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# EVALUATION OF TWO-YEAR REARING PROGRAM FOR STEELHEAD TROUT AT DWORSHAK NFH

by
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by

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TABLE OF CONTENTS


| | Page |
|---|---|
| ACKNOWLEDGMENTS | iii |
| ABSTRACT | iv |
| INTRODUCTION | 1 |
| ADULT RETURNS--AGE I VERSUS AGE II SMOLTS | 2 |
| 1977 Release | 2 |
| 1979 Release | 2 |
| 1980 Release | 7 |
| 1981 Release | 7 |
| 1982 Release | 10 |
| SPECIAL REARING PROGRAM TESTS | 13 |
| Large versus Small Smolts--1978 | 13 |
| Procedures | 13 |
| Results | 15 |
| Migration of Various Size Groups--1980 | 16 |
| Age I Voluntary Migration--1979 | 18 |
| Procedures | 18 |
| Results | 20 |
| Age I Voluntary Migration--1981 | 26 |
| Procedures | 26 |
| Results | 27 |
| Grading Experiment--1981 | 29 |
| Procedures | 29 |
| Results | 29 |
| DISCUSSION | 33 |
| LITERATURE CITED | 35 |

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## ABSTRACT

Steelhead trout reared for two years in a hatchery returned at rates that perpetuated the run and provided surplus production in most years. Two-year-old steelhead released from Dworshak NFH prior to 1980 returned as adults at higher rates than fish reared for one year. Since 1980, good quality one-year-old steelhead have been released from the hatchery, and they have returned at higher rates than fish reared for two years. Precocious maturity of males and development of bimodal length distributions during the second year of rearing reduced the effectiveness of the two-year rearing program.

# INTRODUCTION

In this report, we present an evaluation of the two-year rearing program for steelhead trout at Dworshak National Fish Hatchery (NFH). Specifically, we compared adult return, size, migration and quality of age II smolts versus regular production age I smolts in 1977-1982. We also evaluated fish from a two-year program that were ready to migrate seaward after one year of rearing.

Steelhead have been reared for both one and two years at Dworshak NFH to determine which program would produce the best quality smolts. The rearing programs were designed partly according to the water temperatures available. Water for the hatchery is pumped from the North Fork of the Clearwater River one kilometer downstream from Dworshak Dam and Reservoir. During the early 1970s, discharge from the dam was to mimic natural river water temperatures as close as possible through use of selector gates at the dam. In more recent years, water temperatures in summer are kept in the 8-12C range to control Ichthyophthirius.

The three rearing systems at Dworshak NFH were designed to operate with water reuse. Biofilters, water sterilization and heaters were incorporated into the systems so fish could be reared to smolt stage in one year. Despite the flexibility built into the rearing systems, it was not always possible to produce fully developed smolts in one year.

Perpetuation of all segments of the steelhead stock has been a goal of fish managers that has complicated the smolt rearing program. Offspring from late spawning fish have up to two months less rearing time than early spawning fish. Rearing fish for two years was one way of assuring that progeny from late spawners were full-sized smolts. Fish from late spawners when reared for only one year might be undersized and be selected against by not becoming smolts and by being more vulnerable to predation.

## ADULT RETURNS--AGE I VERSUS AGE II SMOLTS

Marked groups of age I and age II smolts were released from Dworshak NFH in 1977, 1979, 1980, 1981 and 1982. Adult returns were essentially complete for the 1977 through 1980 releases and partial returns were available for the last two years.

### 1977 Release

Two-year old steelhead smolts returned at twice the rate of age I fish released from Dworshak NFH in 1977 (Table 1). Adult returns from smolts marked and released in 1977 were reduced by the unusually low flows during seaward migration of the smolts (Bjornn et al. 1979), but sufficient fish returned to permit a comparison of age II versus age I smolts.

In 1977, quality of age I steelhead smolts reared at Dworshak NFH was less than optimum. Age I fish had higher mortality rates while in the hatchery and higher fungus infection rates when recaptured at Lower Granite Dam than age II smolts (Bjornn et al. 1979). More age II fish were recaptured at Lower Granite Dam (Fig. 1) during their seaward migration than age I fish.

Age II fish were larger (199 mm mean total length) than either of the groups of marked age I fish when released (175 and 184 mm), in addition to their generally better health. Both the larger size and better health likely contributed to the higher returns of age II fish. Precocious maturity of the age II fish in 1977 was 3.4% versus no mature fish in the age I fish.

### 1979 Release

Age II smolts released in 1979 returned as adults at a relatively high rate (0.55%), despite a high fungus infection rate at the dam and their small size (176 mm) (Table 1). The special group of age I voluntary migrants released from the hatchery returned as adults at a much lower rate

Table 1. Adult returns from age I and II steelhead trout released from Dworshak NFH.

| Year of release Group description | Number released | Release date | Length at release (mm) | Adult returns 1-year ocean | Adult returns 2-year ocean | Adult returns 3-year ocean | Percent return |
|---|---|---|---|---|---|---|---|
| 1977 | | | | | | | |
| Age II | 57,200 | 15 April | 199 | 6 | 132 | 13 | 0.26 |
| Age I | 31,100 | 21 April | 175 | 3 | 33 | 2 | 0.12 |
| Age I | 40,200 | 20 April | 184 | 4 | 45 | 3 | 0.13 |
| 1979 | | | | | | | |
| Age II | 42,600 | 6 April | 176 | 2 | 219 | 13 | 0.55 |
| Age I | 30,000 | 23 May | 149 | 0 | 6 | 17 | 0.08 |
| 1980 | | | | | | | |
| Age II | 46,900 | 17 April | 195 | 11 | 93 | 9 | 0.24 |
| Age I | 59,200 | 17 April | 185 | 10 | 207 | 21 | 0.46 |
| Age I | 49,200 | 25 April | 177 | 6 | 197 | 6 | 0.38 |
| 1981 | | | | | | | |
| Age II | 38,200 | 4 May | 175 | 0 | 5 | - | 0.01 |
| Age I | 39,300 | 4 May | 177 | 0 | 18 | - | 0.05 |
| Age I | 41,300 | 4 May | 174 | 0 | 32 | - | 0.08 |
| 1982 | | | | | | | |
| Age II | 41,400 | 3 May | 173 | 6 | - | - | 0.01 |
| Age I | 42,500 | 3 May | 190 | 16 | - | - | 0.04 |
| Age I | 39,200 | 3 May | 208 | 14 | - | - | 0.04 |

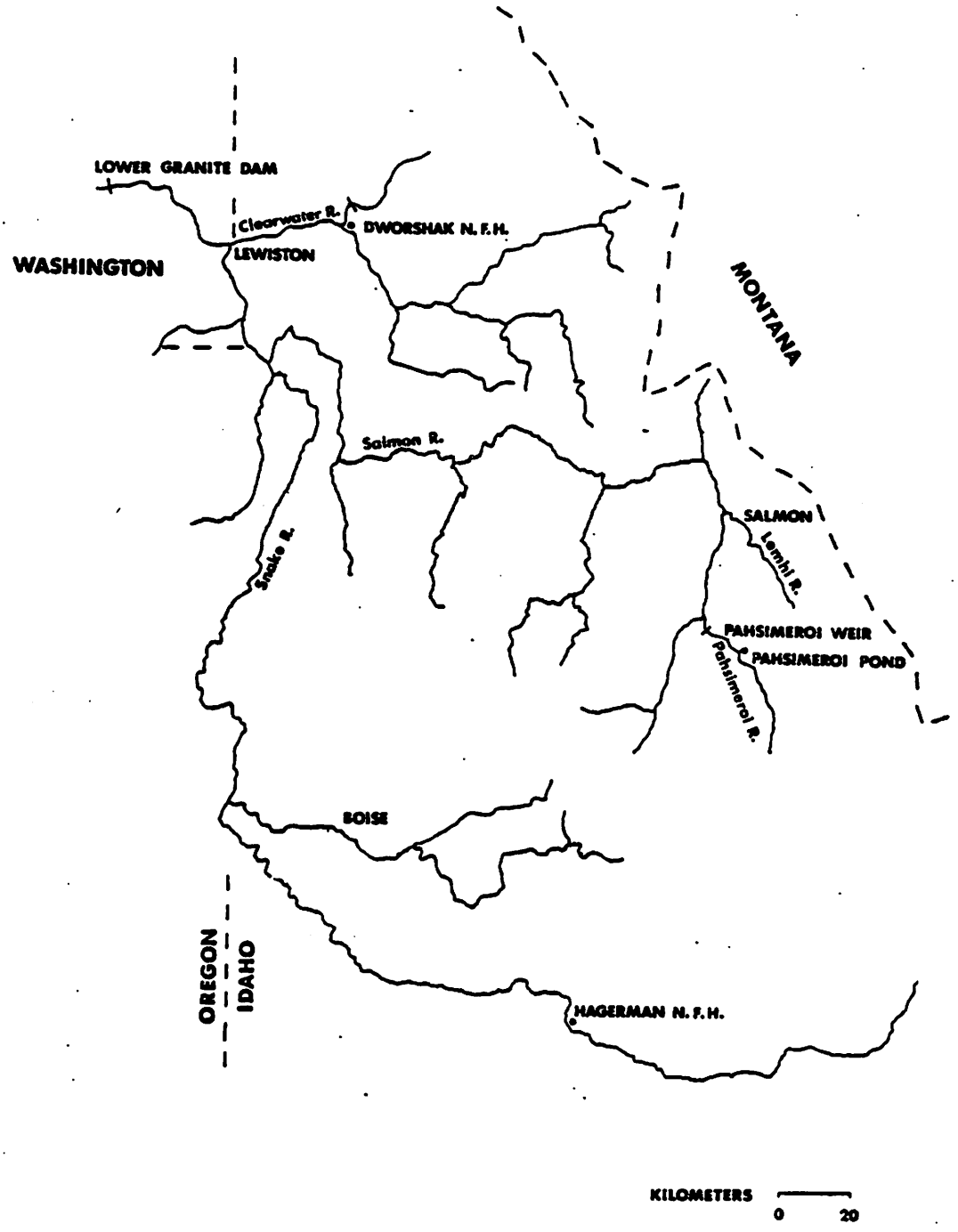


Figure 1. Location of Dworshak NFH in the Snake River basin.

than the age II smolts. The age I fish marked and released from Dworshak NFH in 1979 were those that migrated voluntarily from rearing ponds during late April and May after their first year of rearing. The age I fish averaged 149 mm when marked and released on 18-23 May. More of the age I voluntary migrants were recaptured at Lower Granite Dam and in estuary sampling than age II smolts.

A single group of age II steelhead were available for release in 1979. These fish, originated from a late egg take in 1977, were reared the first year in ponds in system I and the second hear in adult holding ponds converted to a rearing pond. The age II fish averaged 176 mm in length when pumped from the converted holding ponds to the North Fork Clearwater River on April 6.

Age II steelhead released from Dworshak NFH April 6 began arriving at Lower Granite Dam April 12. Largest numbers entered the collection facility May 9 (Fig. 2). Age I voluntary migrants passed Lower Granite Dam during the last half of May.

Based on recovery of branded fish at Lower Granite Dam, we estimate that 25% (10,924) of the 42,600 age II branded fish released entered the collection facility at the dam. A similar percentage of regular production age I steelhead branded and released from system III entered the facilities at the dam, but both of the former groups were recaptured at a lesser rate than the age I voluntary migrants from system I (41%).

Age II fish examined at the dam averaged 191 mm in length, 15 mm larger than those released. Some growth may have occurred between release and recapture, but we suspect the smaller fish did not migrate seaward. Age II steelhead released from Dworshak NFH in 1979 were the smallest of the past four years. On March 30, the fish averaged 176 mm total length. The fish were not in top health, as indicated by the fact that 25% of 160 fish examined at the dam had fungus infections. Despite the small size of the age II fish, 6.5% of 491 fish checked on March 30 were mature males.

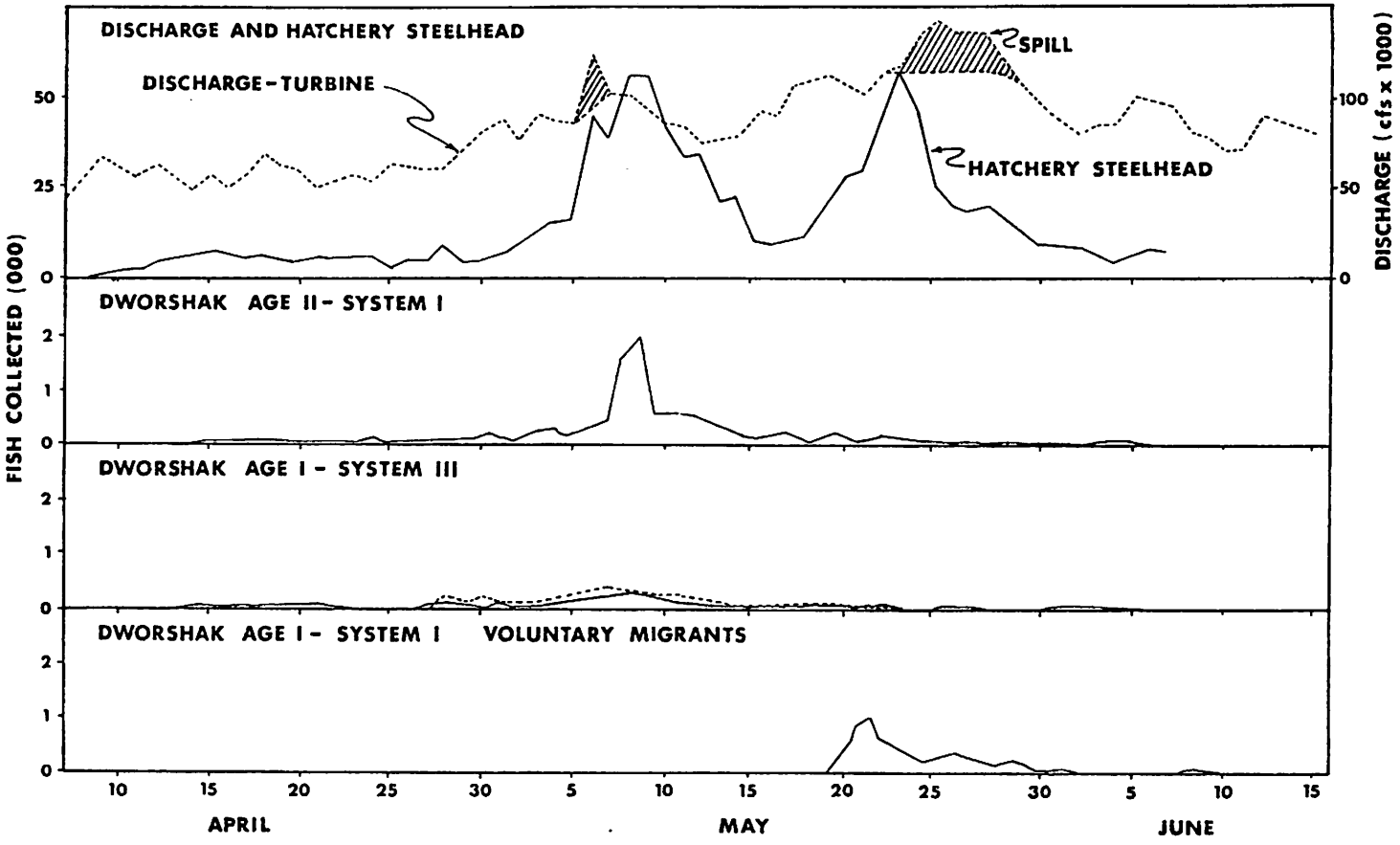


Figure 2. Timing of seaward migration of steelhead trout released from Dworshak NFH past Lower Granite Dam, 1979.

## 1980 Release

Age I regular production steelhead marked and released from Dworshak NFH in 1980 returned as adults at higher rates than age II fish for the first time in three years of tests (Table 1). Age I steelhead produced during the 1979-80 production year were of good quality, with low mortality rates while in the hatchery and low fungus infection rates (1-3%) when recaptured at the dams. Both groups of age I smolts returned at higher rates than the age II fish despite their slightly smaller size (185 and 177 mm versus 195 mm).

Age II steelhead trout released from Dworshak NFH in 1980 were nearly all fish that did not migrate in 1979 when given the chance as one-year olds. In July of 1979, one-year-old steelhead in pond 45 that had not migrated in spring 1979 averaged about 135 mm in length and had a unimodal length-frequency distribution (Fig. 3). After the second year of rearing, steelhead in pond 45 had a slightly bimodal length-frequency distribution, but not as distinct as age II steelhead in the middle and upper experimental raceways or the non-migrants in pond 43 (Fig. 3). Steelhead that migrated voluntarily in 1979, but were returned to pond 43 for an additional year of rearing, had a unimodal length distribution and were larger (216 mm) than the 1979 non-migrants when both were released in 1980 (181-195 mm).

Precocious maturity in age II steelhead released in 1980 that were non-migrants in 1979 ranged from 6% to 16%. Fish that had migrated voluntarily in 1979, but retained for a second year of rearing, had a higher precocious maturity rate (25%). Precociously mature fish were larger, on average, than the immature fish among the non-migrants and migrants held in pond 43 (Fig. 4).

## 1981 Release

Adult returns are incomplete for steelhead released in 1981, but age I fish appear to be returning at higher rates than age II smolts (Table 1). Return rates for 1981 release groups of fish are lower than usual. No fish

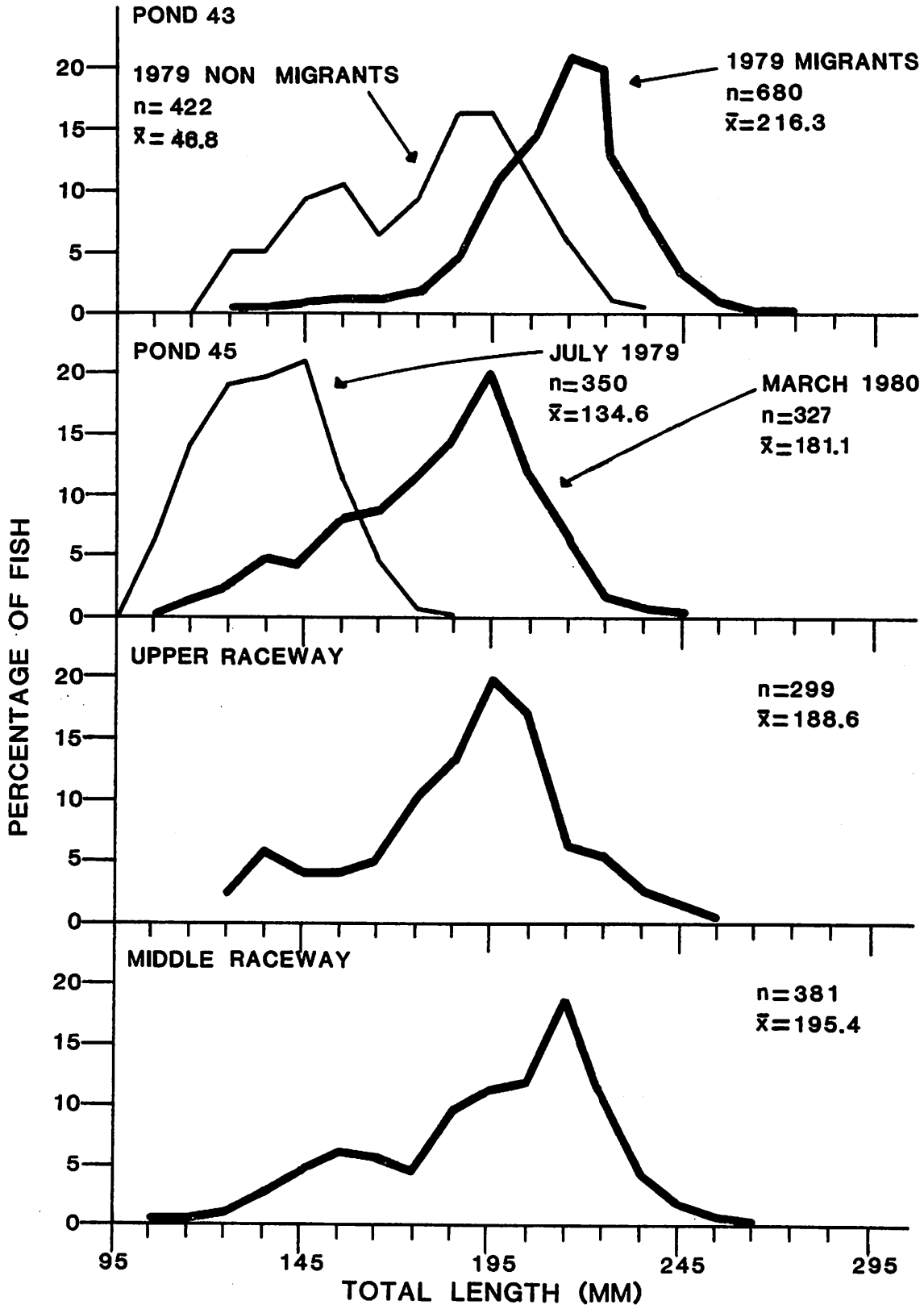


Figure 3. Length distribution of age II steelhead trout at Dworshak NFH on 25 March 1980. Fish in pond 43 were those that did not migrate voluntarily in spring 1979 and a sample of those that did, but were retained for a second year. Fish in Pond 45 were measured in July 1979 when age I and in March 1980 as age II. Fish in the raceways were age II fish that didn't migrate voluntarily in 1979.

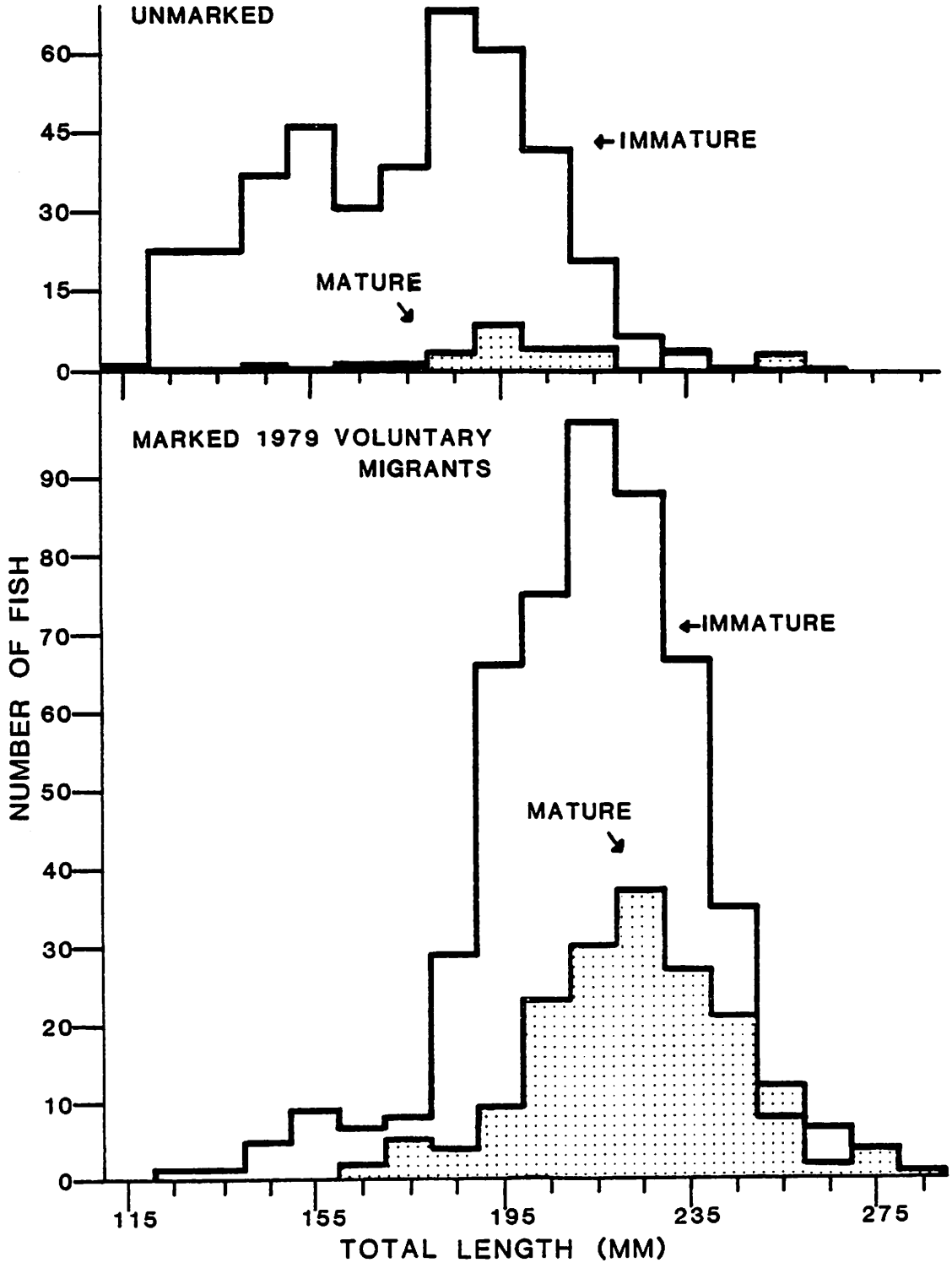


Figure 4. Length distribution of steelhead trout in pond 43 at Dworshak NFH on 25 March 1980. Unmarked fish were those that did not voluntarily leave the pond in spring 1979. Marked fish were 1979 voluntary migrants that were marked and returned to the pond for a second year of rearing.

that had spent one year in the ocean had been recaptured for any of the groups.

Age II steelhead released in 1981 were again smaller than two-year-old fish released in earlier years (164-180 mm mean total length) (Fig. 5). Age I fish were good quality fish again in 1981, similar in size (174-177 mm) to the age II fish, but smaller than desired. Precocious maturity in the age II fish ranged from 7.4% to 17.5% in four groups sampled.

Age II fish had a bimodal length-frequency distribution again in 1981 which is not desirable. Fish in the lower portion of the distribution are usually not smolts. Small-mode fish plus the precociously mature fish can substantially reduce the net number of smolts produced from a two-year rearing program. Fish in pond 27 did not have a bimodal length-frequency distribution after almost one year of rearing (March 1980, Fig. 5), but it developed during the second year of rearing.

## 1982 Release

After the first year of adult returns from the 1982 release, age I fish for the third straight year were returning at higher rates than age II fish (Table 1). Age II marked steelhead released in 1982 averaged 173 mm in length versus 190 and 208 mm for the two groups of marked age I fish. The higher return rate of age I fish could be due to their larger size and better overall health. Few age I steelhead at Dworshak NFH are precociously mature, while significant numbers of age II fish may mature, such as the 3.8% in 1982.

Bimodality in length distribution of steelhead can be a problem in both one- and two-year rearing programs. Reduction in net smolt production because fish in the lower mode are usually not smolts is more prevalent in age II fish, but can be serious in age I fish (Fig. 6). The cause of biomodality in hatchery reared steelhead and salmon is unknown to us.

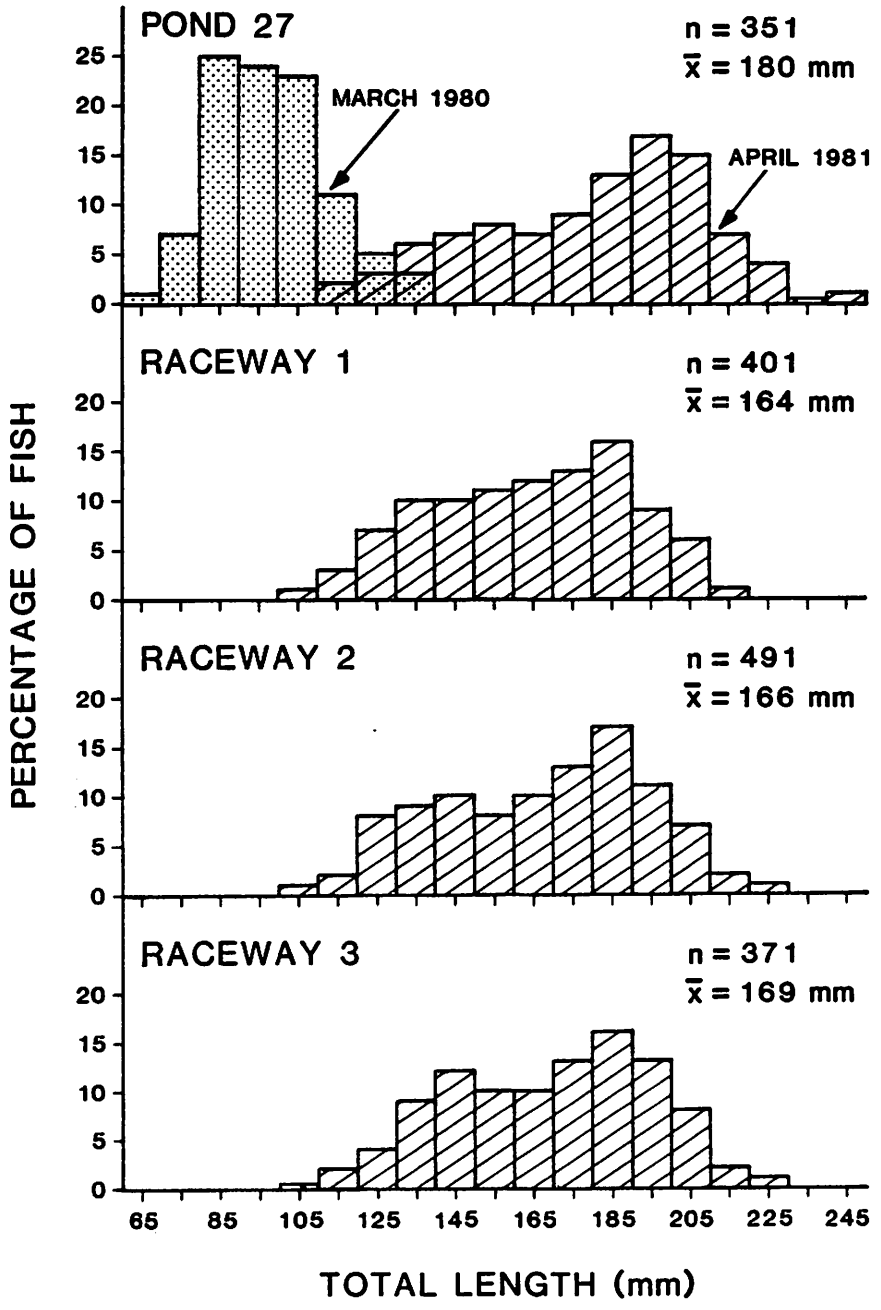


Figure 5. Length distribution of steelhead trout in ponds and raceways at Dworshak NFH in April 1981.

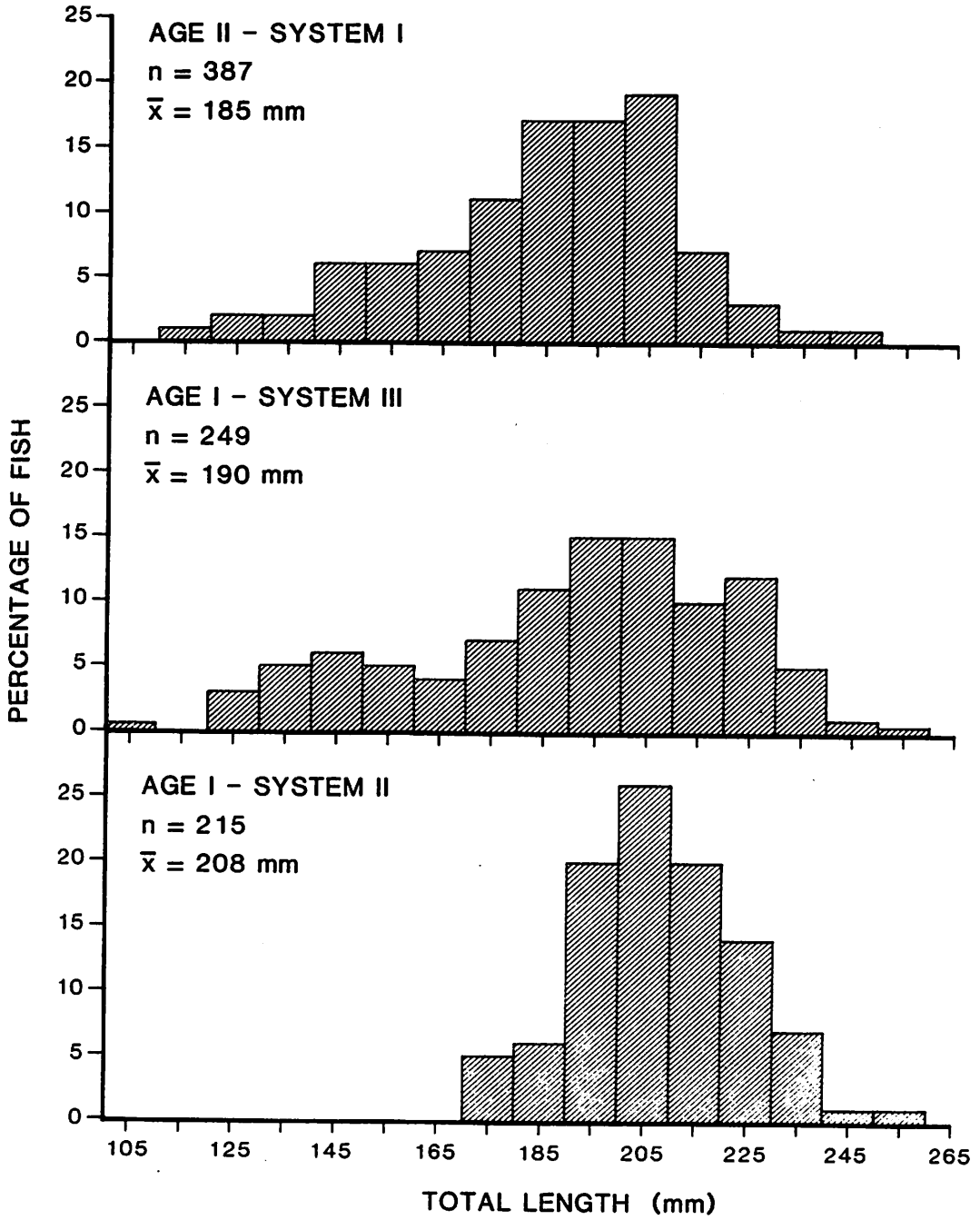


Figure 6. Length distribution of marked steelhead trout released from Dworshak NFH on 3 May 1982.

# SPECIAL REARING PROGRAM TESTS

## Large Versus Small Smolts--1978

Age II steelhead trout of the 1976 brood year were branded and released from Dworshak NFH to evaluate seaward migration of two sizes of fish in 1978.

### Procedures

Steelhead used in these tests were reared for two years on untreated river water at Dworshak NFH. Fish were reared in burrows-type ponds their first year and modified adult holding ponds during their second year. Juveniles were freeze-branded on 11 and 12 April, returned to an adjacent pond, and then pumped to the North Fork of the Clearwater River on 14 April. Fish in the pond were divided into two size groups (less than 220 mm and larger than 220 mm) (Fig. 7). Precociously mature males were not branded.

Seaward migration of the fish was evaluated by counting and examining branded fish recovered in the smolt bypass system and during gatewell dipping at Lower Granite Dam, 70 miles downstream from Dworshak NFH. Marked steelhead were measured, enumerated, and examined for fungus. The total number of branded fish that passed Lower Granite Dam was estimated by expanding the proportion of branded fish in daily gatewell dip samples to the total number of fish entering the collection bypass system, and using an annual collection efficiency of 52% (personal communication: James Smith, NMFS, Clarkston, Washington). If a large number of fish migrated downstream past the dam during a period of high spill, the collection efficiency would be lower than 52% and our estimates of the number passing the dam would be low. We used the proportion of marked fish observed by unit staff in gatewell dip samples rather than the proportion observed by NMFS personnel in collection system samples because NMFS personnel did not notice and record all branded fish because they were watching for fish with adipose fin clips.

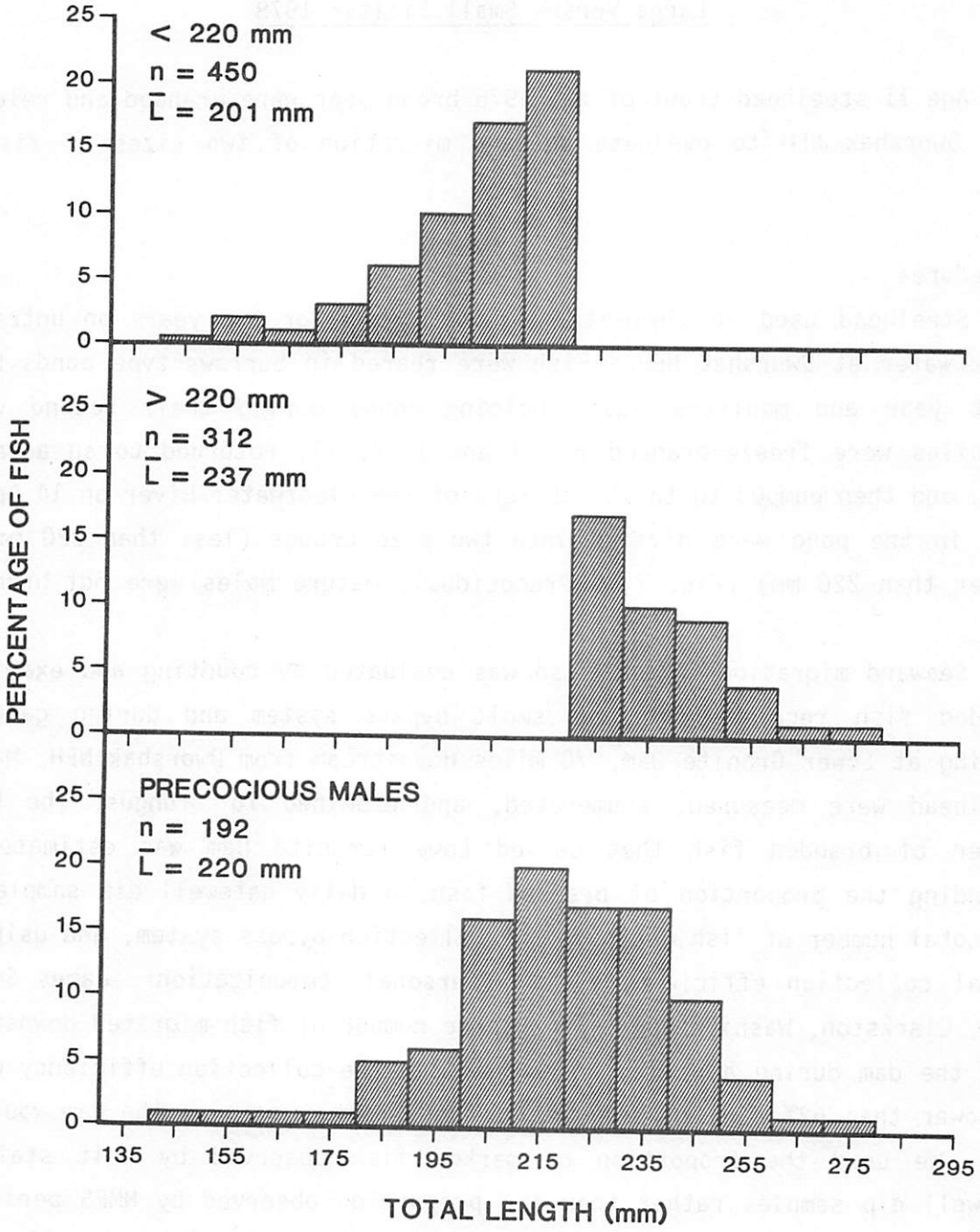


Figure 7. Length-frequency distribution of age II steelhead trout branded in April 1978 in size group test.

Results

The first migrants from the two marked groups were collected at Lower Granite Dam on April 19, five days after release (Table 2). Timing of migration past the dam was similar for both groups, with half of all migrating fish in each group passing Lower Granite Dam between April 29 and May 1, about 16 days after release. The last branded fish was collected on 19 May. Age II steelhead migrated downstream past the dam earlier than age I or other steelhead passing the dam, partly due to an earlier release date.

Table 2. Recapture rate at Lower Granite Dam in 1978 of age II steelhead smolts released from Dworshak NFH April 14 after being divided into two size groups and branded.

| | Shorter than 220 mm | Longer than 220 mm |
|---|---|---|
| Brand | LD IU (2) | LD IU (3) |
| Number branded | 6,090 | 5,215 |
| Mean total length at release | 201 | 237 |
| Branded fish captured | 62 | 25 |
| Estimated passage at dam | | |
| Number | 1,989 | 1,130 |
| Percent | 32.7 | 21.9 |
| Timing of migration at dam | | |
| First fish | 19 April | 26 April |
| Median fish | 29 April | 1 May |
| Last fish | 19 May | 6 May |

Age II steelhead in the longer than 220 mm group had a smaller proportion reaching the dam (22%) than those in the shorter than 220 mm group (33%) (Table 2). Steelhead collected at the dam appeared to be in good health, based on the incidence of fungus infection. Only two of the 129 fish had fungus.

In 1978, 20% of the age II steelhead released from Dworshak NFH were precocious males. Precocious males were slightly longer than non-precocious fish. In 1977, only 4% of the age II steelhead released from Dworshak NFH were precocious males. Age II fish released in 1978 averaged 216 mm in length versus 199 mm in 1977. High rates of precocious maturity have been observed in steelhead reared at other hatcheries. In a group reared at Niagra Springs Hatchery for the first year, then delivered to a pond

adjacent to the Pahsimeroi River at 13.7 fish/lb for another year of rearing, 33% of the fish were mature males when released, and their average length was 220 mm (Melvin Reingold, Idaho Department of Fish and Game, personal correspondence).

## Migration of Various Size Groups--1980

Seaward migration of large, medium and small-sized fish from one pond at Dworshak NFH was monitored in 1980. Regular production, age I fish in pond 12 were divided into less than 160, 160-179, and longer than 179 mm length classes and branded distinctively. The branded fish were released 22 April 1980 and the percent recaptured at Lower Granite Dam during April and May was used as the evidence of seaward migration.

Fish in pond 12 had a bimodal length-frequency distribution as age I fish in spring 1980 (Fig. 8). Fish in the less than 160 mm group made up the smaller mode. Fish in the 160-179 mm group made up the fish between the two modes, and the over 179 mm fish came from the large-size mode. The smaller fish group averaged 141 mm, versus 171 mm for the medium-sized group, and 198 mm for the large-sized fish.

Three times more fish from the group larger than 179 mm passed Lower Granite Dam than fish in the less than 160 mm group (Table 3). Fish in the medium-sized group migrated past the dam at three-fourths the rate of the larger fish.

Migrants recaptured and measured at Lower Granite Dam averaged larger than fish released in each group, but the difference was most noticeable in the small fish group (Fig. 8). Most of the fish in the large-sized group were smolts and migrated seaward, whereas a larger percentage of fish in the groups of smaller fish were not smolts and failed to migrate.

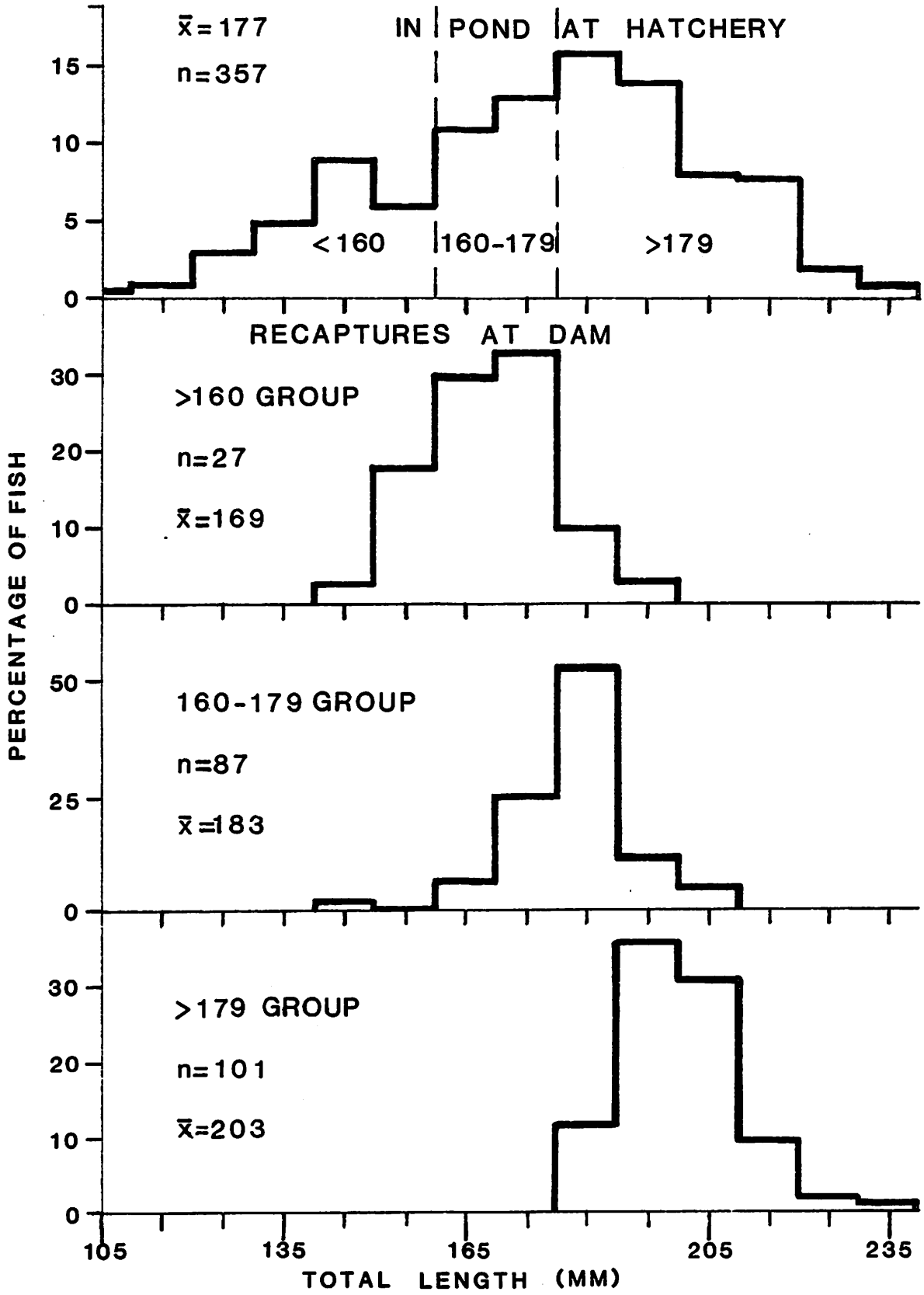


Figure 8. Length frequency distribution of steelhead trout in pond 12 at Dworshak NFH on 26 March 1980 with division points for groups of branded fish released for recapture at Lower Granite Dam.

Table 3. Recapture rates of three size groups of age I steelhead trout reared in a single pond at Dworshak NFH, released 22 April and recaptured at Lower Granite Dam, 1980.

| | Size groups | | |
|---|---|---|---|
| | Less than 160 mm | 160-179 mm | Larger than 179 mm |
| Number released | 5,100 | 5,000 | 5,000 |
| Mean length (mm) | 141 | 171 | 198 |
| Fish recaptured | | | |
| Number examined | 32 | 83 | 103 |
| Estimated number passing dam | 440 | 1,095 | 1,457 |
| Percentage passing dam | 8.6 | 21.9 | 29.1 |
| Mean length of migrants | 169 | 183 | 203 |

Timing of migration for all three groups of fish was within the normal April-May period (Fig. 9). Most of the fish in all groups migrated immediately after release and passed the dam in late April.

## Age I Voluntary Migration--1979

Some steelhead scheduled for two years of rearing at Dworshak NFH appeared ready to migrate seaward after their first year. In 1979, we conducted a test to determine if the age I fish would migrate seaward if released, how best to release the fish, and what percentage of the population would migrate if given the opportunity.

### Procedures

To determine the proportion of fish in the two-year program that would migrate seaward, fish in system I were inventoried on April 16-18 before migration was allowed and again on June 13-14 after migration had ceased. Fish were allowed to leave the rearing ponds through a 250 mm wide by 125 mm deep notch in the outlet headboards. After leaving the ponds, they were captured in the discharge sluiceway, counted, and released to migrate seaward.

Fish were allowed to leave ponds 29 and 31 starting April 13 and the remainder of the ponds in system I starting on May 16. Migration was allowed until June 8. All Fish migrating from the ponds through May 23 were

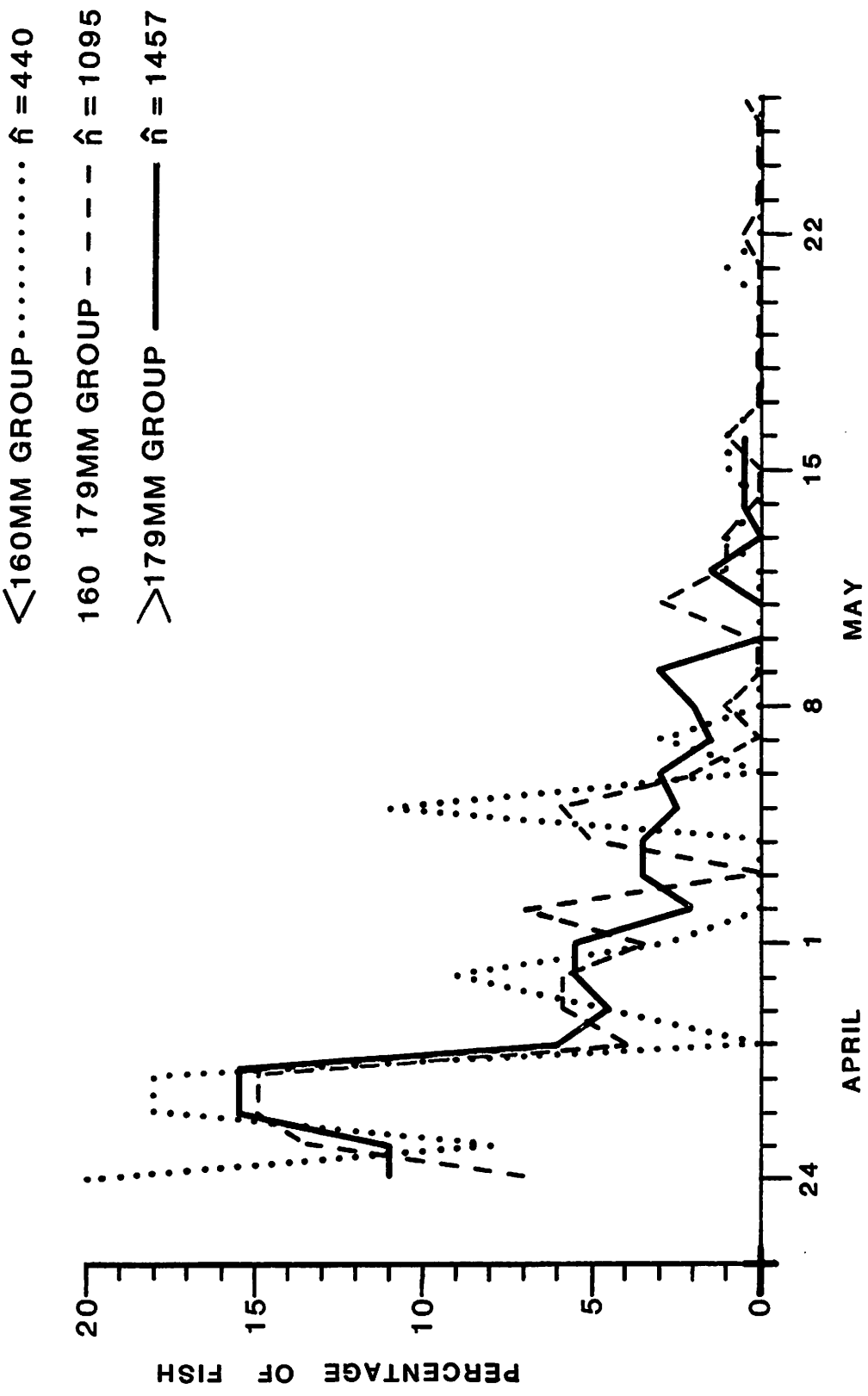


Figure 9. Time of passage at Lower Granite Dam of three size groups of age I steelhead trout released from Dworshak NFH, 1980.

trapped and transferred to a vacant pond for subsequent marking. After marking was completed on May 23, the remaining unmarked fish were counted and released into the sluiceway that emptied into the Middle Fork of the Clearwater River. On weekends, the ponds were left open and trap screens removed from the sluiceway so that fish could migrate directly to the river.

Voluntary migrants that were marked in 1979 were divided into two groups: (1) a group transported to Lower Granite and then to the lower Columbia River, and (2) a group released at the hatchery. Fish (32,368) that were transported directly from the hatchery to the barge at Lower Granite Dam were marked May 16-18 with a nose tag (binary code 10/5/34) and adipose fin clip. Fish released in the North Fork at the entrance to the fish ladder were marked May 18-23 with a nose tag (binary code 10/5/33), adipose clip, and some with a brand. Of the 30,098 fish tagged and clipped, 10,334 were also branded. All other voluntary migrants from system I were released without marks.

To determine the fate of fish that would migrate at age I but were not allowed to do so, we put 3,201 migrants with nose tags and adipose clips in pond 49 on May 22 and held them there until 14 June 1979 when they were added to pond 43. The fish were re-examined in April 1980 prior to release to determine if the fish again had the appearance of smolts, were precociously mature, and had survived as well as non-migrants.

In addition to the age I steelhead from system I, we also allowed domestic rainbow trout in pond 9 and regular age I production fish from system III to migrate from their ponds. Rainbow trout that left pond 9 were trapped separately in the sluiceway and returned to pond 11.

Results

Voluntary migrants among fish completing their first of a two-year rearing program at Dworshak NFH actively migrated seaward and were recaptured at a high rate at Lower Granite Dam, but their smolt-adult return rate was relatively low. Fish released May 18-23 began entering the

collection facility at Lower Granite Dam May 20 with largest numbers May 21 (Fig. 2). Most of the fish had passed the dam by the first of June.

A relatively large percentage (41%) of the 10,334 branded fish released in 1979 entered the collection facilities at Lower Granite Dam (Table 4). The first year fish that voluntarily left the rearing ponds were relatively small with migrants averaging 149 mm in length as they left the hatchery and 163 mm when collected at the dam (Fig. 10). Most of the fish passed the dam within 10 days so there was little chance for growth. Fish collected at the dam were larger because small fish that moved out of the ponds either did not migrate seaward or did not survive.

Table 4. Information on age I and age II steelhead smolts released in 1979 from Dworshak NFH and adults returning to the hatchery or recaptured in Zone 6 and Clearwater River fisheries.

| | Age I smolts | | Age II smolts |
|---|---|---|---|
| | Released at hatchery | Transported to Bonneville Dam | released at hatchery |
| Date released | 23 May | 18-23 May | 6 April |
| Number released | 30,000 | 32,300 | 42,600 |
| Mean length (n) | 149(381) | 153(530) | 176(491) |
| Smolts recaptured at Lower Granite Dam | | | |
| Number examined | 479 | --- | 1,556 |
| Percent transported | 41 | --- | 25 |
| Smolts recaptured at estuary | 26 | 56 | 3 |
| Adults recaptured | | | |
| 1-year ocean | 0 | 0 | 2 |
| 2-year ocean | 6 | 14 | 219 |
| 3-year ocean | 17 | 0 | 13 |
| Total number | 23 | 14 | 234 |
| Percent | 0.077 | 0.043 | 0.549 |

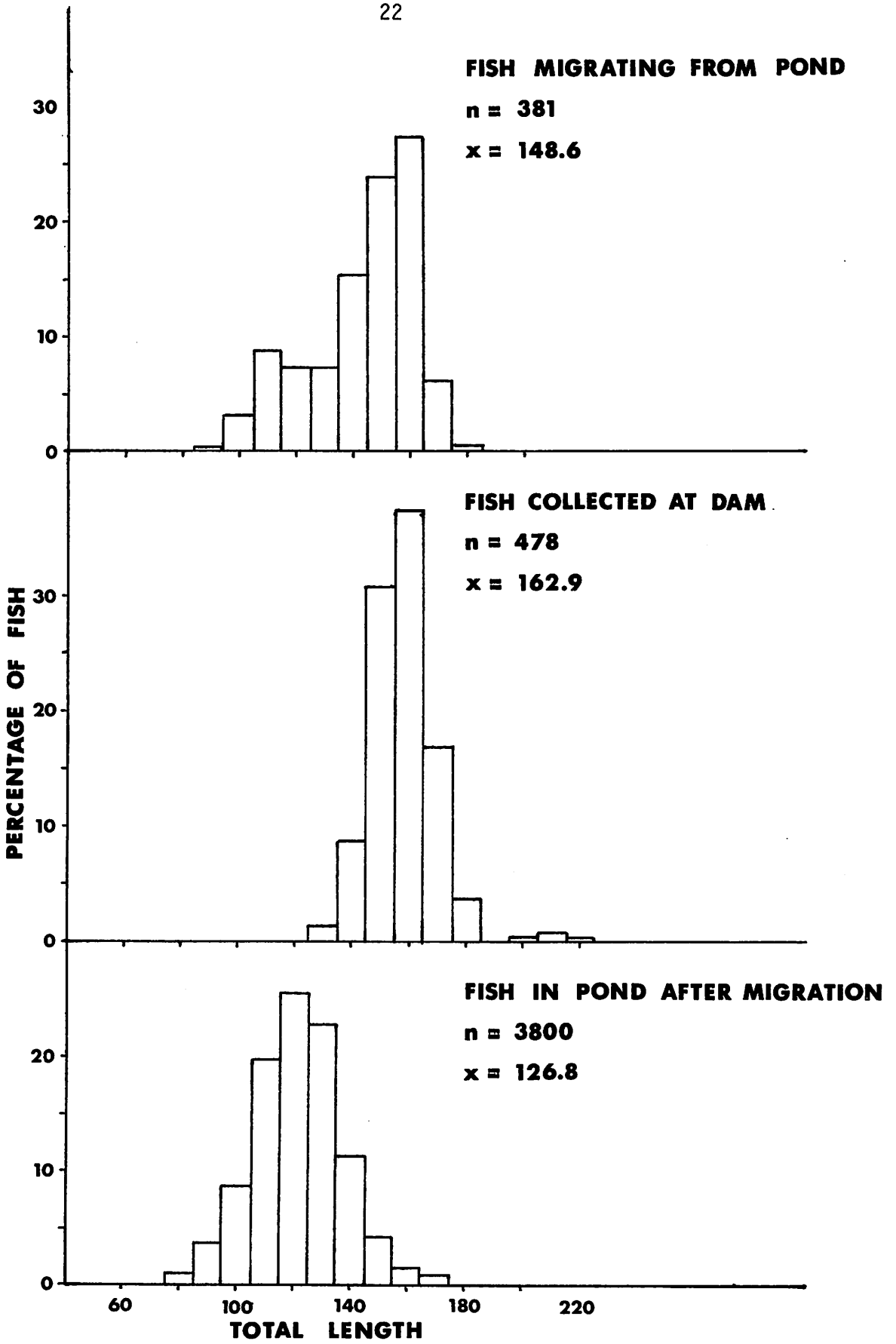


Figure 10. Length distribution of age I steelhead trout migrating from ponds in system I at Dworshak NFH, fish in ponds after voluntary migrants left the ponds, and of the voluntary migrants when trapped at Lower Granite Dam, 1979.

In 1979, one-fourth to one-half of the age I steelhead in system I migrated voluntarily from their ponds and were released to migrate seaward. We cannot pin down the proportion that migrated any closer because of discrepancies between the estimates of fish on hand at start and end of the migration season and the number counted out of the traps.

When the ponds in system I were inventoried April 14 and 18, they contained an estimated 800,000 fish. On June 13-14, the ponds were inventoried again and contained an estimated 359,000 fish. From April 18 to June 13, we trapped all fish that left the ponds on all but 10 days and released 158,300 fish. The number of fish that left during the 10 days the traps were not operated could be estimated in two ways: (1) the difference between the inventory estimates minus the number counted from the traps (278,700 fish or 28,270/day), or (2) use an average of the number trapped on days before and after the days the traps were not operated (6,290/day x 10 days = 62,900). If the estimate from method 2 (62,900) is added to the 158,300 fish counted out of the traps, we get an estimate of 221,200 fish leaving the ponds and 219,800 fish that we cannot account for (800,000 - 359,000 = 441,000 - 221,200 = 219,800). The number leaving the ponds on days the traps were not operated may have been larger than when they were operated because the fish could exit all night versus only half the night. If all the unaccounted for fish left on the night the traps were not operated, the nightly number of migrants would have been 4.5 times larger (28,270/day) when the traps were not operated compared to when they were (6,290/day). We do not believe there was that big a difference in nightly outmigration from the ponds and suspect that unaccountable losses occurred in the ponds or the inventories were not accurate. In any event, a significant proportion of fish in the two-year rearing program were ready to migrate seaward after their first year in the hatchery.

First year steelhead, even though willing to migrate seaward, did not survive as well as larger age II smolts released in 1979. Age II smolts were recaptured as adults at seven times the rate of the age I steelhead released at the hatchery (Table 1). More of the age I fish were recaptured

at Lower Granite Dam and the estuary during their migration to the sea than the age II fish, but apparently did not survive as well in the ocean.

Age I migrants transported from the hatchery to Bonneville Dam after migrating out of their rearing pond, returned as adults at about half the rate of fish that migrated seaward normally (Table 4). Four of the 14 fish recaptured from the transported group were recaptured in the Bonneville pool net fishery. The other 10 fish were recaptured at the hatchery or in the Clearwater River fishery. Three of 23 fish recaptured from the normal migration group were taken in the Bonneville pool fishery and the remainder in Idaho. No three-year-in-ocean adults returned from the transported group. After the two-year-in-ocean adults had returned, the transported group had a higher return rate than the normal migration group, but that was reversed after the third year of returns was completed. Return rates for both groups, however, were lower than that obtained for age II smolts.

Voluntary age I migrants from the two-year program that were retained at the hatchery until spring 1980 grew well their second year in the hatchery (from 149 to 214 mm in length) and had a slightly bimodal length distribution (Fig. 11). Of the 508 branded immature fish released as age II fish in 1980, 10 were recaptured at Lower Granite Dam. The recapture rate at the dam was one of the highest for any group released in 1980, an indication that steelhead willing to migrate seaward in 1979 were again willing to migrate seaward in 1980 if they hadn't matured. Precocious maturity was high among the holdover migrants. Of 680 holdover fish examined in spring 1980, 25 percent (172) were mature males; thus, about half the males that were migrants in 1979 and were then held a second year became mature by spring 1980.

A large number of the domestic rainbow trout in pond 9 also left voluntarily (17,740 out of 42,100 fish in the pond), but we did not mark and release any of those fish to determine if they would migrate seaward the same as the first year steelhead. Rainbow trout that migrated from pond 9 in May averaged 185-190 mm in length.

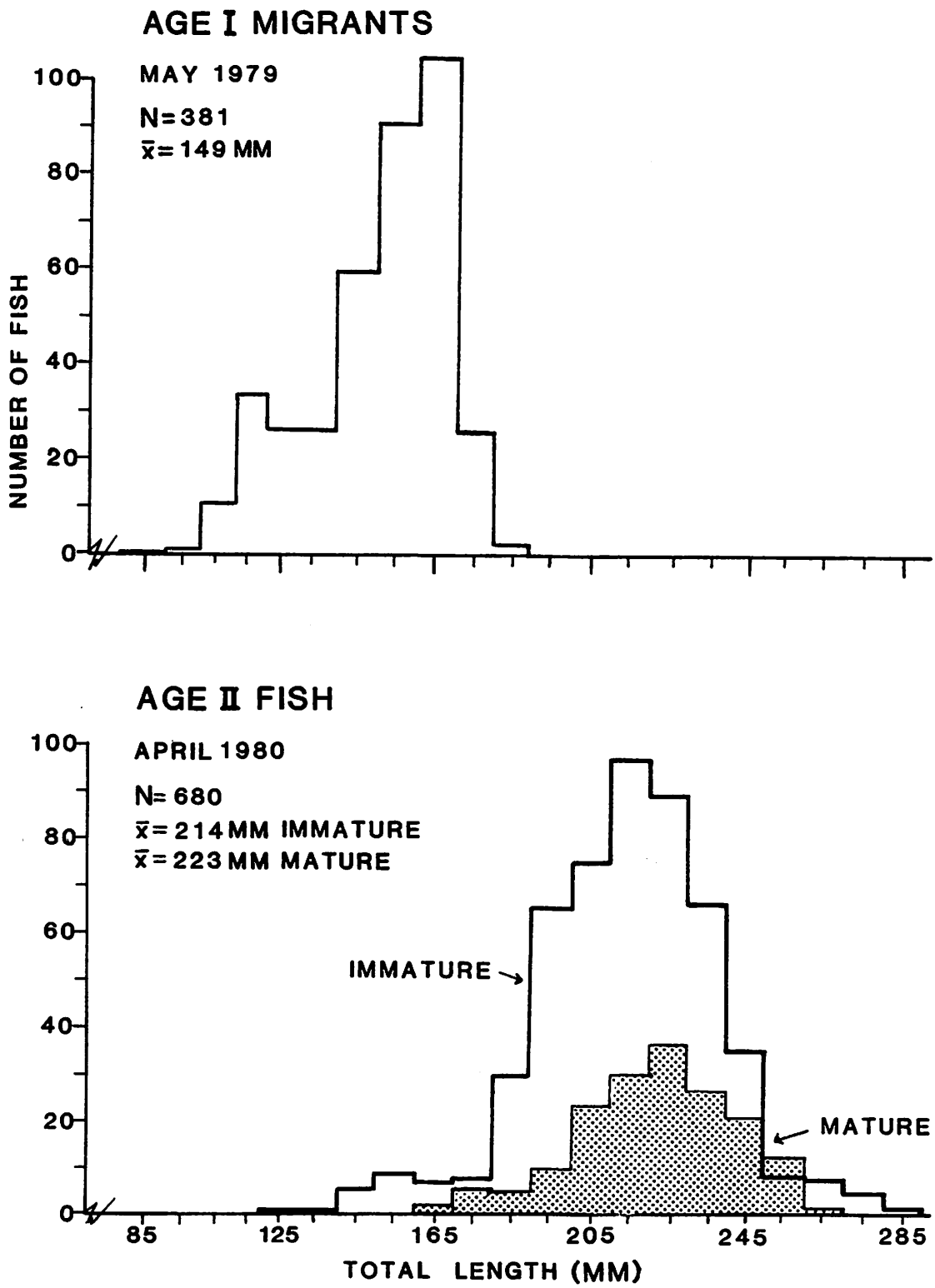


Figure 11. Length-frequency of age I steelhead in two-year program that voluntarily left their pond in May 1979, and a sample of those fish after being reared another year (age II fish).

Recapture rate at Lower Granite Dam for regular production age I steelhead released from system III was the same (25%) as that of the age II steelhead. Fish released April 9 and those released April 20 from system III arrived at Lower Granite Dam mainly during the first half of May. Fish in both groups averaged 156 mm in length when released versus 174-176 mm when recaptured at the dam. Again, we suspect the larger average size at the dam resulted mainly from more of the larger fish migrating seaward.

Recapture rate at Lower Granite Dam for age II smolts and age I fish from system III were the same, but smaller than for the age I voluntary migrants. We suspect, however, that the recapture rate for Age I voluntary migrants would have been no higher and perhaps lower (because of smaller average size) than for other groups if the non-migrants as well as the voluntary migrants had been included in the release.

## Age I Voluntary Migrants--1981

A special test was conducted in spring 1981 to assess the voluntary migration of age I steelhead trout of two sizes. Fish in pond 11 were smaller fish that were part of a two-year rearing program. Fish in pond 37 were larger fish initially in system II at the hatchery in a one-year rearing program, but were transferred in January 1981 to system I with colder water.

### Procedures

An inventory of the fish in each pond was conducted on 16 April and 9 June for pond 11, and 1 May and 3 June for pond 37. Fish were allowed to leave pond 11 from 5 May to 9 June, and pond 37 from 5 May to 2 June. Stoplogs with an outflow notch 250 mm wide and 125 mm deep at the surface were installed in the outlet of each pond. Fish exited the pond by swimming through the notch.

Fish leaving the ponds were monitored on an irregular basis to provide a second method of estimating the proportion migrating and to compare length of migrants versus non-migrants.

Fish remaining in ponds 11 and 37 were retained for a second year of rearing and released in 1982. Size of fish and precocious rate was monitored in spring 1982.

## Results

Similar proportions of steelhead in ponds 11 and 37 voluntarily left the ponds despite difference in size. Based on inventories before and after the period of voluntary migration, 37% of the fish left pond 11 and 40% left pond 37 (Table 5). Fish in pond 11 were larger (126 mm average total length) at the start of the test than fish in pond 37 (98 mm). Pond 11 had half as many fish as pond 37, but more pounds of fish (2892 versus 2282).

Table 5. Statistics on voluntary migration test conducted with age I steelhead at Dworshak NFH in spring 1981 and 1982.

| | Pond 11 | Pond 37 |
|---|---|---|
| Start of test | | |
| Fish in pond | 52,100 | 115,000 |
| Length of fish (mm) | 127 | 98 |
| End of test | | |
| Fish in pond | 32,700 | 68,700 |
| Length of fish (mm) | 131 | 100 |
| Migrants from pond | | |
| Inventory estimate | 19,400 | 46,300 |
| Percent migrating | 37 | 40 |
| Length of migrants (mm) | 157 | 110 |

Migrants from the two ponds were larger on average than fish in the ponds at start or end of the test (Fig. 12). Many of the migrants had the appearance of smolts (silvery, dark band on tail), but many also looked like parr that would likely not migrate seaward, especially from pond 37.

Fish left in the ponds at the end of the test averaged about the same length as at the start of the test (Fig. 12). Since larger fish migrated, growth during the month was sufficient to offset the loss of larger fish. Some fish in the ponds at the end of the test had the appearance of smolts while others were parr.

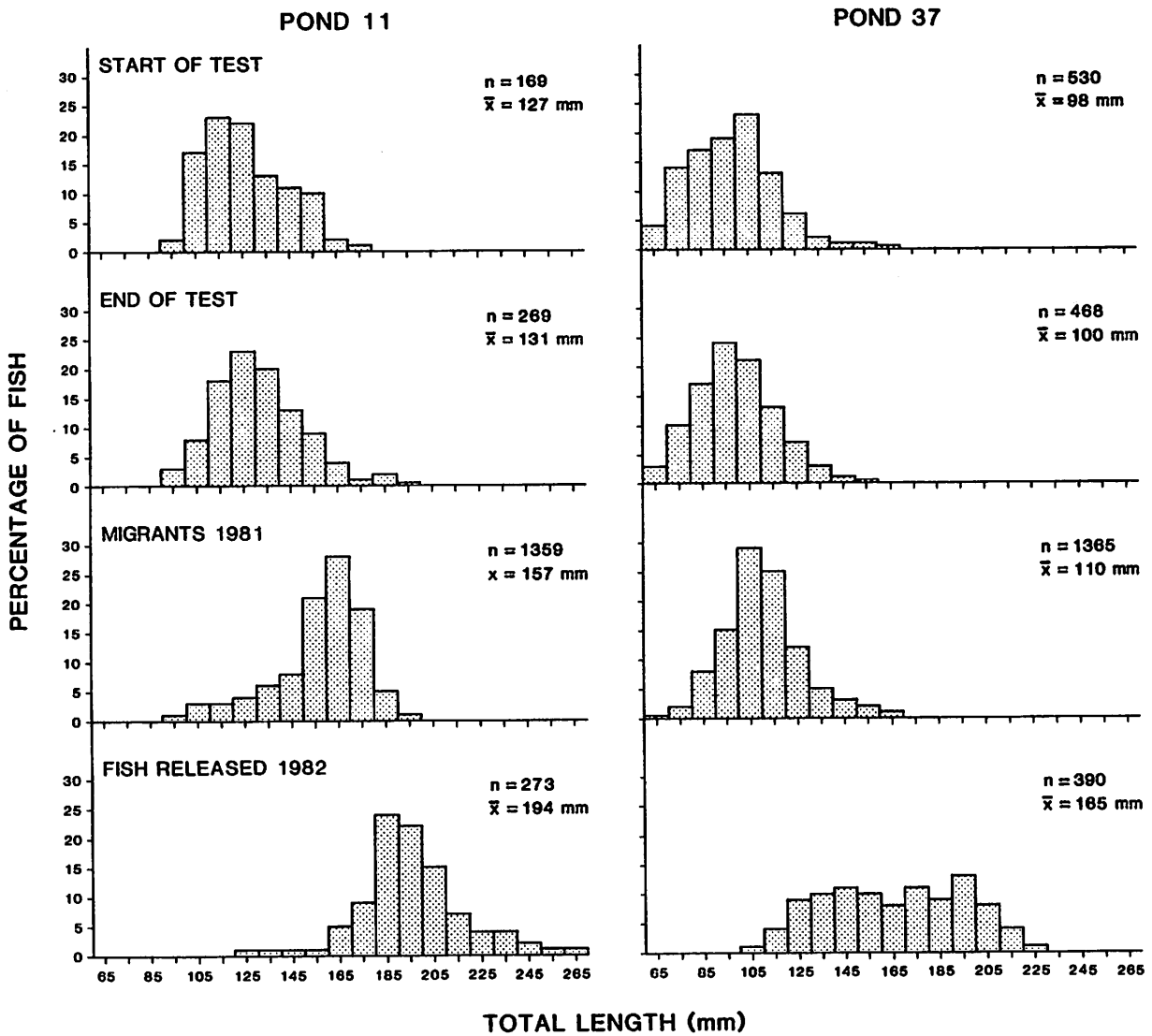


Figure 12. Length distribution of steelhead trout in ponds 11 and 37 at Dworshak NFH at start of voluntary migration test, at end of test, migrants from ponds in 1981, and remainder of fish after a second year of rearing.

Fish in ponds 11 and 37 after the migration test were reared an additional year and released in spring 1982. Fish in pond 11 averaged 194 mm when measured 1 March 1982, and they had a unimodal length distribution (Fig. 12). Twelve percent of the fish were precociously mature males. Fish in pond 37 averaged 165 mm when measured in March, and they had a bimodal length distribution. Three percent of the fish in pond 37 were precociously mature males.

## Grading Experiment--1981-1982

Age I steelhead trout in a pond at Dworshak NFH were graded prior to the second year of rearing to determine if the bimodal length distribution common in age II hatchery smolts could be eliminated by discarding the smaller fish.

### Procedures

In June 1981, pond 35 contained about 82,000 steelhead that had completed their first year of rearing. The fish averaged 36.2 fish per pound, 115 mm in length, and had a unimodal length distribution (Fig. 13). On 25 June, 34,200 fish were transferred to pond 33 to serve as ungraded controls for the experiment. On 8 July, the remaining fish in pond 35 were graded to remove smaller fish that would likely become those in the smaller mode of a bimodal distribution. An estimated 19,800 fish passed through a mechanical grader, averaged 95 mm in length and were released from the hatchery. An estimated 28,000 fish were retained in the pond, and they averaged 121 mm in length (Fig. 13). Fish in ponds 33 and 35 were reared a second year and checked on 1 March 1982 for quality, length distribution, and precocious maturity rate.

### Results

Discarding the smaller fish in a pond after the first year of rearing appeared to eliminate the bimodal, length distribution commonly found in age II hatchery steelhead trout. Graded fish in pond 35 had a unimodal length distribution after the second year of rearing, while ungraded fish in pond 33 had a markedly bimodal distribution (Fig. 14). Fish in pond 35 averaged

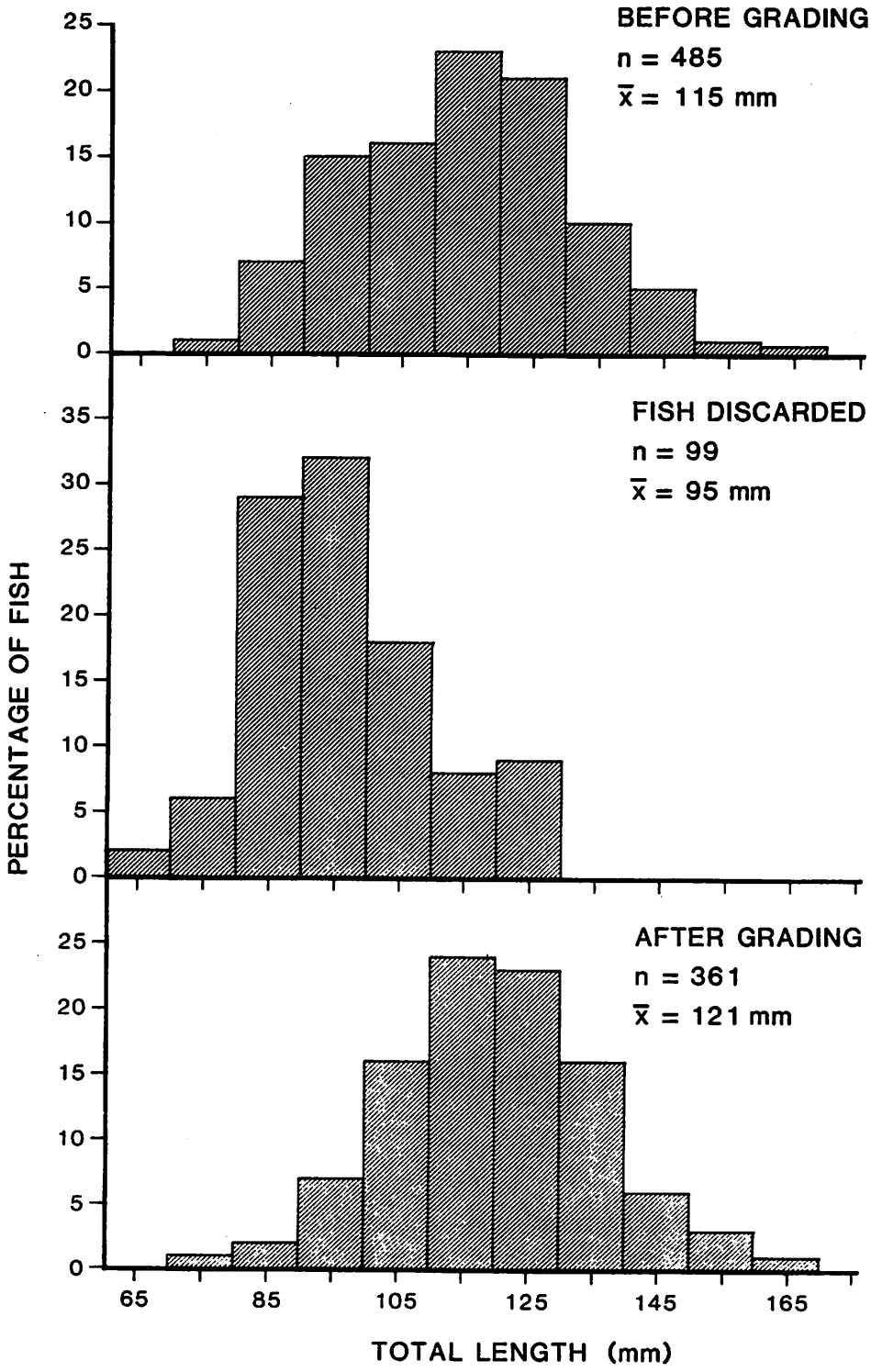


Figure 13. Length-frequency of age I steelhead trout in pond 35 at Dworshak NFH before and after grading, and fish discarded in July 1981 to set up grading test.

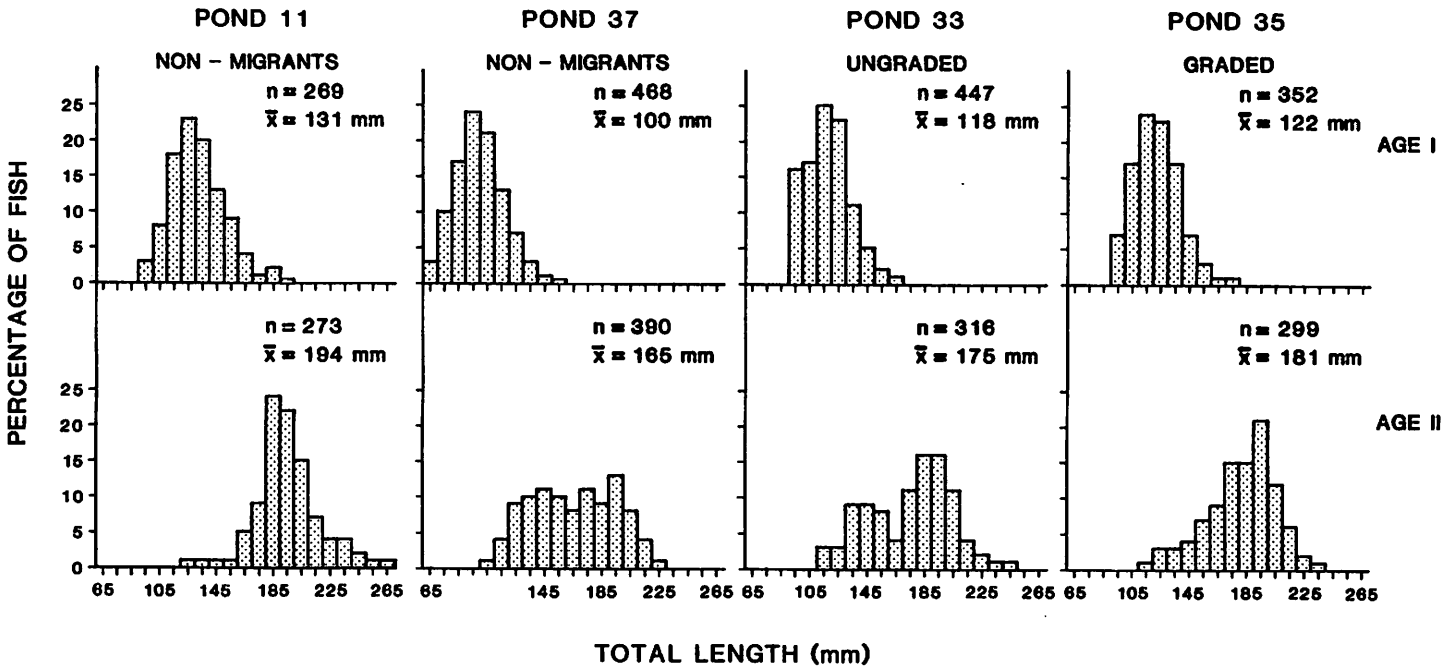


Figure 14. Length distribution of steelhead trout when age I and II in ponds at Dworshak NFH spring 1981 and 1982. Fish in ponds 11 and 37 were fish that failed to migrate voluntarily in spring 1981. Fish in pond 33 were an ungraded control for fish in pond 35 which had smaller fish graded out and discarded.

181 mm in length compared to 175 mm for the ungraded fish in pond 33. Precocious maturity rate was similar for both ponds of fish, 4% in pond 33 and 6% in pond 35.

Releasing steelhead willing to migrate after their first year of rearing does not appear to eliminate the bimodal length distribution of age II steelhead. Steelhead in ponds 11 and 37 were fish that didn't leave the ponds when given the opportunity in spring 1981. After the first year of rearing, they had a unimodal length distribution (Fig. 14). After the second year of rearing, fish in pond 11 had a unimodal length distribution, but fish in pond 37 had a bimodal distribution.

# DISCUSSION

A two-year rearing program for steelhead trout at Dworshak NFH or other hatcheries with similar water supplies has both positive and negative aspects. A two-year rearing program allows ample time to produce full-size, physiologically ready steelhead smolts. The entire spectrum of a spawning run can be more easily perpetuated with a two-year than a one-year rearing program.

Two-year old smolts produced at Dworshak NFH provided adult returns that were higher than from one-year old smolts when the latter fish were of generally poor quality. Starting in 1980, age I smolts released from Dworshak NFH have been of good quality and adult return rates have exceeded those of age II smolts.

If high quality one-year old smolts can be produced in a hatchery, some of the problems of two-year rearing programs can be avoided. More smolts can be produced from a given rearing space with a one-year than with a two-year rearing program. Bimodality in length distribution, although present occasionally in age I fish, can be minimized in age I fish and increase the net number of smolts released. Grading of steelhead after the first year of rearing to discard the smaller fish in the length distribution will minimize the chances of a bimodal length distribution in age II fish. Fish in the smaller mode do not have the appearance of smolts and few migrate seaward when released.

Precocious maturity is generally less of a problem in age I than in age II fish reared in hatcheries. Virtually none of the age I fish mature when their average length is 210 mm or less, whereas 3%-20% of the age II males might be mature. Precocious maturity is related to rate of development and, therefore, size of both age I and age II steelhead in hatcheries. Extra large (>240 mm) age I steelhead can have a significant precocious maturity rate. Precocious maturity rates in excess of 5% are undesirable because the mature fish do not migrate seaward and return as adult steelhead.

Although a large proportion of fish in a two-year rearing program are willing to migrate seaward after their first year of rearing, release of the age I fish does not appear to provide adequate returns. The age I voluntary migrants are relatively small smolts (140-160 mm), migrate actively seaward, but fail to return as adults at a satisfactory rate, perhaps because of their small size. Voluntary migrants held a second year become smolts again and produce adults at a reasonable rate.

Adult return rates for steelhead released from Dworshak NFH must exceed 0.07% to provide enough eggs to perpetuate the fish run (assuming 6,000 eggs per female and 50% egg-to-smolt survival rate). Two-year old steelhead produced at Dworshak NFH have had adult return rates ranging from 0.24% to 0.55% for releases in 1977 to 1980. Adult return rates for regular production age I smolt produced at Dworshak NFH have ranged from 0.12% to 0.46%. Age I steelhead produced at Hagerman NFH have had adult return rates of 0.20% to 0.88%, and those from Niagara Springs SFH 0.01% to 0.49% during the same 1977 to 1980 period of releases. The highest return rate for any group released during that time period was 0.88% for age I steelhead reared at HNFH and conditioned in the Pahsimeroi Pond for 12 weeks before release in 1980. Other groups of marked steelhead released in 1980 had return rates of 0.41% to 0.49% for fish produced at Niagara Springs SFH, 0.38% to 0.41% for other groups produced at Hagerman NFH, and 0.38% to 0.46% for age I steelhead released from Dworshak NFH. Age II steelhead released in 1980 from Dworshak NFH returned at a 0.24% rate.

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