# Assessment of juvenile salmonid populations in two index reaches of McGarvey Creek, a tributary to the lower Klamath River, CA

## First year of investigations- 1998

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Juvenile salmonid populations were quantified above and below anthropogenic logjams in McGarvey Creek during September 1998. McGarvey Creek, a small coastal tributary to the lower Klamath River, supports up to four species of anadromous salmonids but historical anadromous habitat has been blocked by poor land management practices in the basin. Estimates of abundance and biomass were calculated prior to the treatment of these logjams in order to provide pre-project baseline data. Juvenile steelhead (*Oncorhynchus mykiss*) and juvenile coastal cutthroat trout (*0. clarki clarki*) were captured in the lower reach while only juvenile coastal cutthroat trout were observed in the upper reach. Densities and biomass values of comparable salmonid age classes were higher in the upper index reach (above logjams) (0.66 trout fry/$m^2$; 1.82g trout fry/$m^2$) than in the lower reach (0.34 trout fry/$m^2$; 0.98g trout fry/$m^2$). Condition factors were also calculated for specific age classes and compared between the respective reaches. Despite the higher densities observed in the upper reach, trout fry above the logjams had a significantly higher average degree of fitness than those enumerated in the lower index reach. Potential explanations include simple year-to-year population variations, interspecific competition for resources in the lower reach, and differences in food quantity/quality between the reaches. These index reaches will be re-visited after logjam treatment with spring and late summer sampling in order to discern seasonal and long-term trends of species abundance, density, and biomass, as well as to document post-project conditions.

## Introduction

The Yurok Tribe has utilized Klamath River fisheries resources for cultural, subsistence, and commercial purposes since time immemorial. The Klamath River once supported abundant and diverse anadromous fish runs. In the early 1900's, annual salmon runs in the Klamath River Basin were estimated to be in the hundreds of thousands (Rankel 1978, as cited in Trihey 1996). Current estimates of abundance, however, are a fraction of these once-bountiful fish runs. Anthropogenic activities and stochastic events over the past 150 years have contributed to these substantial declines primarily through the degradation of crucial tributary habitats for anadromous spawning and rearing.

In order to reverse downward trends of important anadromous species, the Yurok Tribal Fisheries Program (YTFP) has initiated a long-term restoration program in lower Klamath River tributaries. Initial restoration prioritization identified McGarvey Creek as a pilot watershed for implementation efforts. The McGarvey Creek drainage has experienced widespread habitat degradation from extensive timber harvesting operations and the construction of the Hwy 101 bypass. During the last 50 years, numerous hillslope failures and associated debris torrents have input excessive amounts of sediment and woody material directly to the stream channel, blocking or severely impeding fish passage especially in upper sections of the creek.

In conjunction with other restoration efforts such as logging road decommissioning and hillslope stabilization, YTFP plans on removing or altering logjams of anthropogenic origin in order to improve fish access. Pre- and post-project population estimates above and below restoration efforts will help to assess any changes in salmonid abundance, and continued annual index reach sampling will enable long term project evaluation. In addition, these data will enhance existing biological knowledge of resident vs. anadromous salmonid populations.

Salmonid abundance and biomass were estimated by electrofishing in two reaches of McGarvey Creek during September 1998. The lower sampling reach was located in a stream section accessible to anadromous fish and was representative of lower basin habitat. An upper reach was located above several logjams that likely block upstream migration of anadromous fish.

## Study Area

McGarvey Creek, a low-gradient 3rd order coastal stream, drains 8.7 $mi.^2$ and has a confluence with the Klamath River at river mile (rm) 6.4 (T13N, RlE, S24) (Figure 1). McGarvey Creek usually affords fish access to and from the mainstem Klamath for much of the year, with marginal access during "summer low-flows" (Voight and Gale 1998). At the time this sampling was conducted (September 1998), however, long stretches of dry channel were present both above and below the West Fork McGarvey Creek confluence.

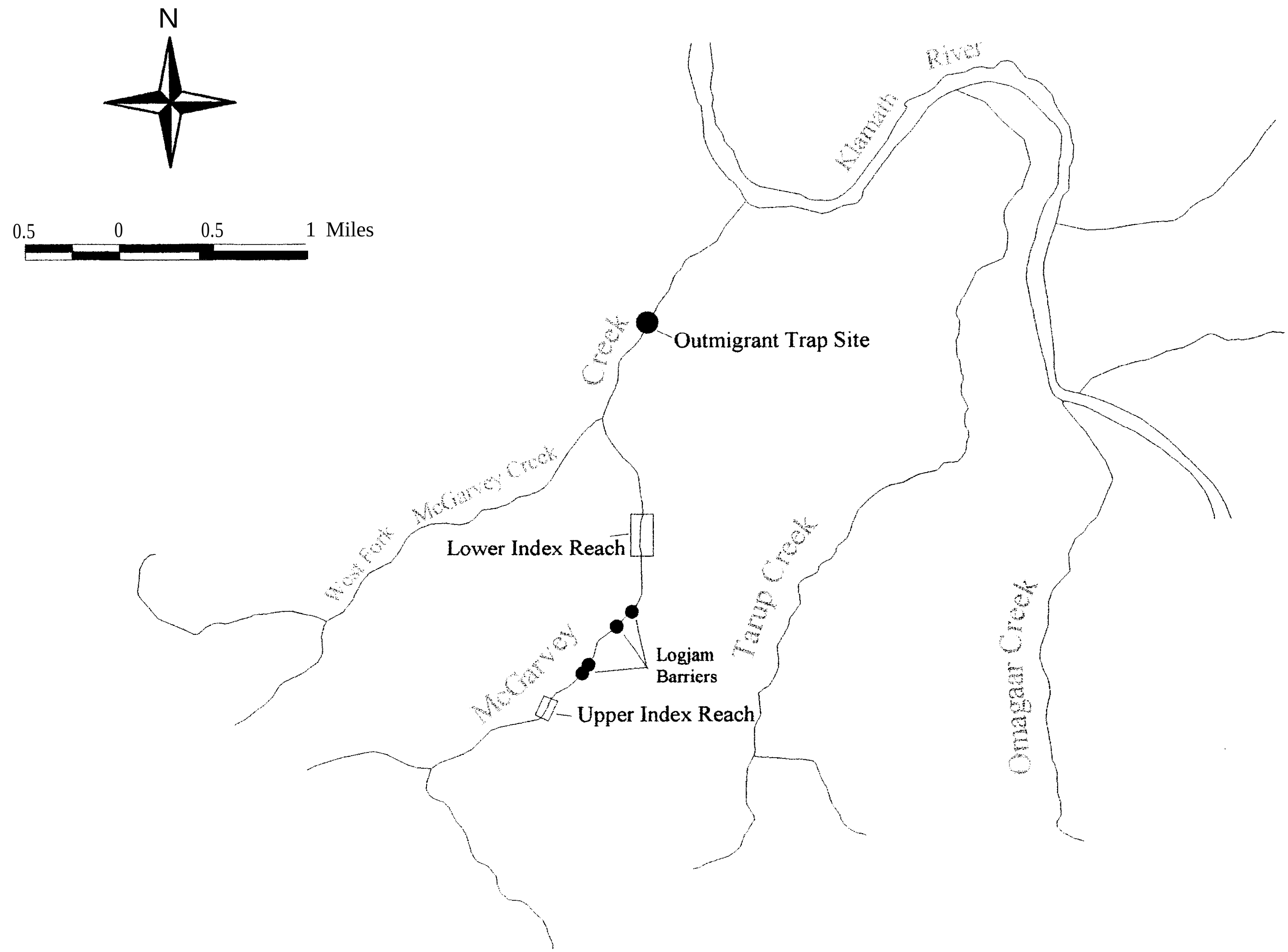


Figure 1. Location of electrofishing index reaches and outmigrant trap, McGarvey Creek, Lower Klamath River, California, 1998.

Four species of anadromous salmonids currently utilize McGarvey Creek: chinook salmon *(Oncorhynchus tshawytscha),* coho salmon *(0. kisutch),* steelhead trout (0. *mykiss*), and cutthroat trout (*0. clarki clarki* (Voight and Gale 1998). Other fish species residing in the drainage include Pacific lamprey *(Lampetra tridentata),* sculpin *(Cottis sp.),* speckled dace *(Rhinicthys osculus),* Klamath small-scale sucker *(Catostomous rimiculus),* and threespine stickleback *(Gasterosteus aculeatus).*

**Index Reach Habitat Characteristics**

Sampling reaches were selected in an attempt to best represent available instream habitats above and below the logjams. A qualitative pre-survey stream inspection was conducted, and the respective index sections were selected based on habitat diversity. Available habitat was quantified in each index reach prior to sampling using California Department of Fish and Game (CDFG) habitat typing techniques (Flosi et al. 1998). These habitat data were then compared with 1996 McGarvey Creek habitat mapping data to document whether index reaches were representative (YTFP habitat typing 1996). Reach boundaries were flagged to facilitate sampling in future years.

Lower Reach Characteristics

The lower McGarvey Creek index reach is a C-4 channel type (Rosgen 1994) with a total length of 199m and a surface area (excluding exposed substrate) of 390$m^2$ (Table 1). The average shelter rating in the pools was 34 on the CDFG scale of 0-300 (Flosi et al. 1998), reflecting the sparse amounts of non-complex cover types present. The average canopy closure for the reach was 94%, with deciduous vegetation comprising 99% of that total.

The lower index reach was generally representative of the lower McGarvey Creek basin, possessing values for average pool shelter rating, pool mean depth and canopy density/composition that were very similar to1996 YTFP habitat typing data. One important difference was the percentage of pools by stream length: 76% observed in the 1996 lower McGarvey reach (YTFP habitat typing 1996) vs. 45% in the 1998 lower index reach. The 1996 lower McGarvey Creek reach was 3443m in length (vs. 199m in 1998), however, and included habitat that was dry when 1998 sampling was conducted.

Upper Reach Characteristics

The upper index reach is a C-3 channel type, with a total length of 84.5m and a surface area (excluding exposed substrate) of 144 $m^2$ (Table 1). The upper index reach possessed habitat attributes that correlated well with YTFP 1996 data collected in the upper creek basin (above anadromous barriers). For example, percentage pools by stream length was found to be 54% during the 1996 survey (56% in 1998), and mean pool shelter rating was observed to be 29 in 1996 (19 in 1998) (YTFP habitat typing 1996).

Table 1. Summary of physical habitat characteristics for YTFP electrofishing index sections, McGarvey Creek, lower Klamath River, California, 16-l 7 Sept 1998.

| Reach location | Stream length (m) | Surface area ($m^2$) | Habitat composition (%) Riffle | Flatwater | Pool | Mean pool depth (m) | Mean shelter rating (pools) | Percent embedded |
|---|---|---|---|---|---|---|---|---|
| **Lower** | **199** | **390** | **3** | **52** | **45** | **0.37** | **34** | **26-50%** |
| **Upper** | **84.5** | **144** | **10** | **34** | **56** | **0.24** | **19** | **26-50%** |

**Methods**

Sampling was conducted using a Smith Root model 15-D POW electrofisher and followed protocols designed to meet assumptions of the removal/depletion method of population analysis (Zippin 1958). Block nets were placed at upstream and downstream reach boundaries. Total "s-time" (the number of seconds that the anode was 'on' during each pass) was recorded. Efforts were made to keep this time consistent between passes (equal sampling effort). Fixed electrofisher settings were used to maintain capture probabilities during sampling. Index reaches were rested for at least 90 minutes between passes to allow recovery time for fish not captured.

Captured fish were held in 5-gallon buckets in the shade. Fish densities in buckets were monitored closely, with fresh water replenished as necessary to reduce stress. Fish were tranquilized using tricaine methanesulfate (MS-222) (0.6g /10 liter water), identified, and measured (fork length in mm). An electronic scale was used to weigh each fish to the nearest 0.1 gm. Scales were collected from below the dorsal fin on both left and right sides of selected fish. After data were recorded for each pass, fish were placed in a floating live car until all sampling was completed. Fish were then released throughout the index reach, approximating the pre-sampling distribution as closely as possible.

Each scale sample was mounted separately between two labeled microscope slides and viewed with a microfiche reader. All samples were aged using methods similar to those described by Devries and Frie (1996) and Jearld (1983).

For population estimates, each species was separated into age classes based on scale analysis. Population estimates were calculated on 95% confidence intervals using the Zippin (1958) three-pass removal-depletion method. Fulton-type condition factors were calculated based on the equation "condition = $(\text{weight}/\text{length})^3 * 10{,}000$" (Anderson and Gutreuter 1983). The age-class specific mean condition factors were compared between upper and lower index sections using a "z-test" or a "2 sample t-test" depending on sample size (Zar 1984).

**Results**

- **Salmonid abundance and biomass**

Lower Reach

A total of 8 steelhead trout, 18 cutthroat trout, and 124 trout fry (age 0+ steelhead and cutthroat) were captured during the three-pass depletion conducted 16 Sept 1998 (Table 2). In addition, prickly sculpin *(Cottis asper)* and coastrange sculpin (C. *aleuticus)* were observed but not enumerated. Trout fry were defined as those trout less than 90 mm FL based on scale analysis and time of year. Although 90 mm FL is a somewhat arbitrary size break, this "best guess" was used to facilitate age class-specific population estimates.

Table 2. Three-pass electrofishing captures for two index reaches, McGarvey Creek, 16-17 Sept 1998.

| | **Pass 1**<br># fish captured | **Pass 2**<br># fish captured | **Pass 3**<br># fish captured |
|---|---|---|---|
| **Lower Reach** | | | |
| Trout fry (age 0+ stlhd/cutt)* | 85 | 26 | 13 |
| Steelhead (age l+) | 5 | 1 | 2 |
| Cutthroat (age l+) | 14 | 4 | 0 |
| Total salmonids | 104 | 31 | 15 |
| **Upper Reach** | | | |
| Trout fry (age 0+ stlhd/cutt)* | 64 | 23 | 5 |
| Cutthroat (age l+) | **25** | **3** | **0** |
| **Total salmonids** | **89** | 26 | 5 |

* Trout fry defined as those steelhead and cutthroat trout less than 90 mm FL.

Table 3. Estimated population size with 95% confidence interval for each salmonid age class in two electrofishing index reaches, McGarvey Creek, 16-17 Sept 1998.

| | actual # fish captured (n) | estimated pop'n size (N) | standard error (N) | 95 % C. I. (N) |
|---|---|---|---|---|
| **Lower Reach** | | | | |
| Trout fry (age 0+ stlhd/cutt)* | 124 | 131 | 4.59 | 124 to 140 fish |
| Steelhead (age l+) | 8 | 10 | 2.98 | 8 to 13 fish |
| Cutthroat (age l+) | 18 | 18 | 0.55 | 18 to 19 fish |
| Total salmonids | 150 | 158 | 4.66 | 150 to 167 fish |
| **Upper Reach** | | | | |
| Trout fry (age 0+ stlhd/cutt)* | 92 | 95 | 2.21 | 92 to 99 fish |
| Cutthroat (age l+) | 28 | 28 | 0 | 28 fish |
| Total salmonids | 120 | 122 | 1.71 | 120 to 125 fish |

* Trout fry defined as those steelhead and cutthroat trout less than 90 mm FL.

Age 0+ steelhead and cutthroat were grouped together as “trout fry”, but all age l+ salmonids were positively identified to species. Estimated population sizes (95% confidence interval) for trout fry, age l+ steelhead, and age l+ cutthroat trout were as follows: 124-140 fish, 8-13 fish, and 18-19 fish, respectively (Table 3).

Biomass estimates were calculated for each age class (Table 4). Although age 0+ trout fry were more numerous, age I+ cutthroat had greater biomass per unit surface area (1.03 $g/m^2$ vs. 0.98 $g/m^2$). The total biomass per unit for all salmonids in the lower index reach was 2.41 $g/m^2$.

Upper Reach

A total of 28 age l+ cutthroat trout and 92 age 0+ trout fry were captured during the three pass depletion conducted 17 Sept 1998 (Table 2). No other fish species were observed. The majority of fish measuring less than 90 mm FL appeared to be cutthroat trout, but were classified as age 0+ trout fry to maintain data collection consistency between index reaches. No steelhead/resident rainbow trout were captured. As was observed in the lower index reach, age 0+ trout fry were much more abundant than older salmonids. Estimated population sizes (95% C. I .'s for age 0+ trout fry and age 1+ cutthroat trout were as follows: 92 to 99 fish, and 28 fish respectively (Table 3).

Biomass estimates were calculated for age 0+ trout fry and age 1+ cutthroat (Table 4). Trout fry comprised an estimated 1.82 $g/m^2$ while age l+ cutthroat biomass was calculated at 3.34 $g/m^2$. The estimated biomass per unit area for all salmonids in the upper reach was 5.16 $g/m^2$.

Salmonid densities and biomass values were noticeably higher in the upper reach compared to the lower reach . For example, the estimated density of trout fry in the upper reach was 0.66 $fish/m^2$ while only 0.34 $fish/m^2$ in the lower index section. In addition, the estimated biomass for trout fry in the upper reach was 1.82 $g/m^2$ versus 0.98 $g/m^2$ in the lower reach. This pattern also held true for the estimated density and biomass of age l+ cutthroat trout.

Table 4. Estimated salmonid biomass values for two electrofishing reaches, McGarvey Creek, 16-17 Sept 1998.

| Species/Age-class | Estimated pop. size (fish) | Surface Area ($m^2$) | Estimated total biomass (gm) | Density (fish/ $m^2$) | Unit biomass ($g/m^2$) |
|---|---|---|---|---|---|
| **Lower Reach** | | | | | |
| Trout Fry (age 0+) | 131 | 390 | 384 | 0.34 | 0.98 |
| Steelhead (age l+) | 10 | 390 | 155 | 0.03 | 0.40 |
| Cutthroat (age l+) | 18 | 390 | 401 | 0.05 | 1.03 |
| **Upper Reach** | | | | | |
| Trout Fry (age 0+) | 95 | 144 | 262 | 0.66 | 1.82 |
| Cutthroat (age l+) | 28 | 144 | 481 | 0.19 | 3.34 |

- **Salmonid Condition Factors**

In order to describe the relative fitness of each fish captured, condition factors (weight/length ratio) were calculated for both reaches (Table 5). Since no age l+ steelhead were captured in the upper reach, specific age-class comparisons between reaches were only possible for age 0+ trout fry and age l+ cutthroat trout.

While the upper reach had almost four times the age l+ cutthroat density and more than three times the biomass than what was found in the lower reach, statistical analysis found no significant difference in condition factors for the fish in each respective locale (95% CI).

Age 0+ trout fiy, however, did possess significantly different condition factors between the two reaches. Like age l+ cutthroat, trout fry had higher density and biomass values in the upper reach. The condition factor for trout fry was also higher in the upper reach, and statistical analysis revealed that this was a significant difference.

Table 5. Salmonid condition factors for two electrofishing reaches, McGarvey Creek, 16-l7 Sept 1998.

| | Sample size | Mean condition factor | Standard deviation |
|---|---|---|---|
| **Lower Reach** | | | |
| Trout fry (Age 0+) | 124 | 0.114 | 0.017716 |
| Steelhead (Age l+) | 8 | 0.111 | 0.007951 |
| Cutthroat (Age l+) | 18 | 0.101 | 0.006881 |
| **Upper Reach** | | | |
| Trout fry (Age 0+) | 92 | 0.120 | 0.013596 |
| Cutthroat (Age l+) | 28 | 0.100 | 0.020195 |

## Discussion

The marked difference in salmonid density and biomass between the upper and lower YTFP McGarvey Creek index reach data supports similar qualitative observations made in other lower Klamath River tributaries. Although fish species diversity decreases progressively upstream in many area tributaries, electrofishing conducted in headwaters reaches often found more fish per unit area than what was observed in anadromous-accessible sections (Voight and Gale 1998).

Salmonid density and biomass estimates for each age-class in the upper reach were at least double the values seen in the lower index section (Table 4). Potential explanations include habitat variation, sampling time, and/or life history differences of resident vs. anadromous fish. Habitat quality was not appreciably better for salmonids in the upper index section based on the physical measurements taken, although food availability was not investigated. While the lower index reach had a lower percentage of pool habitat by stream length, (45% vs. 54% in upper section), the average shelter rating was higher for the pools in the lower section (34 vs. 19). Physical habitat variations were not likely the primary factors in the observed biomass differences.

YTFP McGarvey Creek index reach electrofishing was conducted in September, well after most anadromous smolts would have emigrated from the system. Migration to the sea for juvenile anadromous steelhead, cutthroat, and coho usually occurs in the spring (Meehan and Bjomn 1991; YTFP unpublished data). Thus, sampling time (September) and life history patterns may have been the primary reasons that the resident population (upper index reach) exhibited more than twice the total biomass per unit area than the salmonids in the anadromous section. In order to test this hypothesis, index reach sampling should also be conducted during spring months to observe whether such a difference in fish density and biomass exists year-round, or if this is a seasonal phenomenon.

Analysis of salmonid condition factors for the respective two reaches provided some unexpected results. One would expect that a reach with low relative fish densities (McGarvey Creek- 1998 lower reach) would have individuals with a higher degree of fitness (higher condition factors) than a reach with relatively high densities (1998 upper reach) given that resources were approximately equivalent. This hypothesis (lower fish densities equals higher fish fitness) was not reflected by the data.

Upper reach salmonids possessed condition factors that were equal or greater than the values observed in the lower reach. Aside from simple year-to-year variations in the populations, this phenomenon may be related to the fact that lower reach salmonids (summer “holdovers”) were exposed to competition for resources that upper reach (resident) fish were not. Interspecific competition with sculpin and other native species as well as intraspecific competition with anadromous smolts are factors that upper resident fish do not face. The possibility that the upper reach possessed superior food resources cannot be ruled out since food quantity/quality was not investigated.

Previous quantitative sampling in lower McGarvey Creek has been conducted by CDFG between 1988-1995 (McLeod 1995). The CDFG survey methods and sampling location are analogous with YTFP methods and the location of the lower index reach, thereby enabling direct comparison of data.

Since CDFG did not separate steelhead and cutthroat trout or distinguish age-classes of fish in their estimates, comparisons can only be made concerning total salmonid biomass per unit area. During six years of sampling, CDFG found definite year-to-year variation of salmonid biomass in their index reach. Total salmonid biomass in the CDFG index reach ranged from $2.61 g/m^2$ in 1988 to a low of $1.27 g/m^2$ in August 1993 (McLeod 1995). The 1988 total includes $0.94 g/m^2$ of coho salmon. YTFP calculated a total salmonid biomass of 2.41 $g/m^2$ in the lower McGarvey Creek index reach on 16 Sept 1998.

The YTFP total salmonid biomass value is similar to the CDFG August, 1995 observation of $2.20 g/m^2$ (McLeod 1995). These two observations are approximately equivalent since YTFP sampling occurred one month later in the season; additional salmonid growth would be reflected in the higher value of $2.41 g/m^2$. Although YTFP did not observe age 0+ coho salmon in the lower McGarvey Creek electrofishing index reach in 1998, coho emigrants were captured during 1997 & 1998 outmigrant trapping efforts (YTFP unpublished data).

Over time, projects like the McGarvey Creek index reach population estimates will quantify the biological response (if any) to specific restoration attempts. A one-time "snap-shot" assessment of fish populations would be misleading because of yearly fluctuations. Thus a "long-term" monitoring perspective is necessary, although the assessment period would vary with the type of restoration being monitored. In the case of the McGarvey Creek logjam alteration project, YTFP plans on continuing annual index reach population estimates for a minimum of five years.

In addition, this project will be expanded to assess fish populations in the two index reaches twice yearly, with sampling to be conducted in the spring as well as late summer. Sampling during the spring months will document conditions before all anadromous salmonids leave the system and thus will allow comparison to the late-summer fish community. Sampling in May will also establish a baseline for YOY over-summer production since most trout fry have yet to emerge by early May.

YTFP also plans on incorporating a fish-marking project in conjunction with the index reach population estimates. The application of a durable (lasts up to five years), and easily identifiable (color/reach specific) tag on fish in each index reach will provide a means to confirm fish movement upstream/downstream through the altered logjams. A tag that lasts for up to five years on a specific fish could be identified during future years sampling, and would be readily observable at YTFP's McGarvey Creek pipe trap or by CDFG during their annual Klamath River estuary sampling. Direct evidence of fish passage through altered logjams would not only provide invaluable feedback on restoration efforts, but also would enhance existing knowledge of salmonid migratory behavior.

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