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ANNUAL REPORT
JUVENILE SALMONID ABUNDANCE ESTIMATION IN THE UPPER NOYO RIVER, CALIFORNIA DURING SPRING AND SUMMER 2002
PROJECT 2a2

By

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ABUNDANCE ESTIMATION IN THE UPPER NOYO RIVER, CALIFORNIA
DURING SPRING AND SUMMER 2002
TASK 2a1[1]

By

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ABSTRACT

Modified fyke/pipe trapping and April-June resident population studies in the upper Noyo River were conducted during spring and summer 2002 to estimate juvenile and young-of-the-year (YOY) steelhead (*Oncorhynchus mykiss*) and Chinook (*O. tshawytscha*) and coho salmon *(O. kisutch*) population abundance, size, age, survival, migration timing, and distribution. Information was collected on all species captured and data was compared to results from 2000 and 2001. Six traps were placed in the Noyo River in late-March 2002 and checked daily until 20 June 2002. All steelhead, coho, and chinook salmon >50 mm were marked with weekly and trap-specific freeze brands. Fish < 50 mm fork length were counted. Marked fish were released above traps and recaptured fish were released below the traps. Modified fyke/pipe population estimates were computed using a maximum-likely-hood estimate for stratified populations. Populations were estimated by summing all trap estimates and using a two-trap mark-recapture method. One hundred meter reaches above and below each trap site were electro-fished a minimum of four times between April and July. All steelhead and coho >50 mm were marked with site and time specific freeze brands and released. Fish < 50 mm were counted and released. Resident population estimates were computed using the Jolly-Seber method for each reach and expanded to estimate stream resident populations. Steelhead and coho populations were estimated for traps and stream reaches and survival estimates were made. Steelhead trap population estimates were not different among years. Coho YOY trap population estimates were and Y+ were not significantly different among years. Capture probabilities were not significantly different between steelhead and coho salmon > 50 mm ($t = -0.76$, $p = 0.46$, $n = 5$) during 2002. Rearing population estimates for stream segments were not different between years. Steelhead and Coho survival estimates were not different from estimates reported in the literature. Downstream movement and resident population monitoring could continue in the upper Noyo River to follow cohorts through successive life stages, although the 2002 results suggest the use of trapping for long term monitoring should be approached cautiously.

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[1]Steelhead Research and Monitoring Program Report No. FB-12-Draft, February 04. Philip K. Bairrington, Senior Biologist Supervisor, California Department of Fish and Game, 50 Ericson Ct. Arcata, CA 95521.

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INTRODUCTION

Coho (*Oncorhynchus kisutch*), Chinook (*O. tshawytscha*), and steelhead (*O. mykiss*) are listed as Threatened under the Endangered Species Act in coastal Northern California (Federal Register 1997, 1999, 2000). Little information exists for the majority of steelhead stocks in California and basic life history, biological, and abundance trend information is needed to understand the nature and character of these populations (McEwan and Jackson 1996). Four key parameters for assessing viable salmonid populations are abundance, population growth rate, population spatial structure, and diversity (McElhany et al. 2000). Juvenile abundance, due to the relative ease of data collection, is the most common measure of salmonid abundance in California (Prager et al. 1999). This type of work is rated very desirable and of high cost by Prager et al. (1999). The NMFS recommends continued estimation of juvenile abundance combined with estimates of adult abundance and studies relating juvenile and adult abundance (Prager et al 1999). Information on life stage-specific survival may help assess population bottlenecks. There is a need for a reliable technique for long term monitoring of chinook, coho, and steelhead populations in coastal Northern California.

The Steelhead Research and Monitoring Program (S-RAMP) began conducting studies directed at evaluating techniques for long term monitoring of freshwater life history phases of steelhead in the Noyo River, California in 2000. Because juvenile Chinook and coho are found in the river at the same time as steelhead, testing of methodologies for population assessment also included these species. This report summarizes three years of study of trapping and electro-fishing as techniques to evaluate young-of-the-year (YOY) and juvenile salmonid abundance in the Noyo River.

Existing young-of-the-year (YOY) and juvenile coho and steelhead emigration information for coastal Mendocino County is summarized by Gallagher (2000, 2002a, 2002b) and Harris and Knechtle (2002). Earlier monitoring programs were limited to eight local streams and generally collected data to monitor coho emigration and rearing or examine enhancement programs (Maahs 1995, 1996, 1997, Harris and Hendrix 2000). Gallagher (2000 and 2001, 2002b) summarized existing over-summer resident assessments for coastal Mendocino County Streams. In general, data summarized by Gallagher (2001, 2002b) and reported by Harris and Knechtle (2002), for trapping results prior to 2000, report estimates of fish numbers without error estimates. Krebs (1989) states that a basic rule of descriptive statistics is that one never report an ecological estimate without some measure of the possible error. Since 1999, salmonid trapping programs in coastal Mendocino County have improved (Gallagher 2002, Harris and Knechtle 2002) by including mark-recapture and data analysis with a maximum-likelihood estimate for stratified populations (Darroch 1961). Over summer resident populations can be estimated, including estimates of error, using a variety of methods including removal, mark-recapture, and stratified snorkeling combined with electro-fishing (Hankin and Reeves 1988). Assumptions involved with these methods are outlined in Brower and Zar (1984), Krebs (1989), and Hankin and Reeves (1988), respectively.

The purpose of the fyke/pipe trapping and April-June resident population surveys in the Noyo River was to quantitatively estimate juvenile and YOY salmonid population abundance, size at age, survival, migration timing and distribution, and continue to evaluate the utility and efficiency of trapping and electro-fishing as long-term monitoring tools. Information was collected on all species captured in the river during these studies. Estimates of YOY, one year (Y+), and two year and older (Y++) steelhead were compared to YOY and Y+ estimates from Gallagher (2000 and 2002a) to examine cohort survival. Estimates of one year old (Y+) coho were compared to YOY estimates from Gallagher (2002a) to examine cohort survival.

STUDY AREA

The Noyo River watershed (Figure 1) is a forested, coastal watershed in Mendocino County, California, which drains approximately 260 km^2 immediately west of Willits. The Noyo River flows through the coast range and into the Pacific Ocean at Fort Bragg. The Noyo River was selected to conduct a pilot YOY and juvenile steelhead mark-recapture program to estimate various population parameters and test the ability of trapping and electro-fishing to produce these metrics in 1999 (Gallagher 2000).

The Noyo River watershed is unique in Mendocino County because approximately 19% of the basin is owned and managed by the California Department of Forestry and Fire Protection (CDF) as a demonstration forest (the South Fork). Other major landowners in the basin include the Mendocino Redwood Company (the upper watershed) and The Campbell Group (along the main stem).

Fyke Trapping Study Sites

Six fyke net trapping sites were selected in the Noyo River to enumerate Chinook, coho, and steelhead populations, determine population parameters, and further evaluate trapping methods during 2002 (Figure 2). Trap sites were selected based on access, ability to install the traps, and were located close to the confluence of the stream of interest. Traps were placed in Hayworth Creek (HWC) at rkm 43.6, in the main stem Noyo above Redwood Creek (MSN) at rkm 51.1, in the North Fork Noyo River above the confluence of Hayworth Creek (NFN) at rkm 43.6, in the Noyo River at Northspur below the North Fork confluence (NRS) at rkm 37.6, in Olds Creek (OLD) at rkm 49.5, and in Redwood Creek (RWC) at rkm 51.1 (Figure 2). The OLD and RWC traps were placed at slightly different locations than during previous years to improve captures. Due to staff and gear limitations a trap was not placed at Madsen Hole. Two traps were operated by CDFG (Harris and Knechtle 2002) in the South Fork Noyo River during 2002. One trap was located in the South Fork above the Noyo Egg Collecting Station (ECS) the other was located in the North Fork South Fork (Figure 2). Traps were also operated in Caspar, Hare, and Wages creeks and Little River (Harris and Knechtle 2002).

Resident Population Study Sites

To estimate survival and stream resident populations, 100 m reaches above and below each trap were electro-fished periodically during spring and early-summer 2002. Each 100 m section was located 100 m above or below each trap. The downstream section for the HWC/NFN site was a 100 m section in the North Fork below the confluence of the two streams. The upstream section for NRS was in the mainstem Noyo River above the NFN confluence. One downstream section was shocked (below OLD trap site) in the Noyo River below the OLD confluence because the trap was located at the mouth of OLD.

METHODS AND MATERIALS

Fyke Trapping

The methods developed by Gallagher (2000, 2002a) and Barrineau and Gallagher (2001) were followed for this study. Traps were set in HWC, MSN, NFN, OLD, and RWC on 13 March 2002. The NRS trap was set on 4 April 2002. All traps were checked daily through 20 June 2002. Trap checking procedures followed procedures outlined by Barrineau and Gallagher (2001). All steelhead and coho > 50 mm fork length were measured to the nearest mm, weighed to the nearest 0.1 g, marked with a site and week specific brand following the methods of Everest and Edmundson (1967) and Gallagher (1999) and released upstream of the traps. Thirty fish of each species and size/age class were measured, all others were counted each day. All other species captured were measured to total length and released below the traps. All steelhead and coho >50 mm were examined for marks each day. Those without marks were marked and released a minimum of 100 m above the traps. Recaptured fish were measured, weighed and released a minimum of 100 m below the traps. Measured and branded fish were anesthetized using alka-seltzer (Ross unpublished). Scale and tissue samples were taken from a small sample of coho and Chinook salmon and steelhead each day. Mortalities were recorded by species and size class each day.

Resident Population Field Sampling

To examine delayed emigration above and below traps, estimate survival, and estimate stream resident populations, 100 m sections above and below each trap were electro-fished periodically during spring and summer 2002. In general, one person operated an electro-fisher (Smith-Root model 12-B set at I-5 and 300 volts) accompanied by two persons with dip nets. All crew members wore polarized glasses to help increase detection of fish. All steelhead and Chinook and coho salmon > 50 mm fork length were measured to the nearest mm, weighed to the nearest 0.1 g, marked with a site and date specific freeze brand, and released as near as possible to the place where they had been captured. All fish <50 mm were counted. Fish were continuously monitored during and after capture to detect signs of stress. Water temperature in holding buckets was monitored and replaced often during warm days or when catches were high. Sampling occurred bi-weekly beginning in late-April.

Data Analysis

To estimate steelhead populations, capture probabilities, and timing for each trap, I totaled all captures and recaptures by week and size/age class to create capture-recapture matrices for input to Darr. These matrices were than ran in Darr to produce population estimates and capture probabilities for steelhead 51-70 mm (YOY), 71-120 mm (Y+), and > 120 mm (Y++). Age/size classes were developed by examining fork length frequencies from Gallagher (2000), examination of size age relationships from Shapovalov and Taft (1954), and discussion with local fish biologists. Steelhead < 71 mm captured before fry were first observed in the spring were assumed to be Y+. Coho salmon were treated as Y+ until YOY were found > 50 mm in spring, after which fork length frequencies were used to separate year classes. I also totaled all other species caught by week. Total species and numbers observed throughout the trapping period were used to calculate species diversity for each trap. Species diversity was calculated as H' using the Brillouin index because trapping is a selective and nonrandom collection method (Brower and Zar 1984).

To estimate steelhead YOY populations, fish < 70 mm captured in late-spring were assumed to be YOY. I calculated weekly totals of steelhead and coho <50 mm from the daily catch data, multiplied this by weekly capture probabilities from Darr for each trap, and estimated standard deviations (SD) using the percentage of SD from total estimates multiplied by these estimates. The YOY trap population estimates were combined with steelhead < 50 mm estimates to calculate the total YOY population for each trap. In cases where too few YOY, Y+, or Y++ steelhead were marked and recaptured to make separate population estimates, I used the percentage of each life stage captured in a trap over the season multiplied by the Darr population estimate for all fish > 50 mm to get population estimates. Standard deviations were estimated by multiplying the of proportion each age class present by the confidence estimate for fish >50mm from Darr. The total population above NRS was assumed to be the sum of all traps (all traps combined).

A similar approach was used to calculate populations for each species and size/age class using a two-trap method for NRS. All fish captured and marked at the five traps above NRS were treated as the marked and released portion in the Darr input matrix and all marked fish recaptured at NRS were treated as recaptured in the matrix. These matrices were run in Darr to estimate parameters as above. The total population moving past the traps above NRS was calculated by summing the estimates from the five traps above NRS as it was assumed that the NRS population estimate represents fish moving past NRS.

Steelhead population and survival estimates in electro-fishing reaches were computed using the Jolly-Seber method in the program Jolly (Krebs 1989). In cases where enough (generally > 7 recaptures) steelhead of each size class were marked and recaptured, population estimates were made separately for YOY (51-70 mm), Y + steelhead (71-120 mm), and Y++ (>120 mm). In cases where to few steelhead of one age class (based on fork length size at sample time) were marked and recaptured, total population estimates

were made and multiplied by the percentage of fish in each size class. Total counts of fish < 50 mm were multiplied by the proportion of marked fish from the Jolly-Seber estimates for all life stages combined. The procedure described above was used to estimate 95% confidence intervals for YOY steelhead < 50 mm. All electro-fishing reaches were measured and population estimates for each section were divided by the actual length of stream sampled to produce estimates of the number of fish/m. Stream resident populations were estimated by multiplying the number of fish/m for each age class by the total length of stream in which redds were observed (Gallagher 2001, 2002b, 2003).
YOY populations were estimated for each stream reach by summing the individual trap and stream reach population estimates. To estimate the total population, trap estimates and stream resident population estimates by stream reach were summed. To estimate the total population with the two-trap method, the trap population estimates and the stream resident estimates were summed. The below NRS population estimate was not included in this analysis. Bootstrap confidence levels were the sum of the individual confidence levels. Y+ and Y++ populations were estimated as above.

Coho Y+ and steelhead Y+ and Y++ population estimates from electro-fishing and trapping were combined to estimate the total number of each species present above NRS during 2002. Steelhead Y+ and Y++ trap population estimates were multiplied by two because Gallagher (2002a) found that approximately 50% of the estimated populations moved past the NRS trap between November 2000 and February 2001, before traps were put in place during 2000 and 2002. Coho Y+ trap population estimates were multiplied by 1.03 because Gallagher (2002a) found that approximately 3% of the estimated populations moved past the NRS trap between November 2000 and February 2001, before traps were put in place during 2000 and 2002. These data were compared to YOY and Y+ estimates from 2000 and 2001 (Gallagher 2000, 2002a) to estimate survival.

Populations were compared using ANOVA, repeated measured ANOVA, t-tests, paired t-tests or the Kruskal-Wallis one way ANOVA and Mann-Whitney U-tests when standard kurtosis p-values were < 0.05. Statistical significance was accepted at the 0.05 probability level.

RESULTS

Fyke Trapping-Steelhead

The total number of steelhead captured and population estimates by size class in each trap during 2002 are shown in Table 1. Darr input and output matrices summarizing weekly captures are shown in Appendices A and B. Population estimates and standard deviations (SD) for steelhead 51-70 mm, 71-120 mm, > 120 mm and all > 50 mm are shown in Table 1. Trap population estimates for 2000, 2001, and 2002 are shown in Figure 3. Treating each year as a sample, YOY population estimates were not significantly different over three years (ANOVA $f = 1.47$, $p = 0.26$). However, the power of this test was low ($a = 0.11$). Treating each year as a sample, Y+ population estimates were not significantly different over three years (ANOVA $H = 1.73$, $p = 0.42$), and Y++

population estimates were also not significantly different over three years (ANOVA f = 3.87, p = 0.06). However, the power of this test was low (a = 0.431).

Capture probability for steelhead > 50 mm ranged from 0.01 to 0.27 (Table 1). Treating each year as a sample, capture probabilities were not significantly different over three years (RM ANOVA f = 0.07, p = 0.93). However, the power of this test was low (a = 0.05). Capture probabilities for steelhead 51-70 mm ranged from 0.0 to 0.04. Treating each year as a sample, there was no difference between capture probability for steelhead 50-70 mm (RM ANOVA f = 0.02, p = 0.98). The power of this test was low (a = 0.05). Capture probabilities for steelhead between 71-120 mm ranged from 0.02 to 0.42. Capture probabilities for steelhead between 70-120 mm were not different in 2001 and 2002 (t = -0.79, p = 0.47). The power of this test was low (a = 0.05). Capture probability for steelhead > 120 mm ranged from 0.24 to 0.33. Capture probabilities for steelhead > 120 mm were not different in 2001 and 2002 (t = -0.74, p = 0.49). The power of this test was low (a = 0.05).

Population estimates for the one and two-trap methods overlapped (Table 1). However, trap capture probabilities were significantly lower with the two trap method in 2002.

Weekly trap captures, population estimates, and capture probabilities for marked steelhead for individual traps are listed in Appendix A. The percentage of each size/age class captured at each trap is shown by week in Figure 4. Fry (< 50 mm) were observed after week 12 (17 March 2002). Y+ and Y++ steelhead were generally captured earlier in the season while YOY were captured throughout the trapping period (Figure 4). Most Y++ fish appear to have moved prior to mid-May. It is unknown how many steelhead moved between week 26, 2001 and week 11, 2002 (69% of the year was not sampled).

Fyke Trapping-Coho Salmon

The total number of coho salmon captured and trap population estimates by size/age class for each trap, the total in all traps, and the total for the two-trap estimates are shown in Table 2 and Figure 5. Weekly trap captures, population estimates, capture probabilities for each trap are listed in Appendix A. Population estimates for coho YOY (< 50 and 51-80 mm) and Y+ (> 80 mm) from 2000, 2001, and 2002 are shown in Figure 5. Treating each year as a sample, YOY population estimates were significantly different over three years (ANOVA H = 7.74, p = 0.02). When examined by year, 2002 population estimates were significantly higher than 2000 (q = 3.75, p < 0.05) and 2001 (q = 4.5, P < 0.05) population estimates. The 2000 and 2001 YOY population estimates were not significantly different (q = 1.25, p > 0.05). Treating each year as a sample, Y+ population estimates were not significantly different over three years (ANOVA H = 2.47, p = 0.29). The summed trap estimates were within the range of the two-trap estimates for Y+ coho salmon (Table 2, Figure 5).

Capture probabilities for coho YOY ranged from 0.02 to 0.16. Treating each year as a sample, there was no difference in YOY capture probability between 2001 and 2002 (t = 0.15, p = 0.88). The power of this test (a = 0.05) was low. Capture probabilities for coho

Y+ ranged from 0.02 to 0.50. Treating each year as a sample, there was no difference in Y+ capture probability between 2001 and 2002 ($t = -0.76$, $p = 0.48$). The power of this test ($a = 0.05$) was low. Capture probability was not significantly different between coho and steelhead > 50 mm (Tables 1-2, $t = -0.06$, $p = 0.95$). However, the power of this test was low ($a = 0.05$). Treating each year as a sample, there was no difference between capture probabilities for coho > 50 mm (RM ANOVA $f = 2.28$, $p = 0.15$). However, the power of this test was low ($a = 0.21$).

The percentage of YOY (< 50 and 51-80 mm) and Y+ (>80 mm) coho salmon captured by week is shown in Figure 6. Fry were first observed during week 11, the beginning of trapping. YOY > 50 mm were first observed during week 16. The Y+ coho salmon moved throughout the trapping period during 2002. It is unknown how many coho salmon moved between week 26, 2001 and week 11, 2002 (69% of the year was not sampled).

Fyke Trapping-Chinook Salmon

A total of 24,345 YOY chinook salmon were captured in traps located above NorthSpur between week 11 and week 25, 2002 (Table 3). By far the most Chinook salmon captured in any one trap were captured in Hayworth Creek trap followed by the Northspur trap. Capture probability ranged from 0.24 to 0.48 and was significantly different than that of coho and steelhead (ANOVA $f = 4.17$, $p = 0.04$). However, the power of this test was low ($a = 0.51$).

Fyke Trapping-Other Species

Seven species of fish were captured in fyke traps in the Noyo River during 2002 (Table 4). Pacific lamprey > 250 mm were considered adults and were captured between week 13 and 19. A total of 5 Pacific lamprey adults were captured in traps on the Noyo River during 2002. Three were captured at NRS, one in RWC, and one in the HAY trap. No Pacific lamprey adults were captured at NFN, OLD, or MSN. Juvenile Pacific lamprey were captured at all traps except OLD. One frog species, two of salamander, three of newts, two snake, and one turtle species were captured throughout the trapping season. Species diversity at each trap site ranged from 0.12 to 0.38 and was highest for the NRS trap (Table 4). Species diversity was significantly different for trapping results between 2000, 2001, and 2002 (ANOVA $f = 11.31$, $p = 0.03$). When examined individually, species diversity was significantly higher in 2002 than in 2000 (Tukey's $q = 6.07$, $p = 0.04$) and not different between 2001 and 2002 (Tukeys $q = 0.52$, $p = 0.93$) nor between 2000 and 2001 (Tukey's $q = 5.55$, $p = 0.07$).

Recaptures-Steelhead

Seventy-seven percent of steelhead captured and marked in the traps were recaptured in the traps within seven days (Table 5). Of the fish captured and marked in the traps and recaptured during electro-fishing, 10% were captured more than 84 days after initial capture (Table 5). One fish marked at a trap was recaptured during electro-fishing >91 days after being marked and 20% of fish marked at traps were recaptured < 21 days after being marked (Table 5). Fifty percent of steelhead captured and marked at the five traps above NRS were recaptured within 14 days and the other half were recaptured within 28 days at NRS (Table 5). This suggests travel time between the upper traps and NRS was between < 7 and 28 days, a distance of 11.9 to 14.5 km. Steelhead captured and marked during electro-fishing were recaptured during electro-fishing between < 7 and > 56 days after being marked (Table 5).

When trap marked steelhead recaptures were examined by size/age class, 75% of the YOY were recaptured within one week. The Y+ size/age class had the most diverse recapture percentages with 66.1% recaptured within one week, 24.1 % with in two weeks, 1.6% after three weeks, 4.8% after five weeks, and 3.2% after six weeks. The Y++ size/age class had 80% of the fish recaptured within one week and 20% recaptured within two weeks of being marked.

Recaptures-Coho Salmon

Seventy-one percent of coho salmon captured and marked in the traps were recaptured in the traps within seven days (Table 6). About 96.0% of coho salmon captured and marked in the traps were recaptured in the traps within 14 days. Only two coho salmon captured and marked in the traps were recaptured after 35 days. All of the coho salmon marked at the five traps above NRS were recaptured within 14 days at NRS (Table 6). Coho salmon captured and marked during electro-fishing were recaptured above the traps during electro-fishing between 7 and 56 days after being marked (Table 6).

When trap marked Coho recaptures were examined by age class, 74% of the YOY were recaptured within one week, 22.2% within two weeks, and 3.8% within five weeks. For the Y+, 53.3 were recaptured within one week, 26.6 % were recaptured within two weeks, 6.7% within three, four, and six weeks respectively.

Recaptures-Chinook Salmon

Seventy percent of Chinook salmon (YOY only) captured and marked in the traps were recaptured in the traps within seven days (Table 7). About 90.0% of chinook salmon captured and marked in the traps were recaptured in the traps within 14 days. Only two chinook salmon captured and marked in the traps were recaptured after 35 days. All of the chinook salmon marked at the five traps above NRS were recaptured within 28 days at NRS (Table 7). No chinook salmon captured and marked during electro-fishing were recaptured during subsequent electro-fishing (Table 7). All Chinook salmon captured and marked in the traps and recaptured during electro-fishing were captured within 35 days.

Resident Population Estimates

The estimated number of steelhead/m and 95% confidence levels for 100 m stream reaches electro-fished in the upper Noyo River during 2002 and the length of stream these segments represent are shown in Table 8. Total resident populations were expanded for the entire stream for 2000, 2001, and 2002 (Figure 7). Rearing population estimates by survey reach for 2000, 2001, and 2002 are shown in Figure 8. Treating each year as a sample YOY rearing populations were not significantly different over three years (ANOVA H = 2.26, p = 0.32). Treating each year as a sample Y+ rearing populations were not significantly different over three years (ANOVA H = 5.5, p = 0.06), and Y++ rearing populations were not significantly different over three years (ANOVA H = 1.2, p = 0.54). Resident population estimates for the Noyo River below NRS and the South Fork Noyo River were not made.

The estimated number of coho salmon/m and 95% confidence levels for 100 m stream reaches electro-fished in the Noyo River during 2002 and the length of stream these segments represent are shown in Table 9. Total coho salmon resident populations were expanded for the entire stream for 2000, 2001, and 2002 (Figure 9). Treating each year as a sample YOY rearing populations were not significantly different between 2001 and 2002 (t = 3.71, p = 0.08, a = 0.87), and Y+ rearing populations were not significantly different between 2001 and 2002 (t = -1.07, p = 0.32). However, the power of this test was low (a = 0.06).

Survival Estimates

The probability of survival for coho and steelhead from one marking period to the next from Jolly-Seber mark-recapture electro-fishing in the upper Noyo River during 2002 is shown in Table 10. Survival for marked sized YOY steelhead was significantly different between 2001 and 2002 (t = 10.08, p < 0.001). However, the power of this test (a = 0.05) was low. Survival estimates for Y+ steelhead were not significantly different between 2001 and 2002 (t = 0.73, p = 0.48, a = 0.05), nor for Y++ steelhead between 2001 and 2002 (t = 1.22, p = 0.25, a = 0.09). Coho salmon survival estimates from one marking period to the next from Jolly-Seber mark-recapture electro-fishing in the Noyo River during 2002 is shown in Table 10. Coho and steelhead Y + survival estimates during 2002 were not significantly different from 2001 (t = 0.99, p = 0.37, a = 0.05).

Survival estimates based on the sum of trap and electro-fishing population estimates for steelhead YOY to Y+ (2000 to 2001 and 2001 to 2002) and Y++ (2000 to 2002) and Y+ to Y++ (2000 to 2001 and 2001 to 2002) are shown in Table 11. Coho salmon YOY to Y+ survival (2001 to 2002) is shown in Table 11. Coho and steelhead YOY to Y+ probability of survival was not significantly different (t = -1.25, p = 0.30, a = 0.08).

Known trap mortality for steelhead < 50 mm ranged from 0.60 to 18.9 % and averaged 4.3%. Trap mortality for steelhead 51-70 mm ranged from 0 to 40.1% and averaged 15.5%. Trap mortality for steelhead 71-120 mm ranged from 0.6 to 15.9% and averaged 7.7 %. Trap mortality for steelhead >120 mm ranged from 0 to 10%. No trap caught and branded fish were found dead in the traps. Trap mortality for coho salmon < 50 mm ranged from 0 to 21.0 % and averaged 4.2 %. Trap mortality for coho salmon >50 mm ranged from 0 to 4.8 % and averaged 1.2 %. The number of trap mortalities generally increased as total captures and stream flows increased.

DISCUSSION

Fyke Trapping

Steelhead trapping results in coastal Mendocino County are variable within and among rivers and between years in streams studied by Harris and Knechtle (2002). There are no clear trends in Y+ steelhead captures over 14 years of migration trapping for Caspar Creek and Little River. Similarly, there are no apparent trends in four years of trapping for the South Fork and North Fork South Fork Noyo, Hare Creek, and Wages Creek (Harris and Knechtle 2002). Maahs (1997) compared results of trapping of Y+ steelhead in three tributaries to the South Fork Ten Mile River between 1995, 1996, and 1997. He found two of three streams had fewer out migrants in 1997, while the third stream was relatively constant. Maahs (1995, 1996, 1997) used mark-recapture to estimate trap efficiencies in order to expand trap counts for days in which traps were not in operation.

The lack of significance in YOY, Y+ and, and Y++ steelhead population estimates from trapping in the upper Noyo River over three years suggests that populations are stable. Because capture probabilities were significantly associated with stream flow over two years (Gallagher 2002a) and not significantly different over three years, the idea that populations are stable is further substantiated. Adult populations were not different over three years in the Noyo River (Gallagher 2003), further adding to the idea of population stability. However, Gallagher (2002a) found that approximately 50% of the estimated steelhead Y+ and Y++ population moved past the NRS trap between November and February 2001. Traps were not operated during this period in the Noyo River during 2002 or in rivers studied by Harris and Knechtle (2002) over 14 years. It is unknown how many fish moved past these traps during the winter and early-spring during 2002 nor during previous years. Traps were put in and removed at different times and stream flows were potentially much different in previous years. Thus it may be unrealistic to determine that populations in coastal Mendocino County are stable or that trends in population abundance do not exist.

Average capture probability for YOY steelhead during 2002 was not significantly different than 2000 and 20001 (Gallagher 2000, 2002a). Probability of capture was higher for older age classes suggesting that older age fish are actively moving. Maahs (1995) had a recapture rate of 74% for year plus steelhead trapping in the Little North Fork Noyo River that he attributed to stream size and trap design. Trapping methods and trap design were similar to that described by Maahs (1995) in the Noyo during 2002. During 1996, trap efficiencies were approximately 36% and during 1997 were about 42% for streams monitored by Maahs (1996, 1997). Harris and Knechtle (2002) report 2002 year plus steelhead capture probabilities for the North Fork South Fork and the South Fork Noyo River at 20 and 33%, respectively. Trap capture probabilities for the upper Noyo River during 2002 were generally lower than those reported recently for other local streams. Ward and Slaney (1988) report box trap efficiencies of 90% for Y+ steelhead on the Keogh River in British Columbia. Thedinga et al (1994) found that screw trap efficiencies varied among salmonid species and was lowest for steelhead at 3%. Fyke net trap efficiencies in the Noyo during 2002 were better than those reported for screw traps and lower than box traps and other local fyke traps.

Dempson and Stansbury (1991) used a two-trap approach to estimate Atlantic salmon smolt populations in Newfoundland. Their reported confidence limits were within 8% of the population estimates. The two trap approach on the Noyo River during 2002 had lower estimated capture probabilities and larger confidence intervals for YOY, Y+, and Y++ steelhead than that calculated by summing the results from individual traps. This is opposite to trapping results in the Noyo River during 2000 and 2001(Gallagher 2000, 2002a). The differences in population estimates from summing all individual traps and the two-trap method do not appear to be significantly different. Trends in YOY, Y+, and Y++ population estimates were not significantly different from 2000 and 2001 at the six upstream traps. Therefore the use of one trap at NRS may be sufficient to monitor steelhead trends over time. This would reduce field effort considerably, but would not allow following cohorts and estimation of survival over time in individual tributaries.

Coho salmon > 50 mm capture probabilities were not significantly different from steelhead > 50 mm. Harris and Knechtle (2002) report 2002 capture probabilities for coho in the South Fork and North Fork South Fork of 0.48 and 0.33, respectively. Coho capture probabilities were lower in the upper Noyo during 2002 and are similar to those reported by Gallagher (2000, 2002a). Maahs (1997) reports trap efficiency for coho in the Ten Mile River to range from 24 to 58%. Maahs (1995) had recapture rates of 90% for coho in the Little North Fork Noyo River. Manning (1998) reports trap capture efficiencies for coho in the Little North Fork Noyo River of 77% for 1995 and 91% for 1996. Coho capture probabilities were generally lower than reported previously for other local rivers. This could be due to stream flows, differences in trap placement and design, or different marking techniques.

YOY coho salmon population estimates from trapping during 2002 were higher than during 2000 and 2001. This could be because populations were actually higher, or due to stream flows, differences in trap placement and design, differences in survival, or different marking techniques. Coho salmon Y+ population estimates were not different over three years. Coho salmon population estimates in the South Fork Noyo River during 2002 (Harris and Knechtle 2002) were lower than during 2001. Whereas in the North Fork South Fork Coho salmon Y+ population estimates were higher. The difference is likely insignificant.

Time Between Capture and Recapture

The time between marking and recapture of steelhead for individual traps ranged from < 7 to > 49 days. Steelhead travel time between the upstream traps and NRS ranged between seven and 28 days. The majority of steelhead marked at the traps were recaptured within one week of first capture. This is similar to findings for the Noyo River during 2000 and 2001 (Gallagher 2000, 2002a). This suggests that fish captured in the traps were actively emigrating. During electro-fishing, > 50% of the fish were recaptured above the traps more than 21 days post marking suggesting that these fish were not actively moving. Thedinga et al. (1994) states that 90% of marked and released steelhead in the Situk River, Alaska were captured within 6 days of release and that some fish traveled as far as 33 km/day. Because of weekly marking stratification it was not possible to determine maximum travel time for steelhead in the Noyo River during 2002. However, delayed travel above and below traps in weekly intervals was examined. Electro-fishing above the traps during 2002 recaptured some fish marked in the traps more than 80 days after their original capture similar to findings in 2001 (Gallagher 2002a). Movement of YOY and Y+ fish within a system, rather than actual emigration to the ocean, has been documented in other areas (Loch et al. 1988). Shapovalov and Taft (1954) state that steelhead may migrate downstream in spring and move back upstream in winter before migrating to the ocean. Everest (1973) found that summer steelhead smolts rear in the main stem Rogue River in summer and return to tributaries with winter freshets. There may be other seasonal triggers such as photoperiod that stimulate movement. Loch et al (1988) found that downstream movement of juvenile steelhead in Washington was related to decreasing monthly flow and increasing water temperature. Shapovalov and Taft (1954) found that larger and older steelhead move between March and May in Waddell Creek and the highest proportion of all migrants is in spring and summer. They also state that migration during January through late-February is light due to high flows. Ward and Slaney (1988) found most steelhead in the Keogh River British Columbia migrated in April and May and found no smolts moving in mid-winter. However, Gallagher (2002a) found that about 50% of the total population estimated to move past a trap on the Noyo River moved between November 2000 and early-February 2001.

Coho salmon travel time between traps was similar to that observed for steelhead during 2002. The time between marking and recapture of coho salmon for individual traps ranged between < 7 and 42 days. Coho salmon travel time between the upstream traps and the NRS trap was less than 15 days. The majority of marked coho salmon were re-captured within one week of first capture. This is similar to findings for the Noyo River during 2000 and 2001 (Gallagher 2000, 2002a).

Survival

Steelhead fry mortality in the Noyo River fyke traps during 2002 increased with increasing flow and thus catches. Maahs (1997) estimated fry mortality due to trapping in the South Fork Ten Mile at 25% and attributed at least some of this to predation by sculpin. Thedinga et al. (1994) estimated steelhead mortality at about 10% between traps located 17 km apart on the Situk River in Alaska and found handling mortality to be negligible. Mortality associated with trapping in the Noyo River during 2002 was similar to that reported by Thedinga et al. (1994) and Gallagher (2000, 2002a). Steelhead and coho salmon mortality was similar during 2002. Generally, trap mortality increased with increased flow.

Juvenile steelhead survival estimates derived from Jolly-Seber mark-recapture and calculated from population estimates in the Noyo River are similar to those reported in the literature. Shapovalov and Taft (1954) found that steelhead survival from egg to smolt was 3% and ranged from zero for YOY to almost 18% for Y++. Burns (1971) found that steelhead YOY mortality in Caspar Creek averaged 73% from June to October and that year plus fish averaged 44% mortality over this period. The YOY survival based on mark-recapture estimates in the upper Noyo River averaged 0.38 (38%), thus mortality was 61%. This is similar to estimates from Burns (1971) and Gallagher (2000, 2002a). Bustard and Narver (1975) estimate YOY to Y + steelhead survival at 6%, ranging from 5-13% in Carnation Creek (an unlogged stream) in British Columbia. Survival rates may be lower than estimated because fish < 70 mm were captured in the traps until the traps were removed from the streams whereas Y+ and Y++ size fish were not. Therefore, steelhead < 70 mm appear to be moving downstream through July and this may affect survival estimates. The average YOY 2000 to Y++ 2002 survival of 0.09 and the average Y++ summer survival of 0.47 are similar to the findings of Burns (1971). Age/size relationships that include scale analysis may better define age class separations by fork length and improve population and survival estimates of YOY, Y+, and Y++ steelhead. Trapping throughout the year and using techniques such as the modified Hankin and Reeves (1988) approach to estimate rearing populations might produce better survival estimates. This was the third year of following the 2000 cohort.

Coho salmon over-winter survival (YOY to Y+) in the upper Noyo River from 2001 to 2002 of 20% ± 55 % was similar to estimates reported in the literature. Shapovalov and Taft (1954) found that coho salmon survival from egg to smolt was 1.35%. Bustard and Narver (1975) found coho salmon survival to average 35% in British Columbia and ranged from 61-74% in an unlogged stream. Elliot and Hubart (1978) report survival of 26% in SE Alaska. Quinn and Peterson (1996) found coho survival to be 57% in Washington. Manning (1998) reports over-winter survival rates in coastal Northern California of 31% in the Little North Fork Noyo River, 18% in the South Fork Little River (Humboldt County), and 22% in Little Lost Man Creek. Johnson and Solazzi (1995 as cited in Manning 1998) report survival of 11-23% for Oregon streams. Barber (2002) estimated coho over-winter survival in Little River (Mendocino County, California) over a period of years from 1987 to 1999 to range from 19 to 33%. If the survival range of 61-74% for an unlogged stream (Bustard and Narver 1975) is assumed to be the high end for over-winter survival (not accounting for potential latitudinal differences, Braaten and Guy 2002), the estimated survival in the Noyo River for 2001-2002 is within this range. This suggests that there may be some stream specific limiting factors. Barber (2002) suggested that her (assumed to be) low over-winter survival estimates could be due to insufficient over-wintering habitat. Bell et al (2001) found coho using off channel habitats had increased over-winter survival. Investigation of habitat conditions in the Noyo River and developing relationships between habitat and fish abundance may further understanding of habitat related survival for Coho and steelhead.

Resident Population Estimates

The purpose of the electro-fishing mark recapture in the Noyo River during 2002 was, in part, to estimate rearing populations. Harris (1999) presents summer juvenile steelhead densities for three local creeks from 1986 to 1999 that ranged from 0.01 to 1.3/m^2. Burns (1971) found summer juvenile steelhead densities in Caspar Creek to range between 0.03 to 0.55/m^2 in 1967, 1968, and 1969. The average density observed in the Noyo River during 2002 was 0.62/m^2 (SE = 0.22/m^2) and ranged from 0.17 to 1.93/m^2 was similar to previously reported densities. There was no clear pattern or significant difference in YOY, Y+, or Y++ rearing population estimates between 2000, 2001 and 2002. Suggesting, at least at the level of intensity employed on the Noyo River, either populations over three years were the same or that electro-fishing 2% of the Noyo River above NRS is insufficient for trend detection. However, the power of this analysis was low. Anadromous fish densities in the Little North Fork Noyo have been similar over the last few years (D. Wright Personal Communication) and were not different than those presented by Burns (1971). Suggesting that population levels in the Noyo River have been stable for over 30 years, as measured by summer rearing density. Switching to removal type population estimation methodology might allow more sampling intensity at a similar cost while increasing the power of results. Adult steelhead population estimates were similar in 2000, 2001 and 2002 (Gallagher 2003).

RECOMMENDATIONS

Downstream movement and resident populations monitoring could be continued in the upper Noyo River to follow this season's YOY, Y+, and Y++ populations through successive life stages. This may allow the detection of habitat-induced population bottlenecks. Coordination with other programs in other rivers has improved the standardization of methods for enumeration of YOY and juvenile salmonids. This may allow for large scale comparisons and monitoring of population trends. Age-length relationships should be developed for juvenile steelhead by scale and/or otolith reading in the Noyo River and this information should be used to track year classes and potentially improve population and survival estimates.

Trapping should begin as early in the year as possible after high flows in January, February, or March. Running traps earlier and longer may increase the likely-hood of capturing larger and assumed to be older steelhead. Modifying traps to increase their efficiency should also be done. Because all traps in the Noyo River showed similar capture trends over three years it is possible that the Noyo River basin is behaving as, and is representative of, an independent population as defined by McElhany et al. (2000). It is important to note that, although the power of the tests was low, there was no significant difference in population estimates between 2000, 2001, and 2002. If this three-year trend is real, one or two traps might be all that is necessary for monitoring a watershed. This would allow trapping efforts to be expanded into more rivers.

However, due to:

1). The inability to operate traps throughout the winter and spring (50% of the total 2001 steelhead population estimate at Northspur moved prior to early-March).

2). The fact that year-to-year climate and therefore stream flows are extremely variable.

3). Differences between yearly climate make consistency in the year-to-year timing and duration of trapping difficult.

4). The idea that stream flows affect the number of fish moving, the timing of movement, the number of fish captured in traps, and that generally captures are significantly associated with stream flow and water temperature.

5). The idea that even though traps appear to show similar trends over three years, population estimates were not significantly different.

6). Five years of trapping data on the South Fork and North Fork South Fork Noyo River show no significant trends in fish captures, although there may not be any trends.

Thus:

Trapping as a long-term monitoring tool should be approached cautiously.

Considering the above it is likely that management decisions based on inferences of change over time from trapping population estimates may be susceptible to type I and type II errors. On the other hand, continued monitoring using multiple traps and electro-fishing may allow continued examination of coho, Chinook, and steelhead cohorts over successive years, may help define the variability in steelhead life histories in the upper Noyo River, and hopefully improve management prescriptions.

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PERSONAL COMMUNICATIONS

Dave Wright. November 2002. Campbell Timberland Management, Fort Bragg, CA 95437

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Figure 1. Location of the Noyo River watershed in Mendocino County in California.

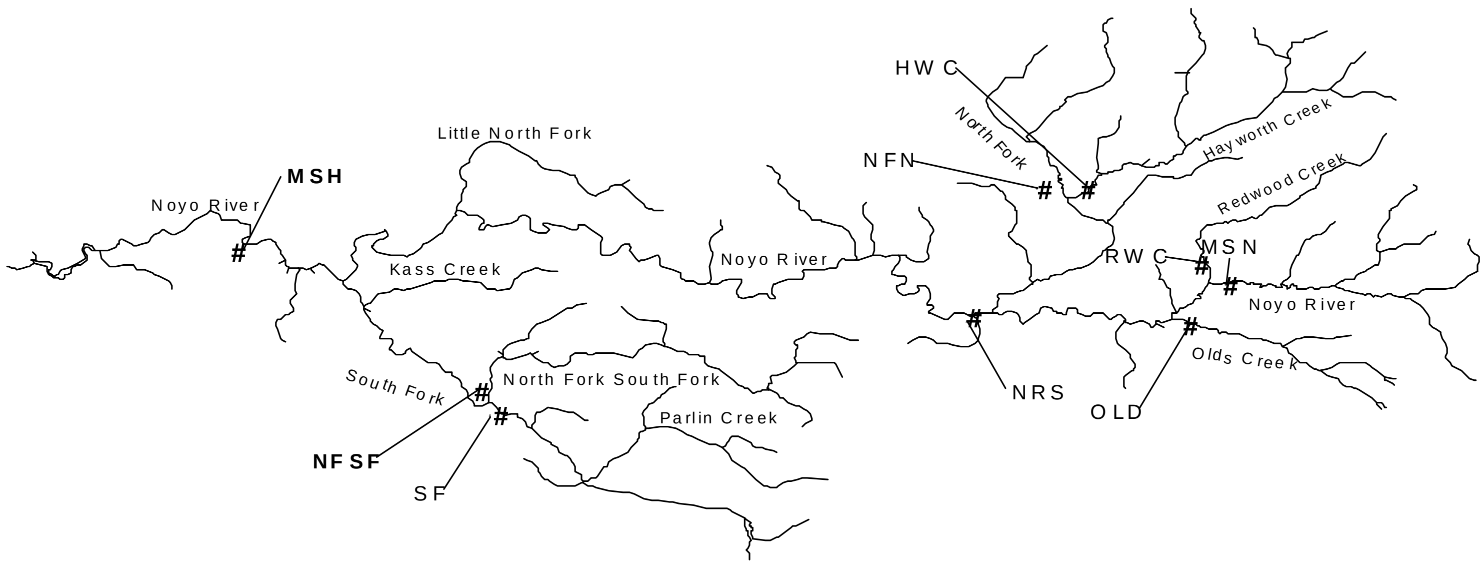

Figure 2. Location of fyke traps in the upper Noyo River during 2002. Circles indicate traps operated for this study. HWC is Hayworth Creek. MSN is the Noyo below Redwood Creek. NFN is the North Fork. NRS is Northspur. OLD is Olds Creek. RWC is Redwood Creek. SF is the South Fork. NFSF is the North Fork of the South Fork (SF and NFSF data not reported herein).

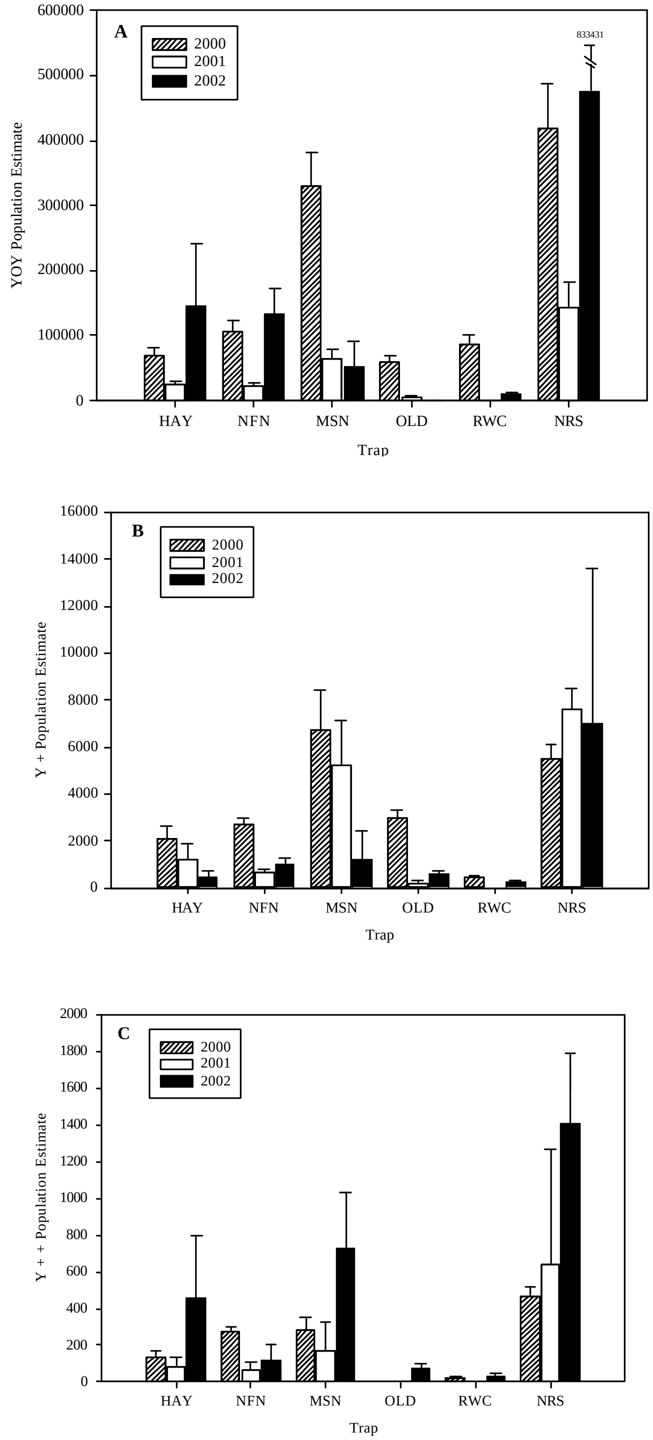

Figure 3. Trap population estimates for YOY (A), Y+ (B), and Y++ (C) steelhead in the Noyo River 2000, 2001, and 2002. Thin lines are standard deviations. Abbreviations are the same as in Figure 2. Note: scales are different.

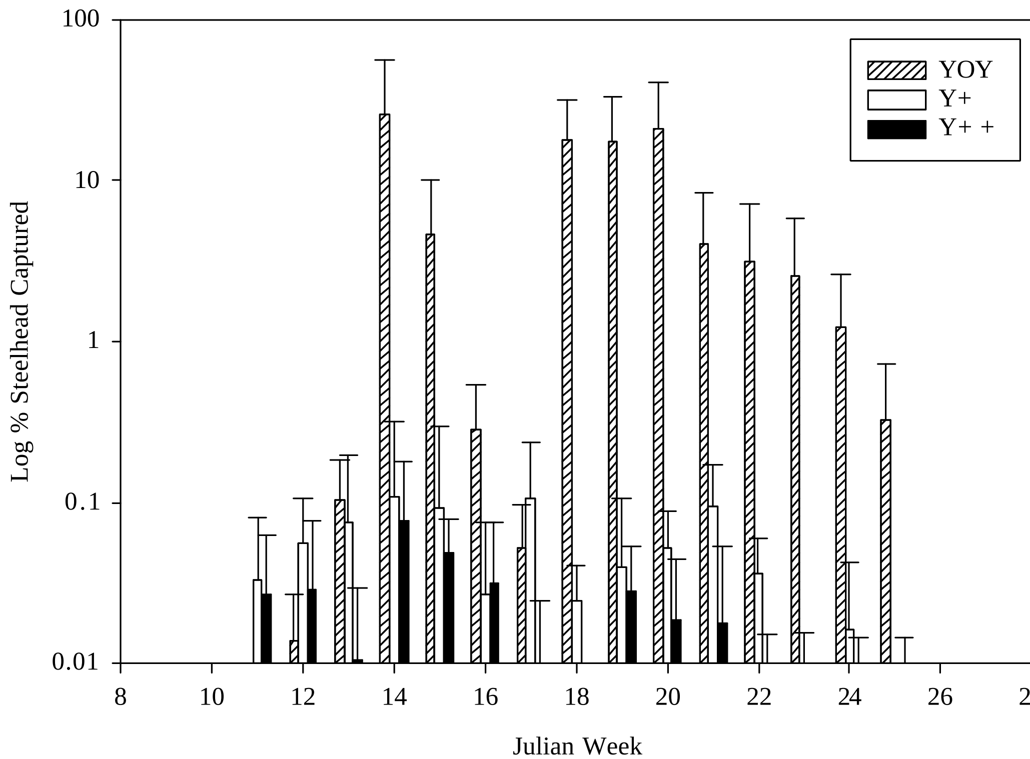

Figure 4. Percent of YOY, Y+, and Y++ steelhead captured by Julian week in the upper Noyo River 13 March to 20 June 2002. Y-axis data are plotted log normal. Thin lines are standard deviations.

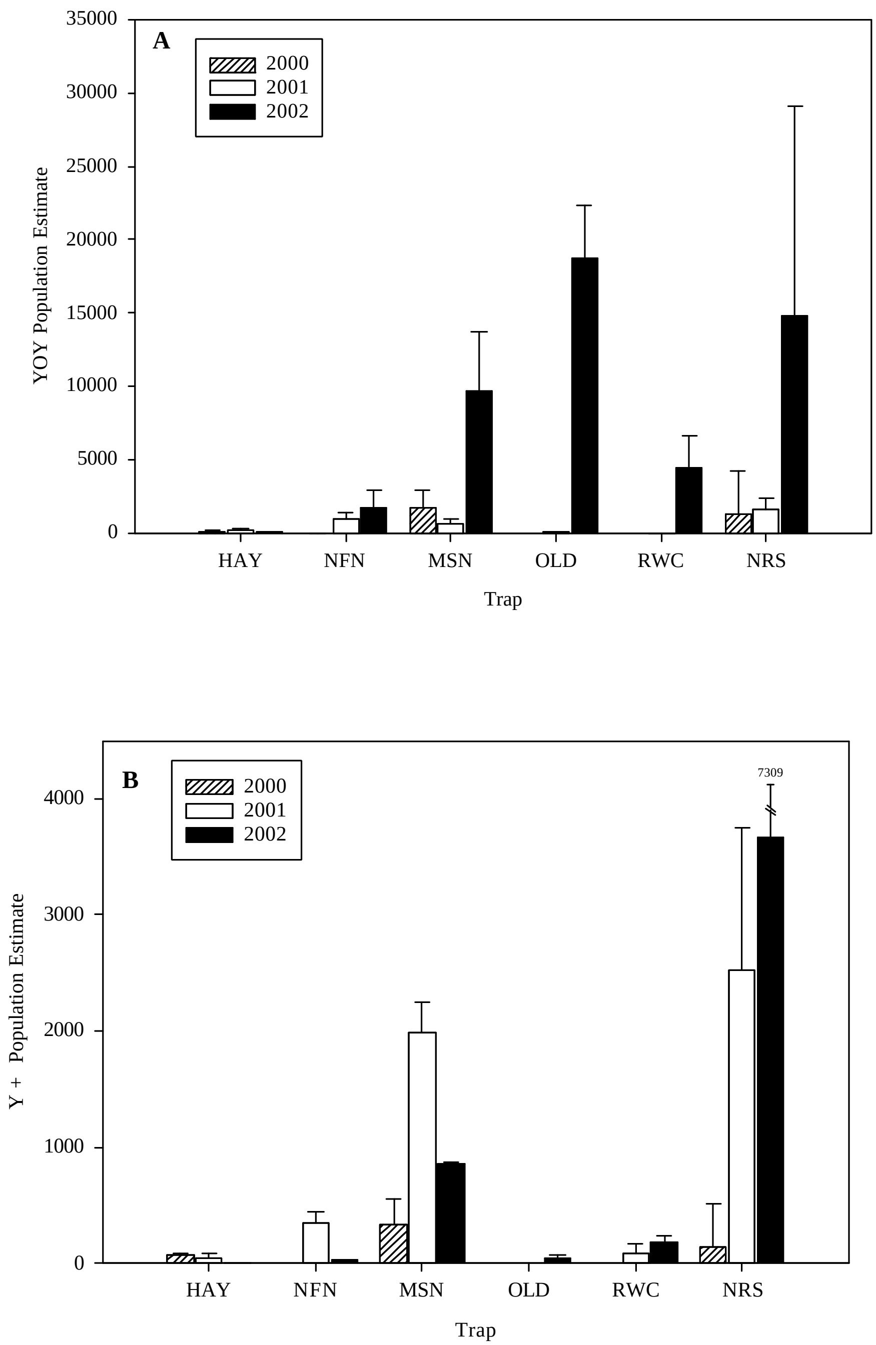

Figure 5. Coho salmon trap population estimates YOY (A) and Y+ (B) in the upper Noyo River 2000, 2001, and 2002. Thin lines are standard deviations. Abbreviations are the same as in Figure 2. Note: Scales are different.

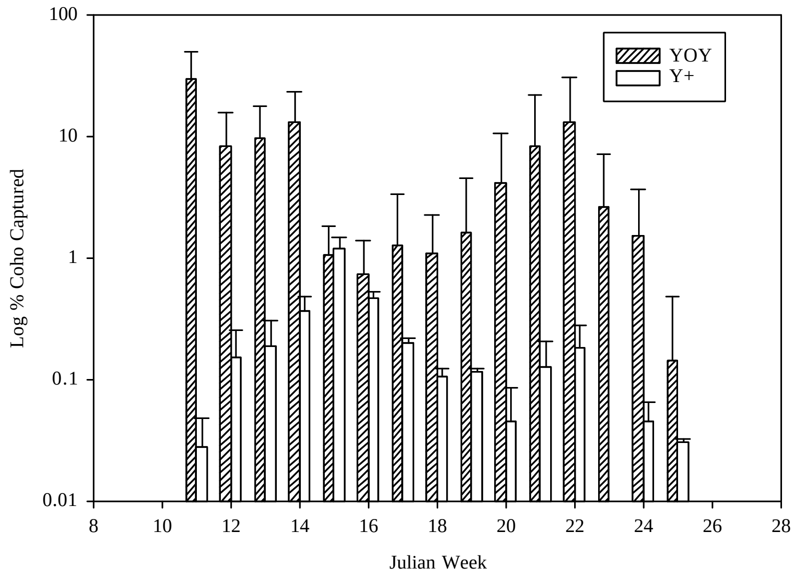

Figure 6. Percent of coho salmon YOY, and Y+ captured by week in traps in the upper Noyo River during 2002. Data is present as Log normal. Thin lines are standard deviation.

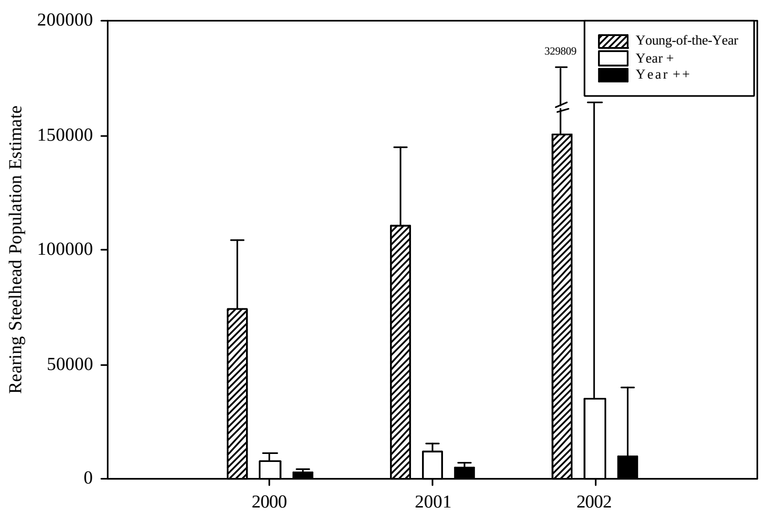

Figure 7. Young- of the year, Y+, and Y++ rearing steelhead populations in the upper Noyo River during 2000, 2001, and 2002. Thin Lines are 95% confidence limits.

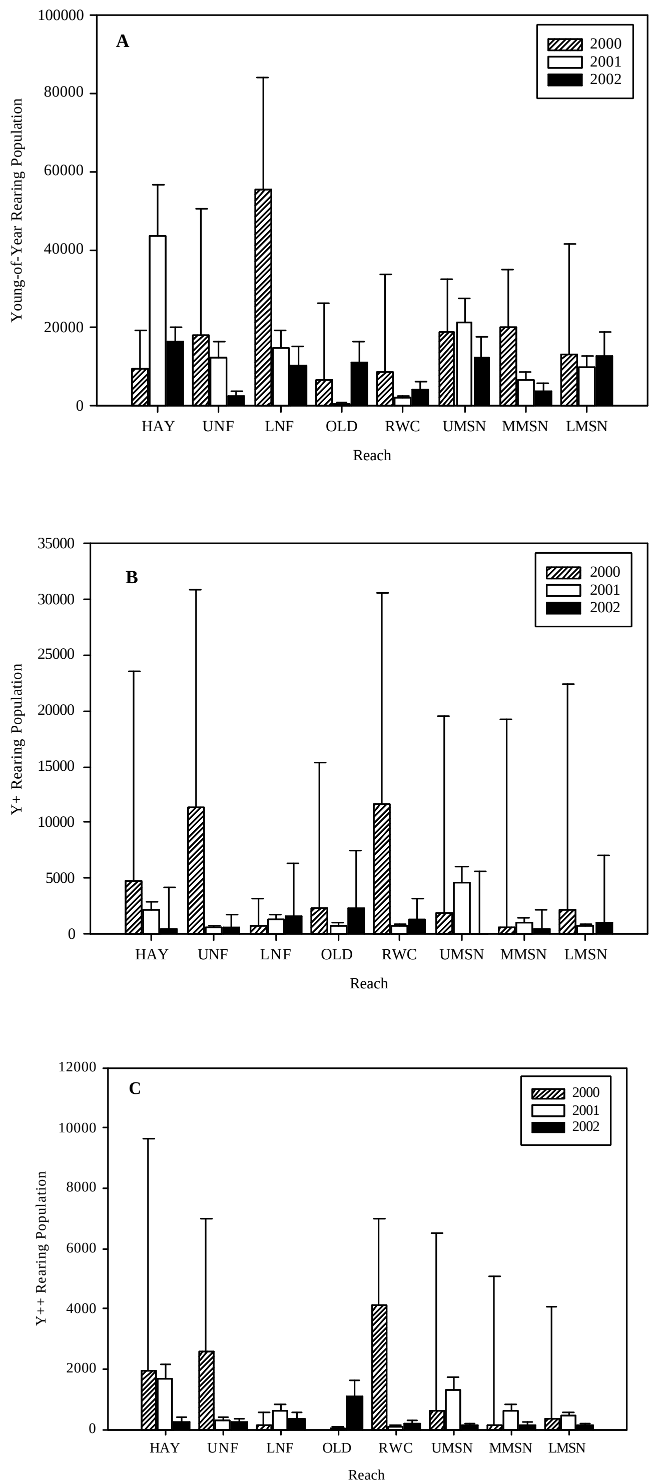

Figure 8. Rearing steelhead populations in the upper Noyo River 2000, 2001, and 2002. YOY (A), Y+ (B), and Y++ (C). Thin lines are 95% confidence limits. Abbreviations are the same as in Figure 2, except UMSN is the Noyo above RWC, MMSN is the Noyo between RWC and OLD, and LMSN is the Noyo from NRS to OLD.

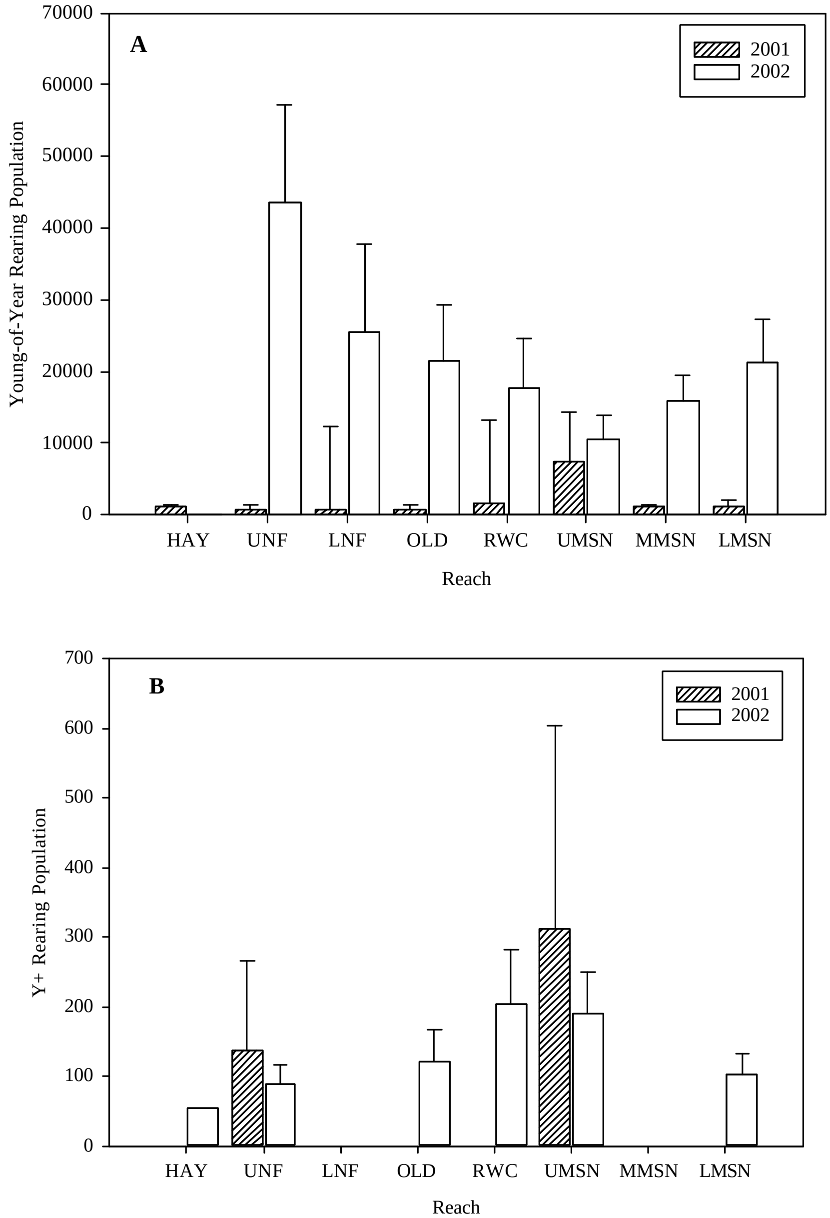

Figure 9. Rearing coho salmon YOY (A) and Y+ (B) populations in the Noyo River 2001 and 2002. Thin lines are 95% confidence limits. Abbreviations are the same as in Figure 2, except UMSN is the Noyo River above RWC, MMSN is the Noyo River between RWC and OLD, and LMSN is the Noyo River from NRS to OLD.

Table 1. Steelhead population estimates from fyke traps in the upper Noyo River during 2002. Numbers in parentheses are standard deviations.

Trap Location	< 50 mm		51-70 mm			71-120 mm			> 120 mm			> 50 mm		
	Total Captured	N	Total Captured	N	Capture Probability	Total Captured	N	Capture Probability	Total Captured	N	Capture Probability	Total Captured	N	Capture Probability
Hayworth Creek	4380	140870 (94383)	82	3575 (3324)	0.03	46	447 (277)	0.13	4	460 (333)	-	132	3388 (2267)	0.06
Mainstem Noyo	13971	51933 (3780)	41	1025 (1004)	0.04	38	1216 (1195)	0.03	10	731 (301)	-	89	2972 (2123)	0.03
North Fork Noyo	1651	133150 (39146)	29	478 (130)	-	145	978 (263)	0.3	28	118 (88)	0.24	202	1412 (415)	0.27
Northspur	5242	472300 (354697)	61	3233 (3201)	0.02	128	6977 (6628)	0.02	11	1407 (382)	-	200	11430 (8580)	0.01
Olds Creek	2915	9542 (1746)	7	299 (31)	-	158	576 (145)	0.42	24	74 (29)	0.32	189	701 (128)	0.25
Redwood Creek	2119	10090 (2936)	0	5 (5)	-	44	233 (78)	0.19	10	30 (17)	0.33	54	258 (75)	0.21
Total Indivdual Traps	30278	817885 (496688)	220	8614 (7694)	-	559	10427 (8586)	0.18	87	2820 (1150)	0.3	866	20161 (13588)	0.14
Two Traps Northspur	1406	165979 (222070)	159	12269 (4890)		431	22483 (9089)	0.02	76	5865 (2337)	-	666	51393 (20843)	0.01

Table 2. Coho salmon population estimates from fyke traps in the upper Noyo River during 2002. Numbers in parentheses are standard deviations.

Trap Location	< 50 mm		51-80 mm			> 80 mm			> 50 mm		
	Total Captured	N	Total Captured	N	Capture Probability	Total Captured	N	Capture Probability	Total Captured	N	Capture Probability
Hayworth Creek	98	-	2	-	-	-	4	-	6	-	-
Mainstem Noyo	411	4888 (655)	99	4801.5 (3361)	0.02	185	859 (17)	0.23	284	3885 (522)	0.11
North Fork Noyo	15	88 (57)	9	102 (71)	-	12	24 (12)	0.5	21	126 (80)	0.17
Northspur	277	13850 (13711)	9	978 (583)	-	68	3672 (3637)	0.02	77	4697 (4658)	0.02
Olds Creek	3685	17584 (3359)	196	1120 (220)	0.16	15	45 (20)	0.33	211	1157 (220)	0.2
Redwood Creek	1083	3969 (1806)	30	490 (398)	0.09	51	179 (52)	0.29	77	459 (209)	0.26
Total Indivdual Traps	5569	40379 (19588)	345	7491.5 (4633)	0.09	331	4783 (3738)	0.274	676	10324 (5689)	0.152
Two Traps Northspur	277	13850 (5124)	336	16800 (6216)	-	266	6612 (2447)	0.04	599	35512 (13307)	0.02

Table 3. Chinook salmon population estimates from fyke traps in the upper Noyo River during 2002. Numbers in parentheses are standard deviations.

Trap Location	< 50 mm	> 50	All		
	Total Captured	Total Captured	Total Captured	N	Capture Probability
Hayworth Creek	20046	775	20821	36296 (2722)	0.48
Mainstem Noyo	139	0	139	-	-
North Fork Noyo	408	23	431	-	-
Northspur	3752	269	4021	20936 (5276)	0.24
Olds Creek	0		0	-	-
Redwood Creek	0		0	-	-
Total Indivdual Traps	24345	1067	25412	57232 (7998)	-

Table 4. Total species captured and species diversity (H') for each trap in the upper Noyo River during 2002.

Species	Common Name	Total Captured					
		Hayworth Creek	Mainstem Noyo	North Fork	Northspur	Olds Creek	Redwood Creek
Clemmys marmorata	Western Pond Turtle	0	3	0	1	0	5
Cottus alueticus	Coast Sculpin	1	1	0	7	1	0
Cottus asper	Prickly Sculpin	1	0	0	1	0	0
Dicamptodon ensatus	Pacific Giant Salamander	4	2	25	1	27	7
Ensatina sp.	Ensatina	1	0	0	0	0	0
Gasterosteus aculeatus	Three-Spined Stickleback	0	6	1	25	3	1
Lampetra tridentata	Pacific Lamprey	27	41	25	64	0	57
Pituophis melanoleucus	Gopher Snake	0	0	0	0	0	0
Rana boylii	Foothill Yellow-Legged Frog	14	31	21	11	21	56
Taricha granulosa	Rough-Skinned Newt	0	1	4	0	0	2
Taricha rivularis	Red-Bellied Newt	12	2	27	0	5	7
Taricha torosa	California Newt	0	5	5	1	1	3
Thamnophis species	Garter Snake	0	3	3	0	0	0
Oncorhynchus mykiss	Steelhead	4512	14060	1853	5442	3104	2173
Oncorhynchus kisutch	Coho Salmon	102	695	36	354	3896	1160
Oncorhynchus tshawytscha	Chinook Salmon	20821	139	431	4021	0	0
Species Diversity **H'**		***0.22***	***0.12***	***0.34***	***0.38***	***0.32***	***0.36***

Table 5. Percent of steelhead marked and recaptured by week and capture method in the upper Noyo River during 2002.

Capture Method	Recapture Method	Total Captured	% By Week Between Capture and Recapture												
			1.0	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0	11.0	12.0	13.0
Traps	Traps	82	76.8	13.4	2.4	0.0	1.2	3.7	2.4	0.0	0.0	0.0	0.0	0.0	0.0
Electrofishing	Electrofishing	91	15.4	34.1	12.1	23.1	9.9	3.3	1.1	2.2	0.0	0.0	0.0	0.0	0.0
Trap	Electrofishing Upstream Traps	8	10.0	10.0	0.0	0.0	0.0	10.0	0.0	10.0	0.0	20.0	10.0	0.0	10.0
	Electrofishing Below Traps	3	0.0	0.0	0.0	0.0	33.3	0.0	0.0	66.6	0.0	0.0	0.0	0.0	0.0
Traps Above NRS	NRS Trap	4	25.0	25.0	0.0	50.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Table 6. Percent of coho salmon marked and recaptured by week and capture method in the upper Noyo River during 2002.

Capture Method	Recapture Method	Total Captured	Weeks Between Capture and Recapture												
			1.0	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0	11.0	12.0	13.0
Traps	Traps	55	70.9	25.5	0.0	1.8	1.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Electrofishing	Electrofishing	66	21.2	31.8	21.2	19.7	0.0	4.5	0.0	1.5	0.0	0.0	0.0	0.0	0.0
Trap	Electrofishing Upstream Traps	5	60.0	0.0	20.0	0.0	0.0	0.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0
	Electrofishing Below Traps	3	33.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	33.3	0.0	33.3
Traps Above NRS	NRS Trap	2	50.0	50.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Table 7. Percent of chinook salmon marked and recaptured by week and capture method in the upper Noyo River during 2002.

Capture Method	Recapture Method	Total Captured	Weeks Between Capture and Recapture												
			1.0	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0	11.0	12.0	13.0
Traps	Traps	211	70.0	20.0	6.6	3.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Electrofishing	Electrofishing	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Trap	Electrofishing Upstream Traps	4	50.0	25.0	0.0	0.0	25.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Electrofishing Below Traps	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Traps Above NRS	NRS Trap	9	77.8	11.1	0.0	11.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Table 8. Estimated number of steelhead per meter and 95% confidence limits in eight reaches in the upper Noyo River during 2002.

Stream	Segment	Length (km)	Estimated Number/m											
			< 50 mm			51-70 mm			71-120 mm			> 120 mm		
			Low 95%	Estimate	High 95%	Low 95%	Estimate	High 95%	Low 95%	Estimate	High 95%	Low 95%	Estimate	High 95%
Hayworh Creek	Above Confulence	5.5	0.78	2.74	20.37	0.08	0.28	2.09	0.02	0.07	0.52	0.02	0.05	0.29
Noyo River	Above Redwood Cr.	4.9	1.09	2.36	17.56	0.06	0.13	0.97	0.01	0.01	0.10	0.01	0.03	0.13
Noyo River	Olds Cr. To Redwood Cr.	1.6	0.27	1.45	23.91	0.17	0.98	27.95	0.06	0.28	3.95	0.02	0.11	12.70
Noyo River	Northspur to Olds Cr.	5.0	0.46	0.71	8.53	1.05	0.58	7.04	0.98	0.10	0.41	1.14	0.01	8.46
North Fork Noyo	Above Hayworth Cr.	5.0	0.28	0.42	1.49	0.05	0.08	0.28	0.07	0.11	0.42	0.03	0.05	2.48
North Fork Noyo	Northspur to Hayworth Cr.	6.2	0.44	1.42	11.12	0.08	0.25	1.96	0.07	0.25	3.40	0.02	0.06	4.40
Olds Creek	Above Confulence	3.5	0.28	2.26	59.47	0.17	0.96	27.40	0.08	0.64	16.91	0.04	0.32	135.28
Redwood Creek	Above Confulence	5.1	0.20	0.79	10.04	0.02	0.05	0.47	0.06	0.24	3.47	0.01	0.04	5.02

Table 9. Estimated number of coho salmon per meter and 95% confidence limits in eight reaches in the upper Noyo River during 2002.

Stream	Segment	Length (km)	< 80 mm			> 80 mm		
			Low 95%	Estimate	High 95%	Low 95%	Estimate	High 95%
Hayworh Creek	Above Confulence	5.5	-	0.020	-	-	0.010	-
Noyo River	Above Redwood Cr.	4.9	0.677	2.144	29.408	0.012	0.039	0.531
Noyo River	Olds Cr. To Redwood Cr.	1.6	0.736	3.227	17.594	-	0.000	-
Noyo River	Northspur to Olds Cr.	5.0	2.729	8.710	149.439	0.006	0.018	0.306
North Fork Noyo	Above Hayworth Cr.	5.0	2.729	8.710	149.439	0.006	0.018	0.306
North Fork Noyo	Northspur to Hayworth Cr.	6.2	1.960	4.127	19.190	-	0.000	-
Olds Creek	Above Confulence	3.5	2.208	6.157	32.820	0.013	0.035	0.186
Redwood Creek	Above Confulence	5.1	1.343	3.470	17.006	0.015	0.040	0.195

Table 10. Jolly-Seber based survival estimates for steelhead and coho salmon from electro-fishing reaches in the Noyo River during 2002.

Site	Steelhead								Coho	
	YOY		Y +		Y + +		All		Y+	
	Estimate	95%Ci	Estimate	95%Ci	Estimate	95%Ci	Estimate	95%Ci	Estimate	95%Ci
Hayworth Creek	0.25	0.55	-	-	0.40	0.60	0.56	0.50	-	-
Northfork Above Hayworth Creek	-	-	0.44	0.56	0.33	0.61	0.46	0.54	0.20	0.80
Northfork Below Hayworth Creek	-	-	0.16	0.84	0.25	0.45	0.33	0.76	0.39	0.61
Olds Creek	-	-	-	-	-	-	-	-	0.84	0.55
Redwood Creek Above Trap	-	-	0.57	0.43	-	-	0.33	0.66	-	-
Redwood Creek Below Trap	0.66	0.66	0.20	0.80	-	-	0.21	0.78	0.48	0.52
Noyo Above Redwood Creeek	-	-	0.50	0.35	0.72	0.28	0.50	0.42	0.17	0.34
Noyo Redwood to Olds Creek	-	-	0.50	0.33	0.50	0.50	0.57	0.37	0.23	0.27
Noyo Northspur to Olds Creek	0.22	0.38	0.88	0.47	0.60	0.60	0.75	0.42	0.50	0.50
Average	0.38	0.53	0.46	0.54	0.47	0.51	0.46	0.56	0.40	0.51
SE	0.14	0.08	0.09	0.08	0.07	0.05	0.06	0.06	0.09	0.06

Note: YOY are fish < 70 mm for steelhead and < 80 mm for coho salmon (ie fish born during 2002). Y+ are steelhead between 70 and 120 mm and coho salmon > 80 mm (fish born in spring 2001). Y++ are steelhead > 120 mm fork length.

Table 11. Steelhead and coho salmon survival estimates from trap and electro-fishing population estimates in the upper Noyo River 2000 to 2002.

	Steelhead						Coho	
	YoY to Y+		YOY to Y+ +		Y+ to Y+ +		YoY to Y+	
Site	Estimate	95%Ci	Estimate	95%Ci	Estimate	95%Ci	Estimate	95%Ci
Hayworth Creeek	0.03	0.05	0.13	0.08	0.54	1.00	-	- -
	0.49	0.21	-	-	0.38	0.03	-	- -
Noyo Above Redowwd Creek	0.12	0.37	0.08	0.05	0.34	0.46	0.15	0.35
	0.79	0.40	-		0.90	0.04	-	- -
Northfork Above Hayworth Creek	0.20	0.20	0.02	0.01	0.87	1.00	0.15	1
	0.10	0.01	-	-	0.04	0.01	-	- -
Olds Creek	-	-	0.20	0.03	-	-	0.23	0.78
	0.15	0.02	-	-	0.03	0.01	-	- -
Redwood Creek	0.82	1.00	0.03	0.01	0.37	0.57	0.25	0.07
	0.08	0.01	-	-	0.01	0.01	-	- -
Average	0.31	0.25	0.09	0.04	0.39	0.35	0.195	0.55
SE	0.10355	0.10617	0.02488	0.00989	0.11257	0.14195	0.02037	0.162

Note: YOY are fish < 70 mm for steelhead and < 80 mm for coho salmon (ie fish born during 2002). Y+ are steelhead between 70 and 120 mm and coho salmon > 80 mm (fish born in spring 2001). Y++ are steelhead > 120 mm fork length.

APPENDIX A

DARR OUTPUT BY WEEK

Table 1A Hayworth creek Darr output by Week.

Week	Steelhead 51-70 mm			Steelhead 71-120 mm			Steelhead > 50 mm			Chinook Salmon > 50 mm		
	Captured Unmarked	Capture Probability	Population Estimate	Captured Unmarked	Capture Probability	Population Estimate	Captured Unmarked	Capture Probability	Population Estimate	Captured Unmarked	Capture Probability	Population Estimate
11	0	0.17	0	0	0.17	0	2	0.13	16	0	0.6	0
12	11	0.17	66	11	0.17	66	12	0.13	96	0	0.6	0
13	17	0.15	110.5	17	0.15	110.5	17	0.15	110.5	0	0.6	0
14	10	0.07	150	10	0.07	150	10	0.03	390	0	0.6	0
15	2	0.07	30	2	0.07	30	2	0.03	78	0	0.6	0
16	2	0.07	30	2	0.07	30	3	0.03	117	0	0.6	0
17	0	0.07	0	0	0.07	0	0	0.03	0	13	0.6	21.53
18	0	0.07	0	0	0.07	0	0	0.03	0	23	0.6	38.1
19	1	0.07	15	1	0.07	15	1	0.03	39	109	0.6	180.54
20	1	0.07	15	1	0.07	15	4	0.03	156	117	0.24	497.34
21	1	0.07	15	1	0.07	15	4	0.03	156	119	0.25	475.65
22	0	0.07	0	0	0.07	0	31	0.03	1209	225	0.6	374.39
23	0	0.07	0	0	0.07	0	29	0.04	783	146	0.33	445.55
24	1	0.07	15	1	0.07	15	16	0.07	224	74	0.19	382.33
25	0	0.07	0	0	0.07	0	1	0.07	14	6	0.19	31

Table 2A Main stem Noyo Darr output by week.

Week	Steelhead 51-70 mm			Steelhead 71-120 mm			Steelhead > 50 mm			Coho Salmon < 80 mm			Coho Salmon > 80 mm			Coho Salmon > 50 mm		
	Captured Unmarked	Capture Probability	Population Estimate	Captured Unmarked	Capture Probability	Population Estimate	Captured Unmarked	Capture Probability	Population Estimate	Captured Unmarked	Capture Probability	Population Estimate	Captured Unmarked	Capture Probability	Population Estimate	Captured Unmarked	Capture Probability	Population Estimate
11	0	0.04	0	2	0.03	64	4	0.03	152	0	0.02	0	1	0.25	3.93	1	0.21	4.67
12	0	0.04	0	0	0.03	0	2	0.03	76	0	0.02	0	5	0.25	19.63	5	0.21	23.33
13	0	0.04	0	4	0.03	128	4	0.03	152	0	0.02	0	8	0.25	31.41	8	0.21	37.33
14	0	0.04	0	9	0.03	288	10	0.03	380	0	0.02	0	24	0.25	94.22	24	0.21	112
15	0	0.04	0	11	0.03	352	13	0.03	494	0	0.02	0	83	0.25	335.07	83	0.27	304.33
16	0	0.04	0	2	0.03	64	3	0.03	114	1	0.02	48.5	21	0.14	154	22	0.11	198
17	0	0.04	0	5	0.03	160	5	0.03	190	5	0.02	242.5	9	0.14	66	14	0.11	126
18	0	0.04	0	0	0.03	0	0	0.03	0	1	0.02	48.5	5	0.15	32.5	6	0.04	145.5
19	3	0.04	75	3	0.03	96	7	0.03	266	7	0.02	339.5	6	0.15	39	13	0.04	315.25
20	12	0.04	300	0	0.03	0	13	0.04	364	14	0.02	679	1	0.15	6.5	15	0.04	363.75
21	10	0.04	250	1	0.03	32	11	0.04	308	31	0.02	1503.5	5	0.29	17.5	36	0.04	873
22	6	0.04	150	0	0.03	0	6	0.04	168	30	0.02	1455	11	0.29	38.5	41	0.04	994.25
23	1	0.04	25	0	0.03	0	1	0.04	28	6	0.02	291	0	0.29	0	6	0.04	145.5
24	3	0.04	75	1	0.03	32	4	0.04	112	3	0.02	145.5	3	0.29	10.5	6	0.04	145.5
25	6	0.04	150	0	0.03	0	6	0.04	168	1	0.02	48.5	3	0.29	10.5	4	0.04	97

Table 3A North Fork Noyo Darr output by week.

Week	Steelhead 71-120 mm			Steelhead > 120 mm			Steelhead > 50 mm			Coho Salmon > 80 mm			Coho Salmon > 50 mm		
	Captured Unmarked	Capture Probability	Population Estimate	Captured Unmarked	Capture Probability	Population Estimate	Captured Unmarked	Capture Probability	Population Estimate	Captured Unmarked	Capture Probability	Population Estimate	Captured Unmarked	Capture Probability	Population Estimate
11	11	0.19	58.67	0	0.24	0	11	0.49	22.6	1	0.5	2	1	0.17	6
12	15	0.19	80	0	0.24	0	15	0.49	30.82	0	0.5	0	0	0.17	0
13	21	0.75	28	1	0.24	4.2	22	0.49	45.2	4	0.5	8	4	0.17	24
14	2	0.75	2.67	2	0.24	8.4	4	0.49	8.22	0	0.5	0	0	0.17	0
15	0	0.75	0	2	0.24	8.4	2	0.49	4.11	0	0.5	0	0	0.17	0
16	0	0.75	0	0	0.24	0	0	0.49	0	0	0.5	0	0	0.17	0
17	18	0.16	111	2	0.24	8.4	20	0.1	196.19	1	0.5	2	1	0.17	6
18	0	0.16	0	3	0.24	12.6	3	0.1	29.43	0	0.5	0	0	0.17	0
19	5	0.16	30.83	2	0.24	8.4	18	0.1	176.57	0	0.5	0	0	0.17	0
20	23	0.16	141.83	4	0.24	16.8	40	0.1	392.38	0	0.5	0	2	0.17	12
21	31	0.1	325.5	12	0.24	50.4	43	0.13	325.57	1	0.5	2	2	0.17	12
22	13	0.1	136.5	0	0.24	0	18	0.13	136.29	4	0.5	8	8	0.17	48
23	4	0.1	42	0	0.24	0	4	0.13	30.29	0	0.5	0	1	0.17	6
24	2	0.1	21	0	0.24	0	2	0.13	15.14	1	0.5	2	2	0.17	12
25	0	0.1	0	0	0.24	0	0	0.13	0	0	0.5	0	0	0.17	0

Table 4A. Northspur Darr output by week.

Week	Steelhead 51-70 mm			Steelhead 71-120 mm			Steelhead > 50 mm			Coho Salmon > 80 mm			Coho Salmon > 50 mm			Chinook Salmon > 50		
	Captured Unmarked	Capture Probability	Population Estimate	Captured Unmarked	Capture Probability	Population Estimate	Captured Unmarked	Capture Probability	Population Estimate	Captured Unmarked	Capture Probability	Population Estimate	Captured Unmarked	Capture Probability	Population Estimate	Captured Unmarked	Capture Probability	Population Estimate
11																		
12																		
13																		
14	0	0.02	0	39	0.13	302.25	44	0.11	396	16	0.02	864	16	0.02	976	0	0.2	0
15	0	0.02	0	53	0.01	3975	58	0.01	4814	44	0.02	2376	44	0.02	2684	0	0.2	0
16	0	0.02	0	2	0.01	150	2	0.01	166	4	0.02	216	5	0.02	305	2	0.2	10.17
17	0	0.02	0	10	0.01	750	10	0.01	830	0	0.02	0	1	0.02	61	10	0.2	50.83
18	0	0.02	0	2	0.01	150	2	0.01	166	0	0.02	0	0	0.02	0	7	0.2	35.58
19	0	0.02	0	1	0.01	75	1	0.01	83	0	0.02	0	1	0.02	61	50	0.2	254.17
20	7	0.02	371	18	0.01	1350	25	0.01	2075	1	0.02	54	3	0.02	183	57	0.2	289.75
21	16	0.02	848	3	0.01	225	20	0.02	1000	0	0.02	0	0	0.02	0	60	0.14	440
22	5	0.02	265	0	0.01	0	5	0.02	250	0	0.02	0	3	0.02	183	63	0.08	819
23	19	0.02	1007	0	0.01	0	19	0.02	950	1	0.02	54	2	0.02	122	20	0.25	80
24	13	0.02	689	0	0.01	0	13	0.02	650	0	0.02	0	0	0.02	0	5	0.5	10
25	1	0.02	53	0	0.01	0	1	0.02	50	2	0.02	108	2	0.02	122	0	0.5	0

Table 5A. Olds Creek Darr output by week.

Week	Steelhead 71-120 mm			Steelhead > 120 mm			Steelhead > 50 mm			Coho Salmon < 80 mm			Coho Salmon > 80 mm			Coho Salmon > 50 mm		
	Captured Unmarked	Capture Probability	Population Estimate	Captured Unmarked	Capture Probability	Population Estimate	Captured Unmarked	Capture Probability	Population Estimate	Captured Unmarked	Capture Probability	Population Estimate	Captured Unmarked	Capture Probability	Population Estimate	Captured Unmarked	Capture Probability	Population Estimate
11	3	0.79	3.78	3	0.25	12	6	0.37	16.31	0	0.15	0	0	0.33	0	0	0.21	0
12	22	0.79	27.74	3	0.25	12	25	0.37	67.96	0	0.15	0	2	0.33	6	2	0.21	9.53
13	21	0.79	26.48	4	0.4	10	25	0.37	67.96	0	0.15	0	1	0.33	3	1	0.21	4.76
14	19	0.79	23.96	3	0.4	7.5	22	0.37	59.81	0	0.15	0	1	0.33	3	1	0.21	4.76
15	22	0.79	27.74	7	0.33	21	29	0.28	104.72	0	0.15	0	5	0.33	15	5	0.21	23.82
16	21	0.79	26.48	0	0.33	0	21	0.28	75.83	0	0.15	0	1	0.33	3	1	0.21	4.76
17	20	0.1	200	1	0.33	3	21	0.28	75.83	0	0.15	0	0	0.33	0	0	0.21	0
18	10	0.1	100	0	0.33	0	10	0.28	36.11	2	0.15	12.94	0	0.33	0	2	0.21	9.53
19	3	0.1	30	0	0.33	0	3	0.28	10.83	2	0.15	12.94	0	0.33	0	2	0.21	9.53
20	6	0.1	60	1	0.33	3	7	0.28	25.28	13	0.15	84.12	3	0.33	9	16	0.21	76.24
21	7	0.22	31.5	1	0.33	3	8	0.13	64	11	0.15	71.18	0	0.33	0	11	0.25	44
22	3	0.22	13.5	1	0.33	3	7	0.13	56	149	0.18	832.65	2	0.33	6	151	0.18	861.59
23	0	0.22	0	0	0.33	0	2	0.13	16	13	0.18	72.65	0	0.33	0	13	0.18	74.18
24	1	0.22	4.5	0	0.33	0	3	0.13	24	6	0.18	33.53	0	0.33	0	6	0.18	34.24
25	0	0.22	0	0	0.33	0	0	0.13	0	0	0.18	0	0	0.33	0	0	0.18	0

Table 6A. Redwood Creek Darr output by week.

Week	Steelhead 71-120 mm			Steelhead > 120 mm			Steelhead > 50 mm			Coho Salmon < 80 mm			Coho Salmon > 80 mm			Coho Salmon > 50 mm		
	Captured Unmarked	Capture Probability	Population Estimate	Captured Unmarked	Capture Probability	Population Estimate	Captured Unmarked	Capture Probability	Population Estimate	Captured Unmarked	Capture Probability	Population Estimate	Captured Unmarked	Capture Probability	Population Estimate	Captured Unmarked	Capture Probability	Population Estimate
11	4	0.19	21.14	2	0.33	6	6	0.21	28.67	0	0.11	0	1	0.27	3.67	1	0.33	3
12	14	0.19	74	4	0.33	12	18	0.21	86	0	0.11	0	7	0.27	25.67	7	0.33	21
13	9	0.19	47.57	3	0.33	9	12	0.21	57.33	0	0.11	0	6	0.27	22	6	0.33	18
14	4	0.19	21.14	0	0.33	0	4	0.21	19.11	0	0.11	0	8	0.27	29.33	8	0.33	24
15	1	0.19	5.29	0	0.33	0	1	0.21	4.78	0	0.11	0	15	0.27	55	15	0.33	45
16	0	0.19	0	1	0.33	3	1	0.21	4.78	0	0.11	0	1	0.27	3.67	1	0.33	3
17	1	0.19	5.29	0	0.33	0	1	0.21	4.78	0	0.11	0	0	0.27	0	0	0.33	0
18	2	0.19	10.57	0	0.33	0	2	0.21	9.56	1	0.11	9	1	0.27	3.67	1	0.33	3
19	1	0.19	5.29	0	0.33	0	1	0.21	4.78	3	0.11	27	0	0.27	0	1	0.33	3
20	3	0.19	15.86	0	0.33	0	3	0.21	14.33	6	0.11	54	0	0.27	0	5	0.33	15
21	3	0.19	15.86	0	0.33	0	3	0.21	14.33	5	0.05	100	8	0.33	24	13	0.33	39
22	2	0.19	10.57	0	0.33	0	2	0.21	9.56	9	0.05	180	3	0.33	9	12	0.07	180
23	0	0.19	0	0	0.33	0	0	0.21	0	6	0.05	120	0	0.33	0	6	0.07	90
24	0	0.19	0	0	0.33	0	0	0.21	0	0	0.05	0	1	0.33	3	1	0.07	15
25	0	0.19	0	0	0.33	0	0	0.21	0	0	0.05	0				0	0.07	0