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2001-2002 ANNUAL REPORT FRESHWATER CREEK ADULT STEELHEAD RUN-SIZE AND LIFE HISTORY PROJECT 1a1

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Steelhead Research and Monitoring Program
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FRESHWATER CREEK ADULT STEELHEAD
RUN-SIZE AND LIFE HISTORY, 2001-2002 SEASON
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ABSTRACT

Adult steelhead escapement into Freshwater Creek was estimated using a Petersen type mark recapture experiment. Seventy-seven steelhead were captured during their upstream migration of which seventy-three were marked with a PIT tag. Ten of thirty-two recaptured downstream running kelts contained tags. The escapement of adult steelhead into Freshwater Creek is estimated at 219 ± 103 (95% C.I.). Of the 72 scale samples collected, 70 displayed intact freshwater growth, and a distinct ocean entry check. Back calculation of fork length to the ocean entry check averaged 194 mm, as compared to 156mm for smolts observed at juvenile outmigrant traps (see project 2a6). The dominant life history interpreted from adult scales is two years spent in freshwater, and two in the ocean, returning to spawn for the first time at age 4. The adult steelhead run was composed of 54% females and 46% males.

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[1] Steelhead Research and Monitoring Program report, available from: Department of Fish and Game, 50 Ericson Court, Arcata California 95521 (707) 825-4850

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INTRODUCTION

Many populations of salmonids in California are considered at risk of extinction, and are listed, or are proposed for listing under the Federal Endangered Species Act (ESA) (Nehlsen et al. 1991, Federal Register 1996, Huntington et al. 1996, Federal Register 2000). In June 2000 The National Marine Fisheries Service (NMFS) formally listed Northern California ESU steelhead as Threatened Species under the ESA (Federal Register 2000). The listing is due in part to the lack of available information regarding the status and trends of populations (McEwan and Jackson 1996).

The NMFS identified four key parameters for assessing viable salmonid populations, including; population size, population growth rate, population spatial structure, and life history diversity (McElhany et al. 2000). Monitoring adult escapement is an appropriate measure of population size for a specific drainage, and over time can indicate the growth rate of that population. Analysis of scale patterns can lead to inferences on growth and associated life history strategies.

Objectives

This study is designed to; i) estimate adult steelhead escapement into Freshwater Creek ii) analyze scale patters to assess growth and life history patterns of successful returning adult steelhead.

Study Area Description

The Freshwater Creek basin is located in Humboldt County between Eureka to the south and Arcata to the north (Figure 1). Freshwater Creek is a fourth order stream with a drainage area of approximately 9,227 hectares (31 square miles) and drains into Humboldt Bay via the Eureka Slough. Elevations in the watershed range from 823 meters at the headwaters to sea level at the mouth. Main stem Freshwater Creek is approximately 23 km long, of which 14.5 km is anadromous fish habitat. Five main tributaries, Little Freshwater, Graham Gulch, Cloney Gulch, McCready Gulch and South Fork Freshwater each provide 2 to 4 km of anadromous fish habitat.

Freshwwater Creek Basin

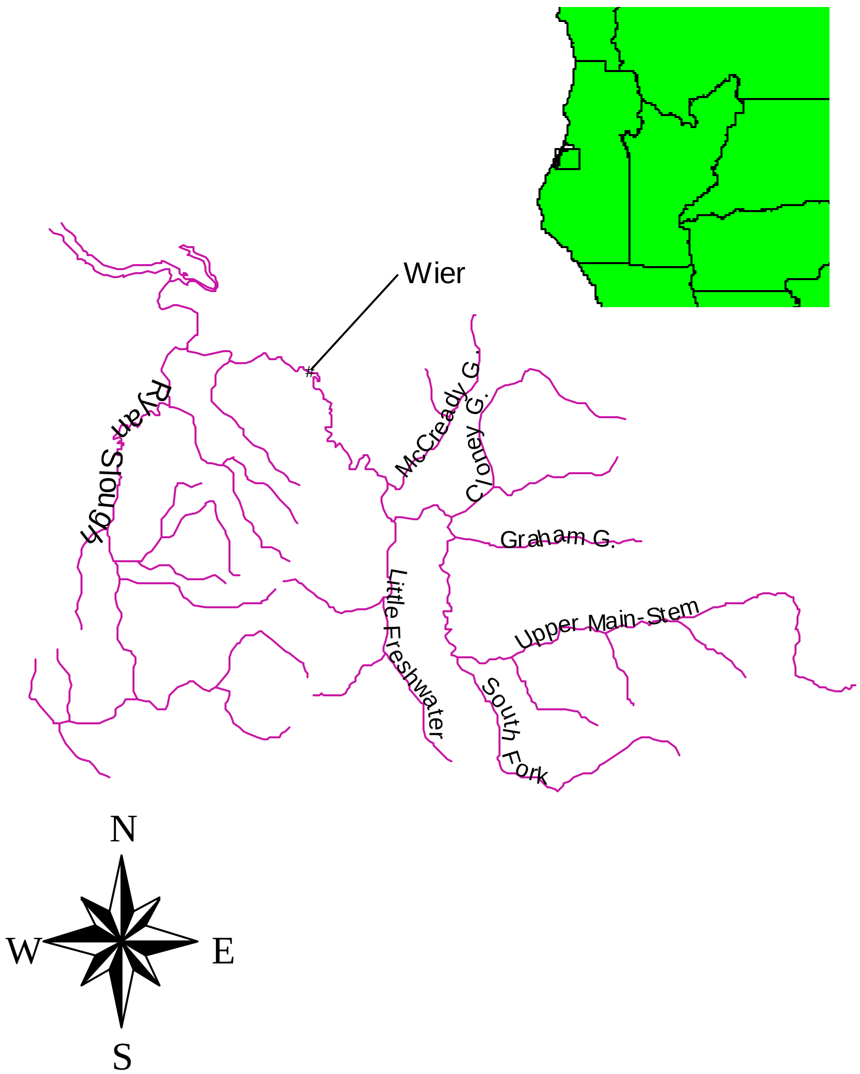

Figure 1. Freshwater Creek basin, depicting relative location in Humboldt County, and the location of the weir used during the 2001-02 Season.

Annual rainfall is approximately 150 cm in the headwaters and 100 cm near the mouth. The lower 6 km of Freshwater Creek is primarily cattle grazing land and is characterized by a low gradient, with limited riparian development. Levees confine the channel in this reach. Upstream of this section, the riparian community is much more highly developed, composed of willow (*Salix spp.),* alder (*Alnus rubra*), black cottonwood (*Populus trichocarpa*), blackberry (*Rubus ursinus*), salmonberry (*Rubus spectasbilis*), and other herbaceous plants. Bordering the riparian areas are forests of redwood (*Sequoia sempervirens*), Douglas-fir (*Psuedotsuga menziesii*), white fir (*Abies concolor*) and Sitka spruce (*Picea sitchensis*).

The fishery resources of the basin include three species of salmon, Chinook salmon (*Oncorhynchus tshawytscha*), coho salmon (*O. kisutch*), and steelhead (*O. mykiss*). Occasionally, chum salmon (*O. keta*) are observed. Other fish present in the basin include Pacific lamprey (*Entosphenus tridentatus*), brook lamprey (*Lampreta pacifica*), cutthroat trout (*O. clarki*), and prickly and coast range sculpin (*Cottus asper, Cottus aleuticus*).

Amphibians and reptiles present include pacific giant salamanders (*Dicamptodon ensatus*), red legged frogs (*Rana boylii*), tailed frogs (*Ascaphus truei*) and western pond turtles (*Clemmys marmorata*).

METHODS

Adult Steelhead Escapement

Theoretically, estimation of adult steelhead escapement would be unnecessary when a continual trapping schedule is employed, a direct count of fish would be sufficient. However, stream flow in Freshwater Creek is highly variable dependant on several factors including the periodicity and intensity of storm events, ground saturation and base flows. Past records indicate that anywhere from 5 to 20 days in a normal trapping season may be "unfishable" due to high flows. Therefore, a Peterson type (change in ratio) estimator was used to calculate steelhead escapement (Ricker 1975). This type of estimator relies upon a known number of marked fish being released into a population, and then a sample from that population checked for marks.

Trapping and Marking We trapped and tagged adult steelhead at a permanent weir site located near "Three Corners" approximately 5 river kilometers (rk) upstream from the mouth of Freshwater Creek where it enters Humboldt Bay. The weir is constructed of a series of metal panels, which are attached to a concrete base on the creek bed and concrete abutments on either bank. Each panel can be raised and lowered independently for cleaning purposes or when flows preclude trapping. The trap is located on the northern side of the weir structure and consists of two concrete walls on each side and metal panels on the up- and downstream ends. Fish volitionally enter the trap through two fyke panels attached to the downstream side of the trap. Captured steelhead were netted and placed in a tagging cradle for biological sampling. Each steelhead was measured for total length, examined for fin-clips, punches, tags, predator marks and other wounds, and sexed. Scale samples were collected from the appropriate location, posterior to the dorsal fin between the lateral line and the dorsal. The trap is operated continuously between the first fall rains in late October or early November and early June.

Prior to release, steelhead received an individual identifying 32mm passive integrated transponder (PIT) tag. The tag is injected anteriorly directly beneath the skin in the same area as the scale sample is taken. The skin is then sealed closed with veterinary skin adhesive. All steelhead were then released immediately upstream of the trapping facility. The procedure is accomplished quickly without the use of anesthetic.

Tag Recovery We obtain the recovery sample by capturing downstream migrating steelhead kelts with a pipe trap at the weir and at juvenile down stream migrant traps (see project 2a6). Numbers of unmarked and marked steelhead were recorded at the downstream traps. Unmarked kelts captured at the juvenile traps received a PIT tag to identify them as "counted" if they were captured again at any of the other traps. All kelts were then released to return to the ocean.

Experimental Recovery Sample Collection An attempt was made at collecting the "recapture" sample remotely. On April 15, 2002 we replaced the weir pipe trap with a PIT tag recording antenna and an underwater camera. The camera and antenna are time/date stamped so fish "captured" by the camera can be divided into "marked" (i.e. PIT tag record coincident with image) or "unmarked" (i.e. no PIT tag record coincident with image). The camera images were recorded on video tape at 12 frames/second, allowing 40 hours of "real time" to be recorded on 8 hours of tape. Once we were certain the upstream entry of new adult fish was over, the downstream passage was taped continuously from April 5 to June 15 when the weir was removed. The video tape and antenna data will be analyzed when pattern recognition software, currently under development, is complete.

Statistical analysis Steelhead escapement in Freshwater Creek was estimated using a modified version of the Petersen mark- recapture method in which the recapture sample is drawn with replacement. The formula is represented by:

$$\hat{N} = \frac{M(C + 1)}{(R + 1)}$$

Where $\hat{N}$ = Estimated population size

M = The number of marked fish

C = The number of fish in the recapture sample

R = The number of fish in the recapture sample that are marked

The estimated variance of this estimate is expressed as,

$$\hat{V}(\hat{N}) \approx \frac{M^2(C+1)(C-R)}{(R+1)^2(R+2)}$$

and 95% confidence intervals constructed as

$$\pm 2\sqrt{\hat{V}(\hat{N})}\ .$$

Scale Analysis

Scale Sample Preparation and Measurements Both juvenile and adult scales were separated with tweezers and cleaned by soaking in water, then rubbed between two fingers and on a sheet of waterproof paper to dislodge any dirt and mucous. A binocular dissecting scope was used to view the scales from each fish. Scales showing the best condition (i.e. little or no regeneration, no reabsorbed edge) were selected. They were then dry mounted between two microscope slides and secured with clear adhesive tape. Six to ten scales were used from each fish. A separate slide was used for each fish and labelled with the date of capture, species, sex, capture location, total length in centimetres (cm), and PIT tag number (if tagged).

An optical pattern recognition system was used to analyze prepared scales. Image-Pro Plus software program captured the image and Spot Insight V 3.2 was used to clarify the image, and to take all measurements. Each magnification setting was calibrated using micrometer slide of 0.01 mm. Pictures were saved with their corresponding magnification so that the correct calibration could be used during measuring. Measurements were taken at a 20-degree angle from the anterioposterior axis of the scale. A transparent sheet with a 20-degree angle drawn on it was placed on the computer screen, then the image of the scale moved to the appropriate area. For all adult scales, the distance was measured from the focus of the scale to the ocean entry check. A second measurement was taken from the focus to outside edge of the scales (Figure 2). Juvenile scales obtained in 2001 at outmigrant traps throughout the basin (See study 2a6) were measured from the focus to scale edge. Seventy three adult scales and 47 juvenile scales were used to define the relationship between fork length in mm and scale radius in mm.

Figure 2 Adult steelhead scale depicting; A) measurement taken to the ocean entry check, B) measurement taken to the scale edge.

<u>Length at Ocean Entry Back Calculated from Returning Adults</u> Back calculation has traditionally been used to estimate body lengths at earlier ages (Jearld 1983). The back calculation of fish size from adult scales is dependent upon the relationship between scale radii and fish length (Ward et al. 1989). These data were log transformed to normalized residuals. The intercept from the regression of body length on scale radius was used to back calculate the lengths at ocean entry check using the modified form of the Fraser-Lee formula (Bartlett et al. 1984, Ward et al. 1989).

$$\ln L_a = ((\ln L - c) \ln S_a / \ln S) + c$$

The variables are defined as:

L = fork length (mm)
S = total scale radius (mm)
c = intercept of the body length and scale radius regression
S_a = scale radius at ocean entry check
L_a = fork length of fish at a given annulus

RESULTS

Population Estimate

We captured 77, and PIT tagged 73 upstream migrating steelhead. Ten of the 32 recaptured kelts were identified as having been tagged. The adult steelhead escapement to Freshwater Creek is estimated to be 219 ± 103 (95% C.I.).

Adjustments will be made to the estimate when additional "recaptures" are identified from the video and PIT antenna data.

Size, Age, Sex Ratio and Repeat Spawning

Seventy adult scales displayed intact freshwater and ocean growth. The dominant life history pattern of all scales interpreted is the 2/2, four-year-old fish having spent 2 freshwater years, and 2 ocean years, spawning after the second ocean year. Seven (9.8%) of the steelhead scales revealed a spawning check, indicating at least one previous spawning attempt (see Figure 3). Sex was determined on sixty-nine of the steelhead captured. Thirty-two (46%) steelhead were male and 37 (54%) female. Fork lengths of captured steelhead ranged from 41 to 88 cm (Figure 4).

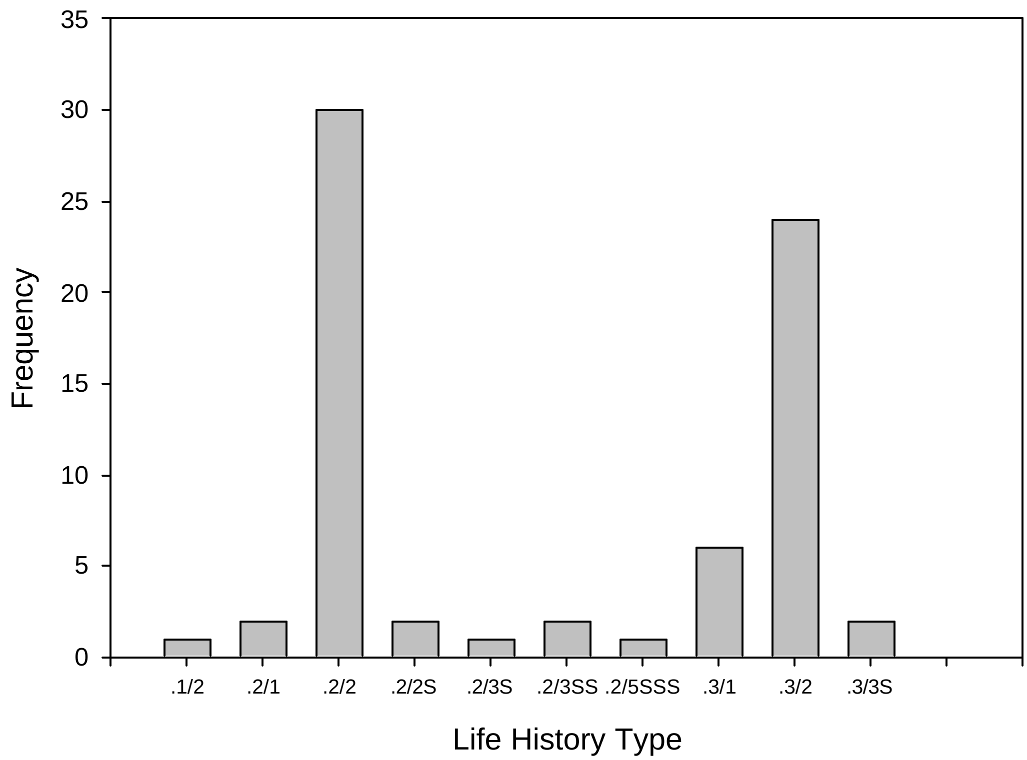

Figure 3. **Frequency of life history types interpreted from scale samples of returning adult steelhead. The number of freshwater annuli is designated as a numeric character to the left of a slash; the saltwater annuli is designated as a numeric character to the right of the slash (Davis and Light 1985). If a spawning check was observed, it is designated with a capital "S".**

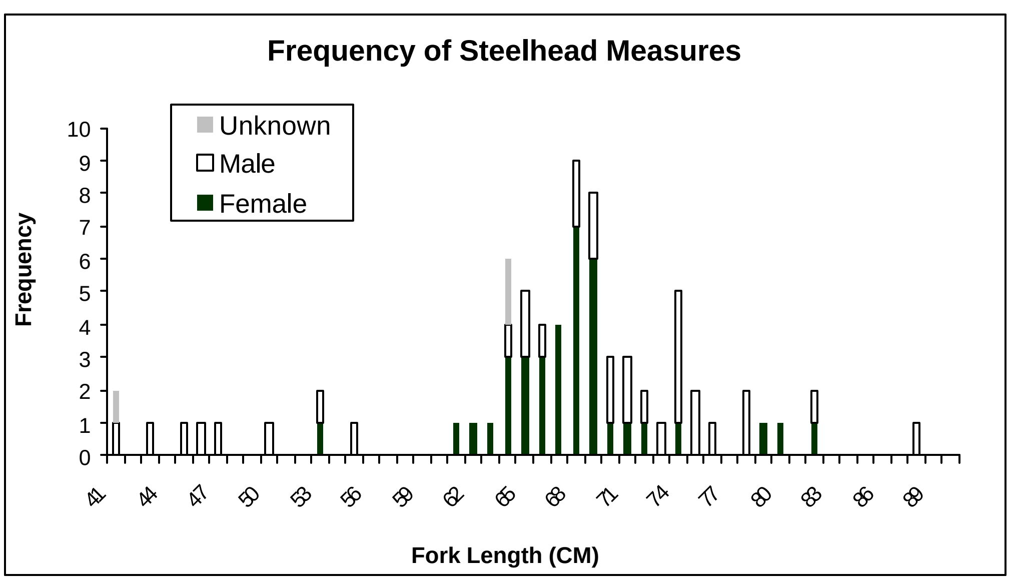

Figure 4. Length-frequency of adult steelhead measured at the permanent weir facility, 2002

Back Calculation

The linear relationship between fork length and scale radius is shown by the line

$$\ln L = 0.867\ln S + 5.35$$

and is highly correlated, $R^2 = 0.99$ (Figure 5).

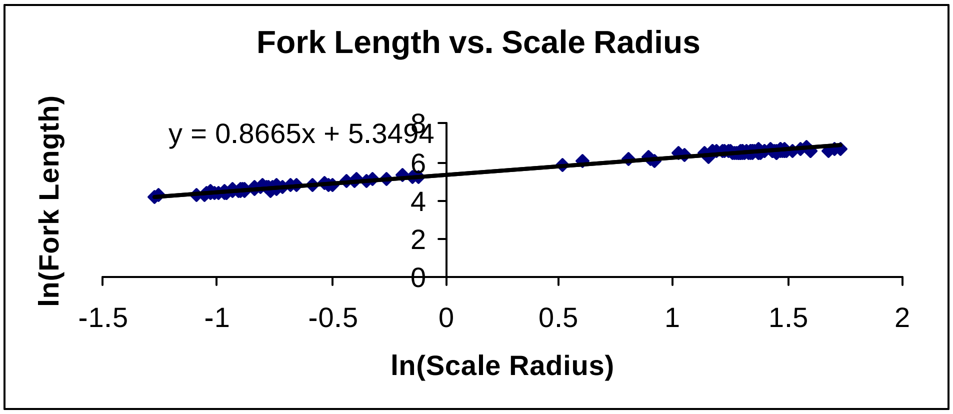

Figure 5. Line and equation defining the relationship between the natural logarithms of fish fork length and scale radius for all adult and juvenile scales.

Back calculated smolt lengths (BSL) at the ocean entry check of return spawners ranged from 95 mm to 294mm and averaged 194 mm. Juvenile steelhead observed smolt lengths (OSL) at the juvenile traps ranged in size from 73 mm to 246 mm and averaged 156mm (Figure 6).

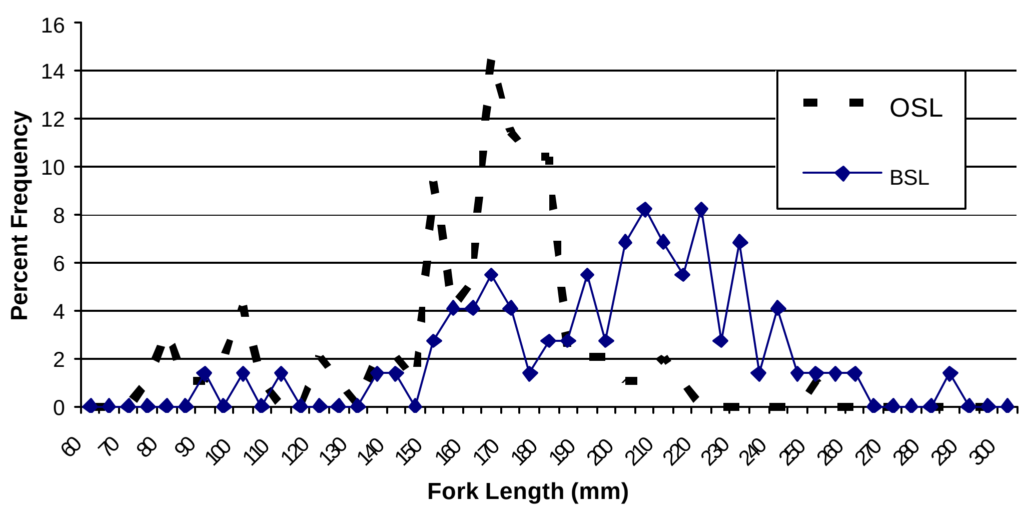

Figure 6. Percent-Frequency of all juvenile steelhead smolts captured at the outmigrant traps, 2001, and back calculated lengths at ocean entry check of successful returning adult steelhead, Freshwater Creek Ca., 2002.

DISCUSSION

There are apparent modes from both the OSL percent frequency distributions and the BSL percent frequency distributions that match fairly well in the 145-180 mm range. The larger size classes (>185mm) are represented only in the BSL return adults, however. Assuming no bias in the back calculation procedure, this discrepancy may be a result of:

- A mismatch in cohort size distributions. Steelhead outmigrating as juveniles for the cohorts making up the returning adults used in analysis differed in size structure from the juveniles outmigrating in the spring of 2001.
- Larger, older age steelhead outmigrate at times of the year either before March or after July and were therefore not encountered at the migrant traps
- Extreme size selective ocean survival favoring the largest outmigrants
- The ocean entry check on adult scales is laid down some time after significant growth has occurred from the time juveniles were captured and measured at the oumigrant trap. It is conceivable that steelhead spend some time growing in the lower river or estuary prior to laying down the ocean entry check on their scales. Juveniles that pass the trap location put on significant growth before they lay down an ocean entry check on their scales.

The proportion of the adult run that is comprised of return spawners dropped in 2001-2002 to 9.8% (7/71), from the previous year of 26%. I believe this to be an apparent decline in return spawning percent, and that the 2001-2002 run was comprised mainly of first time (2/2) fish indicating a strong cohort of fish.

RECOMENDATIONS

Investigation into the residence times, growth and utilization juvenile steelhead in the estuary ecotone should be conducted to interpret successful life history strategies from the analysis of scale patterns. Scales should be collected from fish captured in the estuary in an attempt to define the timing of ocean entry check deposition. Outmigrant trapping should be conducted in the fall and winter to determine the size distribution of outmigrants throughout the year.

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