfs.
- 102 cfs – No change
- 47 cfs – No change
Site location: La Pine State Park SW Slough
Site location: La Pine State Park SW Slough

WICO: 528

WICO: 315
Site location: La Pine State Park SW Slough
Site location: La Pine State Park SW Slough

- 683 cfs – Upstream inlet no longer connected. Some residual pools remain in upstream arm of the slough. Still connected on the downstream outlet arm of the slough.
- 528 cfs – Still connected at the outlet. Water levels down. Large lateral retreat of water’s edge on inlet arm toward the apex of the slough.
- 315 cfs – Further lateral retreat of water’s edge toward apex of slough. Downstream outlet arm of slough is disconnected. Remaining pool is isolated from the river.
- 229 cfs – 180 meter lateral retreat of water’s edge at the outlet compared to when it was connected at 528 cfs. Most residual water on mudflats is gone.
- 102 cfs – No change.
- 47 cfs – No change
Site location: Silver Fox oxbow
Site location: Silver Fox oxbow
Site location: Silver Fox oxbow

WICO: 229

WICO: 102
Site location: Silver Fox oxbow

- 683 cfs – Approximately 50% of river bed exposed on south bend (left). Some water accessing off-channel wetland. No eroding banks. Water surface ~ 0.75-1.0 feet below sedge line.
- 528 cfs – Approximately 65% of river bed exposed on south bend and 50% on north bend. Side channel is cut off.
- 315 cfs – Major lateral recession of active channel with some residual pools remaining on exposed river bed.
- 229 cfs – Further recession of active channel and bed exposure.
- 102 cfs – Flow to channel largely cut off.
- 47 cfs – Mostly residual water on exposed bed surface. Unclear if there is minor connection to main stem river or release of bank storage providing negligible flow.
Site location: East Slough Camp pond
Site location: East Slough Camp pond

- 683/1445 cfs (WICO/BENO discharge) – Water levels decreased. Water’s at the edge of vegetation. Wetland still connected to the river.
- 528/1260 cfs – Further decrease of water surface elevation. Exposure of mud flat near river and at base of butte.
- 315/901 cfs – Significant increase in exposed mudflat. Wetland is disconnected from river.
- 229/790 cfs – Wetland is entirely drained. Some residual water on mud flats.
- 102 cfs – No change
- 47 cfs – No change
Site location: East Slough Camp pond

WICO: 936   BENO: 1442

WICO: 683   BENO: 1186

WICO: 528   BENO: 1106

WICO: 315   BENO: 901
Site location: East Slough Camp pond

- 683/1445 cfs – Water levels decreased. Pond is isolated from surrounding wetland complex.
- 528/1260 cfs – No visible change.
- 315/901 cfs – Possible slight decrease in water surface elevation.
- 229/790 cfs – No visible change.
- 102/665 cfs – Rains may have increased water surface elevations slightly.
- 47/562 cfs – No visible change
- 50/664 cfs December visit – Vegetation has died back. Pond still retaining water
- ??/??? cfs February visit – Significant decrease in water levels. Pond almost dry.
Site location: East Slough Camp pond

East Slough pond re-visited in December 2014. Photo shows that there is a residual pool of water remaining in the pond after the fall ramp down.

East Slough pond was re-visited on February 11, 2015, prior to the spring breeding period. There was little water remaining in the pond at the following flows: WICO: 127 and BENO: 941 cfs. The winter of 2014/2015 was dry compared to other years.