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ANNUAL REPORT
IRON GATE HATCHERY STEELHEAD RESIDUALISM STUDY, 2000-2001
PROJECT 2b1

by

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ABSTRACT

This report summarizes the first year of the Iron Gate Hatchery Steelhead Residualism Study. Data including sex, forklength and spawning status were taken on 312 adults returning to the Iron Gate Hatchery. Adult steelhead released and in good condition had passive integrated transponder (PIT) tags inserted for future identification. Scales and otoliths were taken and will be analyzed this next year to determine ocean migration patterns.

31, 956 juvenile steelhead from The Iron Gate Hatchery (IGH) were given adipose fin and left maxillary clips and ~10% (3172) were PIT tagged. Steelhead were allowed to leave the hatchery volitionally, and had to pass through a flume monitored by video camera and a tube with a PIT tag reader attached before entering the Klamath River. 9629 steelhead were counted by video leaving volitionally and 947 were read by the PIT tag reader. The volitional release ended May 1 and 9,785 steelhead remaining in the ponds were expelled to the Klamath River. Of these, 812 had PIT tags.

The Klamath River was repeatedly electrofished from IGH to Ash Creek. 811 steelhead were caught in total, and 147 (18%) of these had hatchery clips. Of the 147 hatchery steelhead, 98 were from the 2001 IGH release, and 12 of these were PIT tagged. There was a high correlation between the numbers of hatchery fish caught and the proximity to IGH. Data from subsequent years will be needed to determine the extent of residualism of IGH steelhead.

SUMMARY

Objectives

1. To document the emigration behaviour if IGH migrant and non-migrant hatchery steelhead from raceways with a video system.

2. To design and implement an effective in-river sampling program to study the behaviour of IGH steelhead after release.

3. Create a database on IGH released steelhead, scale archives, genetic and otolith samples, in-river PIT tag recoveries and hatchery returns.

Accomplishments and Findings

1. 312 steelhead adults returning were biosampled; 204 were PIT tagged, 303 were scaled and 203 tissue samples were sent to NMFS Santa Cruz Genetic Laboratory for DNA analysis. 11 PIT tagged fish returned once to the spawning building and 2 returned a third time.

2. 31,956 IGH steelhead juveniles were clipped with adipose and left maxillary fin clips. 3,172 of these were PIT tagged.

3. The volitional release occurred from March 19th to April 30th. During this time, 9,629 fish were counted on the video monitor and 947 steelhead passed through the PIT tag reader.

4. 9,785 juveniles that did not leave volitionally were hand counted and released into the Klamath River from May 1st to May 3rd. Of these, 812 had PIT tags. The remainder of the 31,956 that were not counted either volitionally or from hand counting after the volitional release included 12,542 fish that may have been lost due to predation, natural mortality or slipped by the video flume through cracks that developed during the study.

5. A total of 811 steelhead were caught in the Klamath River by electrofishing. Of these, 664 were wild and 147 were hatchery steelhead. 98 were recaptured from the 2001 release. 41 were 2 year old steelhead having adipose and right maxillary clips. 12 PIT tags were recaptured.

6. Most hatchery clipped fish were found in close proximity to the hatchery. 96.6% of the hatchery fish that were caught were found within 5 miles of IGH, relative to 67% of the wild fish that were caught within 5 miles of the hatchery.

7. A grand total of 3,490 steelhead were PIT tagged at IGH or in-river during the year of 2001. Scale samples were collected from 2,059 steelhead.

S-RAMP
STUDY 2B1 IRON GATE HATCHERY STEELHEAD RESIDUALISM STUDY

BACKGROUND STATUS

Iron Gate Hatchery (IGH), a mitigation facility for the Iron Gate Hydro-electric Dam, was completed in 1966 to fulfill federal energy license requirements. The California Department of Fish and Game (CDFG) operates IGH with PacifiCorp funding 80% of the hatchery operation and maintenance. Three species of anadromous salmonids are spawned and reared at IGH. They include fall chinook or king salmon (*Oncorhynchus tschawytscha*), coho salmon or silver salmon (*O. kisutch*) and fall run steelhead (*O. mykiss*). Hatchery mitigation goals include the rearing of 200,000 yearling steelhead. Other mitigation goals include 6 million chinook and 75,000 yearling coho.

Since 1991, returns of adult steelhead to IGH have been insufficient to meet the 200,000 yearling release goals set by CDFG. In addition, CDFG fishery biologists and hatchery personnel noticed that some adult steelhead in the Klamath River upstream of the Interstate 5 bridge have begun to behave and appear more like resident trout. Limited scale analysis performed in 1993 by CDFG indicated that of the 12 scale sets examined, only 3 could be interpreted as possessing any ocean growth patterns. This information has led to concerns regarding hatchery steelhead remaining in the river and competing with or predating on naturally produced salmonids. The occurrence of steelhead to disregard ocean migration has been termed residualism. It is the primary goal of the IGH Steelhead Residualism Study conducted by CDFG SRAMP to determine if IGH steelhead are residualising, and to what extent in the Klamath River.

A secondary goal of the project is to determine the effectiveness of a volitional release program in the production of steelhead smolts. A prior study in eastern Washington volitionally released steelhead smolts that were PIT (passive integrated transponder) tagged upon emigration from rearing ponds in 1991 – 1994. PIT tag identification led to the conclusion that the volitional release program at this hatchery was successful in developing smolt production (Schuck pers. comm.). In addition, PIT tags can be used to monitor growth, survival, and spawning success of hatchery stock and provide a long-term identification code for individual fish. PIT tags (Biomark) are electronic tags that can be coded with a unique code. Tagged fish can be detected and identified *in situ*, eliminating the need to kill fish for data retrieval (Jenkins and Smith 1990). The code is transmitted to a digital reader when a hand held scanning wand activates the transponder.

As a measure to meet the goals of the project, all IGH juvenile steelhead received an adipose and left maxillary clip and 10% were PIT tagged during February 2001. Fish were allowed to leave volitionally from February 19th to May 1st while passing through a video monitored flume and a PIT tag reader. Fish remaining in the raceway after May 1st were counted, scanned for PIT tags and transferred to the Klamath River. The Klamath River was electrofished over several reaches from IGH to Ash Creek (8.5 miles downstream of IGH) periodically in order to monitor the whereabouts of the release group, as well as to investigate the composition of steelhead occurring near the hatchery. Additionally, data have been taken on adults returning to the hatchery and select individuals have been PIT tagged. Results of the first year of the study are presented in this report.

SAMPLING OF RETURNING ADULTS AT IRON GATE HATCHERY

METHODOLOGY

At IGH, steelhead entered one of two traps; a lower trap just above Bogus Creek below the hatchery, or an upper trap located above the hatchery at the dam, where the spawning building is located. Adults from the lower trap were transported by truck upstream and combined with the fish in the upper trap. After being crowded into the spawning building and checked for ripeness, those not ready to spawn were released into holding pools while those ready to spawn were anesthetized with carbon dioxide, spawned by IGH staff, and biosampled by SRAMP staff. Fish that were captured before January 1st, 2001 were classified as early run steelhead; late run steelhead were specified as fish returning after January 1st. Unripe early run steelhead were put into tanks separate from late run (after January 1st) steelhead and checked for ripeness each successive week. Spawning procedures of steelhead at IGH allow fish to survive and return to the river.

Data on returning adults were collected on unripe individuals if they were not being held and on ripe steelhead after hatchery personnel took the eggs and milt. The sex, hatchery clips, general condition and fork length were noted and scales taken from the left side posterior to the dorsal fin. Left ventral fins were clipped to mark returning adults. These clips were kept for tissue samples, and further sent to the SRAMP office in Fort Bragg for analysis. PIT tags were inserted in healthy specimens into the abdominal cavity from February 15th to March 8th. It was decided, however, that from March 14th on, tags would be inserted intramuscularly beneath the dorsal fin due to health reasons for the fish as recommended by Biomark. After injection, each fish was scanned with the hand-held wand in order to obtain the identification code. Fish were recovered in fresh water and released ½ mile downstream of the hatchery. Measurements and samples taken from mortalities followed the same protocol, with the addition of removing and tagging the head. Scales and otoliths will be analyzed for age and ocean residency in 2002.

RESULTS

Data on adults is summarized from January 4 to April 12, 2001. A grand total of 312 steelhead were examined. Scales were taken from 303 of these. 204 of the 312 (65%) fish were PIT tagged. Eleven PIT tagged fish were recaptured and nine of these were hatchery clipped fish. Two of the recaptured fish were recaught on two different sampling days. The average lengths of each age class that could be categorized by clips are summarized in Table 1.0. 17 of the total 312 fish could not be categorized due to uncertainties of clips, or that they had only a right or left maxillary clip with no adipose. 3 fish had right maxillary and adipose clips but were sexually mature and of a size that would rationalize that they were not of the age 2 class. These clip findings may have resulted from fish coming from different hatcheries, poor initial clips, clip regrowth or errors in identifying clips. These outliers have not been included in Table 1.0.

Table 1.0. Average fork length of steelhead that could be identified into adipose (age 4; brood year 1997), adipose and left maxillary (age 3; brood year 1998), adipose and right maxillary (age 2; brood year 1999), and unclipped steelhead.

Age	Average Fork Length (mm)	Count
4	563	28
3	472	141
2	223	4
no clips	460	122
Grand Total	472	295

The ratio of males to females was 1: 1.26, showing slightly more female returns. Scales were taken from nearly every fish (303), though on various males, scales were very hard to retrieve and samples were not taken. Scales are currently being analyzed for age and ocean entry patterns and findings will be included in the next report.

DISCUSSION

By gathering information on adult steelhead returning to IGH, the physical and chemical characteristics and ocean entry and/or residency can be determined. Data including fork length, sex of the individual, and the gathering of scales, tissue and otoliths will aid in describing life histories. PIT tagging will be useful in determining individual identification, growth, and spawning success.

PIT tagging commenced February 15, and 204 fish received a tag. The overall condition of the fish qualified individuals for a tag. There was some questioning as to the best location of the tag. Prentice et al. (1990) declared that the body cavity of both juvenile and adult salmonids was found to be an acceptable site for implantation. They also reported that previously PIT tagged fish did not shed tags when hand stripped of eggs and there were no adverse effects of the tag when spawning. The body cavity was used to implant the tags during the primary days of sampling, but was switched on March 14th onwards to the dorsal surface as recommended by the manufacturer of the tags.

Analysis of scale and otolith samples taken from returning adults at the Iron Gate Hatchery has the ability to determine migration patterns and, therefore, the extent of residualism. Scales were collected on 303 steelhead. Information that scales can relay includes freshwater years, growth, ocean years, half-pounder occurrence, and spawning.

Scale analysis from returning adult steelhead at IGH in February through March in 1980 and 1983 characterized age, growth, and life history (Hopelain 1987). 113 scales were analyzed with the following results. The most common life history included two years spent in freshwater, followed by ocean entry. 99.1% of these returned 4 to 5 months later as half pounders and most spawned for the first time the next fall. Repeat spawners comprised 37.1% of the sample. A summary of the life history that included the whole Klamath basin showed that initial ocean entry occurred when the fish were 210mm to 230mm in forklength. In 1993, scales were taken from returning adults and examined for growth patterns. Of twelve hatchery clipped fish, only three showed ocean growth resident patterns.

Heads were collected from mortalities for otolith removal. Microchemical analysis of strontium (Sr) distribution in otoliths can determine life history patterns. The concentration of Sr in the ocean is about two times greater than in freshwater. Diadromous movements are correlated with Sr distribution patterns in the otoliths, and can be used to describe the diadromous migratory patterns of fish by observing yearly growth rings and concentrations of deposited Sr. In addition to providing evidence of basic anadromy, otolith microprobe techniques can display entire life history records of fish movements across the freshwater/ saltwater interface (Kalish 1990).

Tissue samples were collected from February 22 onwards on almost every fish. These samples were sent to the Anadramous Fish Tissue Collection Project, and will be analyzed at the NMFS Santa Cruz Genetic Laboratory. CDFG, in collaboration with NMFS are creating a DNA archive and conducting DNA genetic analysis to describe the genetic variability and phylogenetic relationships of steelhead in coastal California streams.

2001 IRON GATE HATCHERY STEELHEAD: PIT TAGGING AND VOLITIONAL RELEASE

METHODOLOGY

Juvenile steelhead were raised in the first 50 feet of a 400 foot raceway. Starting on February 8th, 2001 and continuing over 11 days until February 27th, 2001, fish were marked with adipose and left maxillary fin clips and 10% were PIT tagged. To do this, fish were crowded and netted into flowing, freshwater tanks in a portable building stationed next to the raceway. They were anaesthetized with carbon dioxide, clipped and then PIT tagged. Clippers tallied the total of all fish clipped. Fish not PIT tagged were released into the second 50 feet of the runway.

Juvenile steelhead to be PIT tagged were briefly held in carbonated water (pH 5.6) until PIT tagging occurred. PIT tags were inserted into the abdominal cavity between the pectoral and ventral fins approximately 2 mm off the belly line with a 12-gauge needle attached to a syringe. After injection, each fish was placed in a freshwater holding tank until it was scanned with the hand-held wand to detect the PIT tag code and transfer it into the computer. Lengths and weights of all fish were recorded and every second fish had scales taken by scraping a small area posterior to the dorsal fin on the left side. Any observable trait was noted such as dark, silvery, or milty. PIT tagged fish were placed in a freshwater tank for recovery and then ponded in tanks in the hatchery building. PIT tagged fish were not fed for 48 hours after tagging. Release of PIT tagged fish into the raceway with the other clipped fish took place about 5 days after a quality control. The quality control consisted of checking 50 fish from each of 5 ponded groups for clips, tag retention and tag readability.

Steelhead desiring to leave the hatchery (migrants) were allowed to swim through a V-notch in the dam boards, which had attracting aeration, of ponds 1, 2 and 3 before entering a video flume and PIT tag counting station that emptied into pond 4. A Sony video camera model SSCDC50 equipped with a 4mm F 1.2 lens was positioned below the water surface in a waterproof compartment. Images were recorded on a Panasonic AG6740 time lapse VCR. A 24 hour recording mode provided us with sufficient frames

per second to count passing fish. After passing through the video and PIT tag flume, fish could leave the hatchery through a pipe that emptied into the Klamath River. For a short period of time on two different occasions, fish could not leave pond 4 as the water through the pipe was diverted into the adult trap. These fish were manually transported to the river. Observations such as lifestage (parr or silvery parr), and the fork length of random fish were taken on manually moved fish.

The volitional release ended on May 1st and all fish remaining in the raceway were counted and manually passed through the PIT tag reader. Forklengths and lifestage observations were recorded on approximately every 50th fish. Steelhead were placed back into pond 4 before being crowded to the outtake, which leads to the Klamath River. Raceway ponds were electroshocked for any remaining fish, which were PIT tag read and released to the river. Finally, all dam boards were removed, and any remaining fish were crowded to the river.

RESULTS

PIT tagging

A total of 31,956 IGH juvenile steelhead were processed, all having their adipose fin and left maxillary clipped. Of these fish, 3172 (10%) were PIT tagged. Mortalities that occurred over the 11 day PIT tagging and clipping period totaled 97 (0.3%); of these, 5 (0.02%) were PIT tagged. These tags were reclaimed.

Table 2.0 PIT Tagging and Marking Counts

Ad Clip/ Max	PIT tagged	Unclipped Mort	Clipped Mort	PIT Tag Mort	Tags Shed
31956	3172	63	28	5	4

Volitional Release

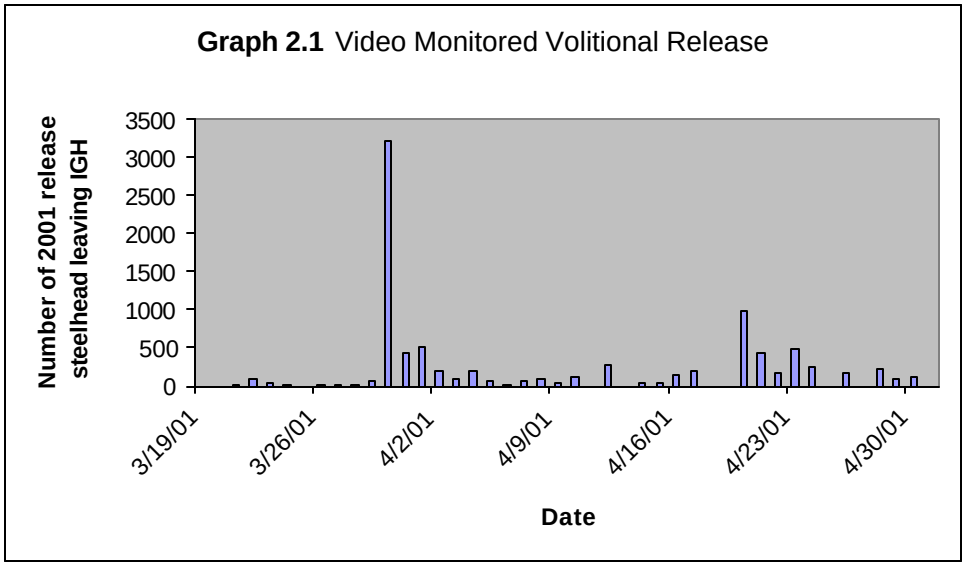
Fish passed through a flume and were recorded by a VHS video from March 19 to April 30. A total of 9021 steelhead were viewed, and an estimated 608 more fish, from days where the screen was dark or the record button did not get turned on, created a grand total of 9629 fish that moved out of the raceway on their own. Of these, 947 were PIT tagged fish. On May 1st, Fish were crowded down the raceway and 260 PIT tagged fish went through the reader that night. The video displayed a very high quantity of fish that could not be accurately counted, so an estimate of 2600 (10X the amount PIT tagged) was used.

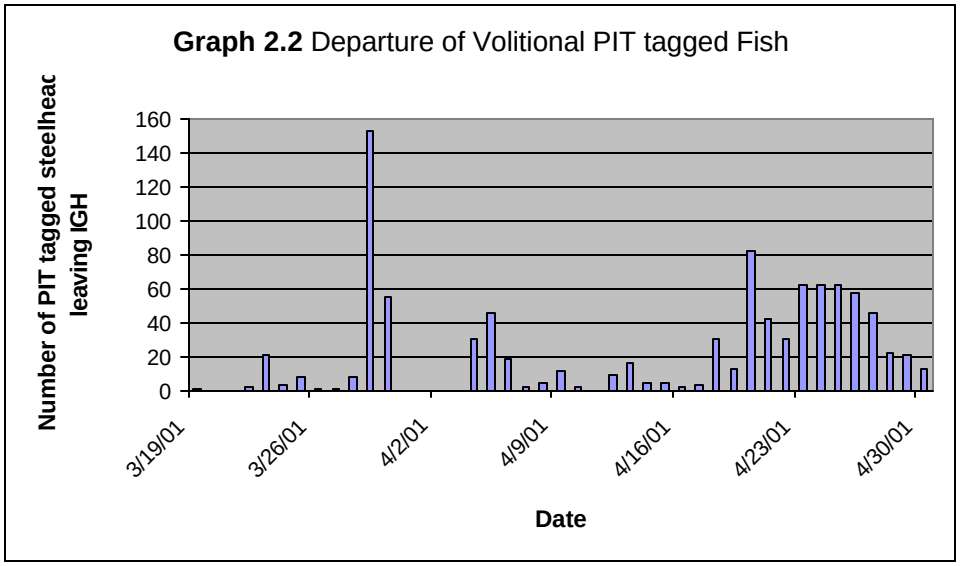
Table 2.1 Volitional Release Results

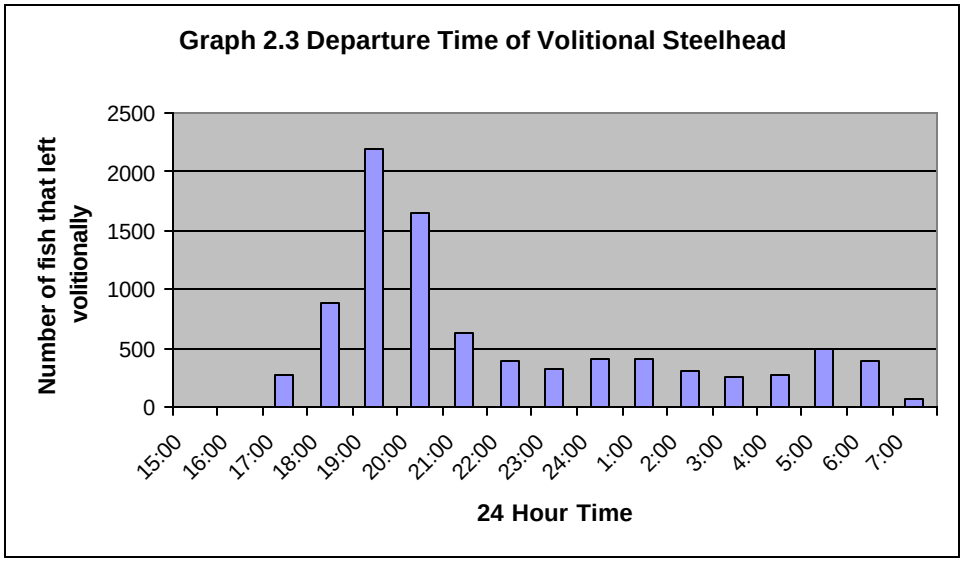
	Volitional (migrants)	**Non Volitional**
Total	9629	9785*
PIT tagged	947	812

*Includes an estimate of 2600 fish extrapolated from the 260 PIT tagged fish that were scanned on May 1.

Graph 2.1 displays a timeline of the volitional counts that were recorded and observed on videotape. Graph 2.2 shows the PIT tagged fish over the volitional release period. Graph 2.3 shows when, during the hours the volitional release ran, the fish passed through the video flume.


Graph 2.1 Video Monitored Volitional Release
Number of 2001 release steelhead leaving IGH
3500
3000
2500
2000
1500
1000
500
0
3/19/01
3/26/01
4/2/01
4/9/01
4/16/01
4/23/01
4/30/01
Date


Graph 2.2 Departure of Volitional PIT tagged Fish
Number of PIT tagged steelhead leaving IGH
160
140
120
100
80
60
40
20
0
3/19/01
3/26/01
4/2/01
4/9/01
4/16/01
4/23/01
4/30/01
Date


Graph 2.3 Departure Time of Volitional Steelhead
Number of fish that left volitionally
2500
2000
1500
1000
500
0
15:00
16:00
17:00
18:00
19:00
20:00
21:00
22:00
23:00
24:00
1:00
2:00
3:00
4:00
5:00
6:00
7:00
24 Hour Time

On May 2nd to May 4th, the flume was closed and fish were hand counted through the reader. A total of 7185 fish were counted, and 552 of these were PIT tagged. Length and lifestage were taken on random individuals during the hand counting efforts on May 2nd to May 4th. The average length of the non-volitional steelhead was 125 millimeters. There were 53 parr and 48 silvery parr measured. To see if these lengths were any different from volitional fish, a t-test was run against the average length of any 2001 IGH released steelhead caught in the river prior to May 1st. It was found that the volitional steelhead caught in river were significantly larger, averaging 155 millimeters ((P = <0.001). 3 parr, 14 silvery parr and 1 smolt were measured from in river sampling prior to May 1st.

DISCUSSION

Marking and PIT tagging ran smoothly. PIT tags were not applied to fish under 70mm, so PIT tags may not represent this portion of the total population. As well, PIT taggers may be biased to picking larger sized fish for the PIT tagged 10th fish. The total count also may have been slightly skewed due to human error. The low mortality rate and number of shed tags observed in the PIT tagged fish is consistent with results of studies that have tested impacts of PIT tagging on fish. Prentice et al. (1990) found that PIT tags did not alter growth, survival, behavior or reproduction in salmonids. Retention has found to be high, as well as the longevity of the tags. Ombredane et al. (1998) found similar results when using PIT tags with brown trout (*salmo trutta L.*).

Rhine *et al.* (1997) reported that length, condition factor and degree of smoltification appear to be strongly related to emigration performance. Past work has shown that steelhead that residualized had significantly higher condition factors (Viola and Schuck 1995; Rhine et al. 1997). This may be attributed to the higher condition factors generally found in sexually developing males, and that a high percentage of residualizing fish are precocious males (Viola and Schuck 1995). Gross (1987) indicated that precocity evolved as an alternative life history pattern. When inadequate numbers of adult male steelhead return to spawning areas, precocious males may serve to ensure the fertilization of eggs. Though the occurrence of precocious males in the Klamath River is presumably natural, it has been proposed that "large percentages of precocious males among residual fish may be partly a result of hatchery practices (Viola and Schuck 1995). Past work on chinook salmon suggested that by releasing fish at a larger than natural size in order to increase survival may result in large numbers of precocious males (Mullan et al.1992). Eleven of the 3,172 juvenile steelhead PIT tagged in February were found to be milty. It is most likely that these fish will be precocious and residualize, as they have the ability to mate with mature adult females. It was found that the average Fulton's Condition Factor of the milty fish was not significantly different from any of the other PIT tagged juveniles. Also, those fish categorized as silvery or dark upon tagging were not significantly different in Fulton's Condition Factor than any other group either.

There were several problems that arose with the volitional release at IGH. The results of the video monitoring and PIT tag flume during the volitional release and the count of fish that were post volitional accounted for 19,414 fish. As 31,859 were initially marked and released, a total of 12,445 were not accounted for. A number of these fish were inevitably lost due to predation from birds, mortality from hatchery conditions, and natural mortality. Other reasons for the loss of these fish include problems with the video flume set-up. The flume was not perfectly flush with the raceway walls and bottom,

therefore allowing the escape of steelhead without being counted. As well, a small number of fish may have escaped prior to the volitional release date due to the improper placement of the partition in the second 50 feet of the raceway. IGH personnel noticed this several days after marking commenced. The video monitor did not record fish on several days. The record button was not pushed on a certain occasion, and the power was disrupted on another. This power failure affected the PIT tag reader as well. The PIT tag reader was adversely affected by moisture in the cable and malfunctioned on a number of occasions as a result.

Steelhead that did leave volitionally migrated fairly consistently over the 42 days with an obvious peak occurring on March 31. This peak was from a pond cleaning that occurred during the day, which inevitably scared fish towards the end of the raceway. It has been suggested that lunar phase may have a role in cueing emigration (U.S. Fish and Wildlife Service 1997). A new moon cycle was observed around April 23. It seems that fish may have been moving around this time, as observed in Graphs 1.1 and 1.2. A new moon creates the darkest surrounding environment in the month, and fish may have an innate behaviour to emigrate during this time as a means of protection. It was also found that a high percentage of fish moved through the flume from 1900 hours (7pm) to 2100 hours (8 pm), steadily throughout the night and then increasededly in the morning hours of 500 to 600 hours.

SAMPLING STEELHEAD IN THE KLAMATH RIVER NEAR IRON GATE HATCHERY

METHODOLOGY

The Klamath River was periodically sampled by electrofishing from IGH to Ash Creek (see Figure 1.1, 1.2 in the appendix) In river sampling was conducted using an electrofishing oar powered raft and a jet powered electrofishing workboat. Five mile sections of river were sampled per sampling day. Within each run, four sampling sites were always fished. These sites varied in length, but most were around 400 feet long. Other sections of river were sampled at random, or where steelhead of the target age were likely to be found.

The crew consisted of two people, and oarsperson and a netter. The raft would drift down the section of river, controlled by the oarsperson, while the netter would start the generator, and control the electroshocking. Shocked fish were caught, placed in an aerated, water filled cooler until the shocking was complete. The raft would then be banked while the processing of the fish commenced. Fish were anaestitised, checked for hatchery clips and PIT tags, measured for forklength, recorded of lifestage by physical characteristics, and scales and tissue were taken on select individuals. Physical characteristics that denoted various lifestages included the presence or absence of parr marks, silvery coloration and size. Steelhead that had parr marks with no silver coloring were termed parr; parr marks with silvery coloring were deemed silvery parr, and those with no parr marks and a high degree of silver coloration were called smolts. Steelhead that were obviously larger were classified as age 2+, and those that were characteristically adult-like were termed adult. Various individuals were PIT tagged and those without PIT tags received fin clips, including a half right ventral (April 20 - 30, lower caudal (May 7 – June 7) and full right ventral clip (June 8 – June 27). Fish were

allowed to recover before being released back into the river. Electrofishing time, voltage and frequency were recorded for each section.

RESULTS

A total of 811 steelhead were electrofished and sampled in the Klamath River. 17 of 570 steelhead that received either a half right ventral, full right ventral or lower caudal clip were recaught. 9 mortalities occurred, most likely through electroshocking stress, and 2 fish were sacrificed for dissection. Only one of these fish ended up being dissected, as the other was lost to the river.

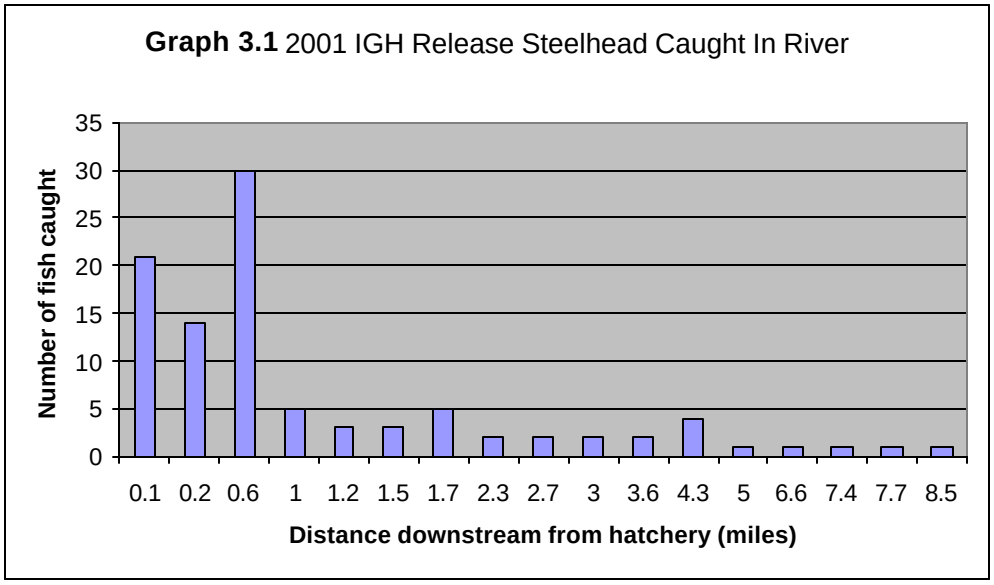
147 (18%) fish that were caught by electrofishing had some sort of hatchery clip, whereas 664 (75%) fish were without clips, therefore determined to be wild. 98 (67%) of all the clipped fish were 2001 IGH released steelhead. 3 fish had the adipose and left maxillary clips, but were over 400 mm long. These were determined to be 3 year old fish from the brood year of 1998. 41 fish, 28% of all hatchery fish caught, had adipose and right maxillary clips. These fish were 2 year olds, released last year (brood year 1999). 1 fish that was caught had been to the spawning building (noted by a left ventral clip), measured 530mm, and had adipose and left maxillary clips (3 year old). 2 fish had only adipose clips and 1 fish had only a left maxillary clip. These fish were either improperly clipped, had regenerated fins, were wild with missing fins or were not properly noted when sampling. They have been included in the hatchery count of 147. The forklengths of the wild fish ranged from 72mm to 385mm. Table 3.1 shows all of the steelhead caught in the Klamath River.

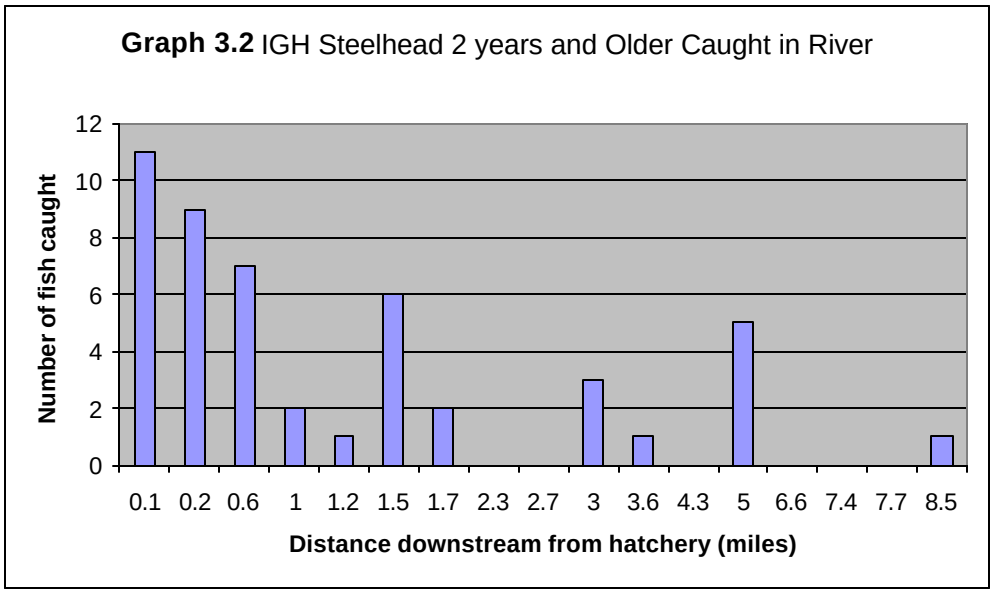
Table 3.1 Numbers and average forklengt hs of steelhead caught in the Klamath River by electroshocking.

Identification	Count	Average Forklength
IGH age 1	98	166
IGH age 2	41	304
IGH age 3	4	460
IGH age 4	1	355
Adipose (Ad) clip	1	208
Ad, Left Maxillary, Right Maxillary clips	1	321
Left Maxillary clip	1	237
Wild age 1	633	167
Wild age 2+	14	275
Wild adult	17	342
Recaptured Wild	14	197
Recaptured IGH	3	171

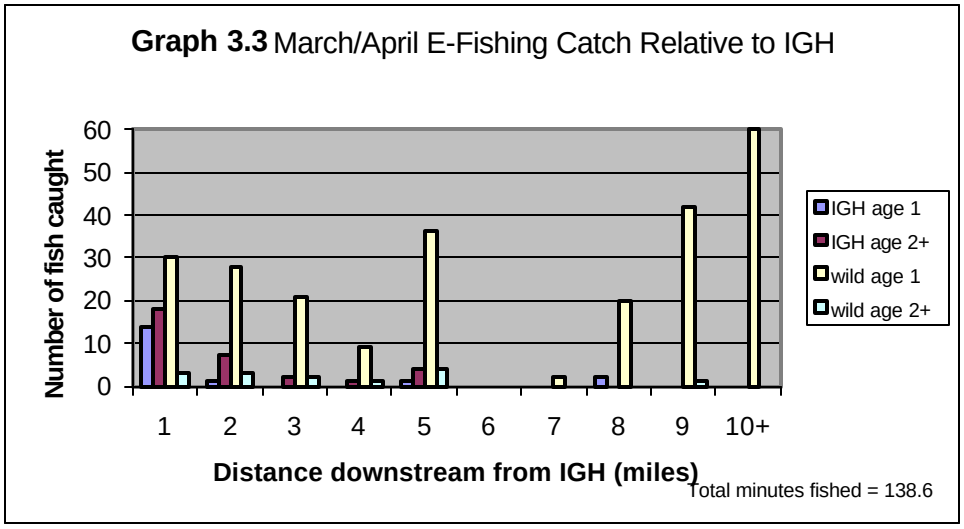
Graph 3.1 shows where in relation to the hatchery the 2001 IGH released steelhead were caught in the Klamath River. Graph 3.2 shows where the rest of the hatchery clipped fish, those that are 2 years and older, were caught. 142 of the 147 (96.6%) hatchery clipped fish from all age classes were caught within 5 miles of the hatchery. The other 5 steelhead were found within 8.5 miles of the hatchery. 81 of 98 (83%) of the 2001 IGH released steelhead were found within 1.7 miles, and 66% (65) of all the 2001 release caught in river was done so within 3300 feet of the hatchery. 79% (38/48) of the hatchery clipped fish that were 2 years or older were found within 1.7 miles; 56% (27/48)

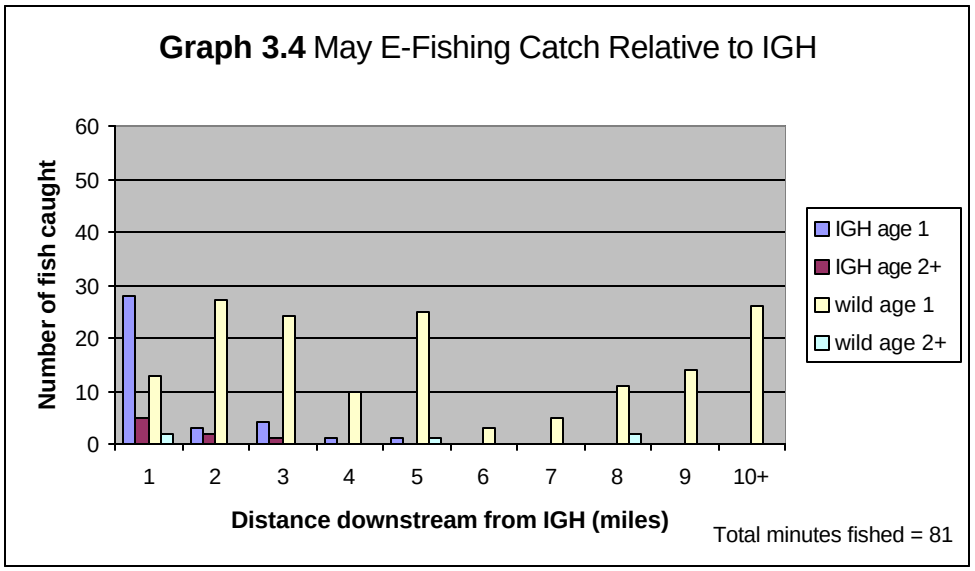
were found within 3300 feet and all but one (97.9%) were found within 5 miles of the hatchery. 442 of the 664 (66.6%) wild fish were caught within 5 miles of the hatchery.

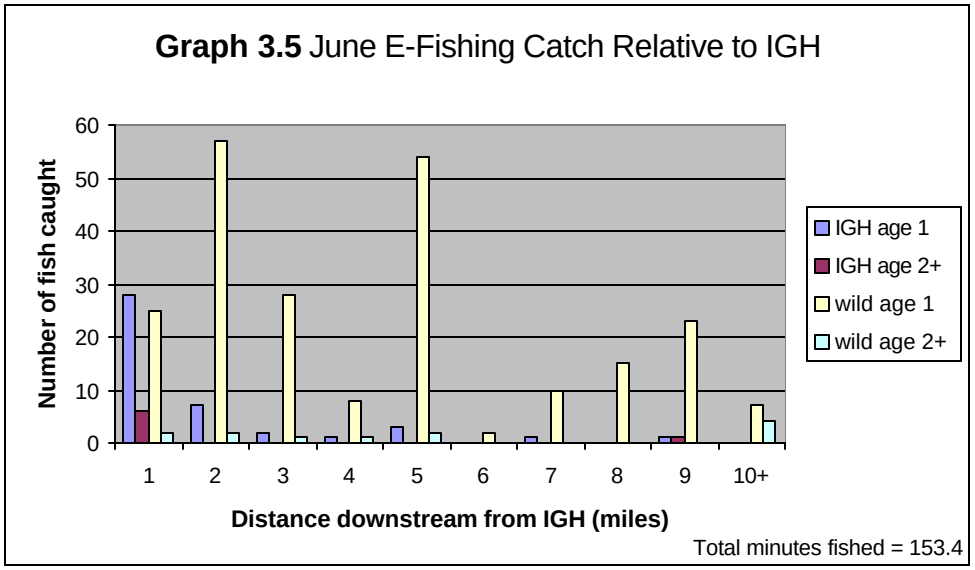




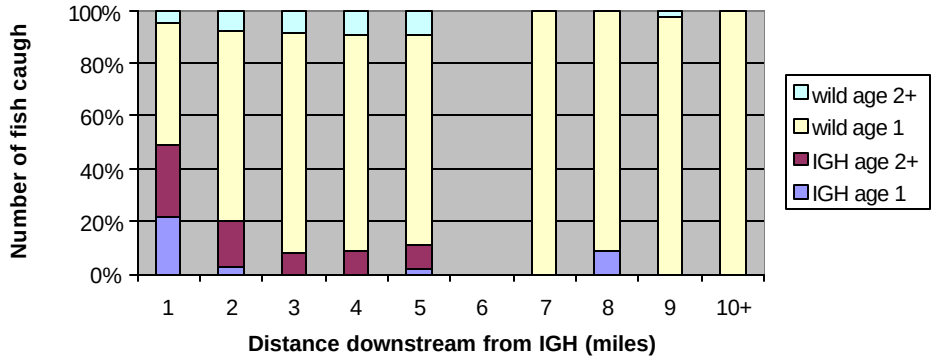
Graphs 3.3 (March/April), 3.4 (May) and 3.5 (June) show where 2001 IGH release steelhead (age one), IGH age two and older and wild age one and age 2 and older steelhead were caught in relation to distance downstream of the hatchery. All steelhead caught within 1 mile are included in the 1 mile bar, those caught between 1 and 2 miles are lumped into mile 2 and so forth. All steelhead caught below 9 miles are lumped into the 10+ category. Graphs 3.6 to 3.8 show the composition of the steelhead catch in March/April, May and June. As the catch was not biased towards either wild or hatchery fish, these graphs give a good indication as to both the effort and composition of the catch between 2001 IGH released steelhead, all other IGH steelhead and wild steelhead. The E-fishing time, as indicated by minutes in the lower right hand corner of the graph, helps differentiate the effort between months.


Graph 3.3 March/April E-Fishing Catch Relative to IGH
Number of fish caught
60
50
40
30
20
10
0
1
2
3
4
5
6
7
8
9
10+
Distance downstream from IGH (miles)
IGH age 1
IGH age 2+
wild age 1
wild age 2+
Total minutes fished = 138.6


Graph 3.4 May E-Fishing Catch Relative to IGH
Number of fish caught
60
50
40
30
20
10
0
1
2
3
4
5
6
7
8
9
10+
Distance downstream from IGH (miles)
IGH age 1
IGH age 2+
wild age 1
wild age 2+
Total minutes fished = 81

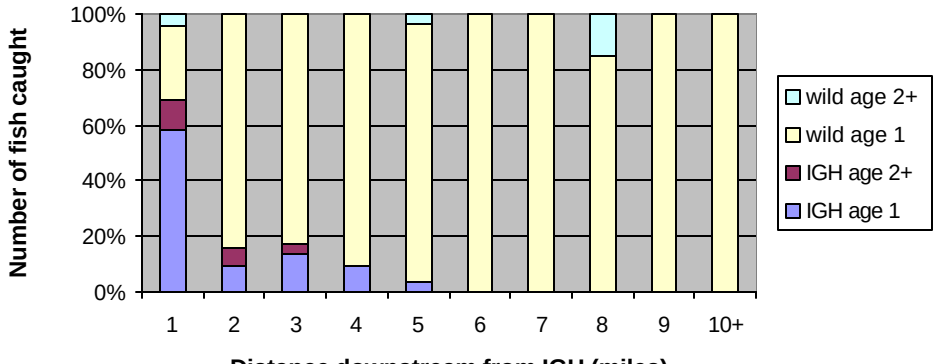

Graph 3.5 June E-Fishing Catch Relative to IGH
Number of fish caught
60
50
40
30
20
10
0
1
2
3
4
5
6
7
8
9
10+
Distance downstream from IGH (miles)
IGH age 1
IGH age 2+
wild age 1
wild age 2+
Total minutes fished = 153.4

Graph 3.6 March/April E-Fishing Catch Composition Relative to IGH



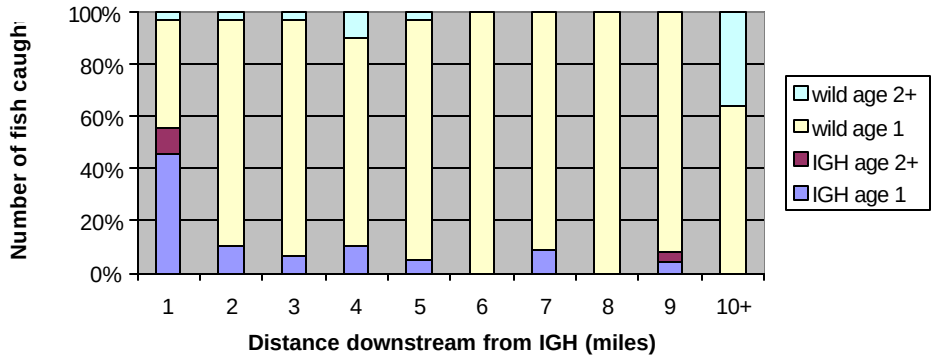
Total minutes fished = 138.6

Graph 3.7 May E-Fishing Catch Composition Relative to IGH



Total minutes fished = 81

Graph 3.8 June E-Fishing Catch Composition Relative to IGH



Total minutes fished = 153.4

12 fish caught in river had PIT tags. All of these were from the 2001 IGH steelhead release. Table 4.1 shows the PIT tagged fish that were caught in river, when they left the hatchery, and when and where they were caught in river.

Table 4.1 IGH 2001 release PIT tagged steelhead recaptures in the Klamath River

PIT tag number (last 9 digits)	Date left hatchery	Volitional/ Un-volitional	Date recaptured	Distance from hatchery recaptured	Forklength when recaptured	Comments
BF11889EE	4/5/01	V	4/25/01	0.6	160	
BF118D6C1	4/25/01	V	4/30/01	0.6	124	Mortality
BF0E2D30E	4/25/01	V	5/14/01	0.6	176	
BF0DDAE63	4/22/01	V	5/18/01	1.7	150	
BF0E2FD36	undetermined		5/18/01	0.6	181	
BF0E378F4	5/2/01	U	5/18/01	0.2	165	
BF1188E98	undetermined		5/18/01	0.2	104	Mortality
BF1188799	undetermined		5/30/01	0.6	170	
BF0E37955	5/2/01	U	6/7/01	0.1	160	
BF118D1D5	5/1/01	U	6/13/01	0.6	203	
BF0E2CD1D	undetermined		6/26/01	5	198	
BF0E16C78	undetermined		6/27/01	6.6	126	

Of the 98 steelhead caught in river that were released from IGH in 2001, 59 were silvery parr, 17 were parr, 16 were smolts 5 had a distinctive pink line, and 1 was not described.

DISCUSSION

Jonasson *et al.* (1996), in a study researching residual hatchery steelhead in Northeast Oregon, found that peak densities of residual steelhead were generally found near release sites. We found a correlation between the numbers of the IGH clipped steelhead caught in river and the proximity to the hatchery, where all IGH steelhead are released. Whether or not these fish are residuals cannot be deciphered at this time. However, these findings have implications to the in river habitat used by IGH releases and may further indicate residualism in forthcoming years.

The natural life history of Klamath steelhead will guide us to outmigration patterns of IGH steelhead. The most common life history of steelhead in the Klamath River is to spend two years in freshwater before out-migration (USFS 1972). Out-migration of smolts appears to be size dependent, occurring after most fish reach approximately 165 millimeters (USFS 1972). Out-migration of winter steelhead occurs from March through June in the Klamath River system, although smolts from all runs may be found emigrating during all months of the year. (Leidy 1983). In the Sacramento River, juvenile steelhead may remain in freshwater from one to four years before undergoing smoltification, with the majority of hatchery reared juveniles in the Sacramento River smolting and migrating as yearlings and naturally spawned steelhead as two-year olds. Bigelow *et al.* (1995) found that hatchery steelhead less than 165mm fork length have an increased tendency to residualize. We found a significant difference in forklength between those fish that opted to leave volitionally and those that did not. Fish that did not move out on their own were measured on May 2nd to 4th, and their average forklength was 125mm. Fish caught in river from April 16th to the 30th that were from the IGH 2001 release group averaged 155mm. The fish that left volitionally were undoubtedly larger in size, and more likely to migrate to the ocean. These findings do not imply that steelhead should be withheld at IGH until they are larger in size. Steelhead withheld past the first year of their development may be more likely to residualize.

Jonasson *et al.* (1996) determined that the presence or absence of parr marks and black fin margins, the degree of silver coloration, condition factor and liver weight appear to be useful characteristics for discriminating between rainbow trout and steelhead smolts during the spring. Rainbow trout were found to have visible parr marks, no black fin margins, and a low degree of silver coloration, whereas steelhead smolts had no visible parr marks, black fin margins, and a high degree of silver coloration. We classified all steelhead caught in the river by such attributes. Most of the 2001 release IGH steelhead were silvery parr (60.8%); 17.5% were parr, 16.5% were smolts and 5% had a pink stripe down the midline. It is hypothesized that the smolts continued to migrate downstream. Those silvery parr that continued the smoltification process may have developed into smolts and migrated, while others may have reverted back to parr and stayed in the river. Those fish with a distinctive pink line are assumed to have reverted from smolt to spend more time in freshwater. Of the 2001 release IGH steelhead, the smolts that were caught in river ranged from 176 millimeters to 256 millimeters. Wild steelhead smolts caught in river measured 158 millimeters and up.

Of the 2001 IGH released steelhead caught in river, 12 PIT tagged fish were recovered. Half of these were found in a riffle located 3300 feet downstream of the hatchery. 2 of the PIT tagged individuals died upon being electrofished. These two individuals were smaller parr. PIT tagging data may be more useful in subsequent years when individual identification can help determine the life history of the steelhead.

We found that when shocking, we had success in riffles and turned few fish in deeper water. We therefore targeted riffles, and passed over deeper water. As we were not set up for night shocking, we did not shock at night. Steelhead may be easier to turn in deeper water during the night due to different feeding and activity patterns. Shocking at night may give us a better representation of what resides in all habitat types.

CONCLUSION

The numbers of PIT tags inserted, and the number of scales taken from all three sections of the project are summarized in Table 5. A total of 255 tissue samples, 52 from in river and 203 from adults, have been sent to be analyzed by NMFS Santa Cruz Genetic Laboratory.

Table 5. Numbers of adults at the spawning buliding, juveniles at IGH and steelhead caught in the Klamath river that were PIT tagged and scaled.

	Age	1	2	3	4	wild	UI Clips	Total
Adults	# PIT tagged		6	87	14	12	85	204
	# scaled		7	139	24	13	120	303
2001 Release	# PIT tagged	3172						3172
	# scaled	~1500						1500
In River Sampling	# PIT tagged	35	16	1	1	61		114
	# scaled	6	32	4	1	211	2	256
Total # PIT tagged								3490
Total # scaled								2059

As this was the first year of the study, data and analysis from subsequent years will be needed to meet the desired goal of determining the extent of residualism of Iron Gate Hatchery steelhead. Data gathered from this year have, however, given valuable insight into life history patterns of steelhead within the Klamath River near the Iron Gate Hatchery, and has established direction to improving the protocol for future study plans.

For the year 2002, it has been proposed to commence otolith and scale analyses that were collected in 2001. We also propose to continue to sample adults returning to the hatchery building for: scales, length, sex, otoliths from recoveries, and to check for PIT tag recoveries. IGH personnel have agreed that a volitional release is valuable as a management tool to produce steelhead that follow natural cues to emigrate and will continue to volitionally release steelhead in 2002. In river sampling will include electroshocking from IGH downstream to Ash Creek with the possibility to continue further downstream. The volitional release will, therefore, be moderately monitored by recovery dates and locations of the 2002 IGH steelhead release group. As well, in river sampling will aim to locate any PIT tags inserted in 2001. With further year 2002 objectives of determining the distribution of hatchery and wild fish within age classes in the Klamath River below IGH, and by collecting scales and otoliths for analysis, the extent of residualism in IGH steelhead may be unravelled.

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APPENDIX

Figure 1.1

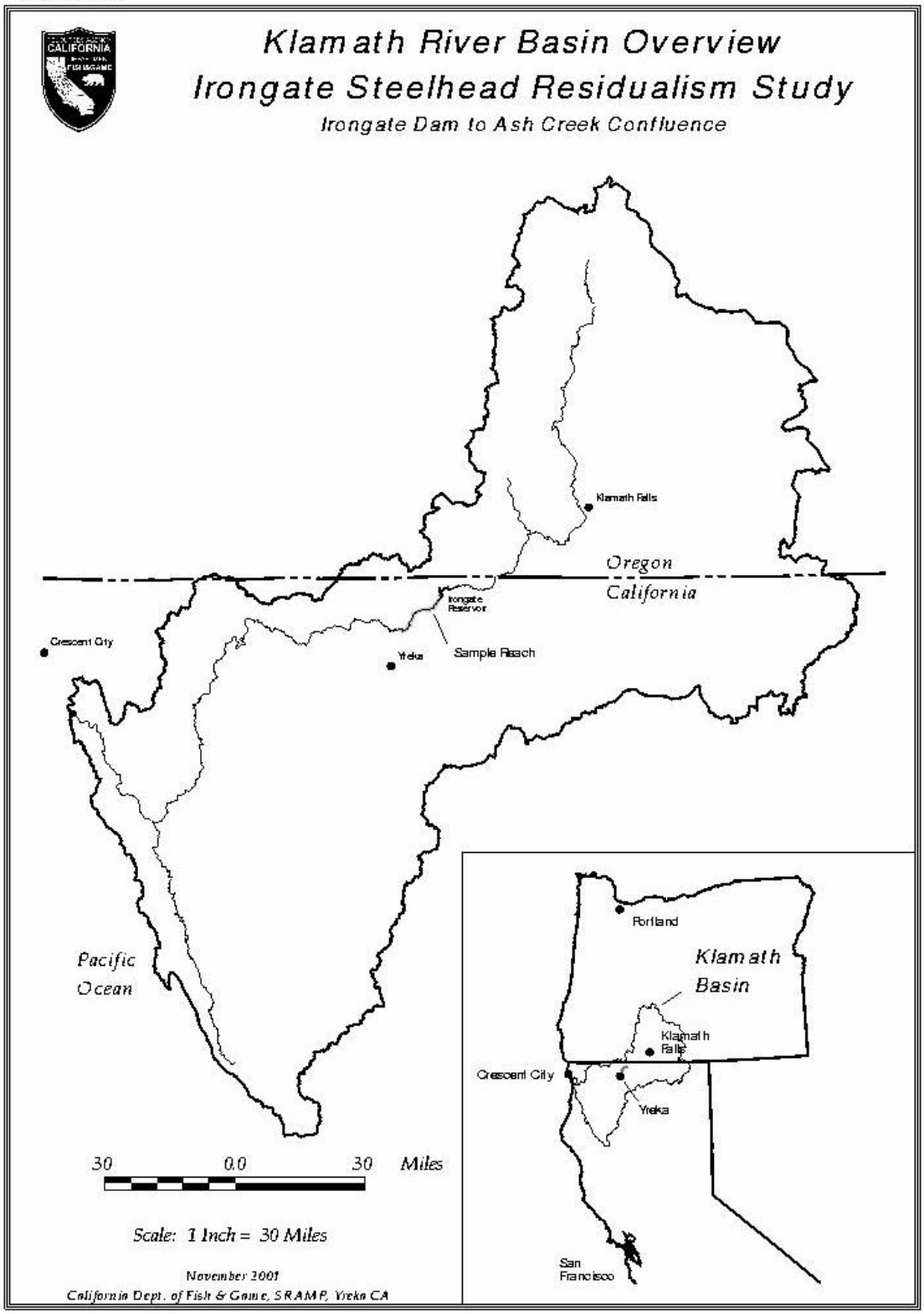
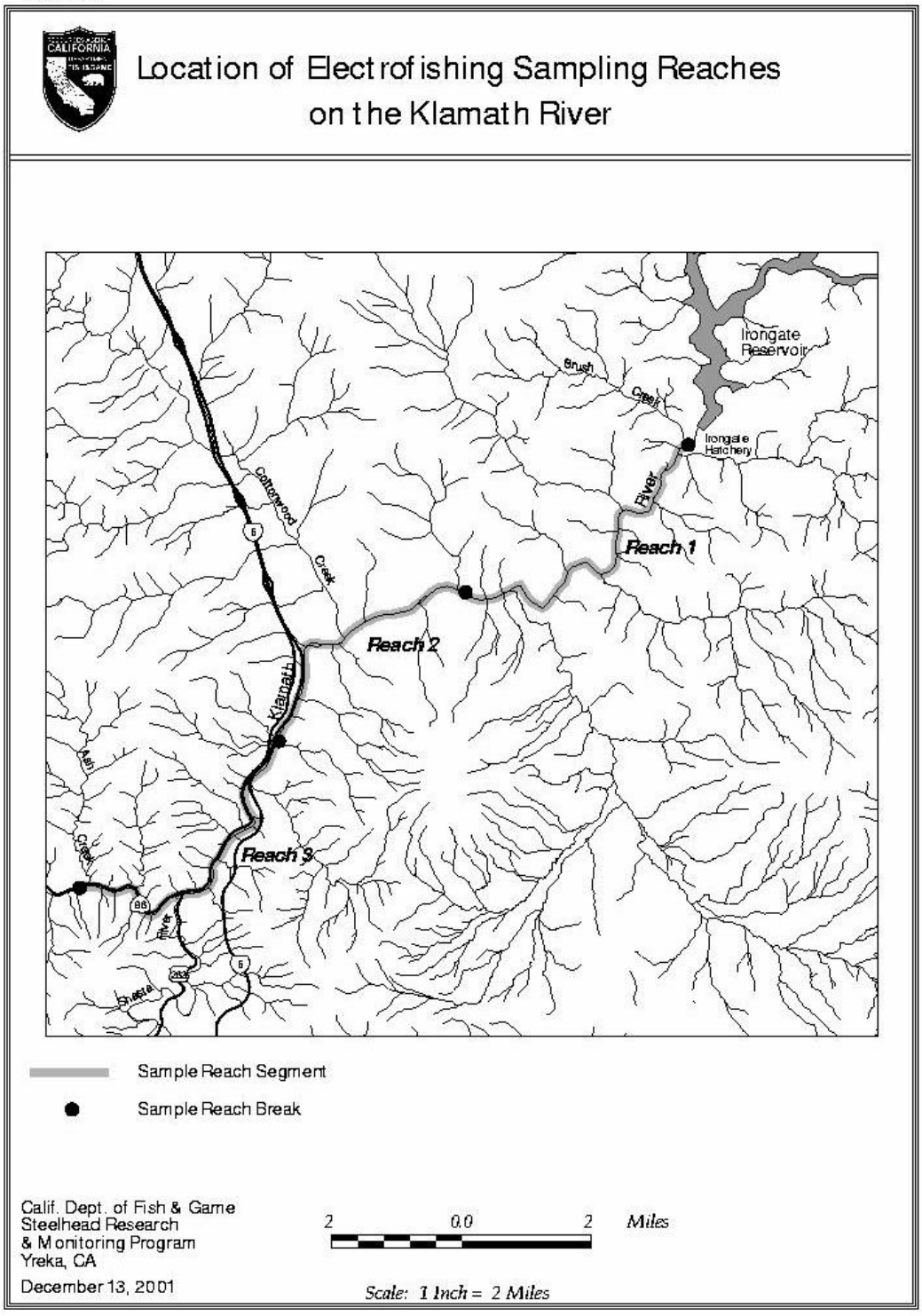


Figure 1.2


Location of Electrofishing Sampling Reaches
on the Klamath River
Irongate Reservoir
Brush Creek
Irongate Hatchery
Irongate River
Cottonwood Creek
Reach 1
Reach 2
Reach 3
Klamath
Ash Creek
Shasta
Sample Reach Segment
Sample Reach Break
Calif. Dept. of Fish & Game
Steelhead Research
& Monitoring Program
Yreka, CA
December 13, 2001
2 0.0 2 Miles
Scale: 1 Inch = 2 Miles