Age and Growth of Coho Salmon and Steelhead Trout in Marin and San Mateo County, California



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Foreword

I worked for the Golden Gate National Recreation Area (GGNRA) during my one year internship in San Francisco, California, USA. GGNRA is a park that begins where the Pacific Ocean meets the San Francisco Bay. It surrounds the narrow entrance to the city's harbor offering a spectacular blend of natural beauty, historic features, and urban development. To the north and south of the Golden Gate bridge, GGNRA follows the Pacific shorelines creating a vast coastal reserve. (Appendix C, figure 1: map of GGNRA)

Darren Fong, the National Park Service aquatic ecologist, here in San Francisco and Louisette Zaninetti, Professor at the University of Geneva, Switzerland, in the "Sciences de la Terre" department were the supervisors of my research.

I was involved in the Coho Salmon and Steelhead Trout Restoration Project between Point Reyes National Seashore, GGNRA and Muir Woods National Monument.

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B. More about scale and tissue samples collecting:

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I. Summary:

Coho salmon and steelhead trout populations have declined significantly during the last decades in coastal streams of central California. These anadromous fish are particularly sensitive to the health of the stream where they were born.

One primary objective of the Coho Salmon and Steelhead Trout Restoration Project was to determine the well being of these two species within the Park. To reach this goal, the GGNRA did a fish population assessment during 6 years (1994-2000).

My research was part of this Project: I tried to determine the age of the fish for both species by using the scales reading method. Using this method, I then tried to answer these following questions:

- What age classes were present in streams which were part of the Restoration Project?
- What were the mean fork length (FL = length of the fish, from the tip of the jaw to the beginning of the tail) and the range of FL of each age class for both species in each creek?
- Was there a relationship between the fork length of coho salmon carcasses and the age of the fish?

Redwood and Olema were the only creeks that represented very well the different age classes for both coho and steelhead populations.
Most of the adult coho salmon returning to spawn in Redwood and Olema creeks were 1.2 (3 years old). These fish spent their first year in freshwater and their second and third year in saltwater. A few males were 1.1 (2 years old) when they came back for spawning purposes. Some coho spent 2 years in freshwater and one, two or even three years in the ocean.
I aged only two adult steelhead that were 1.2 and 2.1 (3 years old), the other 3 years old ones were 3+ ("resident" steelhead). Most of the juvenile steelhead aged were 1 year old (1+), some were younger than a year (0+), some were two years old (2+). The 2+ and 3+ age classes show that steelhead can stay more than one year in freshwater before going to the sea, even if a high number migrate after their first year.
Juvenile coho were present in three streams part of the Restoration Project, but because scales were rarely obtained, I only aged 8 coho that were 0+ and 1+. They were about the same size as the steelhead of the same age class.

"Restoration Project biologists have used 50 cm FL for separating 2 years old and 3 years old coho". One of the great value of aging the coho adults with scales comparing their fork lengths was to provide the means of checking the estimates of "jacks" (males 1.1) and "jills" (females 1.1). The coho 1.2 (3 years old) had a mean FL of 58.5 cm FL for Redwood and of 63 cm FL for Olema. The males 1.1 (2 years old) had a mean FL of 41.7 for Redwood and of 44.7 for Olema (I did not age any female 1.1). Based on these results, we can use "50 cm" as the "cutoff point" to differentiate the 2 years old from the 3 years old (as suggested by Shapavalov and Taft's work), for both creeks.

The juvenile steelhead in Redwood and Olema creeks had very similar mean FL for the same age classes. On the other hand, the steelhead aged in smaller creeks which were part of the Restoration Project appeared to be bigger than the ones in Redwood and Olema for the same age classes, though the scales were not obtained randomly.

There was a relationship between the fork length of the coho salmon carcasses and the age of the fish. That is why I used the Fraser-Lee method to back-calculate the lengths of coho at 1 year old. I found out that this method slightly overestimated the FL of the coho at 1 year old for Redwood Creek.

II. Introduction:

A. Outline of the Life History of Coho Salmon and Steelhead Trout:

❖ Generalities:

The steelhead trout (*Oncorhynchus mykiss*) and the coho salmon (*Oncorhychus kisutch*) are two of the most important fish found along the Pacific Coast of North America. Both the coho salmon and the steelhead trout are members of the Family Salmonidae, which includes such groups as the trout, salmon, charr, and whitefish.

Generally, the salmonids are inhabitants of cool, clear waters in the temperate and boreal regions of the world. The steelhead and the coho are very similar. They are both anadromous fish, which means that they ascend rivers from the sea for spawning purposes. All coho salmon die right after their first spawning, on the other hand the steelhead trout are biologically capable to spawn more than once. (Appendix A: More about the life history of both species concerning the migration, the spawning process and the hatching process)

B. Coho Salmon and Steelhead Trout Restoration Project :

1.) Why was this project important?

Coho and Steelhead are important **biologically**, **economically** and **aesthetically**:

- **biologically:** they are good indicators of the health of aquatic ecosystems. Indeed, they return in coastal streams where they can find a high diversity of habitats, in order to find a good spot to spawn (the eggs have to be well oxygenated). They are not found in streams were habitats are not diverse (e.g. flood control channels)

- **economically**: they are good for the economy. "Coho salmon fishing used to bring in about 100 million dollars a year to the U.S. economy" (Action Alerts: Pacific Rivers Council Files Formal Request to give all Northern Coho Essential Protection, April 1997)

- **aesthetically:** they are part of the history of coastal streams in central California. For example, people come from all over the world to see the adult coho salmon and steelhead trout returning to spawn in Redwood Creek (Muir Woods National Monument).

Unfortunately, spawning populations of coho salmon and steelhead trout have declined significantly during the last decades in coastal streams of central California, an estimated 46 % of California's coho populations are extinct.
Recently, the National Marine Fisheries Services listed both steelhead trout and coho salmon as threatened. "The good news is that these fish are widely distributed along the north coast, the bad news is that not very many of them are left", said Jim Lecky, federal fisheries official (for the Newspaper San Francisco Chronicle, January 2000).

In fact, there are numerous factors contributing to local declines in anadromous fish runs like:

- dam construction
- historic removal of large woody debris from streams
- accelerated sedimentation as a result of logging and poor road construction
- agricultural and grazing practices
- introduction of non-native species
- water withdrawals
- habitat alteration
- over-harvesting
- severe droughts in the late 1970's and 1980's
- periodic flooding
- poor ocean productivity during El Niño events and probable loss of genetic integrity and diversity.

All these factors can have affected the steelhead and coho populations. Some of them are uncontrollable like El Niño or severe droughts but most of them can be reversed (dam construction can be removed, habitat can be restored…)
A Coho Salmon and Steelhead Trout Restoration Project (CSSTRP) was started in 1994 to protect these two species in various creeks within the National Park Service (NPS).

2.) What was this project about?

This long-term restoration project (1994-2000) was created to restore the streams where coho salmon and steelhead trout populations come back to spawn within the NPS lands.

The objectives were:

- To conduct habitat analyses including watershed assessment and instream habitat conditions to understand the past and present processes that may influence the production of anadromous fish
- To conduct a fish population assessment including analysis of historic salmon and steelhead conditions, current population abundance and distribution
- To develop and implement a prioritized fish and habitat restoration plan

- To develop and implement a fish and habitat monitoring plan
- To provide accurate and informative data to the interested public and local park resource managers
- To provide opportunities for community involvement, education, and interpretation

One of the primary objectives was to determine the well being of both species. To reach this goal, Darren Fong (the aquatic ecologist for GGNRA) helped by fishery biologists from Point Reyes National Seashore, community volunteers and interns (I was one of them) did a fish population assessment during these last 6 years. I was involved in this particular project for my research about the coho salmon and steelhead trout for one year (1999-2000).

This fish population assessment had three main goals:

I. To determine the current abundance and the distribution of adults and juveniles for both species
II. To determine the age of the fish by using scale samples (I focused my research on this particular goal).
III. To determine the genetic diversity for both species by collecting tissue samples

3.) Description and objectives of my research:

From 1994 to the present, CSSTRP collected scale and tissue samples from coho salmon carcasses in Redwood Creek, Olema Creek and a few other creeks.

These samples served two purposes:

1) to provide genetic material for future analyses
2) to provide a means of accurately aging fish

More over, since 1997, CSSTRP conducted habitat and fish surveys in streams where juvenile steelhead trout and coho salmon were present. Typical information recorded from the fish surveys included species identification and length. They (CSSTRP) also collected scales from a subset of fish to again provide a means of accurately aging fish.

Objectives for adult coho salmon:

- To archive and mount the scales from adult coho salmon collected in winter 1999-2000.

- To determine the age distribution of adult coho salmon (by sex) returning to spawn in Redwood Creek, in Olema Creek and in a few other creeks (using the scales reading method).

- To determine the relationship between the fork length of coho salmon carcasses and the age based on scale readings (using the back-calculation method).

Objectives for juvenile coho salmon and steelhead trout:

- To archive and mount the scales from juvenile steelhead and coho collected in summer 1999.

- To determine the age distribution of juvenile coho and steelhead from surveys conducted in Redwood, Olema and a few other creeks.

III. Methods:

A. Study area information:

❖ **Description of the creeks which were part of the Project:**
(Appendix C, figure 2: Coho and Steelhead Restoration Project watersheds)

Redwood Creek:
(Appendix C, figure 3: Redwood Creek Watershed / figure 4: Redwood Creek with its 3 spawning reaches)

Redwood Creek is particularly significant because of its intact native population of coho salmon. This creek is located in Marin County, about 10 miles north of San Francisco. It originates at an altitude of 2000 feet on the southern slopes of Mount Tamalpais, wanders through Mount Tamalpais State Park, Muir Woods National Monument, to Muir Beach. Redwood Creek Watershed can support a high diversity of life thanks to its microclimate and its variety of habitats. Indeed, northern California's coastal climate is typically Mediterranean, with sunny-dry springs and falls, rainy winters, and foggy summers. This way, summers are mild due to the fog and the dense forest of redwoods in Muir Woods. The temperature is always cool enough to support life in the surroundings.

One famous American writer (Mark Twain) said: "The coldest winter I've ever had, was the summer I spent in San Francisco." Indeed, as soon as the temperature inland is much warmer than the water temperature, it gets foggy in the Bay Area (e.g. San Francisco) and along the coast (e.g. Muir Woods).
The stream itself has a very high diversity of habitats, like riffles, pools, cascades, and flatwater, which can all be found throughout the creek length and can provide "homes" for a rich biological life.
The National Park Service (NPS) conducted annual surveys along 6.7 km of Redwood Creek for coho salmon and steelhead trout. I will make frequent reference to this particular stream, where I conducted most of my fieldwork.

Olema Creek:
(Appendix C, figure 5: Olema Creek Watershed / figure 6: Olema Creek with its 7 spawning reaches)

Olema Creek, which is the main tributary of Lagunitas Creek is located in Point Reyes (north of Redwood Creek). This creek receives some current protection from grazing activities, but had been severely altered by past land use practices including impoundment and grazing. Olema Creek benefits also from the same coastal northern California climate and has to be protected because of its high diversity of biological life. Annual surveys were conducted by the NPS along 17.6 km of Olema Creek for coho salmon and steelhead trout.
Blueline Creek, Giacomini Creek and **Quarry Gulch** are tributaries of Olema Creek. They are shown on figures 5 and 6.
Devil's Gulch, which is a tributary of Lagunitas Creek is shown in appendix C, on figure 7: Lower Lagunitas Creek Watershed.

Eskoot Creek: is located near the town of Stinson Beach and is a tributary to Bolinas Lagoon. (Appendix C, figure 8: Eskoot Creek Watershed)

West Union Creek: is a tributary of San Francisquito Creek in San Mateo County, near the town of Woodside. (Appendix C, figure 9: West Union Creek)

B. Age and Growth: description of analyses

Introduction:

Although the words **"age and growth"** are commonly used throughout fisheries, we rarely stop to consider what they mean. **Age** refers to some quantitative description of the length of time that an organism has lived, whereas **growth** is a measure of the change of the body. Both age and growth can be measured across intervals that span a wide temporal range, from hours to days to years. Although age and growth describe different aspects of a fish, they are closely related and typically used together in the field of fisheries (Devries and Frie, 1996).

Objectives:

Knowing the average size and the size variation at different ages over several years is important for basic comparison studies. Differences in these may be normal or may reflect a change in the suitability of the environment.
The CSSTRP collected scale and tissue samples for six years (1994-2000) from adult coho salmon carcasses and for three years (1997-2000) from juveniles of both species. Darren Fong gave me the opportunity to answer a lot of questions related to the age of the coho salmon and the steelhead trout in streams restored by the Golden Gate National Recreation Area, by using the scales reading method.

Method used to age the fish:

Many different techniques can be used to age a fish. We could have used otoliths or other bony structures to determine the age of the fish, but we would have had to kill them. We chose the scales reading method because it does not require hurting or killing any fish and it is relatively easy to collect scales.

1.) Scale and tissue samples collecting:

Purposes of scale samples:

a) To determine the age of adult coho salmon
b) To determine the age of juvenile coho salmon and steelhead trout

Purpose of tissue samples:

- To determine the genetic diversity for both species (by Bodega Marine Lab[1])

Tissue and scale samples from adult coho salmon were collected during winter spawner surveys (Appendix B: More about scale and tissue samples collecting; description of a winter spawner survey for adult coho salmon and criteria usually observed to recognize an adult coho from an adult steelhead).
Tissue and scales samples from juvenile coho and steelhead were collected during electrofishing surveys from mid-summer through early fall (Appendix B: More about scale and tissue samples collecting; description of electrofishing surveys for juveniles of both species and criteria usually observed to recognize a juvenile coho from a juvenile steelhead). In addition, scales were collected from steelhead and coho smolts during their spring-summer outmigration.

[1]Bodega Marine Lab: the lab where we sent the tissue samples to be analyzed.

2.) Scales Mounting:

Purposes:

a) To preserve scales for many years
b) To select which scales are good for aging the fish

Method:

Tissue and scale samples (from each fish) that were collected during the surveys, were placed in a folded piece of paper and dropped into an envelope.

1) I labeled each envelope which contained scales for one fish:

❖ By chronological order (by sample date) for each creek. I put on the envelope the two-letter abbreviation of the name of the creek , followed by an identification number (= ID number)
I labeled the envelope with the first sample date, with the lowest ID number and the envelope with the following date, with the next ID number (Appendix C, figure 10: fish scale envelope)

2) I checked the envelope for scale and tissue samples:

❖ If I found scales inside the envelope, I followed this procedure:

- First, I transferred the scales from the envelope to a petri dish. Then, I put the petri dish under a microscope to look at the scales in detail
- I used 15x magnification
- If some scales were dirty or curling, I added some water to remove the parts of tissue or to make them flat
- Then, I picked 6 good scales (meaning non-regenerated[1]) with tweezers and I put them on one side of the slide (Appendix C, figure 11: myself, looking at non-regenerated scales to mount them on a slide)
- I oriented each scale on the slide with its anterior field (with circuli[2]) looking up and its posterior field (with pigment) looking down
(Appendix C, figure 12: scale with anterior field up (with circuli) and posterior field down (dark area = with pigment))

[1]regenerated scales: new scales that grow to replace lost scales.
[2]circuli (singular: circulus): dark concentric lines that appear on the scales; synonym: rings.

3) I mounted 6 scales on a slide:

- If some samples had less than 6 scales, I mounted them all
- I tried to mount only good scales, meaning non-regenerated scales

4) I mounted scales from two fish per slide (Appendix C, figure 13: slide with scales from 2 different fish):

- I drew a dividing line with a red marker on the middle of the slide where the scales were to be mounted in order to separate the scales from each fish.
- I tried to mount the scales close to the line and away from the edges in order to keep the scales close to one another
- I placed the fish ID number next to each set of scales directly on the slide

After having done these manipulations for 2 different fish, I placed another slide on the top of the slide containing the scales and I taped the two slides together, making sure that the tape didn't obscure the viewing of the scales.

Finally, I organized the envelopes in a box and the slides in a slide holder for each creek, by chronological order. (Appendix C, figure 14: one of the slide holder for Redwood Creek)

3.) Scales reading: interpretation of a scale

Purposes:

a) Age determination for juveniles of both species (freshwater part). We can find out:
- how many years did the fish stay in the stream before going to the ocean

b) Age determination of adult coho salmon (difference between the freshwater part and the sea). We can find out:
- how many years did the fish stay in freshwater before it migrated down to the ocean
- how many years did the fish stay in the ocean before it went back to the stream for spawning purposes

c) "Resident" steelhead trout (only freshwater part). We can find out:
- how many years did the fish stay in the stream (it might stay in the stream for its whole life!)

Method:

After having mounted the scales on a slide, I examined at least 2 good scales for each fish with a microfiche reader (magnification 36x) and a magnifying glass.
(Appendix C, figure 15: microfiche reader used to read a fish scale).
The scale's type of coho salmon and steelhead trout is cycloid[1]. I read the anterior field (with circuli) to determine the age of the fish.

Material:

- microfiche reader (magnification 36x)
- magnifying glass
- ruler
- pencil and datasheet

[1]Cycloid scale: scales have circuli which extend completely around the scale edge as growth continues.

Procedure:

First, I put the slide under the microfiche reader with the anterior field looking up and the posterior field looking down on the screen. Using a magnifying glass, I looked at all the scales I had for one fish (about 6 scales) and I chose one or two really good scales, meaning non-regenerated to determine the age of the fish (Appendix C, figure 16: regenerated scale / 17: non-regenerated scale).

For each good scale, I recorded on the datasheet:
(Appendix C, figure 18: datasheet used to age the fish = fish scale form)

1. the ID (the 2 letters abbreviation for the creek and the number written on the envelope and on the slide)
2. the date sampling
3. the fish length
4. the specie
5. the sex (only for adults)
6. the radius length: I used a ruler to measure in millimeters the length from the focus[1] to the edge of the scale at 90 degree. (Appendix C, figure 19: fish scale of a 3 years old coho)
7. the annulus[2] length: I measured the length of each annulus with the ruler in millimeters, also at 90 degree (refer to the paragraph: age determination). The length of all the annuli together should correspond with the length of the radius.
8. the estimated age: I counted the number of annuli (refer to the paragraph age notation)
9. the freshwater part: the length of the freshwater part in millimeters (= stream zone[4])
10. the ocean part: the length between the last stream annulus and the last sea annulus. This includes the sea zone[5] and the run-out[6]

[1]Focus: the point on the scale that is the center of the concentric lines; synonymous: nucleus.
[2]Annulus: the theoretical boundary between two successive annual zones[3].
[3]Annual zone: a concentric region of the scale referring to a complete year of life.
[4]Stream zone: the period spent in freshwater up to the last stream annulus.
[5]Sea zone: the period spent in the sea up to the last sea annulus (it may include time spent in freshwater as an adult returned to spawn).
[6]Run-out or also called Spring growth: a period of intermediate growth between the last stream annulus and the start of the sea growth (period often spent in a lagoon situated at the end of the stream, before the junction with the ocean)

Age determination:

The determination of the age of a fish is based on the number of annulus found on the fish scale. (Appendix C, figure 19: fish scale of a 3 years old coho)

Criteria used to identify an annulus:

The transition between one annual zone to the next is identified by the presence of a crossing-over between the circuli. The crossing-over is identified by the first continuous circulus of the new growth season cutting over the last incomplete circulus of the preceding season. (Appendix C, figure 20: crossing-over found where the first continuous circulus is cutting over the last incomplete circulus of the preceding season)
The crossing-over can always be found in two different areas of the scale: at 2 o'clock and 10 o'clock. (Appendix C, figure 21: two different areas where a crossing-over can be found)
When all the annuli are identified, the age of the fish can be determined.

Age Notation:

For juveniles:

The juvenile scales have only the freshwater zone.

- **0+ :** the fish is younger than a year, the first annulus is not present. We can see circuli, with the difference between the spring-summer band[1] and the winter band[3]; but no crossing-over is identified.
- **1+ :** the fish is one year old, the first annulus is present. The crossing-over is identified. The + means plus-growth[4]: a second year of life has not been completed.
- **2+ :** the fish is two years old, two annuli are present. Two crossing-over are identified. The + means plus-growth: a third year of life has not been identified.

[1]spring-summer band: light band[2] composed of wide-spaced ciculi because of the rapid growth during the warmer period and abundant food.
[2]Band: a concentric region of the scale, which is formed during a particular time of a year.
[3]Winter band: dark bands composed of narrow-spaced ciculi because of the slow growth during the cold period.
[4]Plus-growth (+): a region of wide spaced circuli, which may follow the last annulus of the sea zone for adults or the last annulus of the stream zone for juveniles. A full year of growth has not been completed.

For adults:

The adult scales have the freshwater zone and the sea zone. The only exception is for the "resident" steelhead. Indeed, they can stay their whole life in freshwater. (The age notation for a 3 years old "resident" steelhead would be: **3+**).
Otherwise, two numbers are used to age the adults:

The first number is the number of annuli in the stream zone.
The second number is the number of annuli in the sea zone.
(Shapavalov and Taft, 1954)

- **1.1 :** the fish is two years old. Two annuli are present, the first annulus is identified in the stream zone and the second is identified in the sea zone.
- **1.2 :** the fish is three years old. Three annuli are present, the first annulus is in the stream zone and the second and third are in the sea zone.
- **2.1 :** the fish is three years old. Three annuli are present, the first and the second annuli are in the stream zone and the third annulus is in the sea zone.
- **2.2 :** the fish is four years old. Four annuli are present, the first and the second annuli are in the stream zone and the third and fourth annuli are in the sea zone.

Other observations:

By looking at an adult scale, we can find a spawning mark[1]. It's usually a "strange mark" in the sea zone, the circuli are not concentric in this particular area. I've seen only once a spawning mark on a 2.1 steelhead scale from Blueline Creek. I was able to see a spawning mark on this scale, because steelhead can come back to spawn in the stream and can go back to the ocean many times. We cannot see a spawning mark on an adult coho scale, for the reason that the salmon die right after it spawned. We often see some erosion[2] on the edge of an adult coho scale. The salmon are so tired when they come back to spawn, and don't have a lot of energy left that they sometimes consume their body to survive until the last minute of their life.

[1]Spawning mark: erosion associated with the spawning migration.
[2]Erosion: resorption of the edge and sometimes the surface of the scale.
(Appendix C, figure 22: scale of a 1.1 coho with erosion)

IV. Results:

A. Age classes present in streams which were part of the Restoration Project:

I aged 510 fish from all the creeks which were part of the Restoration Project.
(Appendix D, table 1: summary of the fish aged for each creek)

Redwood and Olema were the only creeks that represented very well the different age classes for both coho and steelhead populations. Most of the adults salmon returning to spawn in Redwood and Olema creeks were 1.2 (3 years old) and a few males were 1.1 (2 years old). Two coho were 2.1, three were 2.2 and one was 2.3. I only aged two steelhead that were 1.2 and 2.1 years old, the other three years old ones were 3+ ("resident"). Most of the juvenile steelhead aged were 1 year old (1+), some were younger than a year (0+), some were two years old (2+). Juvenile coho were present in three streams part of the Restoration Project, but because of a small number of scales, I only aged 8 coho that were 0+ and 1+. They were about the same size as the steelhead of the same age class.
In fact, Redwood was the creek that represented the best the two populations of coho salmon and steelhead trout, with 5 different age classes (life history strategies) for the adult coho and 4 for the juvenile steelhead. Olema represented well both populations also, with 4 different age classes for both species.
The juvenile steelhead were well represented in Blueline, Giacomini, Quarry Gulch and West Union creeks. Devil's Gulch with only 8 adult coho aged and Eskoot with only one juvenile steelhead aged were not representative of a population.
(Appendix D, table 2a and 2b: summary of the different age classes found in each creek)

Table 3: Percentage of the different age classes (life histories strategies) for adult coho (co), juvenile steelhead (sh) and "resident" steelhead (3+) in Redwood and Olema creeks (1994-2000).

Adult co age class	Redwood (%)	Olema (%)
1.1	23	20.5
1.2	70.5	75
2.1	1.6	2.25
2.2	3.3	2.25
2.3	1.6	0

Juvenile sh age class + "resident" sh	Redwood (%)	Olema (%)
0+	7.4	41.6
1+	69.8	50
2+	20.1	8.4
3+	2.7	0

B. Mean fork length and range of fork length of each age class in each creek:

Knowing the age of the fish, I classified all the adult co/sh and the juvenile co/sh, by creek / age class / fork length (FL) on different tables. Then, I calculated the mean FL of the main age classes for each creek. I did not use the data of the two adult steelhead and of the few juvenile coho because of the fact that such a low number would not be representative of a population.

- **Mean fork length and range of FL for 1.1 and 1.2 coho in Redwood and Olema:**

The males that came back in both creeks at 2 years old were between 40 and 50 cm FL, with a mean FL of 41.7 for Redwood and of 44.7 for Olema. These 2 years old fish were smaller than all the fish of both sexes that were 3 years old. Indeed, the 3 years old ones were usually between 50 to 80 cm FL, with a mean FL of 58.5 for Redwood and of 63 for Olema. (Appendix D, graphs 1 and 2: length frequency of coho 1.1 and 1.2 in Redwood Creek, 1994-2000/ and to graphs 5 and 6: length frequency of coho 1.1 and 1.2 in Olema Creek, 1995-2000)

Mean fork length of 1.1 and 1.2 age classes for the coho returning to spawn in Redwood Creek (Appendix D, table 4: FL of adult coho in Redwood Creek, 1994-2000)

Age class	n	Mean FL(cm)	Range of FL (cm)
1.1	13*	41.7	40-45
1.2	42*	58.5	50-75

(*: 13* = 14 fish were aged, but only 13 FL were recorded / 42* = 43 fish were aged, but only 42 FL were recorded)

Mean fork length of 1.1 and 1.2 age classes for the coho returning to spawn in Olema Creek (Appendix C, table 5: FL of adult coho in Olema Creek, 1995-2000)

Age class	n	Mean FL(cm)	Range of FL (cm)
1.1	7*	44.7	40-50
1.2	30*	63	50-80

(*: 7* = 9 fish were aged, but only 7 FL were recorded / 30* = 33 fish were aged, but only 30 FL were recorded)

The mean FL for 1.1 and 1.2 coho calculated above were for all years together. Now, to see if there was a difference in FL between different years within a creek, I can not use the mean FL of an age class for each year because of the fact that I only aged a part of the population. That is why I used non-parametric statistics tests (Elliott, 1971):

- Kruskal-Wallis test: for making a comparison between 3 or more samples
- Mann-Whitney U-test: for making a comparison between 2 samples.

I used the Kruskal-Wallis statistic test to see if there was a significant difference in FL for the coho 1.1 and 1.2 between all the winters in Redwood Creek (from 1994 to 2000) and in Olema Creek (from 1995 to 2000).

Table 6: Kruskal-Wallis test for coho 1.1 in Redwood Creek (1996-1999)
Kruskal-Wallis test (at 0.05 significance level, chi-square=5.99, with 2 degree of freedom, p>0.05)

winters	n	mean rank
96-97	4	10.13
97-98	6	4.77
98-99	3	7.33

There was no significant difference in FL for the coho 1.1 in Redwood Creek between all the winters (1996-1999).

Table 7: Kruskal-Wallis test for coho 1.2 in Redwood Creek (1994-2000)
Kruskal-Wallis test (at 0.05 significance level, chi-square=11.4, with 5 degree of freedom, p=0.04)

winters	n	mean rank
94-95	12	27.63
95-96	9	23.22
96-97	4	30.25
97-98	5	15.6
98-99	11	13.86
99-00	1	11

There was a significant difference in FL for the coho 1.2 in Redwood Creek between all the winters (1994-2000).

Table 8: Kruskal-Wallis test for coho 1.1 in Olema Creek (1995-2000)
Kruskal-Wallis test (at 0.05 significance level, chi-square=2.8, with 3 degree of freedom, p=0.42)

winters	n	mean rank
95-96	1	3
97-98	4	3.25
98-99	1	5
99-00	1	7

There was no significant difference in FL for the coho 1.1 in Olema Creek between all the winters (1995-2000).

Table 9: Kruskal-Wallis test for coho 1.2 in Olema Creek (1995-2000)
Kruskal-Wallis test (at 0.05 significance level, chi-square=3.0, with 3 degree of freedom, p=0.4)

winters	n	mean rank
95-96	5	17.3
97-98	13	17.12
98-99	6	10.08
99-00	6	15.92

There was no significant difference in FL for the coho 1.2 in Olema Creek between all the winters (1995-2000).

Unusual conditions that could have had a possible impact on the size of the fish:

By looking at the graphs 1,2 for Redwood I noticed that for the winter 97-98, I aged two 1.2 coho that were 40 and 45 cm FL. These fish were about the same size as the 1.1 (2 years old). Thus, I used the Mann-Whitney U-test to see if there was a significant difference in FL between the population of 1.2 that came back in winter 97-98 and all the other winters.

Table 10: Mann-whitney U-test for 1.2 of the winter 97-98 and all the other winters for Redwood Creek
Mann-Whitney U-test (at 0.05 significance level, p=0.017, Z=2.389)

winters	n	mean rank
<>97-98	31	24.21
97-98	11	13.86

There was a significant difference in FL for the 1.2 of the winter 97-98 and all the other winters. Indeed, the 1.2 of 97-98 were significantly smaller than the 1.2 of all the other winters. One reason that could explain this is **El Niño**[1].

[1]**El Niño** was originally recognized by the fishermen off the coast of South America as the appearance of unusual warm water in the Pacific ocean, occurring near the beginning of the year. El Niño means "The Little Boy" or "Christ child" in Spanish. This name was used for the tendency of the phenomenon to arrive around Christmas.

The winter 97-98 was a strong El Niño year. The sea surface was about 8 degrees C higher than normal. This warm ocean temperature certainly had a big impact on the size of the fish. Indeed, fish might not have found enough food, because of a low ocean productivity. When the water warms up, nutrients needed for the production of phytoplankton (algea) - including phosphorous, nitrogen and silicon – drop down. When phytoplankton production decreases, tiny invertebrates organisms called zooplankton also decreases. Because salmon feed on zooplankton, they certainly have suffered accordingly and this might be one reason that could explain why the fish found in Redwood Creek in winter 97-98 were significantly smaller than the ones of all the other winters.

Another unusual year was the winter 99-00 for both creeks. Indeed, I aged only one adult coho from this winter in Redwood and 8 in Olema. Just a few adult coho came back in both streams to spawn. The heavy rain came only in February to destroy the sandbar (area where the freshwater joins the ocean). We believe that the adults waited too long in the ocean and might have been eaten by seals or other predators. They also might have chosen another creek not closed by a sandbar for their upstream migration. Another possibility would be that these fish that were supposed to come back to spawn this particular year are going to wait until next winter.

Determination of 2 years old and 3 years old:

One of the great values of aging the coho adults and looking at their fork length was to provide the means of checking the estimates of "jacks" (males 1.1) and "jills" (females 1.1). CSSTRP has been using 50 cm in the field to separate 2 years old from 3 years old. Based on scales reading data, I wanted to see if "50 cm" could be used as the "cutoff point" to differentiate the 2 years old from the 3 years old, in Redwood and Olema creeks. Thus, I checked how many coho 1.1 were >= 50 cm FL for both creeks (percentage of error for 1.1) and how many coho 1.2 were < 50 cm FL (percentage of error for 1.2).

Table 11: number of coho 1.1 and 1.2 < or >= 50 cm FL for Redwood Creek:

Stream	age	n < 50 cm FL	n >= 50 cm FL
Redwood	1.1	13	0
	1.2	4	38

The percentage of error for 1.1 was 0 %, they were all <50 cm (FL).
The percentage of error for 1.2 was 9.5 %, 4 were <50 cm (FL) and 38 were 50 cm (FL) or bigger.

Table 12: number of coho 1.1 and 1.2 < or >= 50 cm FL for Olema Creek:

Stream	age	n < 50 cm FL	n >= 50 cm FL
Olema	1.1	6	1
	1.2	1	29

The percentage of error for 1.1 was 16.6 %, 6 were < 50 cm FL and only one was >= 50 cm FL.
The percentage of error for 1.2 was 3.4 %, only one was < 50 cm FL and 29 were 50 cm FL or bigger.

We can definitely use "50 cm" as "the cutoff point" to differentiate the 2 years old from the 3 years old for both creeks. Indeed, the 2 years old in Redwood Creek were 100 % of the time less than 50 cm and the 3 years old were 90.5 % of the time 50 cm or more.
For Olema Creek, the 2 years old were 83.4 % of the time less than 50 cm and the 3 years old were 96.6 % of the time 50 cm or bigger.

- **Mean fork length and range of fork length for juvenile and "resident" steelhead in Redwood and Olema:**

The steelhead 0+ (younger than a year) were between 60 mm and 120 mm FL, with a mean FL of 91.3 for Redwood and 95.63 for Olema. The 1+ were between 90 mm and 160 mm FL, with a mean FL of 121.3 for Redwood and of 116.08 for Olema. The 2+ were between 130 mm and 200 mm FL, with a mean FL of 157 for Redwood and of 175.83 for Olema. Only one 2+ was 250 mm FL, this fish found in Redwood Creek was considered as an exception. The 3+ "resident" were between 190 and 250 mm FL, with a mean FL of 219.5. (Appendix D, graph 4: length frequency of sh 0+/1+/2+/3+ in Redwood Creek, 1997-2000/ and to graph 7: length frequency of juvenile sh 0+/1+/2+ in Olema, 1998-1999)

Mean fork length of each age class for the juvenile and "resident" steelhead in Redwood Creek (Appendix D, table 13: FL of juvenile and "resident" steelhead in Redwood Creek, 1997-2000)

Redwood	Age class	n	Mean FL (mm)	Range of FL (mm)
	0+	10	91.3	60-110
	1+	101	121.3	100-160
	2+	20	157	130-180
	3+	4	219.5	190-250
Big Lagoon	0+	1	91	90-100
	1+	3	115	100-140
	2+	10	158.4	130-190

Mean fork length of each age class for the juvenile steelhead in Olema Creek (Appendix D, table 14: FL of juvenile steelhead in Olema Creek, 1998-1999)

Age class	n	FL (mm)	Range of FL (mm)
0+	30	95.63	70-120
1+	36	116.08	90-150
2+	6	175.83	140-200

The 3+ adult steelhead found in Redwood were not very big compared to a fish of the same age that would have already spent some time in the ocean (1.2). Indeed, the fish can get much bigger in the ocean because they find more food. This difference of the size between a 1.2 and a 3+ was observed on the scales, too.
The circuli were much more widely spaced in the ocean area for the 1.2 than in the freshwater area. For the "resident" 3+, the space between the circuli was always about the same, I did not find wide spaced circuli like for the 1.2. Indeed, the size of the fish is related to the environment where they live and not only to the age.

I was actually interested to see if there was a difference of the size between the juvenile steelhead found in Big Lagoon (brackish water, at the mouth of Redwood Creek) and the ones found in the rest of the creek (much more narrow than the lagoon).

Mean FL of juvenile steelhead found in Redwood and in Big Lagoon in 1999:
(Appendix D, graph 3: length frequency of juvenile and "resident" sh in Redwood Creek and Big Lagoon, fall 99)

To see if there was a significant difference in FL between the fish found in Big Lagoon and the ones in Redwood Creek for 0+/1+/2, I used the Mann-Whitney U-test.

Table 15: Mann-Whitney U-test for 0+, 1+, 2+ steelhead in Big Lagoon and Redwood Creek.
Mann-Whitney U-test (at 0.05 significance level, p=0.007, Z=2.707)

Location	n	Mean rank
Redwood	130	69.41
Big Lagoon	14	101.21

The steelhead found in Big Lagoon were bigger than the ones found in Redwood Creek. One reason that could explain this difference is that we found a large amount of 2+ in the lagoon. Indeed, I noticed by looking at the 2 graphs (graphs 3 and 4) that there were more 2+ in the Big Lagoon than in Redwood Creek. The steelhead might decide to migrate downstream at one year old and then they might stay in the lagoon, either because the sandbar is already closed and they are forced to stay or because they want to spend some time in the lagoon before going to the sea. I do not think that steelhead coming back from the ocean stay a long time in the lagoon. Indeed, they would have been much bigger having spent some time in saltwater and we would have found older steelhead. Thus, to see if there was a real difference in FL between the juvenile steelhead from both sites, I had to use the Mann-Whitney U-test for each age class.

I used the Mann Whitney U-test to see if there was a difference in FL between the 0+ found in Big Lagoon and Redwood Creek.

Table 16: Mann-Whitney U-test for 0+ steelhead in Big Lagoon and Redwood Creek.
Mann-Whitney U-test (at 0.05 significance level, p=0.727, Z=0.348)

Location	n	Mean rank
Redwood	9	5.67
Big lagoon	1	4

There was no significant difference in FL between the steelhead 0+ in Redwood Creek and Big Lagoon.

I used the Mann Whitney U-test to see if there was a difference in FL between the 1+ found in Big Lagoon and Redwood Creek.

Table 17: Mann-Whitney U-test for 1+ steelhead in Big Lagoon and Redwood Creek
Mann-Whitney U-test (at 0.05 significance level, p=0.427, Z=0.794)

Location	n	Mean rank
Redwood	100	52.41
Big lag	3	38.33

There was no significant difference in FL between the steelhead 1+ in Redwood Creek and Big Lagoon.

I used the Mann Whitney U-test to see if there was a difference in FL between the 2+ found in Big Lagoon and Redwood Creek.

Table 18: Mann-Whitney U-test for 2+ steelhead in Big Lagoon and Redwood Creek
Mann-Whitney U-test (at 0.05 significance level, p=0.566, Z=0.574)

Location	n	Mean rank
Redwood	19	14.32
Big lag	10	16.3

There was no significant difference in FL between the steelhead 2+ in Redwood Creek and Big Lagoon.

One reason that could explain why the fish of the same age class were not bigger in the lagoon (even if they had more food and space than in the creek) could be the time spent in the lagoon. As a matter of fact, while I was reading the scales, I noticed that on the fish scales from Big Lagoon, I could see the difference between the freshwater part and the time spent in the lagoon for the 1+ and 2+. The circuli were a little bit more spaced in the brackish water part than in the freshwater part, but not as big as the circuli found in the ocean part. I think that if we could not see a big difference between the fish length from the fish in the Big Lagoon and the ones in Redwood Creek that was because the fish did not stay a very long time in the lagoon. (It would be interesting to count the number of circuli in the lagoon part compared to the number of circuli in the stream part). Indeed, it has been found that the rate of formation of scale circuli was significantly and positively correlated with fish growth rate and with scale growth rate for young coho salmon. (Fisher et al. 1990).
The time spent in the lagoon can be called run-out. On an adult steelhead scale we would see the freshwater part (narrow spaced circuli), the ocean part (wide spaced circuli) and an area in between called run-out = time spent in the lagoon.

- **Mean fork length and range of fork length for co/sh of the main age classes present in smaller creeks part of the Restoration Project:**

Blueline, West-Union, Quarry Gulch, Giacomini, Devil's Gulch and Eskoot were smaller creeks than Redwood and Olema. I did not age many fish for each one of these creeks, because few scales were available. Indeed, winter spawner surveys and electrofishing surveys were not done as often as in Olema and Redwood creeks. That is why I only calculated the mean FL for the main age classes of each creek.

Mean fork length of juvenile steelhead in Blueline Creek (from smolt trap surveys in spring-summer 1998-1999):

Age class	n	Mean FL (mm)
0+	1	99
1+	46	144.32
2+	16	163.93
3+	1	230

The 1+ were between 106 and 189 mm FL, with a mean FL of 144.32. The 2+ were between 147 and 229 mm FL, with a mean FL of 163.93.

Mean fork length of juvenile steelhead in West-Union Creek (from electrofishing surveys in summer 1999):

Age class	n	Mean FL (mm)
0+	8	98.37
1+	8	130.62
2+	2	168

The 0+ were between 90 and 102 mm FL, with a mean FL of 98.37. All the 1+ were between 110 and 146 mm FL, with a mean FL of 130.62. All the 2+ were 158 and 178 mm FL, with a mean FL of 168.

Mean fork length of juvenile steelhead in Quarry Gulch (from electrofishing surveys in spring-summer 1999):

Age class	n	Mean FL (mm)
0+	7	101.28
1+	34	122.64
2+	1	163

The 0+ were between 78 and 119 mm FL, with a mean FL of 101.28. The 1+ were between 97 and 155 mm FL, with a mean FL of 122.64.

Mean fork length of juvenile steelhead in Giacomini Creek (from electrofishing surveys in spring-summer 1999):

Age class	n	Mean FL (mm)
0+	14	105.57
1+	30	134.43
2+	3	209

The 0+ were between 100 and 115 mm FL, with a mean FL of 105.57. The 1+ were between 112 and 167 mm FL, with a mean FL of 134.43. The 2+ were between 178 and 225 mm FL, with a mean FL of 209.

Mean fork length of adult coho in Devil's Gulch (from winter spawner surveys in 1997-1998 and 1998-1999):

Age class	n	Mean FL (cm)
1.2	6	58.66
1.1	2	40

The 1.2 were between 53 and 64 cm FL, with a mean FL of 58.66. The 1.1 were both 40 cm FL.

C. Relationship between the fork length of coho salmon carcasses and the age of the fish:

Information on the growth history of each year class can be obtained with the back-calculation Fraser-Lee method (Carlander 1982; Frie 1982; Busacker et al. 1990). The ability to back-calculate is based on a repeatable relationship between the annulus length on the scale and the length of the fish. If such a relationship exists, then one can back-calculate fish lengths at all previous marks on the scale by translating the distance between annuli on the scale into annual growth in fish length.

It has been proved that such a relationship does exist for the coho salmon (by Fisher et al. 1990) and for the steelhead trout (by Davies and Sloane 1986, Klumb et al. 1999)
Thanks to this repeatable relationship between the annulus length on the scale and the length of the fish, I was able to use the back-calculation Fraser-Lee method:

To use this method, the only data that were required were:

- the length of the fish at capture
- the radius length of the scale at capture (from the nucleus to the edge)
- the length of each of the annuli

Validation of the back-calculation method:

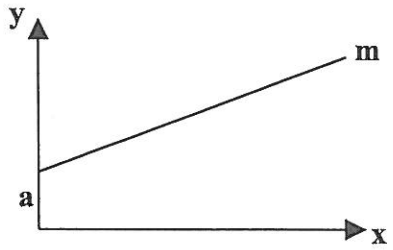
I had all these required information, but I first had to check if the Fraser-Lee method could be used to back-calculate the FL of the fish within the creeks which were part of the Restoration Project.
To see if the back-calculated lengths were similar to actual fork lenghts, the only references that I actually had were the FL of 533 coho smolts (1+) captured in 1996 in Redwood Creek (during an outmigrant trapping program). I used the Mann-Whitney U-test to see if there was a significant difference between the back-calculated FL at 1+ for coho 1.2 from winter 97-98 and the FL of the "smolts" captured in 1996. The coho 1.2 from winter 97-98 had all been captured as smolts in spring 1996.

To describe how I back-calculated the lengths, I would like to give you an example:

Example with a coho 1.2 (Appendix C, figure 19: fish scale of a 3 years old coho):

- FL at capture : 550 mm
- scale radius : 100 mm
- length of each annuli: 1st annulus (1 year old) = 20 mm / 2nd annulus (2 years old) = 58 mm / 3rd annulus (3 years old) = 100 mm

The relationship between the lengths of the fish and the annuli on the scale can be illustrated by a graph:



x = length of the fish
y = length of the scale radius
m = slope
a = y-intercept of the regression of fish length on scale radius

The intercept "a" means that there is a certain time needed until the circuli on the scale can be seen. Indeed, the fish has to be of a certain size before the circuli would appear on the scale. This intercept is different for different species. For the coho salmon, a = 30 mm (as suggested by Jerry Smith, Professor at San Jose University, California).

To back-calculate the lengths at previous annuli, I used the formula: $L_i = \frac{L_c - a}{S_c} \cdot S_i + a$

L_i = back-calculated length of the fish when the i^{th} annulus was formed
L_c = length of the fish at capture
S_c = scale radius at capture (from the focus to the edge of the scale)
S_i = scale radius at the i^{th} annulus (from the focus to the end of the i^{th} annulus)
$m = \frac{L_c - a}{S_c}$ (slope of a two-point regession line to estimate L_i)

By using this formula, I back-calculated the lengths of the fish at all previous annuli:

The back-calculated fish lengths for the example above were as follows:

- $L_1 = 5.2 \times 20 + 30 = 134$ mm FL (at 1 year old, young coho ready to migrate downstream)
- $L_2 = 5.2 \times 58 + 30 = 331.6$ mm FL (at 2 years old, coho that already spent 1 year in freshwater and 1 year in the ocean)

This adult coho came back in Redwood for spawning purposes at 1.2 (3 years old) and was 550 mm (= FL at capture). At 1 year old, it was 134 mm FL and at 2 years old it was 331.6 mm FL.

I used the same formula to back-calculate the lengths for coho 1.2 of winter 97-98 in Redwood Creek. The results were as follows:

Table 19: FL for coho (1.2) of winter 97-98 and back-calculated lengths at 1+.

FL coho (1.2) winter 97-98 (mm)	Back-cal at 1+ (mm)
550	134
500	135
650	111
570	119
550	92
550	99
400	87
500	111
500	120
630	124

The back-calculated lengths for the coho 1.2 of winter 97-98 at 1+ were between 87 mm and 135 mm FL.

The mean FL for the back-calculated lengths at 1+ (97-98) and the mean FL for the coho "smolts" (96) were as follows:

Table 20: mean FL for coho smolts (96) and mean FL of the back-calculated lengths at 1+ for coho 1.2 of winter (97-98).

Redwood creek	n	mean FL (mm)
co smolts (1+)	533	102.9
co back-cal at 1+	10	113.2

In order to see if there was a significant difference in FL between the back-calculated lengths at 1+ (97-98) and the recorded lengths of the "smolts" (96), I used the Mann-Whitney U-test:

Table 21: Mann-Whitney U-test for FL of coho smolts (96) and back-calculated lengths at 1+ of the coho 1.2 of winter (97-98).
Mann-Whitney U-test (0.05 significance level, $z = 2.173$, $p = 0.030$)

years	n	mean rank
96	533	270
97-98	10	378.85

There was a significant difference between the back-calculated lengths at 1+ and the real FL of the coho smolts (1+).
The back-calculation method overestimated growth for coho salmon with a percentage difference less than 5% ($p = 0.03$) at 1+.

Many reasons can explain this overestimation:

a) One reason could be that there is no linearity between the scale growth and the body growth during the first year of life. Indeed, I found out that growth to the first annulus generally has the greatest deviation from non-linearity because scales initially grow faster than the body (Van Oosten, 1929).
b) Another reason could be that we did not use recaptured fish. Indeed, we did not have the exact FL at 1+ for the 10 coho that were captured at 3 years old. All the studies on the validation of a back-calculation method used recaptured fish.
c) The smolt trap was several hundred meters upstream of the lagoon and the ocean. An unknown amount of time and growth may have occured before the coho smolts were released and entered the ocean.

V. Discussion and conclusion:

- Age classes present in streams which were part of the Restoration Project:

Adult coho salmon:

Most of the fish returning to spawn in Redwood and Olema creeks were 1.2 (3 years old), (70.5 % for Redwood and 75 % for Olema). These adults coho spent their first year in freshwater and their second and third year in saltwater. A few males were 1.1 (2 years old) when they came back for spawning purposes (23 % for Redwood and 20.5 % for Olema). These fish are called "jack" and are already mature to fertilize the eggs. Some coho spent 2 years in freshwater and one, two or even three years in the ocean (1.6 % were 2.1 for Redwood and 2.25 % for Olema / 3.3 % were 2.2 for Redwood and 2.25 % for Olema / the 2.3 were only found in Redwood with 1.6 %). It is interesting to see that even coho salmon can stay more than one year in freshwater, like the steelhead. Steve Gough from the National Marine Fisheries Service (Tiburon) and Bill Jong from the Department of Fish and Game (Arcata) confirmed (by reading the scales) that these fish spent 2 years in freshwater.

Other workers have reported that the great majority of coho salmon adults fall in the 1.2 categorie, but have noted some exceptions that actually confirm my results. Marr (1943) recorded that of 885 coho salmon taken in the commercial gill net fishery of the lower Columbia River in 1914, 1.2 fish comprised 83.9 % of the total sample and 1.1 fish 6.1 percent. The other categories recorded by Marr are composed of 2.2 fish (9.7 %) and 2.1 fish (0.3 %). Pritchard (1936a, 1940), in addition to the above age categories, has reported 2.3, 2.4 and 1.3 coho salmon from British Columbia.

We can definitely say that all these different age classes (life history strategies) were very well represented in Redwood and Olema creeks and that the 1.2 age class is undoubtedly the dominant one.

Juvenile and "resident" steelhead:

Many juvenile steelhead found in Redwood and Olema creeks were 1+ (1 year old), which makes sense considering that most of them leave the creek after one year and migrate to the ocean. The fish 0+ (younger than a year) are either going to stay for a few more months, even a year or two before moving downstream to the ocean The 2+ (two years old) might migrate at any time and the 3+ might stay their whole life in the creek. Some of the fish I aged were younger than a year (7.4 % for Redwood and 41.6 % for Olema), some were one year old (69.8 % for Redwood and 50 % for Olema), some were two years old (20.1 % for Redwood and 8.4 % for Olema), and other were even three years old (2.7 % only for Redwood).

These results show that steelhead can definitely stay more than one year in freshwater before going to the sea, even if a high number migrate after their first year.

I would like to talk more about the three years old ones. These steelhead are called "resident". It can be possible that these fish are never going to migrate to the ocean; they might stay their whole life in freshwater. Considering this possibility, this means that the fish can find enough food to live in the creek and do not feel the need to migrate downstream to the ocean. Redwood Creek has been part of the Restoration Project since 1994 and these results confirm that the creek is since 1998 (first year with some three years old steelhead) a good habitat and even a "home" for the steelhead.

- **Mean fork length of each age class in each creek:**

Redwood and Olema were the only creeks that did represent very well the different age classes (life history strategies) for the coho and the steelhead populations.
The coho 1.2 had a mean FL of 58.5 cm FL for Redwood and of 63 cm FL for Olema. The males 1.1 ("jacks") had a mean FL of 41.7 for Redwood and of 44.7 for Olema. Based on Shapavalov and Taft's work, we can use "50 cm" as the "cutoff point" to check the estimates of coho 2 years old and 3 years old for each creek. The 3+ "resident" steelhead had a mean FL of 219.5 mm FL for Redwood only.
The juvenile steelhead in Redwood and Olema creeks had very similar mean FL for each age class and can be used as references. The 0+ had a mean FL of 91.3 mm FL for Redwood and of 95.63 mm FL for Olema. The 1+ had a mean FL of 121.3 mm FL for Redwood and of 116.08 mm FL for Olema. The 2+ had a mean FL of 157 mm FL for Redwood and of 175.83 mm FL for Olema. On the other hand, the steelhead in smaller creeks appear to be bigger than the ones in Redwood and Olema for the same age classes.

I can see 2 reasons that could explain this difference:

1) We did not collect enough scales from the smaller streams to be able to have a mean FL for each age class that could be representative of the actual population. Moreover, the fish we collected scales from were not representative of the actual population because of the fact that we collected scales mainly from the biggest fish (it is not always easy to collect scales from tiny fish).
2) These streams had smaller populations than Redwood and Olema. It is possible that the fish can find more food and very good habitats (have more space) than the ones part of a bigger population.

To confirm the actual difference in mean FL for these smaller creeks, we should collect more scales and then compare the results with what we found for Redwood and Olema.

I did not talk about the juvenile coho because of a small number of scales. In fact, they were present in study streams and were usually about the same size as the steelhead of the same age classes.
I could not discuss a lot about the 2 adult steelhead that I aged (1.2 and 2.1), first because few scales were available and secondly because of their different life history, the scale reading was laborious and subject to some errors.

- **Relationship between the fork length of coho salmon carcasses and the age of the fish:**

There is a relationship between the fork length of the coho salmon carcasses and the age of the fish. That is why I used the Fraser-Lee method to back-calculate the FL of coho at 1 year old. I found out that this method slightly overestimated the FL at 1+ for the coho in Redwood Creek.

To prove that this Fraser-Lee method could be used to back-calculate the FL of coho in Redwood Creek, we should do the same procedure with marked fish and recapture them. If we find out that there is no significant difference between the back-calculated lengths and the FL of the recaptured fish, we can say with no doubt that the Fraser-Lee method is a good back-calculation method to use for the coho in Redwood Creek. Now, if there is a significant difference we can find a way to adapt the method for this particular creek.
This Fraser-Lee back-calculation method has a long history of application and is simple to use (Klumb et al.,1999). This method would be very useful to use in research situations where a fish population is not sampled annually. Indeed, back-calculation from coho scale could provide a great amount of useful growth information from one sampling event. Especially now, that the Coho Salmon and Steelhead Trout Restoration Project is almost over, scales collected from carcasses once a year could be used to keep having information about the life history of the coho. The back-calculated lengths could be used to see whether habitat changes increase or decrease the size of coho smolts within the Park.

VI. Acknowledgements:

Completion of this project would not have been possible without the assistance of Darren Fong. Indeed, he gave me the opportunity to work on this particular project and for the whole year he was always available to answer my questions.
I also want to thank Mia Monroe in charge of the management and restoration of Muir Woods National Monument, which includes Redwood Creek. Spawner surveys and electrofishing surveys would not have been possible without the work of folks from Point Reyes National Seashore: Gregory Brown, Ken Kundarzi and Dave Press. Tsahai Codner (Americorps member) gave me a hand to mount the fish scales on slides. Steve Gough from the National Marine Fisheries Service (Tiburon) and Bill Jong from the Department of Fish and Game (Arcata) checked my results by reading scales from Redwood Creek. Dr. Jerry Smith, Professor at San Jose University gave me a lot of information about fish scales reading and the back-calculation method.



Tsahai and I walking upstream during a spawner survey in Redwood Creek

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APPENDICES:

A. More about the life history of both species

1.) The migration
2.) The spawning process
3.) The hatching process

B. More about scale and tissue samples collecting

1.) Description of a winter spawner survey for adult coho salmon and criteria usually observed to recognize an adult coho from an adult steelhead
2.) Description of an electrofishing survey for juveniles of both species and criteria usually observed to recognize a juvenile coho from a juvenile steelhead.

C. Figures

D. Tables and graphs

A. More about the life history of coho salmon and steelhead trout:

1.) The migration:

"Homing" and "straying":

Many marking experiments proved the existence of "homing" among anadromous members of the salmon family. Basically, young salmonids, which descend from freshwater to the sea, return to their "parents' stream" for spawning purposes. Indeed, it is thought that they use an acute sense of smell to recognize their native stream. An adult is able to migrate back home even after many years because each creek has its own unique smell. Both, specific chemicals released in the water from leaves or the combination of soil and vegetation typical from the stream, can be detected by the fish.
"Straying" can happen in creeks that are geographically close. The fish migrate up the wrong stream either because the smell is too similar to their "parents' stream" for them to be able to notice the difference or simply because of the impossibility of going up "their" stream. Indeed, these problems can happen when the raining season comes late, as for example during the winter 1999-2000 in Redwood Creek[1] and in many other streams that are also closed by a sandbar during the dry season. These streams need a lot of rain before the freshwater can join the saltwater and we think that because the rain came at the end of January and the raining season usually starts in December, the salmon went up to other streams not closed by a sandbar. Some might have died in the ocean while they were waiting for the opening of the sandbar, maybe eaten by seals or other predators!

Time of the spawning migration:

Coho salmon:

Adult coho salmon move upstream for spawning purposes between late November and February, with a peak number in December-January. The reason why the fish do not enter the stream all at the same time is not known, but it is probably determined by the habits and migrations of the fish in the ocean. In the open sea, fish may be guided by magnetic forces and light, but the ocean life history of coho salmon is still a mystery. A combination of short days, cool temperature and rain may stimulate their instinct to move up the creek in which they were born.
In California, many streams are closed by a sandbar at their mouth (area where the freshwater meets the saltwater) during the dry season, like Redwood Creek. Fish migrating back to small creeks like Redwood are called "short-run" salmon. They have to wait until heavy winter rains can open the sandbar at Muir Beach (area closed by the sandbar).

[1]Redwood Creek: creek which was part of the Restoration Project

In the ocean, adult salmon face numerous threats while they are waiting, but for those that survive, they completely stop feeding and depend on their own tissue to nourish themselves during their way upstream. Their muscles are absorbed back into their systems just to keep them alive until the end of the spawning process that requires a lot of energy, before they die.

Steelhead Trout:

The spawning season of the steelhead trout extends over a much longer period of time than the one of the coho salmon. In general, they enter the streams and spawn in winter and spring. Steelhead trout arrive at Redwood Creek between January and the end of March, when the sandbar is still open, but in larger rivers some fish enter from the sea in nearly any months.
As for the coho salmon, the ocean life history of the steelhead trout is still a mystery. Therefore, one can only suppose that the reason why the fish do not enter the stream all at the same time is probably determined by their habits and migration in the ocean.

Steelhead unlike coho salmon do not die after they spawn, they can spawn more than once and can go back and forth many times from freshwater to saltwater. They are also known as strong leapers! Indeed, they are able to pass higher cascades than coho salmon. For example, in Olema Creek[1], the steelhead have been able to pass a culvert, but no coho has ever been found past this point.

2.) <u>The spawning process for coho salmon and steelhaed trout:</u>

For spawning purposes, coho salmon and steelhead trout have to face the powerful current of the stream. They pause to rest in pools and slow flowing waters. On their way upstream, several areas may be selected then abandoned, before the female selects a suitable spawning site. After a satisfactory site is finally chosen, the female begins nest digging, usually at a tail of a pool where the water picks up some speed and turns into a riffle or a flatwater area. The site where the eggs are going to be buried is called a redd[2]. It has to be of clean gravel and cobble in order to leave the water going through to oxygenate the eggs. If the eggs are deposited in an anoxic area (without oxygen), it can kill them.
One or several males may accompany the female, but the male does not participate in the digging. If more than one male are present, they will have to fight to determine which one will be the mate. While the female is digging the nest, the male assumes a position slightly behind (downstream) and to one side of her. At frequent intervals he approaches the side of the female closely and the two fish quiver (vibrate tremulously), together or separately. Fish of both sexes face upstream during the spawning activities.

[1]Olema Creek: creek which was part of the Restoration Project
[2]redd: area in the gravel where the eggs are deposited by the female; synonym: nest

I remember having seen a female during a spawner survey in Redwood Creek, while she was digging her nest. She would turn on her side and with powerful and rapid movements of her tail, she would disturb the gravel on the bottom of the stream. As this process was repeated, the redd took form and finally resulted in an oval pit (also called depression).

The pit is approximately of 10 to 30 centimeters in depth and of 30 centimeters in diameter. At the moment of deposition of the eggs, the female drops into the pit and lowers her vent and anal fin into the deepest part. The male instantly moves into a position parallel and next to her, so that the vents are opposite. Both fish open their mouths wide and arch their bodies so that they are rigid, with their back concave, the eggs and milt are exuded simultaneously. The eggs are dropped into the bottom of the pit in a compact group and are enveloped by a cloud of milt to be fertilized. The whole process, from the time that the female drops into the pit until the synchronized orgasm resulting in the actual deposition of the eggs, takes only a few seconds. Immediately after the deposition of the eggs and milt, the female alone, begins to cover up the eggs. The male appears uninterested in this process. When the eggs are well covered the female begins to dig another pit about 50 centimeters to one meter directly upstream from the first. A female can deposit from 500 to 1500 eggs at a time and a female of about 60 centimeters long can have from 3800 to 7800 eggs.

After the spawning process, both coho male and female die, their bodies feeding the stream with nutrients, such as nitrogen and phosphates, that are then pulled up by water plants. Coho salmon carcasses are then often eaten by animals that live in the surrounding of the creek, like raccoons.
I was fortunate to find a coho salmon carcass while I was doing a spawner survey in Redwood Creek. The carcass was stuck on a tree branch under the water, we took the fish out of the water and we measured its fork length (length of the fish from the head to the beginning of the tail). We took some scales that I used to age the fish and we also opened the fish to see if any eggs were left, but we didn't find any.
The steelhead trout never die because of the spawning process. They can stay in larger pool for a while after they spawned or they can directly go back to the ocean. Adult steelhead are very nimble. We don't have a lot of adult steelhead's scales for the simple reason that we can not catch them, unless using a fishing rod, and that's not our intention.

3.) The hatching process for both species:

The number of days required for the eggs to hatch depends on the water temperature of the stream. For Redwood Creek and all the streams studied by CSSTRP, the usual hatching period is about after 2 months. In spring, freshly hatched coho and steelhead, take up residence in shallow gravel areas and tend to congregate in schools. As time passes and fish grow, these schools break up and the fish spread up and down the stream, selecting individual small "territories". Soon after the peak of emergence there is a marked decline in the number of fry in the stream, due to mortality. Predatory fish, among other predators, drying stream channels and disease, are believed to be the main cause of losses. In Redwood Creek, while we were walking upstream during a spawning survey, we saw on the bottom of the stream just a "half of a steelhead". We took it out of the water and we found out that a sculpin (a bottom fish) was actually eating the steelhead and the steelhead was already half in its mouth!

I also remember doing a redd survey in 2 different creeks at the end of March 2000, in which we actually found dried channels. Redds could have been dried out and juveniles could have died because of the lack of water.
For the ones that may survive all these hazards, they start growing very fast during the dry season. Two factors seem to influence this extremely rapid growth: the rising temperatures of the water and an abundance of aquatic food organisms. These juveniles stay at least one year in the stream before migrating out to the ocean.

A. More about scale and tissue samples collecting:

1.) Description of a winter spawner survey for adult coho salmon and criteria usually observed to recognize an adult coho from an adult steelhead:

Description of a winter spawner survey for adult coho salmon:

I will describe a typical spawner survey in Redwood Creek (I participated during the winter 1999-2000 in all the spawner surveys for this particular creek). Spawner surveys in Redwood Creek can start as soon as the sandbar, situated at the mouth of the creek at Muir Beach, breaks; this usually happens after heavy winter rain. The frequency of surveys ranged from 10 to14 days in order to count as precisely as possible the number of adult coho salmon returning to spawn in their stream of birth.

Unrolling of a typical spawner survey:

Three teams of 2 to 3 people surveyed reaches from 2 to 4 kilometers long. Redwood Creek was divided in three reaches[1] (Appendix C, figure 4: Redwood Creek with its 3 spawning reaches):

- Reach 1 (2.7 km), from Muir Beach to Kent Creek
- Reach 2 (2.4 km), from Kent Creek to Muir Woods National Monument parking lot
- Reach 3 (1.6 km), from the parking lot to the area where no coho has ever been seen

Equipment requested for a spawner survey:

- Waders, to walk in the creek without getting wet
- A marked rod of about 1.5 meter, to give an estimated length (in centimeters) of a live fish or the exact length (in centimeters) of a carcass
- A pencil and a clipboard with a spawner survey datasheet (waterproof!) (Appendix C, figure 23: spawner survey datasheet)

[1]reach: a particular area of the stream that has to be surveyed

Protocol:

Spawner surveys were conducted by at least 2 observers. We had to begin the survey at the end of the predetermined reach and walk upstream in the channel and on the banks, avoiding pool tails and redds (fish nests). By walking up the stream, everyone had to look for live fish by probing the banks, woody debris, and pools with the survey rod. At the same time, each observer inspected the channel and banks for fish carcasses. We also had to look for redds usually located at a tail of a pool or in a flatwater area. Another important thing was to always look ahead, because it was very common to scare the fish situated upstream.

Species:

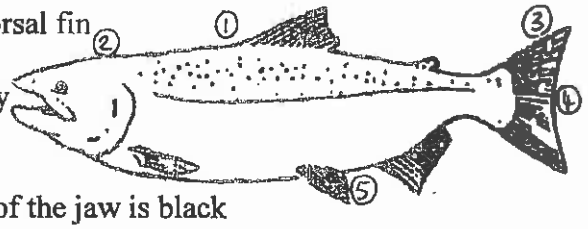
When a live fish or a carcass was found:

Coho salmon and steelhead trout were not always easy to recognize when they were in the same stream. That is why typical criteria were sometimes necessary to identify of which sex and specie the fish belonged to.

Criteria usually observed to recognize an adult coho from an adult steelhead:

Most of these criteria could be observed on a carcass or on a live fish swimming in a big clear pool.

Identification of adult coho (for both sexes):

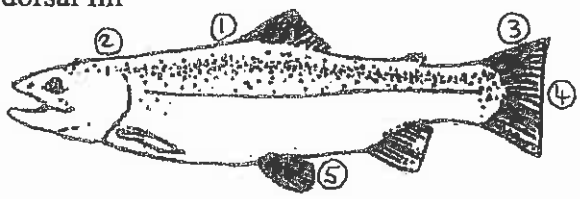


①- few scattered small spots on the back and the dorsal fin
②- no spots on the head
③- scattered spots on the top lobe of the tail fin only
④- shallow curve in tail
⑤- 13-19 anal rays, a long and shallow anal fin
- gums are white at the base of the teeth, the rest of the jaw is black

Males have a hooked upper and lower jaw, a broad red band slightly humped, and large curved teeth. (Appendix C, figure 24: coho male with its hooked upper and lower jaw and its red band)

Females have worn anal and tail fins, no hooked jaw, teeth not as large and curved as males.

Identification of adult steelhead (for both sexes):



①- many scattered small spots on the back and the dorsal fin
②- spots on the head
③- uniform spots along rays of the tail fin
④- a straight tail
⑤- 8-12 anal rays, a short and deep anal fin
- gums and jaw all white

Males and females are not easy to recognize, there is no specific sexual criterion that can be observed on a live fish.

When a live coho was found:

The sex and the approximate length (to the nearest 5 centimeters) had to be recorded. A question mark could be used if there was any doubt.

When a coho carcass was found:

For all the carcasses found, the sex and the fork length (from the tip of the jaw to the beginning of the tail) was recorded. (Appendix C, figure 25: illustration of a coho male showing its fork length). The fork length was measured by using the marked rod and recorded in centimeters. To confirm the gender of the carcass, the body cavity could be operated to inspect the gonads and the number of retained eggs by the female. The general condition of the carcass was also mentioned (e.g. fresh and intact, decomposed or skeleton).

In addition to counting and noting the location of carcasses, tissue and scale samples were collected for genetic and age analysis.

Redds:

A redd was usually located at the well-oxygenated tail of a pool or flatwater area. (Appendix C, figure 26: Darren Fong standing next to a redd located in a flatwater area). The area of disturbed gravel was not always obvious; females may construct numerous "false" redds before choosing a suitable spawning site. A question mark was used if it was not certain that a feature was actually a redd. The width (across the center of the tail spill) and the length (from the top of the pit to the end of the tail spill where the eggs were buried) were measured by using the marked rod (Appendix C, figure 27: cross section of a redd).
Each redd was then marked with plastic survey flagging to prevent double counting in later surveys and tied to the vegetation on the banks.

A winter spawner survey for adult steelhead would not have been productive for the reason that they are too elusive. They can hide near the bank of the creek and can swim to an undercut quickly, before we would even have noticed that they were in the creek. We only did redd surveys for steelhead trout in creeks where coho salmon were absent. Indeed, we could not have done redd surveys for steelhead where coho were present for the simple reason that steelhead arrive in the stream later than coho and we would not have been able to tell the difference between a redd made by a coho or one by a steelhead.
In Redwood Creek for example, steelhead could sometimes make their redd on the top of another redd made by a coho a few weeks earlier. The stream is not very long and has limited potential redd sites.

Tissue and scale samples for adult coho salmon:

The following supplies were provided for the tissue and scale samples collection:

- a hole puncher
- a filter paper
- a coin envelope
- tweezers

When a carcass was found, some tissue was removed from the opercula (gill covers) with a hole puncher (Appendix C, figure 25: illustration of a coho male showing the body location for tissue samples collection). The tweezers were used to remove the punches and place the tissue in a folded piece of filter paper. Then, the filter paper was placed in a coin envelope and the name of the stream, reach, date, collector, specie, fork length (FL), sex, and any other notes were written on the envelope (Appendix C, figure 10: fish scale envelope).
In some cases, the fins were extremely eroded (e.g. only cartilage and flesh were left). In such cases, the actual FL was estimated.
Five to ten scales were removed with the tweezers from one side of the fish, between the lateral line and the dorsal fin (Appendix C, figure 25: illustration of a coho male showing the body location for scale samples collection). Then, the scales were also placed in a folded piece of paper and dropped into the same envelope (where the tissue was dropped).

2.) Description of an electrofishing survey for juveniles of both species and criteria usually observed to recognize a juvenile coho from a juvenile steelhead:

Description of an electrofishing survey for juveniles of both species:

Unrolling of a typical electrofishing survey:

I participated many times in electrofishing surveys. First, we placed block nests upstream and downstream the surveyed area, which was usually a pool. Then, a team of 2 to 4 people entered the stream. One of us was carrying the backpack electrofishing unit that produced electricity in a water area of about one quadrate meter (Appendix C, figure 28: backpack electrofishing unit carried by someone doing an electrofishing survey). Two of us were carrying nets and were ready to catch the fish coming up at the surface of the water after having been electrified for one second. Finally, one of us was carrying a bucket filled half way with stream water. As soon as fish were caught with the nest, they were transferred into the bucket. Usually, two to three passes were necessary to estimate the fish abundance (calculated with a specific computer program).

To reduce fish injury, a variety of measures had to be used to catch the fish:

- a large diameter electrodes with minimal voltage
- a programmable electrofisher to select lower pulse DC frequencies

Then, when all the fish were in the bucket, the specie, the weight and the length of each fish had to be recorded:

To minimize stress during the handling of juveniles, a few more measures were undertaken:

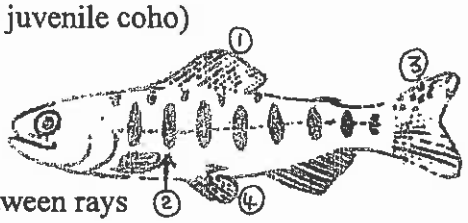
- juveniles were too active to handle without injury. To sedate the fish, tablets of AlcaSelzer were added to the water in a separate bucket where the fish had to stay for about 1 minute.

Then, each fish was placed in a small bag to take its weight in grams. Its fork length (from the tip of the jaw to the beginning of the tail) was measured with a ruler and recorded in millimeters.
After having recorded the specie, the fork length and the weight, each fish was placed in an aerated bucket, also called "recovery bucket", for about 20 minutes, before all the fish would be released to their stream.

Juvenile coho and steelhead are not always easy to recognize when they are small. That is why typical criteria are sometimes necessary to be able to identify the specie. Moreover, the sex can not be determined because they have to be sexually mature to express sexual criteria.

Criteria usually observed to recognize a juvenile coho from a juvenile steelhead:

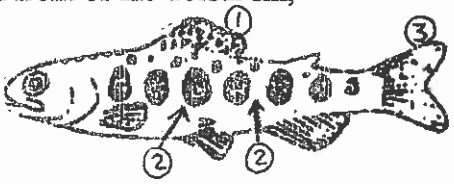
Identification of juvenile coho: (Appendix C, figure 29: juvenile coho)



① - no dark spots on dorsal fin
② - parr marks[1] : narrower than the spaces between them
③ - may have spots on the upper lobe of the tail fin
④ - first 2-3 fin rays longer on anal fin and pigmented between rays

Identification of juvenile steelhead: (Appendix C, figure 30: juvenile steelhead)

① - dark spots on dorsal fin
② - parr marks : almost round, 5-10 parr marks located in front of the dorsal fin, spaces are narrower than the parr marks
③ - few or no spots on the tail fin



The first and easiest things to look at are the dark spots on the dorsal fin and then the parr marks.

[1]parr marks: dark marks that appear on both sides of the fish ready to start migrating downstream

Tissue and scale samples for juveniles of both species:

The following supplies were provided for the tissue and scale samples collection:

- a knife
- a filter paper
- a coin envelope
- tweezers

Some tissue was removed from the fish with a knife. About five to ten scales were removed with the tweezers from one side of the fish, between the lateral line and the dorsal fin. (Appendix C, figure 25: illustration of a coho male showing the body locations for tissue and scale samples collection). It happened with recaptured fish (fish already captured the previous year, for example) that scales were collected from the same side for the second time. These scales were regenerated[1] and could not be used to determine the age of the fish because the first part of their age history disappeared.

[1]regenerated scales: new scales that grow to replace lost scales.

C. Figures:

Figure 1: map of GGNRA

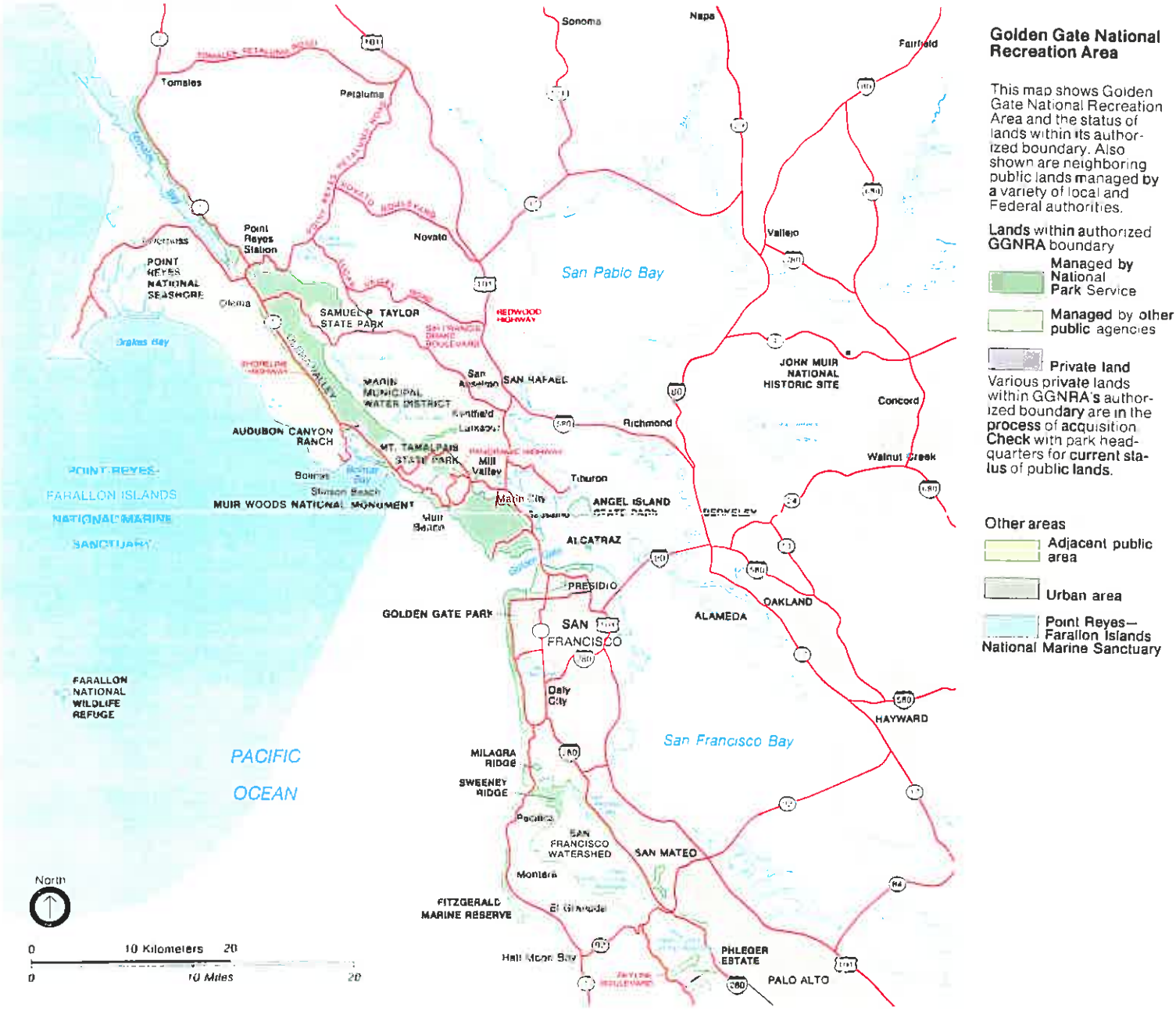


Figure 2: Coho and Steelhead Restoration Project watersheds

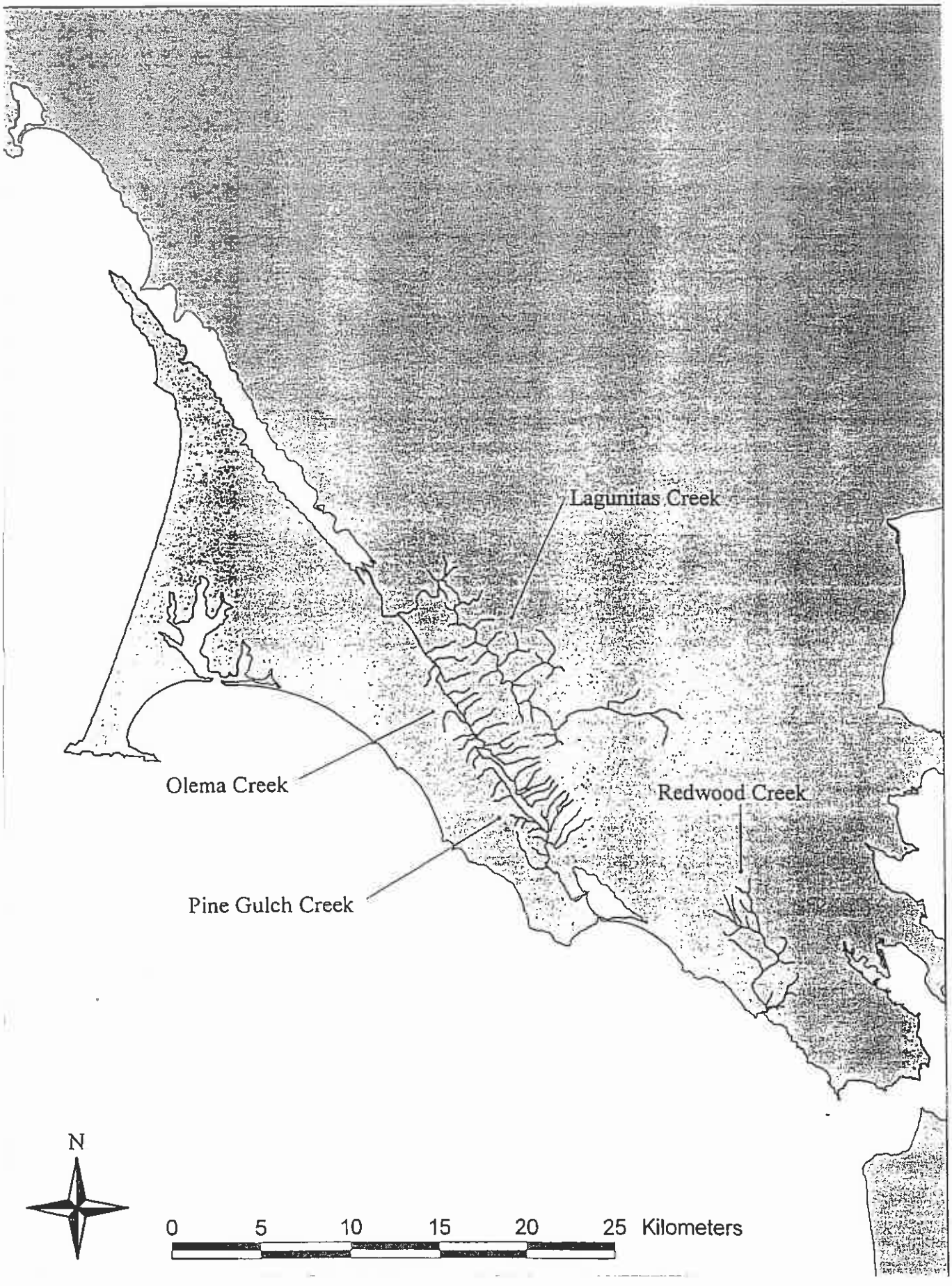


Figure 3: Redwood Creek Watershed

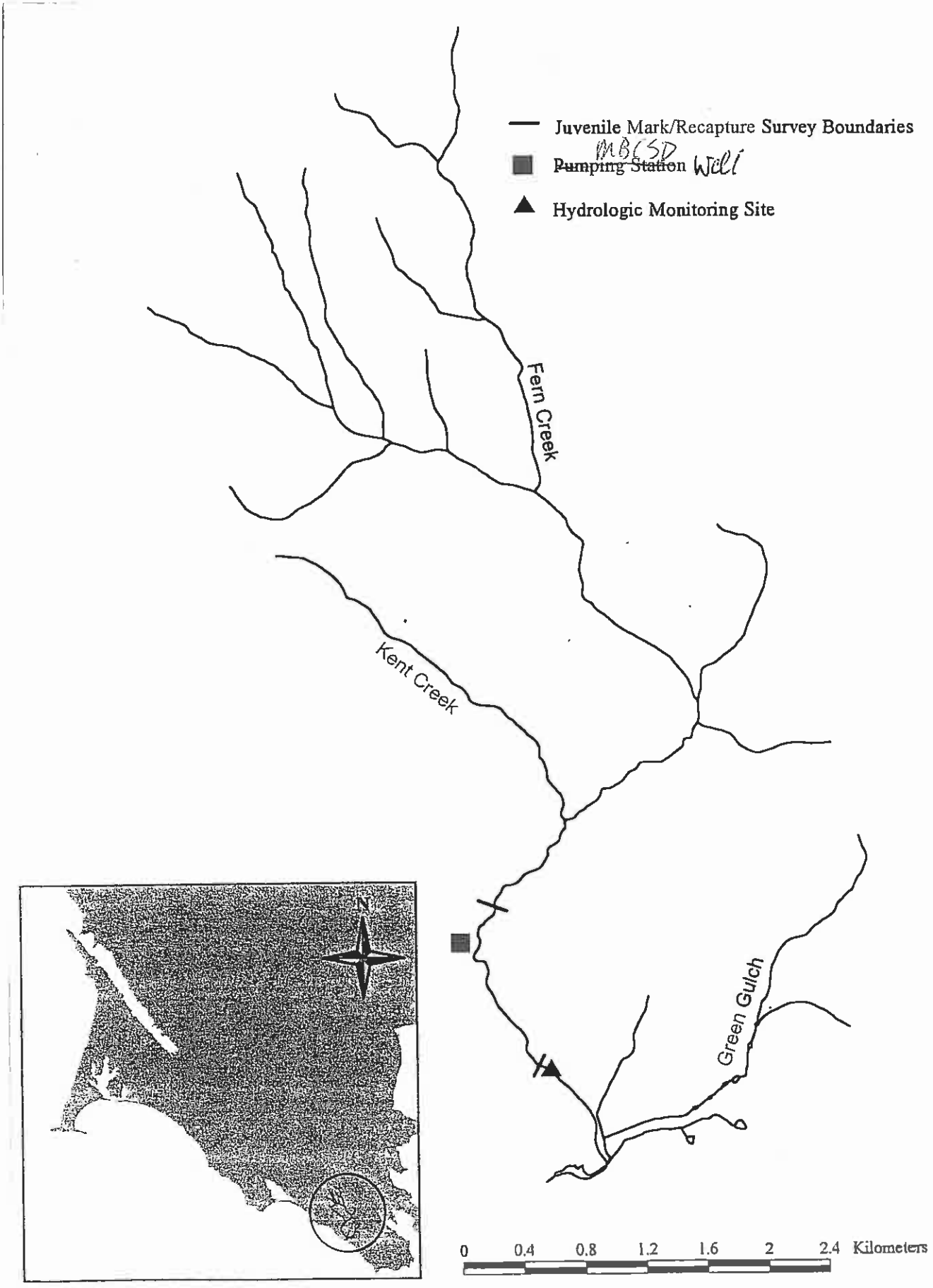


Figure 4: Redwood Creek with its 3 spawning reaches

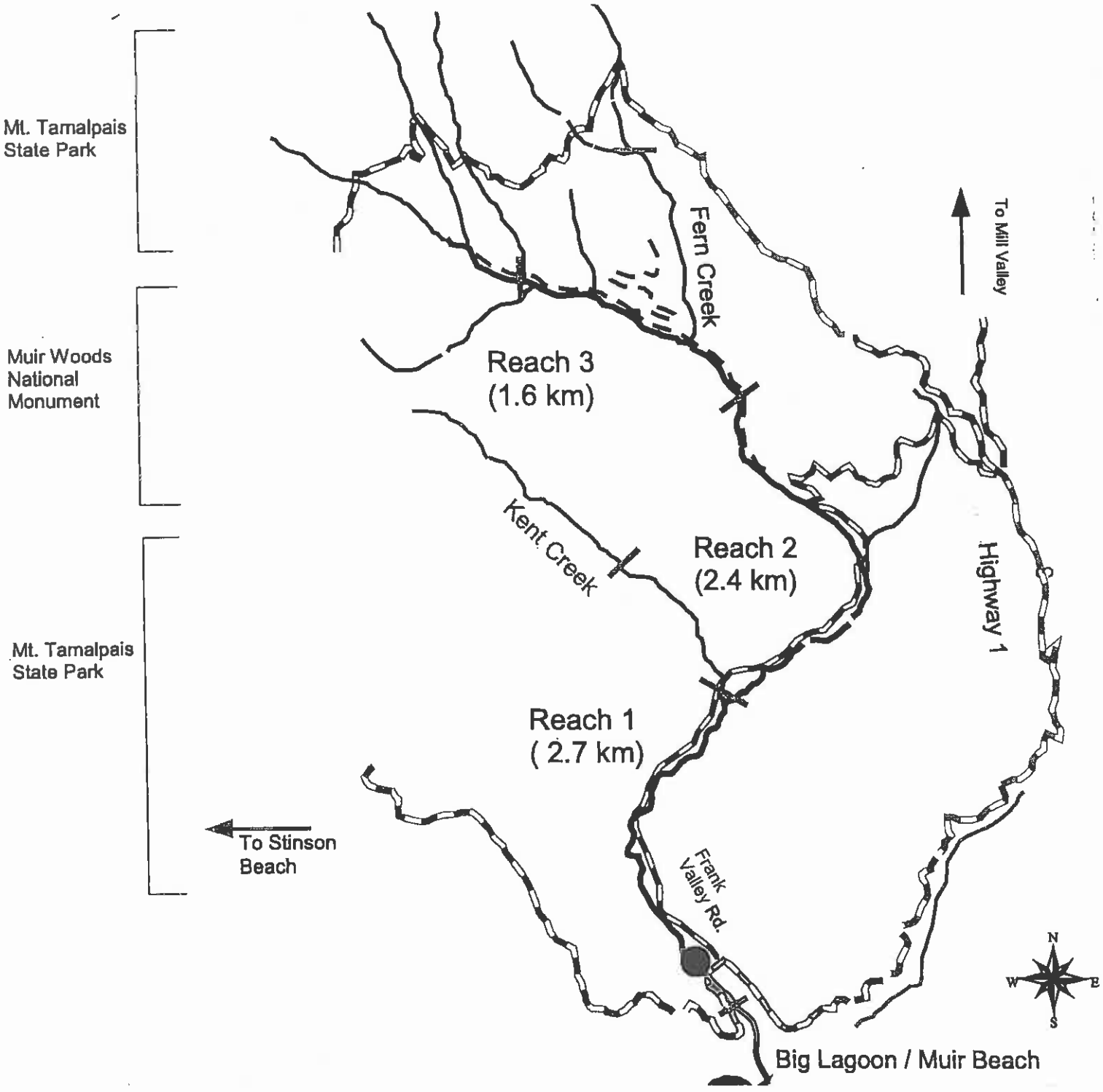


Figure 5: Olema Creek Watershed

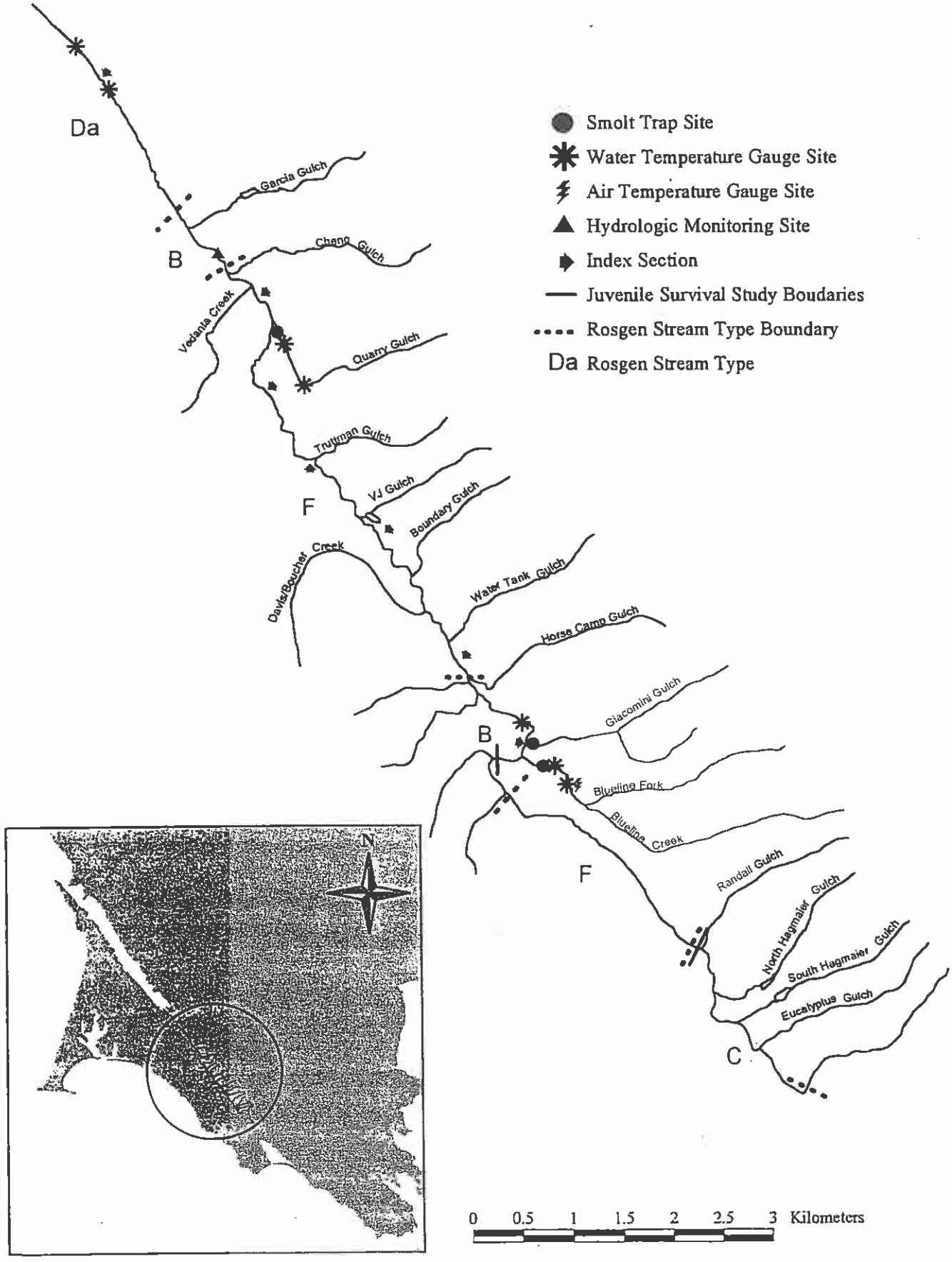


Figure 6: Olema Creek with its 7 spawning reaches

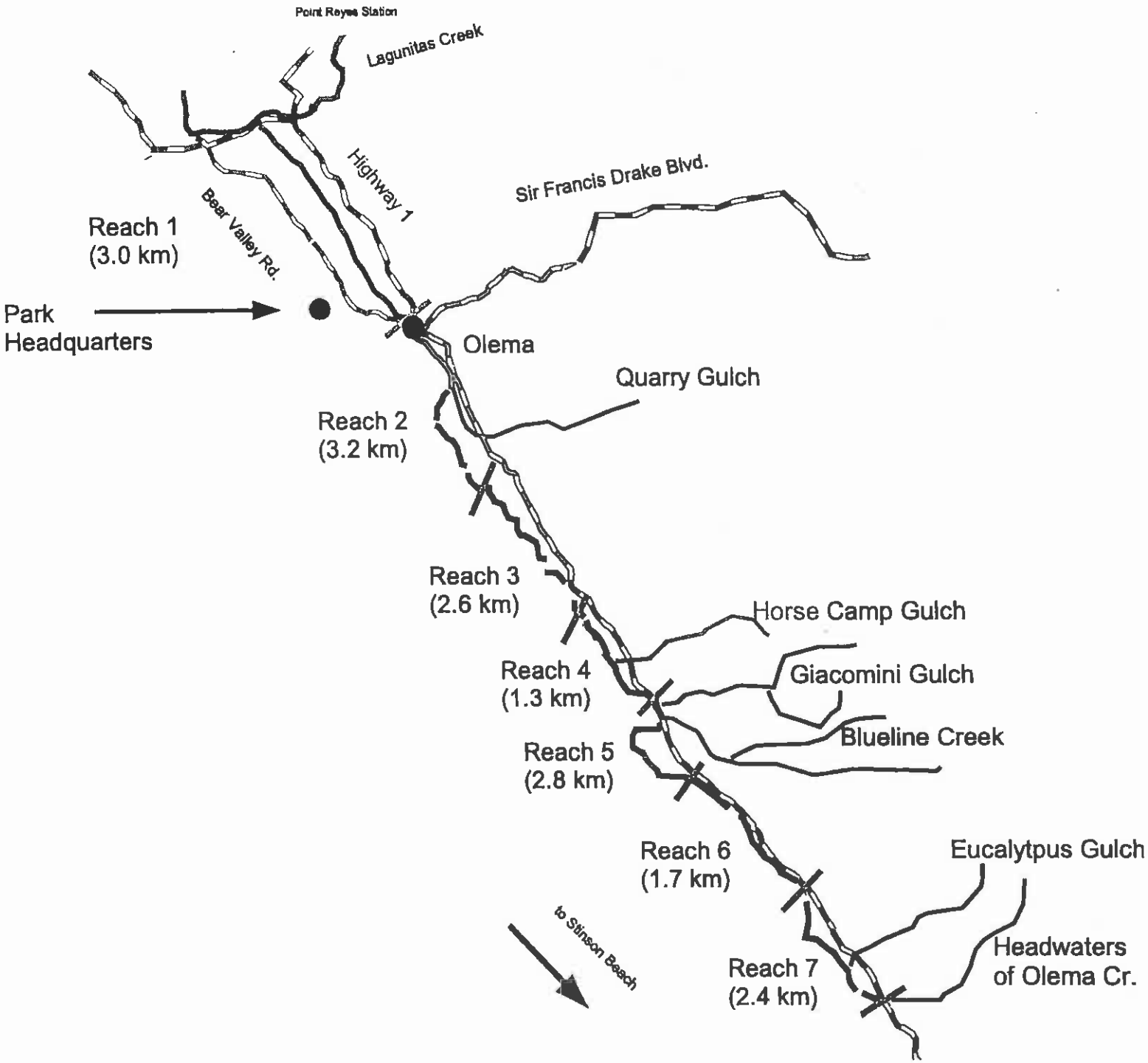


Figure 7: Lower Lagunitas Creek Watershed showing Devil's Gulch

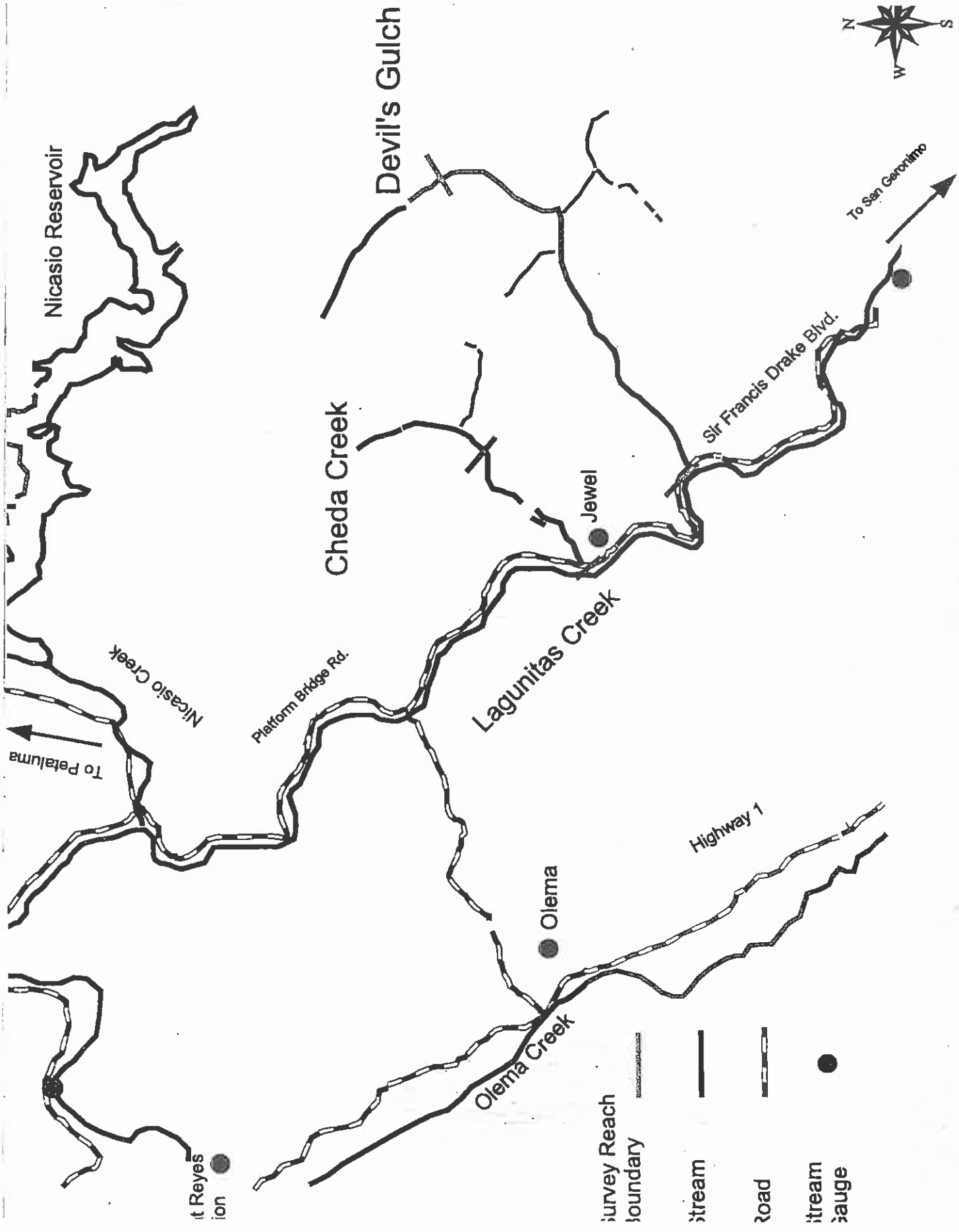


Figure 8: Eskoot Creek Watershed

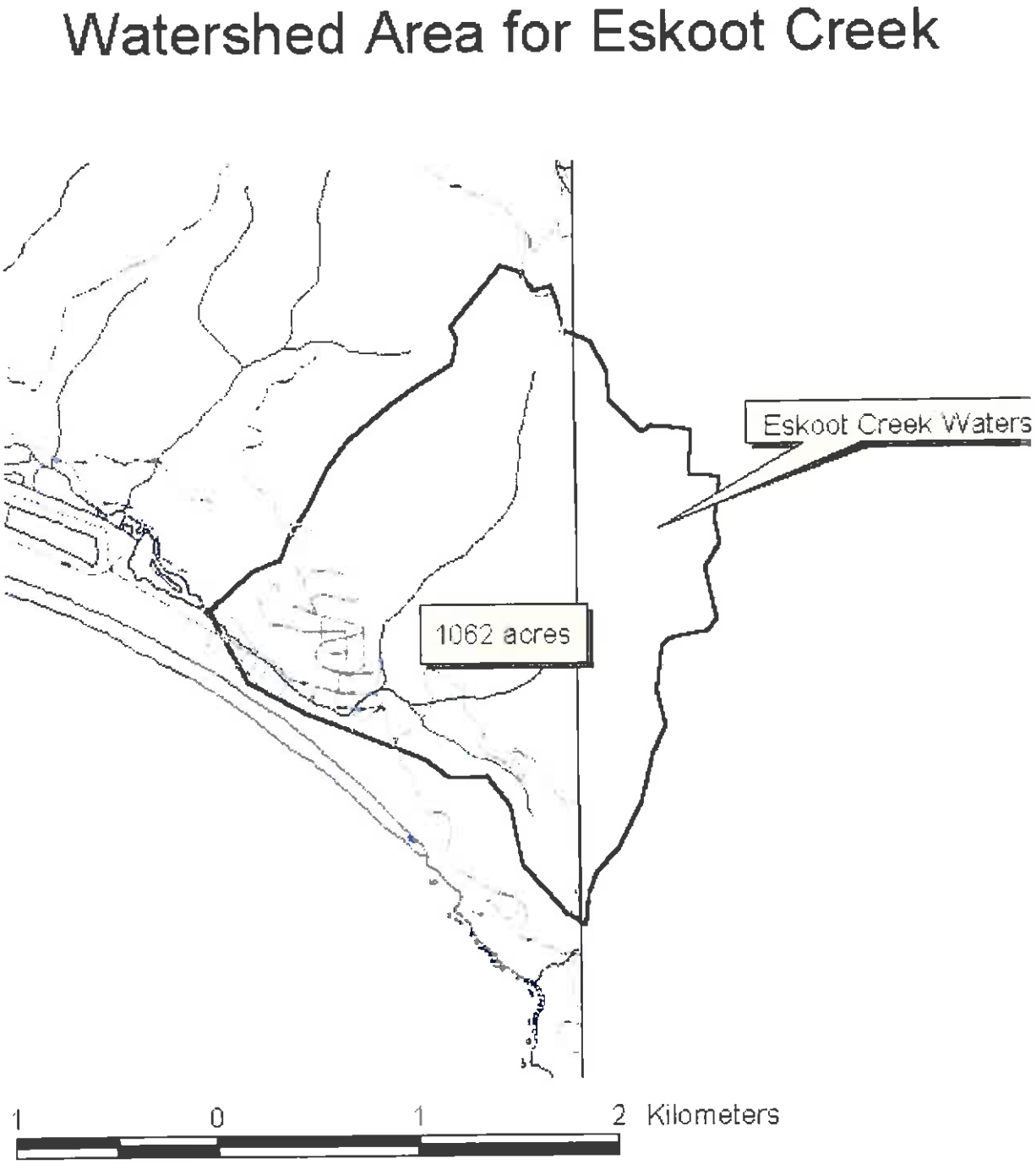


Figure 9: West Union Creek

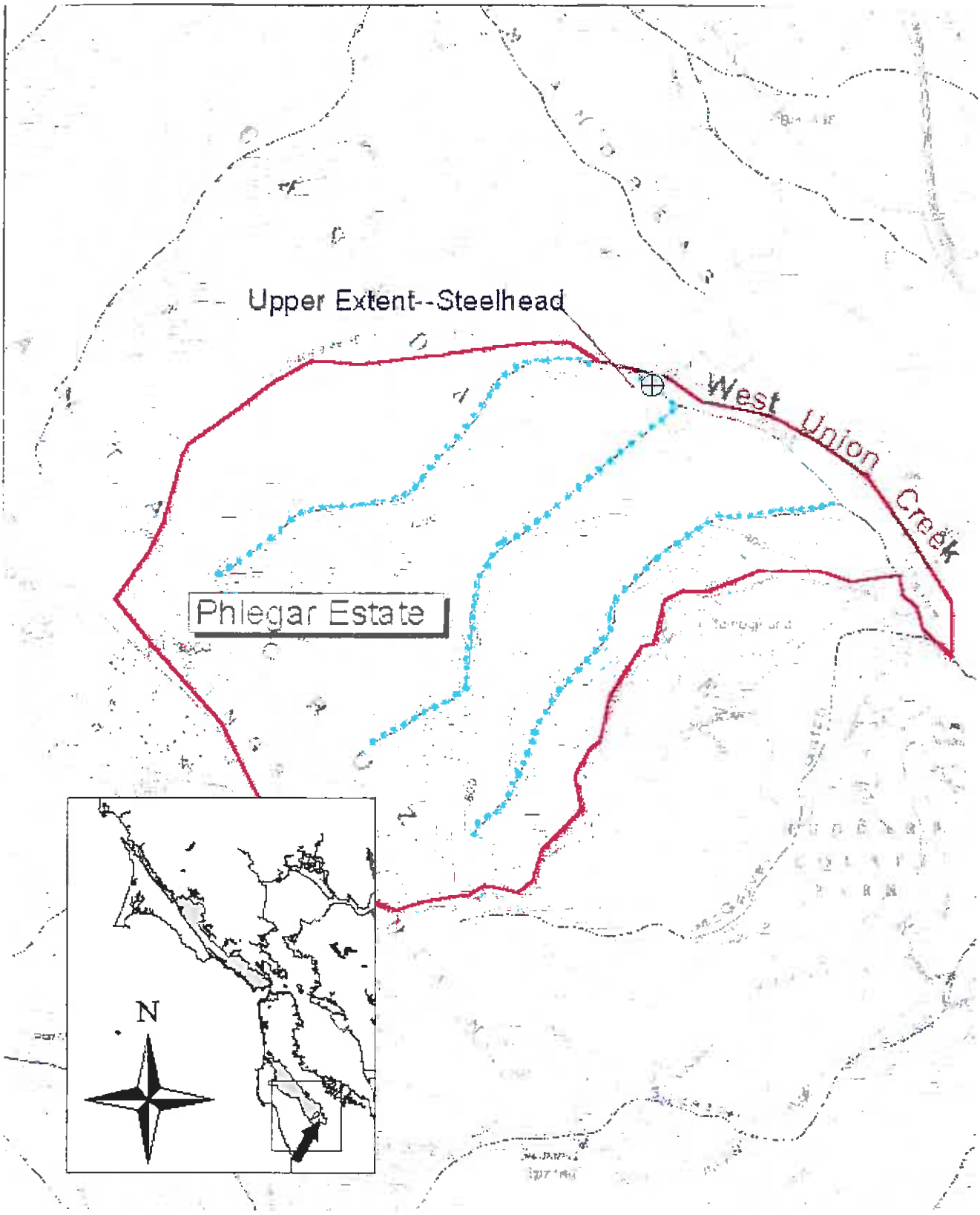


Figure 3 - Steelhead Trout (Oncorhynchus mykiss) Distribution in GGNRA, San Ma

Figure 10: fish scale envelope (90 x 55 mm)

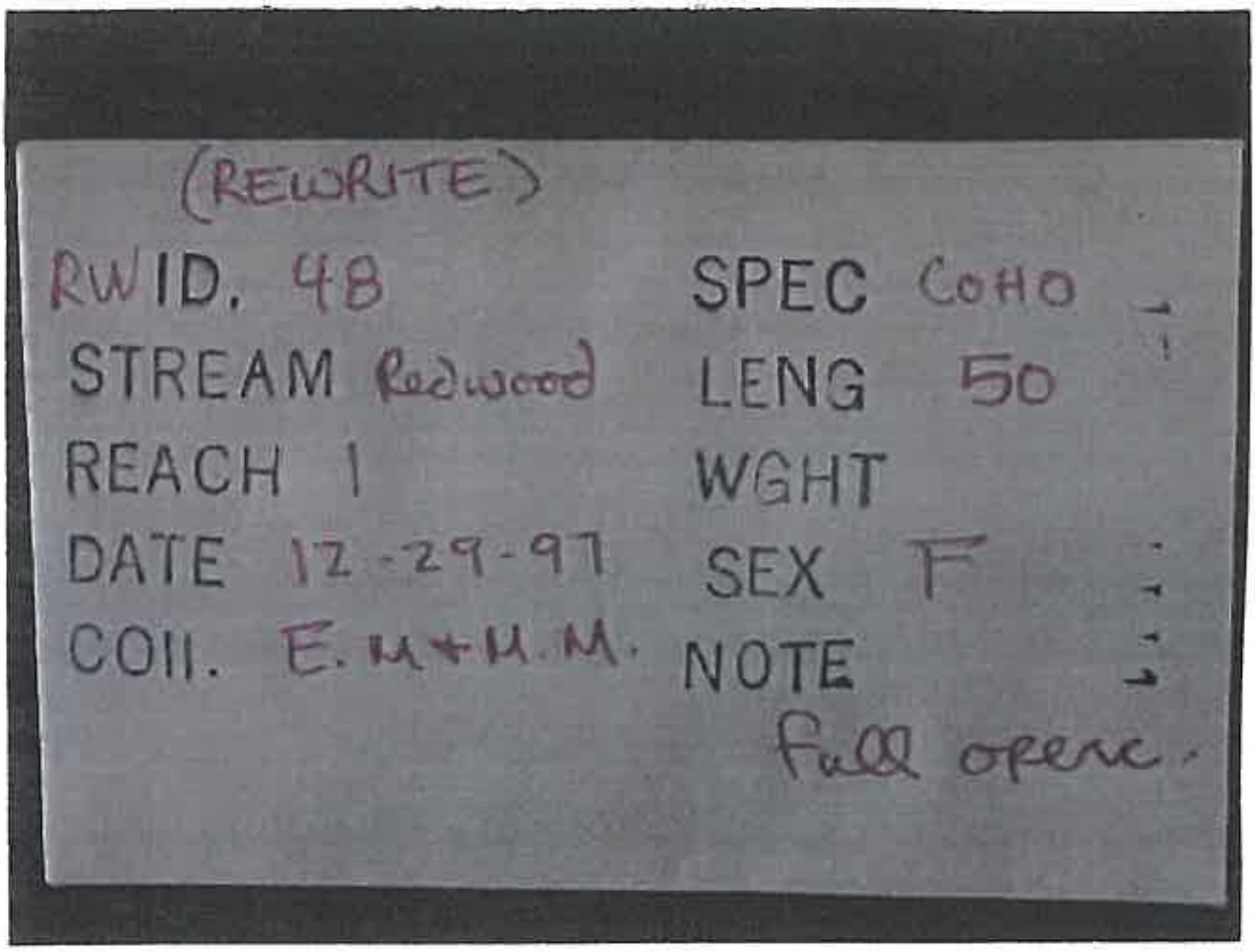


Figure 11: myself looking at non-regenerated scales to mount them on a slide



Figure 12: scale with anterior field up (with circuli) and posterior field down (dark area)

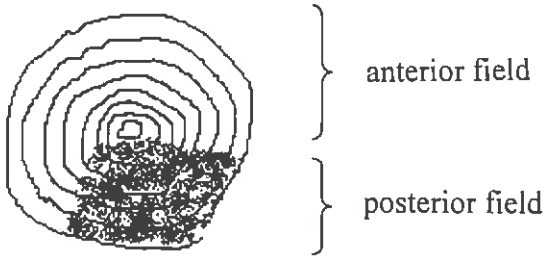


Figure 13: slide (75 x 25 mm) with scales from 2 different fish (Redwood Creek)



Figure 14: one of the slide holder (125 x 80 mm) for Redwood Creek

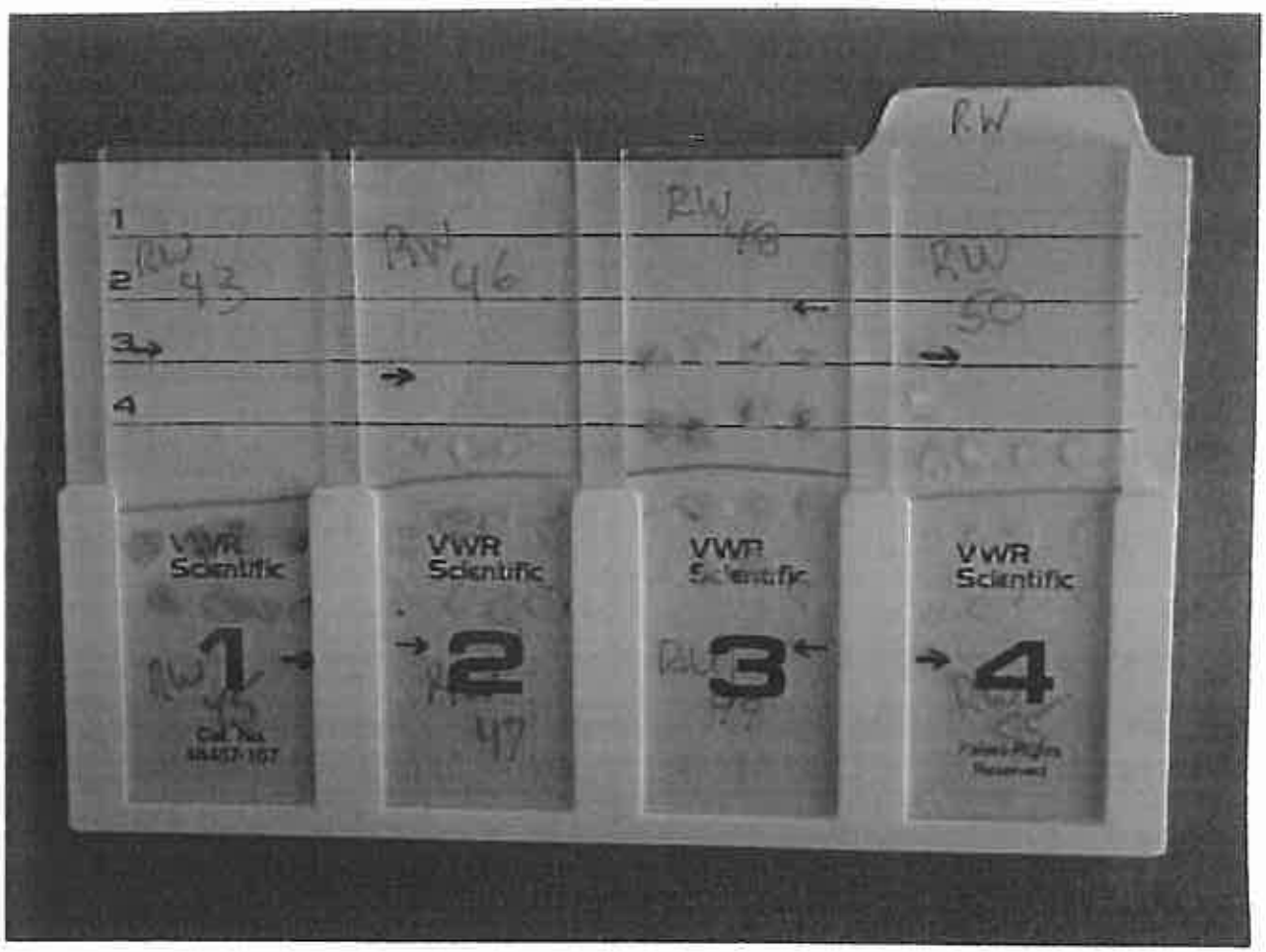


Figure 15: microfiche reader used to read a fish scale



Figure 16: regenerated scale (cannot be used to age a fish, the arrow shows only one crossing-over)

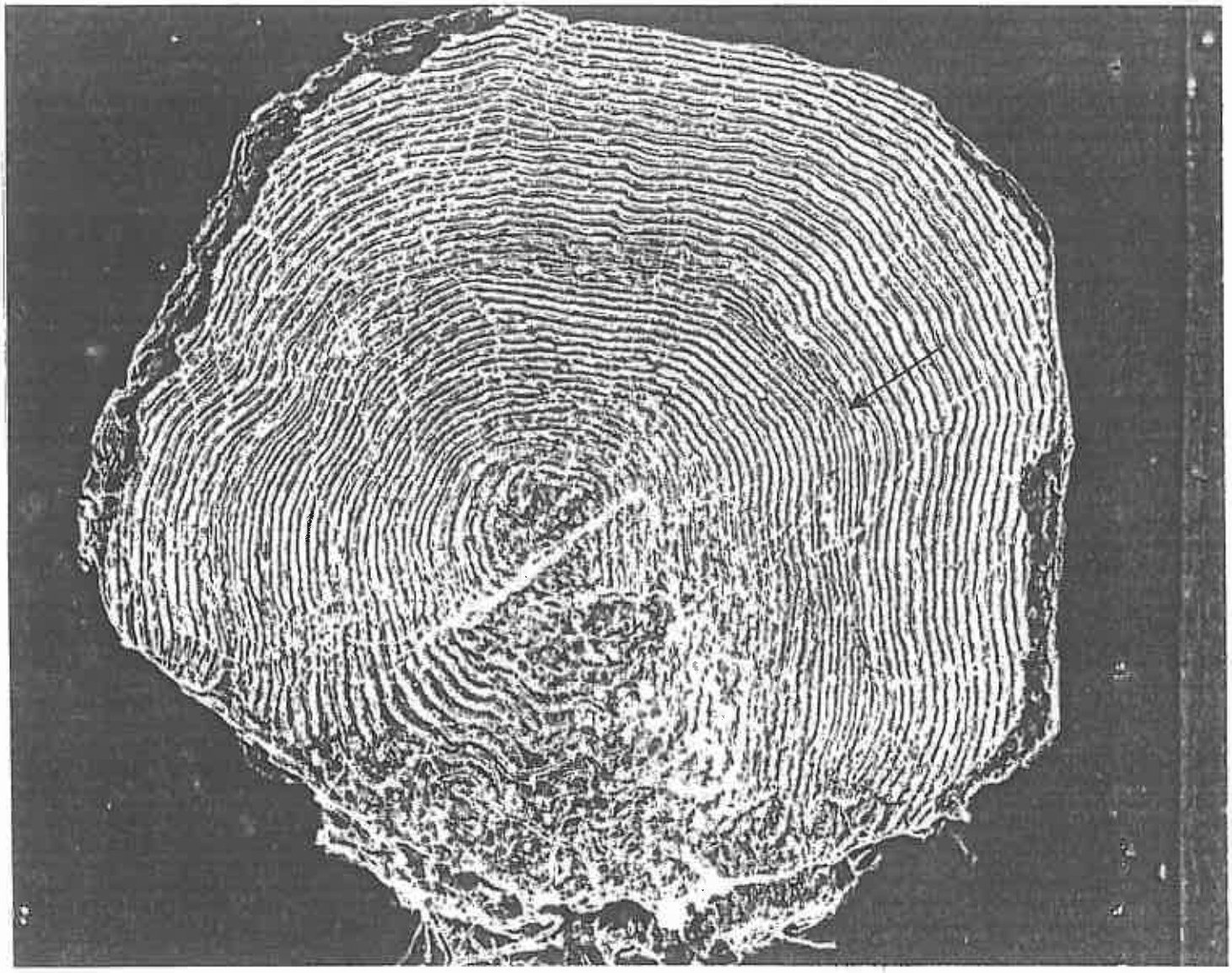
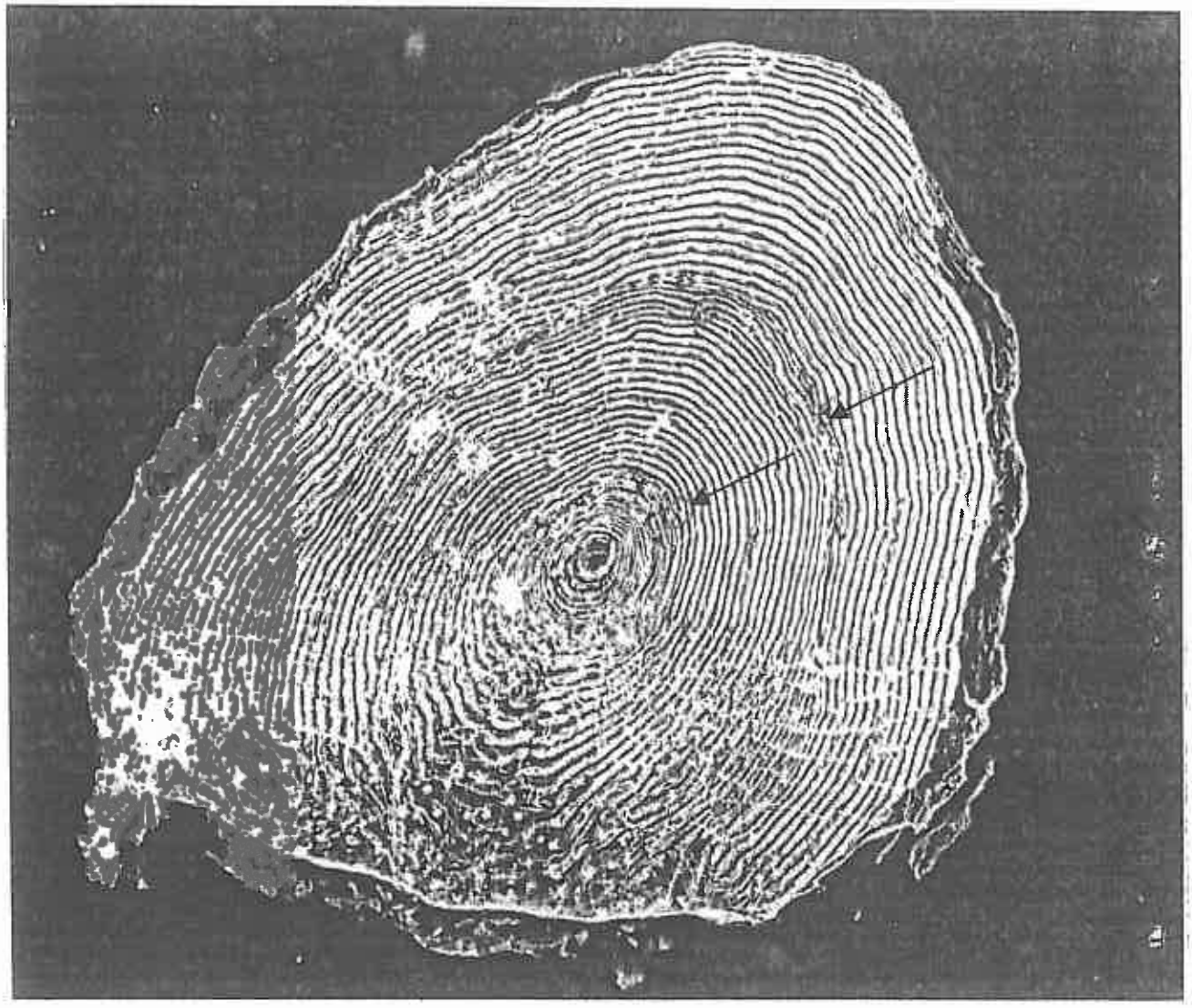


Figure 17: non-regenerated scale (can be used to age a fish, the 2 arrows show 2 crossing-over: the fish is 1.2 years old)



COHO-STEELHEAD RESTORATION PROJECT (GOGA/PORE) FISH SCALE FORM

Sampling Location: Redwood Species: Sh Equipment: Microfiche reader (Magnif 36) Microscope

Reader: Rauber Anne-Laure Reading number: (1) 2 3 4 Reading date: 1/27/00 - 1/31/00

	ID	Sample Date	Fish length (Specify units)	Est. Age	Scale Radius	Length (cm) to annuli: I	II	III	IV	V	Number of circuli (per annulus) <I	I-II	II-III	III-IV	IV-V	Notes (e.g., scale regen?)
✓ sc.4	RW175	6/29/99	123 mm	~1+	19mm	15mm	4mm									19mm
✓ sc 6	RW176	6/29/99	108 mm	~1+	17mm	14mm	3mm									17mm
sc.3	RW177	6/29/99	104 mm	~1+	20mm	14mm	6mm									20mm
sc.4	RW178	6/28/99	97 mm	~0+	15mm	15mm										15mm
✓ sc 1	RW179	6/30/99	147 mm	~2+	25mm	10mm	5mm	10mm								25mm
sc 4	RW180	6/30/99	135 mm	~1+	27mm	15mm	12mm									27mm
sc 1	RW181	6/30/99	136 mm	~1+	22mm	11mm	11mm									22mm
sc.1	RW182	6/30/99	129 mm	~1+	18mm	10mm	8mm									18mm
sc.1	RW183	6/30/99	114 mm	~1+	22mm	15mm	7mm									22mm
sc 1	RW184	6/30/99	107 mm	~0+	17mm	17mm										17mm
sc 4	RW185	10/5/99	114 mm	~1+	20mm	10mm	10mm									20mm
sc.2	RW186	10/5/99	124 mm	~1+	20mm	10mm	10mm									20mm
✓ sc 1	RW187	10/5/99	116 mm	~1+	20mm	13mm	7mm									20mm
sc2	RW188	10/5/99	133 mm	~1+	24mm	13mm	11mm									24mm
sc 2	RW189	10/5/99	106 mm	~1+	20mm	15mm	5mm									20mm
ll reg.	RW190	10/5/99	124 mm	—	—	—	—	—	—	—	—	—	—	—	—	
sc.2	RW191	10/5/99	101 mm	~1+	20mm	10mm	10mm									20mm
too dusty	RW192	10/5/99	133 mm	—	—							—	—			
sc.2	RW193	10/5/99	116 mm	~1+	19mm	11mm	8mm									19mm
all reg	RW194	10/5/99	117 mm													
sc 1	RW195	10/6/99	121 mm	~1+	20mm	11mm	9mm									20mm
sc.5	RW196	10/6/99	117 mm	~1+	17mm	11mm	6mm									17mm
sc 6	RW167	6/28/99	10 mm	~1+	20mm	15mm	5mm									20mm

COHO-STEELHEAD RESTORATION PROJECT (GOGA/PORE)

FISH SCALE FORM

Sampling Location: Redwood Species: Sh Equipment: Microfiche reader (Magnif 36) Microscope

Reader: Rauber Anne-Laure Reading number: (1) 2 3 4 Reading date: 1/31/00

	ID	Sample Date	Fish length (Specify units)	Est. Age	Scale Radius	Length (cm) to annuli: I	II	III	IV	V	Number of circuli (per annulus) <I	I-II	II-III	III-IV	IV-V	Notes (e.g., scale regen?) Freshwater	Ocean
	RW 197	10/6/99	112 mm	~ 1+	25mm	12mm	11mm									23mm	
all reg.	RW 198	10/6/99	113 mm	-	-	-	-									-	
	RW 199	10/6/99	107 mm	~ 1+	16mm	10mm	6mm									16mm	
sc.5	RW 200	10/6/99	114 mm	~ 1+	21mm	14mm	7mm									21mm	
sc. 6	RW 201	10/6/99	120 mm	~ 1+	18mm	10mm	8mm									18mm	
sc.1	RW 202	10/6/99	108 mm	~ 1+	20mm	12mm	8mm									20mm	
sc 1	RW 203	10/6/99	127 mm	~ 2+	23mm	10mm	8mm	5mm								23mm	
sc.3	RW 204	10/6/99	125 mm	~ 1+	22mm	10mm	11mm									22mm	
sc.1	RW 205	10/6/99	111 mm	~ 1+	15mm	8mm	7mm									15mm	
sc.3	RW 206	10/6/99	121 mm	~ 1+	20mm	13mm	8mm									20mm	
sc.2	RW 207	10/6/99	112 mm	~ 1+	18mm	11mm	7mm									18mm	
sc.2 ~ reg.	RW 208	10/6/99	142 mm	~ 2+	23mm	10mm	9mm	4mm								23mm	
sc.2	RW 211	10/6/99	105 mm	~ 1+	20mm	11mm	8mm									20mm	
sc 4	RW 212	10/6/99	125 mm	~ 1+	19mm	12mm	7mm									19mm	
reg sc 4	RW 213	10/6/99	171 mm	~ 2+	28mm	12mm	9mm	7mm								28mm	
✓ sc 1	RW 214	10/6/99	155 mm	~ 1+	25mm	11mm	14mm									10mm	18mm
sc 6	RW 215	10/6/99	124 mm	~ 1+	20mm	9mm	11mm									20mm	
sc. 6	RW 216	10/6/99	106 mm	~ 1+	19mm	12mm	7mm									19mm	
sc 3	RW 217	10/6/99	123 mm	~ 1+	21mm	12mm	9mm									21mm	
sc. 6	RW 218	6/30/99	124 mm	~ 1+	20mm	10mm	10mm									10mm	10mm
sc.1	RW 220	10/6/99	130 mm	~ 1+	20mm	10mm	10mm									20mm	
sc.4	RW 221	10/6/99	124 mm	~ 1+	21mm	10mm	11mm									21mm	
*	RW 219	10/6/99	142 mm	~ 2+	23mm	10mm	7mm	6mm								23mm	

COHO-STEELHEAD RESTORATION PROJECT (GOGA/PORE) — FISH SCALE FORM

Sampling Location: Redwood — Species: Sh — Equipment: Microfiche reader (Magnif 36) Microscope

Reader: Rauber Anne-Laure — Reading number: (1) 2 3 4 — Reading date: 2/1/00 - 2/2/00

	ID	Sample Date	Fish length (Specify units)	Est. Age	Scale Radius	Length (cm) to annuli: I	II	III	IV	V	Number of circuli (per annulus) <I	I-II	II-III	III-IV	IV-V	Notes (e.g., scale regen?) Freshwater	Ocean	
√ sc 1	RW 222	10/6/99	132 mm	~ 1+	25mm	17mm	8mm									25mm		
sc 4.	RW 223	10/6/99	120 mm	~ 1+	21mm	12mm	9mm									21mm		
sc.2	RW 224	10/7/99	127 mm	~ 1+	22mm	13mm	9 mm									22mm		
sc.6	RW 225	10/7/99	112 mm	~1+	17mm	11mm	6mm									17mm		
sc 2	RW 226	10/7/99	114 mm	~ 1+	16mm	11mm	5 mm									16mm		
sc 1	RW 227	10/7/99	122 mm	~ 1+	18mm	9mm	9 mm									18mm		
sc 1	RW 228	10/7/99	132 mm	~ 1+	22 mm	9mm	13mm									9mm	13mm	
sc.4	RW 229	10/7/99	142 mm	~ 1+	26mm	16mm	10mm									26mm		
sc.6	RW 230	10/7/99	108 mm	~ 0+	14mm	14mm										14mm		
all reg.	RW 231	10/7/99	133 mm	———	———	———	———	———	———	———	———	———	———	———	———			
sc 5.	RW 232	10/7/99	119 mm	~1+	18mm	11mm	7mm									18mm		
sc 4.	RW 233	10/7/99	109 mm	~ 1+	20mm	14mm	6 mm									20mm		
sc 4	RW 234	10/7/99	117 mm	~1+	20mm	11mm	8mm									20mm		
sc.2	RW 235	10/7/99	133mm	~1+	21mm	13mm	8mm									21mm		
! sc.4	RW 236	10/7/99	198mm	~3+	37mm	12mm	10mm	3mm	3mm		resident !					37mm		
sc.1	RW 237	10/7/99	113mm	~ 1+	20mm	10mm	10mm									20mm		
sc.5	RW238	10/7/99	142 mm	~ 1+	20mm	9mm	11mm									20mm		
sc.1	RW 240	10/4/99	124mm	~1+	18mm	11mm	7mm									18mm		
sc.3	RW241	10/4/99	93mm	~0+	13mm	13mm										13mm		
sc.6	RW242	10/4/99	65 mm	~0+	8mm	8mm										8mm		
sc.3	RW 243	10/4/99	119mm	~1+	22mm	12mm	10mm									22mm		
sc.3	RW 244	10/4/99	64 mm	~0+	7mm	7mm										7mm		

COHO-STEELHEAD RESTORATION PROJECT (GOGA/PORE) FISH SCALE FORM (8)

Sampling Location: Redwood Species: Sh Equipment: Microfiche reader (Magnif 56) Microscope

Reader: Rauber Anne-Lise Reading number: (1) 2 3 4 Reading date: 2/2/00

	ID	Sample Date	Fish length (Specify units)	Est. Age	Scale Radius	Length (cm) to annuli: I	II	III	IV	V	Number of circuli (per annulus) <I	I-II	II-III	III-IV	IV-V	Notes (e.g., scale regen?) Freshwater	Ocean	
sc.3	RW 245	10/4/99	71 mm	~ 0+	10mm	10mm										10mm		
sc.1	RW 246	10/4/99	160 mm	~ 1+	30mm	13mm	17mm									16mm	14mm	
sc.1	RW 247	10/4/99	241 mm	~ 2+	40mm	13mm	18mm	3mm								17mm	23mm	
sc.5	RW 248	10/8/99	91 mm	~ 0+	15mm	15mm										15mm	?	
sc.3	RW 249	10/8/99	164 mm	~2+	32mm	12mm	16mm	4mm								12mm	Big lag 2 to mm	RO
sc.1	RW 250	10/8/99	157 mm	~2+	25mm	14mm	8mm	3mm								25mm	? or Big lag	
sc.3	RW 251	10/8/99	150 mm	~2+	31mm	12mm	12mm	7mm								12mm	19mm Big lag	
sc.4	RW 252	10/8/99	111 mm	~1+	21mm	15mm	6mm									21mm	} big lag	?
sc.2	RW 253	10/8/99	132 mm	~1+	26mm	16mm	10mm									26mm	} big lag	?
sc.1	RW 254	10/8/99	140 mm	~2+	24mm	8mm	12mm	4mm								8mm	16mm Big lag	
sc.1	RW 255	10/8/99	171 mm	~2+	30mm	11mm	14mm	5mm								11mm	19mm Big lag	
sc.4	RW 256	10/8/99	151 mm	~2+	23mm	10mm	8mm	5mm								10mm	13mm Big Lag	
sc.3	RW 258	10/8/99	102 mm	~1+	15mm	11mm	4mm									15mm	Big lag	?
sc.1	RW 259	10/8/99	131 mm	~2+	32mm	19mm	10mm	3mm								19mm	32mm Big lag	
sc.1	RW 260	10/8/99	188 mm	~2+	35mm	11mm	13mm	11mm								13mm	35mm Big lag	
sc.5	RW 261	10/8/99	162 mm	~2+	30mm	13mm	12mm	5mm								13mm	17mm Big lag	
sc.4	RW 262	10/8/99	170 mm	~2+	30mm	10mm	17mm	8mm								10mm	20mm Big lag	

~15 LAGOON

COHO-STEELHEAD RESTORATION PROJECT (GOGA/PORE) — FISH SCALE FORM

Sampling Location: Redwood Species: CO Equipment: Microfiche reader (Magnif 35) Microscope

Reader: Rauber Anne-Laure Reading number: (1) 2 3 4 Reading date: 2/4/00 - 2/7/00

ID	Sample Date	Fish length (Specify units)	Est. Age	Scale Radius	Length (cm) to annuli: I	II	III	IV	V	SEX	Number of circuli (per annulus) I-II	II-III	III-IV	IV-V	Notes (e.g., scale regen?) Freshwater	Ocean
RW 2																
RW 18																
RW 45																
RW 46	1/23/98	partial carcass	1.2 (3)	75mm	12mm	28mm	35mm			F					12mm	63mm
RW 47	12/29/97	55 cm	1.2 (3)	100mm	20mm	38mm	42mm			F					20mm	80mm
RW 48	12/29/97	50 cm	1.2 (3)	75mm	17mm	34mm	24mm			F					17mm	58mm
RW 49	12/29/97	65 cm	1.2 (3)	98mm	13mm	42mm	43mm			M					13mm	85mm
RW 50	12/12/97	57 cm	1.2 (3)	95mm	16mm	42mm	37mm			F					16mm	79mm
RW 52	12/29/97	39 cm	1.1 (2)	68mm	12mm	8mm=RO	48mm			M	jack				12mm	56mm
RW 53	12/12/97	40 cm	1.1 (2)	54mm	13mm	RO=5mm	36mm			M	jack				13mm	41mm
RW 55	12/12/97	42 cm	1.1 (2)	69mm	9mm	RO=11mm	49mm			M	jack				15mm	54mm
RW 56	12/18/97	55 cm	1.2 (3)	90mm	11mm	44mm	35mm			?					11mm	79mm
RW 57	12/29/97	55 cm	1.2 (3)	82mm	11mm	36mm	35mm			M					11mm	71mm
RW 76	12/28/98	50cm	1.2 (3)	83mm	17mm	33mm	33mm			F					17mm	66mm
RW 77	1/5/99	39cm	1.1 (2)	63mm	16mm	47mm				M					16mm	47mm
RW 78	1/22/99	45cm	1.1 (2)	56mm	17mm	39mm				M					17mm	39mm
RW 79	1/29/99	64cm	1.2 (3)	105mm	18mm	48mm	39mm			M					18mm	87mm
RW 80	1/29/99	~40cm ?	1.2 (3)	33mm	13mm	37mm	33mm			M					13mm	70mm
RW 81	2/5/99	54cm	2.1 (3)	71mm	11mm	10mm	50mm			F	2 Years freshwater !				21mm	50mm
RW 82	2/5/99	43cm	1.1 (2)	56mm	12mm	44mm				M	jack				12mm	44mm
RW 83	2/5/99	50cm	1.2 (3)	73mm	13mm	RO=7mm	25mm	28mm		F					13mm	60mm
RW 100	12/12/98	18in = 46 cm	1.2 (3)	83mm	18mm	8mm RO ✓	41mm	16mm		M	jack				18mm	65mm

#11 Darren has those scales!

✓ sc 3 ✓ sc 4 ✓ sc 2 ✓ sc 7 ✓ sc 3 ? ✓ sc 2 ? sc 4 ? sc 8 ✓ sc 1 ✓ sc 1 ✓ sc 6 ✓ sc 2 ✓ sc 6 ✓ sc 8 ✓✓ sc 8 ⚠ ✓✓ sc 8 ✓✓ sc 4 ✓✓ sc 8 △✓ sc 6 + RO ✓

⚠ RO is part of the ocean part!

COHO-STEELHEAD RESTORATION PROJECT (GOGA/PORE)

FISH SCALE FORM

Sampling Location: Redwood Species: CO Equipment: Microfiche reader (Magnif 36) Microscope

Reader: Rauber Anne-Laure Reading number: (1) 2 3 4 Reading date: 2/8/00

	ID	Sample Date	Fish length (Specify units)	Est. Age	Scale Radius	Length (cm) to annuli: I	II	III	IV	V	sex	Number of circuli (per annulus) I-II	II-III	III-IV	IV-V	Notes (e.g., scale regen?) Freshwater	Ocean
sc.3	RW 101	12/22/94	25in = 64cm	~(3)1.2	100mm	15mm	35mm	50mm			F					15mm	85mm
sc.6	RW 102	12/22/94	62 cm	~(3)1.2	87mm	13mm	33mm	41mm			M					13mm	74mm
sc 2	RW 103	1/2/95	24in = 61cm	~(3)1.2	85mm	15mm	30mm	40mm			F					15mm	70mm
sc 1	RW 104	1/2/95	24.5 = 62cm	~(3)1.2	78mm	13mm	25mm	40mm			F					13mm	65mm
sc 3	RW 105	. ?	24.5 = 62cm	~(3)1.2	86mm	16mm	35mm	35mm			F					16mm	70mm
sc.4	RW 106	1/2/95	18.3 = 47cm	~(3)1.2	74mm	13mm	29mm	32mm			M					13mm	61mm
sc 5	RW 107	1/2/95	26.7 = 68cm	~(3)1.2	63mm	12mm	28mm	23mm			M					12mm	54mm
sc.4	RW 108	1/2/95	24.7 = 63cm	~(3)1.2	80mm	13mm	26mm	41mm			F					13mm	67mm
sc.2	RW 109	1/19/95	25.5 = 65cm	~(3)1.2	100mm	15mm	40mm	45mm			F					15mm	85mm
sc.3	RW 110	1/20/95	65 cm	~(3)1.2	75mm	12mm	28mm	35mm			M					12mm	63mm
sc 6	RW 111	1/20/95	73 cm	~(3)1.2	97mm	15mm	35mm	42mm			M					15mm	77mm
sc.4	RW 112	1/7/96	56 cm	~(3)1.2	75mm	13mm	34mm	28mm			F					13mm	68mm
sc 2	RW 113	1/7/96	58 cm	~(3)1.2	101mm	15mm	43mm	43mm			F					15mm	86mm
sc.2	RW 114	1/7/96	57 cm	~(3)1.2	81mm	16mm	30mm	35mm			F					16mm	65mm
sc.6	RW 115	1/7/96	60 cm	~(3)1.2	85mm	12mm	37mm	36mm			F					12mm	73mm
sc 2	RW 116	1/7/96	60 cm	~(3)1.2	88mm	13mm	35mm	40mm			M					13mm	75mm
sc 2	RW 117	1/7/96	57 cm	~(3)1.2	97mm	16mm	39mm	42mm			M					16mm	81mm
sc.2	RW 118	1/8/96	62 cm	~(3)1.2	80mm	13mm	25mm	42mm			F					13mm	67mm
sc 4	RW 119	1/8/96	66 cm	~(3)1.2	100mm	14mm	44mm	42mm			F					14mm	86mm
sc.4	RW 120	1/8/96	65 cm	~(3)1.2	76mm	13mm	25mm	38mm			M					13mm	63mm
sc 6	RW 123	12/3/97	39 cm	~2)1.1	44mm	16mm	28mm				M					16mm	28mm
sc 3	RW 124	12/3/97	40 cm	~2)1.1	46mm	16mm	30mm				M					16mm	30mm

COHO-STEELHEAD RESTORATION PROJECT (GOGA/FORE)

FISH SCALE FORM

Sampling Location: Redwood Species: CO Equipment: Microfiche reader (Magnif 36) Microscope

Reader: Rauber Anne-Laure Reading number: (1) 2 3 4 Reading date: 2/3/00

	ID	Sample Date	Fish length (Specify units)	Est. Age	Scale Radius	Length (cm) to annuli: I	II	III	IV	V	Sex	Number of circuli (per annulus) I-II	II-III	III-IV	IV-V	Notes (e.g., scale regen?) Freshwater	Ocean
Sc.3	RW 125	12/4/97	<50 cm	~(3)1.2	86mm	15mm	36mm	35mm			?					15mm	71mm
sc 5	RW 127	1/8/97	45 cm	~(2)1.1	65mm	19mm	46mm				M					19mm	46mm
Sc 6	RW 128	1/8/97	60 cm	~(3)1.2	97mm	16mm	35mm	46mm			M					16mm	81mm
Sc.3	RW 129	1/8/97	45 cm	~(2)1.1	76mm	18mm	58mm				M					18mm	58mm
eg, sc.4	RW 133	1/18/97	40 cm	~(2)1.1	65mm	18mm	47mm				M					18mm	47mm
sc 6	RW 134	1/18/97	60cm	~(3)1.2	130mm	22mm	51mm	57mm			?					22mm	108mm
sc 6	RW 135	1/18/97	66 cm	~(3)1.2	93mm	22mm	31mm	40mm			M					22mm	71mm
Ro? sc 6	RW 136	1/18/97	66cm	~(3)1.2	115mm	18mm	7mm RO	33mm	57mm		M					25mm	90mm
sc.4	RW 140	1/18/97	?	~(3)1.2	87mm	16mm	22mm	49mm			F					16mm	71mm
! jack sc.1	RW 141	1/18/97	?	~(2)1.1	55mm	17mm	43mm				M					17mm	43mm
! sc 1	RW 142	1/30/98	62 cm	~(5)2.3	110mm	22mm	16mm	32mm	[illegible]	19mm	F					38mm	77mm
jack sc 1	RW 143	1/30/98	46 cm	~2)1.1	74mm	20mm	54mm				M					20mm	54mm
✓sc.2	RW 26	1/23/98	50cm	1.2(3)	78mm	15mm	6mm PO	49mm	8mm		M					15mm	63mm
✓sc.3	RW 28	1/23/98	60 cm	2.2(4)	109mm	14mm	9mm	43mm	43mm		F					23mm	86mm
✓ sc.8	RW 2	1/23/98	55 cm	2.2(4)	92mm	9mm	8mm	33mm	42mm		F					17mm	75mm
too small to make a copy	RW 18	1/30/98	101mm	———	———	———										———	———
✓sc.5	RW 45	1/7/98	63cm	1.2(3)	35mm	15mm	47mm	33mm			M					15mm	80mm
? sc 1	RW 58	12/12/97	40cm	1.1(2)	57mm	17mm	40mm				M					17mm	40mm
too small to make a copy	RW 65	10/27/98	105mm	0+	15mm	15mm					F					15mm	
✓ sc.1	RW 75	1/5/99	55 cm	1.2(3)	70mm	13mm	36mm	21mm			F					13mm	57mm
✓sc.7	RW 84	2/5/99	60 cm	1.2(3)	72mm	17mm	29mm	31mm			M					17mm	60mm
1000 sc.2	RW 263	2/3/99	55 cm	1.2(3)	72mm	13mm	27mm	32mm			F					13mm	59mm

COHO-STEELHEAD RESTORATION PROJECT (GOGA/FORE) — **FISH SCALE FORM**

Sampling Location: Olema **Species:** Sh **Equipment:** Microfiche reader (Magnif 56) Microscope

Reader: Rauber Anne-Laure **Reading number:** (1) 2 3 4 **Reading date:** 2/11/00 - 2/23/00

	ID	Sample Date	Fish length (Specify units)	Est. Age	Scale Radius	Length (cm) to annuli: I	II	III	IV	V	Number of circuli (per annulus) SR x SR	I-II	II-III	III-IV	IV-V	Notes (e.g., scale regen?) Freshwater	Ocean	
(1) sc.4 adult	OL 34	12/20/97	60 cm	1.2(3)?	99 mm	23mm	30mm	46mm			F					23mm	76mm	
sc.8	OL 48	11/5/98	144 mm	~ 1+	25mm	14mm	11mm									21mm		
reg sc.3	OL 50	11/5/98	145 mm	~ 1+	20mm	12mm	8mm									20mm		
sc. 1	OL 51	11/5/98	120 mm	~ 1+	17mm	18mm	9mm									27mm		
sc.2	OL 52	11/5/98	116 mm	~ 0+	20mm	20mm										20mm		
? sc.1	OL 53	11/5/98	129 mm	~1+	23mm	18mm	5mm									23mm		
sc 8	OL 54	11/5/98	143 mm	~ 1+	27mm	14 mm	13mm									27mm		
sc 5	OL 55	11/5/98	114 mm	~ 0+	17mm	17mm										17mm		
sc 1	OL 56	11/5/98	143 mm	~1+	22mm	15mm	7mm									22 mm		
sc 1	OL 57	11/5/98	192 mm	~2+	33mm	14mm	14mm	5mm								33mm		
sc 4	OL 58	11/5/98	125 mm	~1+	22mm	13mm	9mm									22 mm		
sc.4	OL 59	11/5/98	94 mm	~ 0+	13mm	13mm										13mm		
all reg	OL 60	11/5/98	165 mm	~ ?	—	—												
sc 5	OL 61	11/5/98	139 mm	~1+	20mm	9mm	11mm									20mm		
sc.7	OL 62	11/5/98	106 mm	~1+	18mm	10mm	8mm									18mm		
sc 4	OL 63	11/5/98	122 mm	~ 1+	25mm	12 mm	13mm									25 mm		
sc.4	OL 64	11/5/98	135 mm	~ 1+	24mm	11mm	13mm									24mm		
sc 5	OL 65	11/5/98	134 mm	~ 1+	17mm	10mm	7mm									17mm		
sc.4	OL 66	11/5/98	115 mm	~ 1+	15 mm	7mm	8mm									15 mm		
all. reg	OL 68	11/5/98	155 mm	—	—	—	—	—	—	—								
sc.5	OL 69	11/5/98	140 mm	~ 2+	27mm	14mm	10mm	3mm								27mm		
reg. sc 4	OL 70	11/5/98	123 mm	~ 1+ ?	17mm	14mm	3mm									17mm		

COHO-STEELHEAD RESTORATION PROJECT (GOGA/PORE) FISH SCALE FORM

Sampling Location: Olema Species: Sh Equipment: Microfiche reader (Magnif 36) Microscope

Reader: Rauber Anne Louise Reading number: (1) 2 3 4 Reading date: 2/24/00 – 2/25/00

	ID	Sample Date	Fish length (Specify units)	Est. Age	Scale Radius	Length (cm) to annuli: I	II	III	IV	V	Number of circuli (per annulus) <I	I-II	II-III	III-IV	IV-V	Notes (e.g., scale regen?) Freshwater		
sc.4	OL 72	7/15/99	105 mm	0+	15mm	15mm										15mm		
sc.5	OL 73	7/15/99	130 mm	1+	22mm	15mm	7mm									17mm		
30	OL 75	7/15/99	185 mm	—	—	—	—				—							
sc.6	OL 91	7/15/99	100 mm	0+	12mm	12mm										12mm		
sc 4	OL 92	7/15/99	203 mm	2+	34mm	14mm	14mm	6mm								34mm		
sc.5	OL 93	7/15/99	100 mm	1+	16mm	12mm	4mm									16mm		
sc.2	OL 94	7/21/99	188 mm	2+	40mm	8mm	14mm	8mm								40mm		
sc 5	OL 96	10/26/99	107 mm	1+	22mm	16mm	6mm									22mm		
sc.4	OL 97	10/26/99	103 mm	1+	17mm	12mm	5mm									17mm		
sc.2	OL 99	10/26/99	90 mm	0+	15 mm	15 mm										15 mm		
sc.3	OL 100	10/26/99	111 mm	1+	20mm	14mm	6mm									20mm		
sc 1	OL 101	10/26/99	150mm	1+	22 mm	14mm	8mm									22 mm		
sc.1	OL 102	10/26/99	105mm	1+	15 mm	10mm	5mm									15 mm		
sc 4	OL 103	10/26/99	88 mm	0+	16mm	16mm										16mm		
sc.5	OL 104	10/26/99	100 mm	0+	16mm	16mm										16mm		
sc 1	OL 105	10/26/99	101 mm	0+	14mm	14mm										14mm		
sc 5	OL 106	10/26/99	113 mm	1+	22mm	13mm	9mm									22 mm		
sc 1	OL 108	10/26/99	92 mm	0+	15 mm	15 mm										15 mm		
sc 3	OL 110	10/27/99	85 mm	0+	12 mm	12 mm										12 mm		
sc 2	OL 111	10/27/99	116 mm	1+	19 mm	14mm	5mm									19 mm		
sc 4	OL 112	10/27/99	95 mm	0+	15 mm	15 mm										15 mm		
sc 5	OL 113	10/27/99	91 mm	0+	13mm	13mm										13mm		
sc 1*	OL 90	7/15/99	99 mm	1+	20mm	15 mm	5mm									20mm		

COHO-STEELHEAD RESTORATION PROJECT (GOGA/FORE)

FISH SCALE FORM

Sampling Location: Olema Species: Sh Equipment: Microfiche reader (Magnif 36) Microscope

Reader: Rauber Anne-Laure Reading number: ① 2 3 4 Reading date: 2/29/00 – 3/1/00

	ID	Sample Date	Fish length (Specify units)	Est. Age	Scale Radius	Length (cm) to annuli: I	II	III	IV	V	Number of circuli (per annulus) <I	I-II	II-III	III-IV	IV-V	Notes (e.g., scale regen?) Freshwater	Ocean	
sc.4	OL 114	10/27/99	94 mm	1+	16mm	11mm	5mm									16mm		
sc.3	OL 115	10/27/99	100 mm	1+	15mm	10mm	5mm									15mm		
sc 4	OL 116	10/27/99	99 mm	0+	15mm	15mm										15mm		
sc 3	OL 117	10/27/99	92 mm	0+	13mm	13mm										13mm		
sc1	OL 118	10/27/99	92 mm	0+	15mm	15mm										15 mm		
sc1	OL 119	10/27/99	92 mm	0+	16mm	16mm										16 mm		
sc 3	OL 120	10/27/99	98 mm	1+	15mm	9mm	6mm									15mm		
sc.1	OL 121	10/27/99	88 mm	0+	11mm	11mm										11mm		
reg sc.1	OL 122	10/27/99	89mm	0+	13mm	13mm										13mm		
sc.1	OL 123	10/27/99	88 mm	0+	12mm	12mm										12mm		
sc.6	OL 124	10/27/99	100 mm	1+	19mm	10mm	9mm									19mm		
sc.5	OL 125	10/27/99	91 mm	0+	15mm	15mm										15 mm		
sc 2	OL 126	10/28/99	103 mm	0+	15mm	15mm										15 mm		
sc.3	OL 127	10/28/99	98 mm	1+	15mm	9mm	6mm									15 mm		
sc.2	OL 128	10/28/99	93mm	0+	15mm	15mm										15mm		
sc.4	OL 129	10/28/99	95 mm	1+	18mm	8mm	10mm									18mm		
?reg. sc 5	OL 130	10/28/99	104 mm	1+	15mm	9mm	6mm									15 mm		
sc 1	OL 131	10/28/99	103mm	1+	17mm	8mm	9mm									17mm		
? sc 1	OL 132	10/28/99	160mm	2+	27mm	10mm	6 mm	11mm								27mm		
sc.5	OL 133	10/28/99	104mm	0+	17 mm	17mm										17 mm		
sc.3	OL 134	10/28/99	173mm	2+	30mm	17mm	10mm	3mm								30mm		
forty sc. 6	OL 135	10/28/99	102 mm	0+	17mm	17mm										17mm		

COHO-STEELHEAD RESTORATION PROJECT (SOGA/PORE)

FISH SCALE FORM

Sampling Location: Olema **Species:** Sh **Equipment:** Microfiche reader (Magnif 36) Microscope

Reader: Rayber Anne-Laure **Reading number:** (1) 2 3 4 **Reading date:** 3/1/00

	ID	Sample Date	Fish length (specify units)	Est. Age	Scale Radius	Length (cm) to annuli: I	II	III	IV	V	Number of circuli (per annulus) <I	I-II	II-III	III-IV	IV-V	Notes (e.g., scale regen?) Trajectory		
reg sc.3	OL136	10/28/99	125 mm	1+	17mm	11mm	6mm									17mm		
sc.1	OL137	10/28/99	95 mm	0+	11mm	11mm										11mm		
sc.1	OL138	10/28/99	99 mm	0+	17mm	17mm										17mm		
sc.5	OL139	10/28/99	91 mm	0+	17mm	17mm										17mm		
sc.2	OL140	10/28/99	100 mm	1+	17mm	11mm	6mm									17mm		
sc.2	OL141	10/28/99	99 mm	1+	18mm	9mm	9mm									18mm		
sc.5	OL142	10/28/99	106 mm	1+	18mm	10mm	8mm									18mm		
sc.1	OL143	10/28/99	103 mm	0+	20mm	20mm										20mm		
sc.6	OL144	10/28/99	91 mm	0+	15mm	15mm												

COHO-STEELHEAD RESTORATION PROJECT (GOGAFORE) — **FISH SCALE FORM**

Sampling Location: Olema **Species:** CO **Equipment:** Microfiche reader (Magnif 36) Microscope

Reader: Rauber Anne-Laure **Reading number:** (1) 2 3 4 **Reading date:** 3/1/00 - 3/6/00

	ID	Sample Date	Fish length (specify units)	Est. Age	Scale Radius	Length (cm) to annuli: I	II	III	IV	V	Number of circuli (per annulus) M/F <I	I-II	II-III	III-IV	IV-V	Notes (e.g., scale regen?) Freshwater	Ocean
sc.3	OL 1	12/20/97	48 cm	1.1 (2)	65 mm	11mm	7mm = RO	47mm			M					11mm	54mm
sc 1	OL 2	1/8/98	57 cm	1.2 (3)	110 mm	17mm	8mm = RO	44mm	41mm		M					17mm	93mm
sc 1	OL 3	1/8/98	55 cm	1.2 (3)	110mm	20mm	43mm	47mm			M					20mm	90mm
sc 6.	OL 4	1/8/98	40cm	1.1 (2)	78 mm	18mm	2mm=RO	37mm	15mm		M	Jack				18mm	60mm
sc.1	OL 5	1/8/98	66cm	1.2 (3)	89mm	16mm	36mm	37mm			M					16mm	73mm
sc 7	OL 8	12/2/97	?	1.2 (3)	77mm	17mm	15mm	35mm			F					17mm	60mm
all reg.	OL 10	1/8/98	55 cm								F						
reg.? sc.4	OL 13	1/8/98	66 cm	1.2 (3)	100mm	21mm	13mm=RO	31mm	35mm		M					21mm	79mm
sc.2	OL 15	12/29/97	80 cm	1.2 (3)	84mm	13mm	36mm	35mm			F					13mm	71mm
sc.2	OL 16	12/30/97	65 cm	1.2 (3)	100mm	17mm	43mm	40mm			M					17mm	83mm
sc.1	OL 19	12/29/97	72cm	1.2 (3)	115mm	16mm	8mm=RO	35mm	56mm		M					16mm	99mm
sc.1	OL 20	12/29/97	61 cm	1.2 (3)	78mm	11mm	6mm=RO	25mm	36mm		M					11mm	67mm
sc 5	OL 21	12/29/97	64cm	1.2 (3)	82mm	13mm	9mm=RO	19mm	41mm		M					13mm	69mm
sc.1	OL 22	12/13/97	53cm	1.2 (3)	65mm	14mm	6mm=RO	24mm	24mm		M					14mm	51mm
sc.4	OL 27	12/30/97	58 cm	1.2 (3)	81mm	13mm	36mm	32mm			F					13mm	68 mm
reg. sc.3	OL 28	12/29/97	60cm	1.2 (3)	87mm	12mm	40mm	35mm			F					12 mm	75mm
sc.1	OL 30	12/12/97	42 cm	1.1 (2)	53mm	11mm	42mm				M	Jack				11mm	42 mm
sc 3	OL 31	12/12/97	? cm	1.2 (3)	105 mm	18mm	35mm	52mm			M					18mm	87mm
⚠ sc.4	OL 32	12/26/97	46 cm	2.1 (3)	84mm	14mm	13mm	57mm			F					27mm	57mm
reg sc 1	OL 33	12/29/97	63 cm	1.2 (3)	115mm	17mm	12mm=RO	41mm	45mm		M					17 mm	98 mm
reg. sc 2	OL 35	12/20/97	70 cm	1.2 (3)	115mm	21mm	44mm	50mm			M					21 mm	94 mm
sc 4	OL 36	12/20/97	70 cm	1.2 (3)	127mm	25mm	47mm	50mm			M					25 mm	97mm

COHO-STEELHEAD RESTORATION PROJECT (GOGAPORE) — **FISH SCALE FORM**

Sampling Location: Olema **Species:** CO **Equipment:** Microfiche reader (Magnif 36) Microscope

Reader: Rauber Anne-Laure **Reading number:** (1) 2 3 4 **Reading date:** 3/8/00 - 3/10/00

	ID	Sample Date	Fish length (specify units)	Est. Age	Scale Radius	Length (cm) to annuli: I	II	III	IV	V	Number of circuli (per annulus) M/F <I	I-II	II-III	III-IV	IV-V	Notes (e.g., scale regen?) Freshwater	Ocean
sc 1	OL 37	12/13/98	57cm	1.2(3)	90mm	14mm	35mm	61mm			F					14mm	76mm
reg! sc.7	OL 38	12/13/98	60 cm	1.2(3)	105 mm	24mm	35mm	46mm			F					24mm	81mm
sc 8	OL 33	1/6/99	44cm	1.1(2)	63 mm	13mm	11mm+RD	39mm			M	Jack				13mm	50mm
sc.3	OL 40	2/12/98	1 cm	1.1(2)	54 mm	17mm	37mm				M	Jack				17mm	37mm
⚠ sc.3	OL 41	12/13/98	62 cm	2.2(4)	88mm	13mm	17mm	24mm	34mm		F					30mm	58mm
sc.5	OL 42	1/30/99	60 cm	1.2(3)	79mm	15mm	30mm	34mm			F					15mm	64mm
sc.2	OL 43	12/12/98	? cm	1.2(3)	89mm	16mm	37mm	36mm			?					16mm	73mm
sc.5	OL 45	12/13/98	45 cm	1.1(2)	46mm	14mm	32mm				M	Jack				14mm	32mm
dirty scale	OL 47	1/30/99	66 cm	1.2(3)	92mm	22mm	34mm	36mm			M					22mm	70mm
sc.6	OL 48	1/30/99	63cm	1.2(3)	104mm	20mm	37mm	47mm			M					20mm	84mm
reg! sc.2	OL 77	1/6/96	63cm	1.2(3)	100mm	18mm	38mm	44mm			M					18mm	82mm
sc.5	OL 81	1/6/96	65 cm	1.2(3)	87mm	14mm	39mm	34mm			M					14mm	83mm
sc.2	OL 82	1/6/96	64 cm	1.2(3)	106mm	16mm	40mm	50mm			F					16mm	90mm
sc.1	OL 83	1/6/96	7 cm	1.1(2)	50mm	14mm	36mm				M	Jack				14mm	36mm
sc 3	OL 84	1/6/96	53 cm	1.2(3)	88mm	13mm	35mm	40mm			M					13mm	75mm
sc.3	OL 85	1/6/96	43 cm	1.1(2)	67mm	18mm	49mm				M	Jack				18mm	49mm
sc.6	OL 86	1/6/96	66 cm	1.2(3)	80mm	17mm	30mm	33mm			M					17mm	63mm
reg! sc.4	OL 200	2/1/00	50 cm	1.1(2)	65mm	13mm	37mm				F					13mm	52mm
sc.2	OL 201	2/1/00	65 cm	1.2(3)	89mm	15mm	37mm	37mm			?					15mm	74mm
sc.5	OL 202	2/1/00	70 cm	1.2(3)	100mm	17mm	41mm	43mm			F					17mm	86mm
sc.2	OL 203	2/1/00	65 cm	1.2(3)	83mm	11mm	22mm	41mm			M					11mm	72mm
sc 3	OL 204	1/30/99	48 cm	1.2(3)	84mm	17mm	26mm	41mm			M					17mm	67mm

COHO-STEELHEAD RESTORATION PROJECT (GOGAPORE)

FISH SCALE FORM

Sampling Location: Oleina Species: CO Equipment: Microfiche reader (Magnif 36X) Microscope

Reader: Rueber Anne-Laure Reading number: (1) 2 3 4 Reading date: 3/10/00

ID	Sample Date	Fish length (specify units)	Est. Age	Scale Radius	Length (cm) to annuli: I	II	III	IV	V	Number of circuli (per annulus) n/f <I	I-II	II-III	III-IV	IV-V	Notes (e.g., scale regen?) Freshwater	Ocean	
OL 205	2/11/00	50cm	1.2 (3)	95mm	25mm	47mm	23mm			F					25mm	70mm	

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10/19/99

COHO-STEELHEAD RESTORATION PROJECT (SCOGAFORE)

FISH SCALE FORM

Sampling Location: Blueline Species: Sb Equipment: Microfiche reader (Magnif 36X) Microscope

Reader: Anne-Laure Rauber Reading number: (1) 2 3 4 Reading date: 4/13/00

	ID	Sample Date	Fish length (specify units)	Est. Age	Scale Radius	Growth (mm) to annuli I	II	III	IV	V	Number of checks (per annulus) I	II	III	III-IV	IV-V	Notes (e.g., scale regen?) Freshwater	Ocean
sc.3	BL1	4/19/99	151 mm	2+	23mm	12mm	8mm	3mm								25mm	
all reg.	BL2	11/13/98	131 mm	-		—	—										
resident? reg. sc.4	BL3	11/13/98	230 mm	3+	30mm	12mm	6mm	8mm	6mm								
sc 2	BL4	11/10/98	149 mm	2+	25mm	10mm	10mm	6mm								30mm	
all reg.	BL5	11/22/98	180 mm	—	—	—	—	—	—	—						26mm	
n the ed line) sc 5.	BL6	11/22/98	93 mm	0+	12mm	12mm											
sc 7	BL7	11/19/98	121 mm	1+	21mm	11mm	10mm									12mm	
sc.4	BL8	11/13/98	171 mm	2+	26mm	12mm	8mm	6mm								21mm	
sc 1	BL9	4/19/99	124 mm	1+	18mm	9mm	9mm									25mm	
all reg.	BL10	4/16/99	250 mm	—	—	—	—	—	—	—						18mm	
sc.2	BL11	3/31/99	105 mm	1+	14mm	10mm	4mm										
sc.2	BL12	4/19/99	152 mm	2+	25mm	10mm	10mm	5mm								14mm	
reg. sc 3	BL13	3/22/99	132 mm	1+	17mm	11mm	6mm									25mm	
reg. sc. 2	BL14	3/23/99	165 mm	2+	26mm	11mm	9mm	6mm								13mm	
sc.8	BL15	3/30/99	116 mm	1+	19mm	12mm	7mm									26mm	
sc 2	BL16	3/30/99	116 mm	1+	22mm	12mm	10mm									19mm	
sc.3	BL17	3/23/99	112 mm	1+	17mm	11mm	6mm									22mm	
sc.7	BL18	3/29/99	142 mm	1+	21mm	11mm	10mm									17mm	
sc.5	BL19	3/23/99	116 mm	1+	17mm	12mm	5mm									21mm	
sc.1	BL20	4/6/99	158 mm	1+	20mm	12mm	8mm									17mm	
sc.2	BL21	4/7/99	142 mm	1+	20mm	12mm	8mm									20mm	
sc.5	BL22	4/2/99	179 mm	1+	20mm	14mm	6mm									20mm	

COHO-STEELHEAD RESTORATION PROJECT (GOGA/PORE)

FISH SCALE FORM

Sampling Location: Blueline Species: Sh Equipment: Microfiche reader (Magnif 36x) Microscope

Reader: Anne-Laure Rauber Reading number: (1) 2 3 4 Reading date: 4/13/00

	ID	Sample Date	Fish length (Specify units)	Est. Age	Scale Radius	Length (cm) to annuli: I	II	III	IV	V	Number of circuli (per annulus) Sex <I	I-II	II-III	III-IV	IV-V	Notes (e.g., scale regen?) freshwater	Ocean	
sc.3 spawning mark / adult Sh sc.2 reg.	BL23	3/16/99	107mm	1+	14mm	12mm	2mm									14mm		
	BL24	4/17/99	130mm	1+	22mm	10mm	12mm									22mm		
	BL25	3/16/99	550mm	2.1(3)	95mm	20mm	15mm	40mm			?					35mm	40mm	
sc.3	BL26	4/7/99	142mm	1+	22mm	12mm	10mm									22mm		
sc.6	BL27	4/9/99	130mm	1+	25mm	13mm	12mm									25mm		
sc.1	BL28	4/9/99	155mm	1+	20mm	11mm	9mm									20mm		
all reg.	BL29	4/9/99	128mm															
sc5	BL30	4/9/99	146mm	1+	25mm	11mm	14mm									25mm		
sc.6	BL31	4/9/99	152mm	1+	23mm	12mm	11mm									23mm		
reg. sc.4	BL32	4/9/99	154mm	1+	20mm	11mm	9mm									20mm		
sc 2	BL33	4/9/99	150mm	1+	23mm	12mm	11mm									23mm		
sc.2	BL34	4/9/99	122mm	1+	17mm	12mm	5mm									17mm		
sc3	BL35	4/9/99	168mm	1+	28mm	12mm	16mm									28mm		
sc.6	BL36	4/9/99	189mm	1+	27mm	13mm	14mm									27mm		
reg. sc.3	BL37	4/9/99	186mm	2+	27mm	10mm	8mm	9mm								27mm		
sc.4	BL38	4/18/99	151mm	1+	23mm	15mm	8mm									23mm		
reg. sc.5	BL39	4/18/99	158mm	1+	24mm	13mm	9mm									24mm		
sc.3	BL40	4/18/99	229mm	2+	35mm	12mm	11mm	12mm								35mm		
sc 2	BL41	4/2/99	161mm	1+	20mm	14mm	6mm									20mm		
sc.3	BL42	4/2/99	176mm	1+	20mm	12mm	8mm									20mm		
sc.3	BL43	4/2/99	158mm	1+	25mm	12mm	13mm									25mm		
sc.2	BL47	3/28/98	203mm	2+	35mm	10mm	6mm	19mm								35mm		

Sampling Location: Blueline Species: Sh Equipment: Microscope (Magnif. 36x) Microscope

Recorder: Annie-Laure Rauber Reading number: (1) 2 3 4 Reading date: 4/14/00

	ID	Sample Date	Fish length (specify units)	Est. Age	Scale Radius	Circuli count (per zone): I	II	III	IV	V	Notes (e.g., annuli regions if)	
											Freshwater	Ocean
all reg.	BL48	3/28/98	?									
sc 4	BL49	4/1/98	180 mm	2+	27mm	11mm	11mm	5mm				
sc 4	BL50	4/1/98	165 mm	2+	30mm	11mm	9mm	10mm			27mm	
sc 3	BL51	4/1/98	156 mm	2+	25mm	10mm	10mm	5mm			30mm	
sc 5	BL52	4/3/98	161 mm	1+	20mm	9mm	11mm				25mm	
sc.5	BL53	4/4/98	174 mm	2+	22mm	8mm	9mm	5mm			20mm	
all reg + one tob dirty	BL54	4/4/98	174 mm								22mm	
X	BL55	4/4/98	163 mm	no	scales	mounted	on	a	slide	!		
sc.5	BL57	4/13/98	143 mm	1+	20mm	8mm	12mm				20mm	
sc.1	BL58	4/23/98	159 mm	2+	25mm	11mm	10mm	4mm			25mm	
sc.1	BL59	5/31/98	129 mm	1+	18mm	14mm	4mm				18mm	
sc.6	BL60	4/6/98	163 mm	1+	20mm	8mm	12mm				20mm	
sc.6	BL61	4/6/98	162 mm	1+	24mm	12mm	12mm				24mm	
sc.5	BL62	4/16/98	167 mm	1+	22mm	11mm	11mm				22mm	
sc.3	BL63	4/6/98	165 mm	1+	20mm	9mm	11mm				20mm	
sc.7	BL64	4/6/98	192 mm	2+	30mm	12mm	15mm	3mm			30mm	
sc.6	BL65	4/14/98	143 mm	1+	17mm	13mm	4mm				17mm	
sc.2	BL66	4/16/98	162 mm	1+	27mm	15mm	12mm				27mm	
sc.1	BL67	5/30/98	193 mm	2+	31mm	10mm	14mm	7mm			31mm	
sc.2	BL68	6/2/98	156 mm	1+	22mm	14mm	8mm				22mm	
sc2	BL69	6/2/98	133 mm	1+	17mm	12mm	5mm				17mm	
reg. sc 3	BL70	5/3/99	157 mm	1+	20mm	11mm	9mm				20mm	

COHO-STEELHEAD RESTORATION PROJECT (BOGAP ONE)

FISH SCALE FORM

Sampling Location: Blueline Species: Sh Equipment: Microfiche reader (Magnif. 36x) Microscope

Reader: Anne-Laure Rauber Reading number: (1) 2 3 4 Reading date: 4/14/00

ID	Sample Date	Fish length (from snout)	Est. Age	Scale Radius	Annuli (mm) to outside: I	II	III	IV	V	Number of checks (per annulus): I	II	III	III-IV	IV-V	Notes (e.g., scale regen?): Freshwater	Ocean
sc 2	BL72	4/27/99	147mm	1+	24mm	14mm	10mm								24mm	
sc 2	BL73	4/21/99	157mm	1+	17mm	13mm	4mm								17mm	
sc 1	BL75	4/21/99	169mm	1+	25mm	14mm	11mm								25mm	
sc 1	BL76	4/20/99	162mm	1+	21mm	11mm	10mm								21mm	
sc 5	BL78	4/20/99	136mm	1+	18mm	13mm	5mm								18mm	
sc 1	BL80	4/24/99	150mm	1+	22mm	11mm	11mm								22mm	
	BL81	6/15/98	?	2+	24mm	12mm	14mm	8mm							24mm	

ECHO-STEELHEAD RESTORATION PROJECT (ECOSAP ONE)

FISH SCALE FORM

Sampling Location: Giacomini Species: Sh Equipment: Microfiche reader (Magnif. 36X) Microscope

Reader: Anne-Laura Rauber Reading number: (1) 2 3 4 Reading date: 4/17/00

	ID	Sample Date	Fish length (Specify unit)	Est. Age	Scale Radius	Length (mm) to annuli: I	II	III	IV	V	Number of checks (per annulus): I	II	III	IV	V	Notes (e.g., scale regen?): Freshwater	Ocean	
sc1	GC1	3/18/99	225mm	2+	30mm	10mm	9mm	11mm								19mm	11mm	
sc1	GC2	3/23/99	148 mm	1+	23mm	11mm	12mm									14mm	9mm	
reg. sc2	GC3	4/19/99	130 mm	1+	17mm	9mm	8mm									17mm		
sc7	GC4	4/19/99	107 mm	0+	14mm	14mm										14mm		
sc2	GC5	4/15/99	114 mm	1+	17mm	10mm	7mm									17mm		
sc.1	GC7	4/2/99	110 mm	0+	12mm	12mm										12mm		
sc2	GC9	4/19/99	121 mm	1+	18mm	10mm	8mm									18mm		
sc2	GC10	3/31/99	100 mm	0+	14mm	14mm										14mm		
reg.sc.7	GC11	5/27/99	140 mm	1+	23mm	12mm	11mm									23mm		
sc1	GC12	3/27/99	144 mm	1+	28mm	14mm	14mm									28mm		
reg sc.1	GC13	3/23/99	102 mm	0+	12mm	12mm										12mm		
sc3	GC14	4/17/99	117 mm	1+	15mm	10mm	5mm									15mm		
sc.3	GC15	4/17/99	104 mm	0+	15mm	15mm										15mm		
sc.6	GC17	4/17/99	118 mm	1+	16mm	11mm	5mm									16mm		
sc2	GC18	3/23/99	101 mm	0+	14mm	14mm										14mm		
sc.6	GC19	3/23/99	102 mm	0+	13mm	13mm										13mm		
sc.4	GC20	3/30/99	104 mm	0+	11mm	11mm										11mm		
reg sc3	GC21	3/30/99	104 mm	0+	12mm	12mm										12mm		
sc3	GC22	4/5/99	160mm	1+	22mm	13mm	9mm									22mm		
sc2	GC23	3/31/99	113 mm	0+	14mm	14mm										14mm		
reg sc.1	GC24	3/31/99	104 mm	0+	13mm	13mm										13mm		
sc.1	GC26	4/8/99	139 mm	1+	22mm	12mm	10mm									22mm		

COHO-STEELHEAD RESTORATION PROJECT (SCGAPORE)

FISH SCALE FORM

Sampling Location: Giacomini Species: Sh Equipment: Microfiche reader (Magnif 36X) Microscope

Reader: Anne-Laure Rauber Reading number: (1) 2 3 4 Reading date: 4/17/00 - 4/19/00

	ID	Sample Date	Fish length (specify units)	Est. Age	Scale Radius	Length (mm) to annuli: I	II	III	IV	V	Number of circuli (per annulus): I	II	II-III	III-IV	IV-V	Notes (e.g., scale regen?) Freshwater	Ocean - I	
sc.5	GC 27	4/8/99	164 mm	1+	27mm	15mm	12mm									27mm		
all reg	GC 35	4/5/99	195 mm															
sc 2	GC 36	4/2/99	224 mm	2+	25 mm	10mm	10mm	5mm								25mm		
all reg	GC 37	4/1/99	132 mm															
sc 2	GC 38	4/3/99	103mm	0+	12mm	12mm										12mm		
sc 5	GC 40	4/5/99	178 mm	2+	35mm	11mm	12mm	11mm								35mm		
sc.1	GC 41	4/22/99	117 mm	1+	17mm	10mm	7mm									17mm		
sc.1	GC 42	4/22/99	118 mm	1+	15mm	9mm	6mm									15mm		
reg. sc.3	GC 43	4/22/99	112 mm	1+	17mm	11mm	6mm									17mm		
sc.4	GC 44	5/17/99	157 mm	1+	21mm	12mm	9mm									21mm		
sc.1	GC 45	4/20/99	157 mm	1+	21mm	13mm	8mm									21mm		
sc.2	GC 49	4/20/99	112 mm	1+	18mm	10mm	8mm									18mm		
sc 4	GC 52	4/20/99	119 mm	1+	15mm	10mm	5mm									15mm		
sc.1	GC 53	4/23/99	139 mm	1+	25 mm	17mm	8mm									25mm		
reg. sc.2	GC 60	4/24/99	125 mm	1+	16mm	10mm	6mm									16mm		
sc 4	GC 61	4/24/99	109 mm	0+	11mm	11mm										11mm		
sc.4	GC 62	4/24/99	167 mm	1+	23mm	11mm	12mm									23mm		
sc 4	GC 63	4/24/99	120 mm	1+	16mm	10mm	6mm									16mm		
sc.3	GC 64	4/24/99	163 mm	1+	25 mm	12mm	13mm									25mm		
sc.1	GC 65	4/24/99	120 mm	1+	16mm	10mm	6mm									16mm		
sc.1	GC 66	4/24/99	129 mm	1+	23mm	13mm	10mm									23mm		
sc.1	GC 68	4/24/99	115 mm	0+	12mm	12mm										12mm		

COHO-STEELHEAD RESTORATION PROJECT (SOGA/PORE)

FISH SCALE FORM

Sampling Location: Giacomini Species: Sh Equipment: Microfiche reader (Magnif 36X) Microscope

Reader: Rawber Anne-laure Reading number: (1) 2 3 4 Reading date: 4/19/00

	ID	Sample Date	Fish length (specify units)	Est. Age	Scale Radius	Length (cm) to annuli: I	II	III	IV	V	Number of circuli (per annulus): <I	I-II	II-III	III-IV	IV-V	Notes (e.g., scale regen?) Freshwater/Ocean/		
sc 4	GC 69	4/24/99	140mm	1+	18mm	11mm	7mm									18mm		
reg. sc 2	GC 70	4/26/99	147mm	1+	20mm	11mm	9mm									20mm		
sc 1	GC 72	4/24/99	128mm	1+	20mm	13mm	7mm									20mm		
sc 1	GC 73	4/26/99	126mm	1+	19mm	13mm	6mm									19mm		
sc 5	GC 74	4/26/99	142mm	1+	18mm	13mm	5mm									18mm		
										+ growth								
adult Sh 2000 (1 mm a store)	Pilfar	St -	Sh :	2.2 (4)	157mm	20mm	17mm	55mm	55mm	10mm						37mm	120mm	

File:scalefrm.xls

10/19/99

DEVIL'S STEELHEAD RESTORATION PROJECT (DSRAP/CRC)

FISH SCALE FORM

Sampling Location: Quarry Gulch Species: Sh Equipment: Microfiche reader (Magnification: 36X) Microscope

Reader: Annie-Laure Rauber Reading number: 1 2 3 4 Reading date: 4/18/00

	ID	Sample Date	Fish length (mm)	Fish age	Scale radius	Circuli spacing (mm) I	I	II	IV	V	Annuli spacing (mm) I	II	III	IV-V	IV-V	Est. ocean migrant: freshwater	Ocean
sc. 3	QG 5	4/14/99	125 mm	1+	18mm	9mm	9mm									18mm	
sc. 3	QG 6	4/17/99	105 mm	1+	17mm	11mm	6mm									17mm	
sc. 3	QG 7	4/17/99	106 mm	1+	15mm	10mm	5mm									15mm	
sc. 3	QG 8	4/19/99	155 mm	1+	20mm	11mm	9mm									15mm	5mm
sc. 3	QG 9	4/17/99	163 mm	2+	25mm	12mm	10mm	3mm								25mm	
sc. 3	QG 11	4/15/99	125 mm	1+	17mm	12mm	5mm									17mm	
sc. 3	QG 13	4/14/99	117 mm	1+	19mm	13mm	6mm									19mm	
sc. 1	QG 14	4/17/99	109 mm	1+	18mm	11mm	7mm									18mm	
all reg.	QG 15	4/19/99	152 mm	—													
sc. 3	QG 16	4/17/99	116 mm	1+	18mm	13mm	5mm									18mm	
sc. 1	QG 17	4/17/99	88 mm	0+	10mm	10mm										10mm	
sc. 2	QG 18	4/17/99	78 mm	0+	9mm	9mm										9mm	
sc. 2	QG 19	3/31/99	110 mm	0+	15mm	15mm										15mm	
sc. 3	QG 21	4/17/99	134 mm	1+	18mm	11mm	7mm									18mm	
all reg.	QG 22	3/31/99	104 mm	—													
sc. 2	QG 23	3/31/99	117 mm	1+	18mm	13mm	5mm									18mm	
sc. 3	QG 24	3/31/99	128 mm	1+	20mm	10mm	10mm									20mm	
sc. 3	QG 25	3/31/99	109 mm	0+	11mm	11mm										11mm	
all reg.	QG 26	4/6/99	160 mm	—													
sc. 7	QG 27	4/14/99	94 mm	0+	12mm	12mm										12mm	
sc. 6	QG 28	4/18/99	111 mm	1+	17mm	14mm	3mm									17mm	
sc. 6	QG 29	4/15/99	114 mm	1+	19mm	12mm	7mm									19mm	

Photocopy to: Return to:

DOKO-STEELHEAD RESTORATION PROJECT (SCOAP ORG)

FISH SCALE FORM

Sampling Location: Quarry Gulch Species: Sh Equipment: Microfiche reader (Magnif. 36x) Microscope

Reader: Anne-Laure Rauber Reading number: 1 2 3 4 Reading date: 4/19/00

	ID	Sample Date	Fish length (from vial)	Est. Age	Scale Radius	Annuli (mm) to annulus: I	II	III	IV	V	Number of circuli (per annulus): I	II	III	IV-V	IV-V	Notes (e.g., scale regen?): Freshwater	Ocean
sc 1	QG 30	4/15/99	119 mm	1+	17mm	12mm	5mm									17mm	
sc.7	QG 31	4/18/99	97 mm	1+	19mm	15mm	4mm									19mm	
sc.2	QG 35	4/5/99	113 mm	1+	17mm	12mm	5mm									17mm	
all reg.	QG 36	4/5/99	154 mm														
sc.3	QG 40	5/3/99	125 mm	1+	22mm	11mm	11mm									22mm	
sc.6	QG 41	4/29/99	106 mm	1+	17mm	12mm	5mm									17mm	
sc 3	QG 42	5/5/99	130 mm	1+	20mm	14mm	6mm									20mm	
sc 1	QG 43	4/22/99	145 mm	1+	23mm	13mm	10mm									23mm	
all reg.	QG 45	4/22/99	129 mm														
reg. sc. 2	QG 47	5/3/99	150 mm	1+	22mm	13mm	9mm									22mm	
sc. 3	QG 48	5/3/99	116 mm	1+	16mm	11mm	5mm									16mm	
sc. 1	QG 50	5/3/99	129 mm	1+	15mm	10mm	5mm									15mm	
sc. 1	QG 51	5/17/99	119 mm	1+	20mm	10mm	10mm									20mm	
sc. 3	QG 52	5/17/99	118 mm	1+	18mm	11mm	7mm									18mm	
sc. 1	QG 53	5/17/99	124 mm	1+	20mm	12mm	8mm									20mm	
sc. 3	QG 54	4/27/99	106 mm	1+	21mm	12mm	9mm									21mm	
sc. 1	QG 56	4/22/99	135 mm	1+	21mm	15mm	6mm									21mm	
sc. 1	QG 60	4/21/99	132 mm	1+	25mm	18mm	7mm									25mm	
sc. 3	QG 63	4/22/99	122 mm	1+	17mm	10mm	7mm									17mm	
sc. 1	QG 77	4/23/99	109 mm	1+	23mm	14mm	9mm									23mm	
sc. 3	QG 78	4/23/99	130 mm	1+	20mm	13mm	7mm									20mm	
sc. 6	QG 79	4/23/99	153 mm	1+	28mm	16mm	12mm									28mm	

DUNE-STERILIZING RESTORATION PROJECT (DSRP)

FISH SCALE FORM

Sampling Location: Quarry Gulch Species: Sh Equipment: Binocular microscope (Magnification: 36x) Micrometer

Reader: Anne-Laure Rauber Reading number: (1) 2 3 4 Reading date: 4/19/00

ID	Sample date	Fish length (mm)	Sex, Age	Scale radius (mm)	Circuli count: I	II	III	IV	V	Annuli count: I	II	III	IV	V	Freshwater/Ocean
sc.2	QG82	4/24/99	119mm	0+	17mm	17mm									17mm
sc.2	QG83	4/24/99	111mm	0+	16mm	16mm									16mm
sc.1	QG88	4/24/99	130mm	1+	18mm	11mm	7mm								18mm

Photocopies to:

TOTALS:

COHO-STEELHEAD RESTORATION PROJECT (SCOAP ORE) — **FISH SCALE FORM**

Sampling Location: Blueline Quarry Gulch / Devil's Gulch — Species: CO — Equipment: Microfiche reader (Magnif 36) / Microscope

Reader: Raiber Anne-Laure — Reading number: (1) 2 3 4 — Reading date: 3/14/00 - 3/15/00

	ID	Sample Date	Fish length (specify units)	Est. Age	Scale Radius	Length (mm) to annuli: I	II	III	IV	V	Number of circuli (per annulus): ♀/M I	II	III-II	IV-III	V-IV	Notes (e.g., scale regen?) Freshwater	Ocean	
)	sc.3	BL 44	3/28/98	124 mm	1+	18mm	13mm	5mm									18mm		
)	sc.3	BL 45	3/28/98	125 mm	1+	15 mm	13mm	2mm									15mm		
)	sc 3	BL 46	3/28/98	125 mm	0+	15mm	15mm										15mm		
)	sc.6	QG 32	4/18/99	86mm	0+	14mm	14mm										14mm		
)	sc.4	QG 38	11/23/99	86 mm	0+	9 mm	9 mm										9mm		
) RO?	sc.1	QG 73	4/23/99	152 mm	1+	20mm	12mm	8mm RO									12mm	8mm RO	?
)	sc 1	QG 86	4/25/99	96mm	0+	12mm	12mm										12mm		
	sc.8	DG 1	12/15/98	53 cm	1.2 (3)	79mm	15mm	26mm	38mm			♀					15mm	64mm	
reg!	sc.3	DG 34	1/6/98	40 cm	1.1 (2)	65mm	17mm	48mm				♂	jack				17mm	48mm	
)	sc 2	DG 37	12/17/97	64 cm	1.2 (3)	90mm	13mm	34mm	43mm			♀					13mm	77mm	
)	sc 1	DG 38	12/17/97	64 cm	1.2 (3)	86mm	17mm	26mm	43mm			♀					13mm	73mm	
)	sc.6	DG 39	12/11/97	53 cm	1.2 (3)	96mm	18mm	38mm	40mm			♀					17mm	79mm	
)	sc.3	DG 40	12/11/97	58 cm	1.2 (3)	83mm	13mm	RO=6mm	34mm	30mm		♂					18mm	78mm	
) reg!	sc 4	DG 87	2/3/99	40 cm	1.1 (2)	69mm	18mm	51mm				♂	jack				13mm	70mm	
)	sc.4	DG 88	2/3/99	60 cm	1.2 (3)	106mm	14mm	46mm	46mm			♀					18mm	51mm	
																	14mm	92mm	

COHO-STEELHEAD RESTORATION PROJECT (COHAPCRE) — **FISH SCALE FORM**

Sampling Location: West Union Easkoot — Species: SH — Equipment: Microfiche reader (Magnif 36) Microscope

Reader: Raüber Anne-Laure — Reading number: (1) 2 3 4 — Reading date: 3/16/00

	ID	Sample Date	Fish length (specify units)	Est. Age	Scale Radius	Length (mm) to annuli: I	II	III	IV	V	Number of checks (per annulus): I	II	II-III	III-IV	IV-V	Notes (e.g., scale regen?) Freshwater	Ocean
(1)	sc.1	EA 6	8/4/99	205 mm	2+	31mm	14mm	11mm	6mm=RO								25mm	6mm=RO
(1)	reg! sc 3	WU 1	11/5/99	97 mm	0+	16 mm	16mm										16mm	
(2)	reg! sc.4	WU 2	11/5/99	100 mm	0+	15mm	15mm										15mm	
(3)	sc.1	WU 4	11/5/99	96mm	0+	13mm	13mm										13 mm	
(4)	sc.1	WU 5	11/5/99	101 mm	0+	14mm	14mm										14mm	
(5)	sc.1	WU 6	11/5/99	90 mm	0+	17mm	17mm										17mm	
(6)	sc.3	WU 8	11/5/99	110 mm	1+	15mm	11mm	4mm									15 mm	
(7)	sc.5	WU 9	11/5/99	128 mm	1+	19 mm	13mm	6mm									19mm	
(8)	sc.4	WU 10	11/5/99	102 mm	0+	13 mm	13mm										13mm	
(9)	sc2.	WU 11	11/5/99	146 mm	1+	23 mm	16mm	7mm									23mm	
(10)	sc.5	WU 12	11/5/99	101 mm	0+	13mm	13mm										13mm	
(11)	sc.5	WU 13	11/5/99	131 mm	1+	21mm	14mm	7mm									21mm	
(12)	sc.5	WU 14	11/5/99	143 mm	1+	24mm	14mm	10mm									24mm	
(13)	sc.1	WU 15	11/5/99	178 mm	2+	27mm	15mm	10mm	2mm								27mm	
(14)	sc.3	WU 17	11/5/99	158 mm	2+	25 mm	13mm	10mm	2mm								25mm	
(15)	sc2	WU 18	11/5/99	124mm	1+	22mm	15mm	7mm									22mm	
(16)	sc.1	WU 20	11/5/99	142 mm	1+	23mm	14mm	9mm									23mm	
(17)	sc.3	WU 22	11/5/99	100mm	0+	16 mm	16mm										16mm	
(18)	sc3	WU 23	11/5/99	121 mm	1+	19mm	12mm	7mm									19mm	

EA = (1)

WU = (18).

D. Tables and graphs:

Table 1: summary of the fish aged for each creek

Stream	Date (season / year)	CO/juv. aged	CO/ad. aged	Sh/juv. aged	Sh/ad. aged	Total fish aged
Redwood	winter 94-95		12			12
	winter 95-96		9			9
	winter 96-97		11			11
	winter 97-98		19	8		27
	fall 98	1		31		32
	winter 98-99		9			9
	summer 99			39		39
	fall 99			71		71
	winter 99-00		1			1
Total	**all years**	**1**	**61**	**149**		**211**
Olema	winter 95-96		7			7
	winter 97-98		21		1	22
	fall 98			21		21
	winter 98-99		9			9
	sum 99			5		5
	fall 99			46		46
	winter 99-00		7			7
Total	**all years**		**44**	**72**	**1**	**117**
Blueline	spring 98	3		13		16
	fall 98			4	1	5
	winter 98-99			1	1	2
	spring 99			39		39
Total	**all years**	**3**		**57**	**2**	**62**
Giacomini	spring 99			47		47
Total	**all years**			**47**		**47**
Quarry G.	spring 99	3		42		45
	fall 99	1				1
Total	**all years**	**4**		**42**		**46**
West U.	fall 99			18		18
Total	**all years**			**18**		**18**
Devil's G.	winter 97-98		5			5
	winter 98-99		3			3
Total	**all years**		**8**			**8**
Eskoot	summer 99			1		1
Total	**all years**			**1**		**1**
Total all streams		**8**	**113**	**386**	**3**	**510**

Table 2a: summary of the different age classes found in each creek

Stream	Date (sea/yr)	CO 0+	CO 1+	CO 1.1	CO 1.2	CO 2.1	CO 2.2	CO 2.3	Sh 0+	Sh 1+	Sh 2+	Sh 3+	Sh 1.2	Sh 2.1	Total fish aged
Redwood	winter 94-95				12										12
	winter 95-96				9										9
	winter 96-97			5	5			1							11
	winter 97-98			6	11		2			7	1				27
	fall 98	1							2	16	10	3			32
	winter 98-99			3	5	1									9
	summer 99								2	33	4				39
	fall 99								7	48	15	1			71
	winter 99-00				1										1
Total	**all years**	**1**		**14**	**43**	**1**	**2**	**1**	**11**	**104**	**30**	**4**			**211**
Olema	winter 95-96			2	5										7
	winter 97-98			5	15	1							1		22
	fall 98								4	15	2				21
	winter 98-99			1	7		1								9
	summer 99								1	2	2				5
	fall 99								25	19	2				46
	winter 99-00			1	6										7
Total	**all years**			**9**	**33**	**1**	**1**		**30**	**36**	**6**		**1**		**117**
Blueline	spring 98	1	2							11	2				16
	fall 98								1	1	2	1			5
	winter 98-99									1				1	2
	spring 99									34	5				39
Total	**all years**	**1**	**2**						**1**	**47**	**9**	**1**		**1**	**62**
Giacomini	spring 99								14	30	3				47
Total	**all years**								**14**	**30**	**3**				**47**
Quarry G.	spring 99	2	1						7	34	1				45
	fall 99		1												1
Total	**all years**	**2**	**2**						**7**	**34**	**1**				**46**
West U.	fall 99								8	8	2				18
Total	**all years**								**8**	**8**	**2**				**18**
Devil's G.	winter 97-98			1	4										5
	winter 98-99			1	2										3
Total	**all years**			**2**	**6**										**8**
Eskoot	summer 99										1				1
Total	**all years**										**1**				**1**
TOTAL all streams	**all years**	**4**	**4**	**25**	**82**	**2**	**3**	**1**	**71**	**259**	**52**	**5**	**1**	**1**	**510**

Table 2b: summary of the different age classes found in each creek

Stream	CO 0+	CO 1+	CO 1.1	CO 1.2	CO 2.1	CO 2.2	CO 2.3	Sh 0+	Sh 1+	Sh 2+	Sh 3+	Sh 1.2	Sh 2.1
RW	x		x	x	x	x	x	x	x	x	x		
OL			x	x	x	x		x	x	x		x	
BL	x	x						x	x	x	x		x
GC								x	x	x			
QG								x	x	x			
WU								x	x	x			
DG			x	x									
ES										x			

Table 4: FL of adult coho in Redwood Creek (1994-2000)

Redwood	sea/year	num. fish	age adults CO	FL (cm)
	winter 94-95	12	1.2	46
			1.2	64
			1.2	62
			1.2	61
			1.2	62
			1.2	62
			1.2	46
			1.2	68
			1.2	63
			1.2	65
			1.2	65
			1.2	73
	winter 95-96	9	1.2	56
			1.2	58
			1.2	57
			1.2	60
			1.2	60
			1.2	57
			1.2	62
			1.2	66
			1.2	65
	winter 96-97	5	1.2	60
			1.2	60
			1.2	66
			1.2	66
			1.2	?
		5	1.1	45
			1.1	45
			1.1	40
			1.1	46
			1.1	?
		1	2.3	68
	winter 97-98	11	1.2	45
			1.2	57
			1.2	55
			1.2	55
			1.2	50
			1.2	65
			1.2	55
			1.2	63
			1.2	50
			1.2	60
			1.2	40
		6	1.1	39
			1.1	40
			1.1	40
			1.1	42
			1.1	40
			1.1	39
		2	2.2	55

			2.2	60
	winter 98-99	5	1.2	50
			1.2	55
			1.2	64
			1.2	50
			1.2	60
		3	1.1	39
			1.1	45
			1.1	43
		1	2.1	54
	winter 99-00	1	1.2	55
total	all winters	61		

Table 5: FL of adult coho in Olema Creek (1998-1999)

Olema	sea/year	num. fish	age adults co	sh	FL (cm)
	winter 95-96	5	1.2		63
			1.2		65
			1.2		64
			1.2		63
			1.2		66
		2	1.1		?
			1.1		43
	winter 97-98	1		1.2	60
		15	1.2		?
			1.2		?
			1.2		59
			1.2		63
			1.2		70
			1.2		70
			1.2		80
			1.2		72
			1.2		60
			1.2		65
			1.2		58
			1.2		57
			1.2		55
			1.2		66
			1.2		66
		1	2.1		46
		5	1.1		42
			1.1		49
			1.1		44
			1.1		40
			1.1		?
	winter 98-99	7	1.2		?
			1.2		57
			1.2		60
			1.2		60
			1.2		66
			1.2		63
			1.2		48
		1	1.1		45
		1	2.2		62
	winter 99-00	6	1.2		61
			1.2		64
			1.2		65
			1.2		70
			1.2		65
			1.2		50
		1	1.1		50
total	all winters	45			

Table 13: FL of juvenile and "resident" steelhead in Redwood Creek (1997-2000)

Redwood	season/year	num. fish	age juv CO	age juv SH	FL (mm)
	winter 97-98	7		1+	148
				1+	109
				1+	116
				1+	100
				1+	101
				1+	103
				1+	111
		1		2+	155
	fall 98	3	0+		105
				0+	90
				0+	113
		16		1+	131
				1+	145
				1+	132
				1+	145
				1+	145
				1+	132
				1+	128
				1+	131
				1+	138
				1+	121
				1+	132
				1+	144
				1+	127
				1+	132
				1+	131
				1+	124
		10		2+	168
				2+	138
				2+	145
				2+	136
				2+	160
				2+	170
				2+	160
				2+	172
				2+	147
				2+	158
		3		3+	219
				3+	217
				3+	244
	summer 99	2		0+	97
				0+	107
		33		1+	130
				1+	99
				1+	117
				1+	113
				1+	133
				1+	120

				1+	115
				1+	103
				1+	108
				1+	118
				1+	117
				1+	122
				1+	115
				1+	124
				1+	112
				1+	111
				1+	119
				1+	100
				1+	104
				1+	129
				1+	121
				1+	119
				1+	127
				1+	106
				1+	130
				1+	123
				1+	108
				1+	104
				1+	135
				1+	136
				1+	129
				1+	114
				1+	124
		4		2+	153
				2+	142
				2+	166
				2+	147
	fall 99	7		0+	93
				0+	65
				0+	64
				0+	71
				0+	109
Big lagoon				0+	91
				0+	104
		48		1+	124
				1+	119
				1+	160
				1+	114
				1+	124
				1+	116
				1+	133
				1+	106
				1+	101
				1+	116
				1+	121

				1+	112
				1+	112
				1+	102
				1+	114
				1+	120
				1+	108
				1+	125
				1+	111
				1+	121
				1+	112
				1+	105
				1+	125
				1+	155
				1+	124
				1+	106
				1+	123
				1+	130
				1+	124
				1+	132
				1+	120
				1+	127
				1+	112
				1+	114
				1+	122
				1+	132
				1+	142
				1+	119
				1+	109
				1+	112
				1+	133
				1+	113
				1+	142
Big lagoon				1+	111
Big lagoon				1+	132
Big lagoon				1+	102
				1+	117
				1+	131
		15		2+	241
				2+	127
				2+	142
				2+	171
				2+	142
Big lagoon				2+	164
Big lagoon				2+	157
Big lagoon				2+	150
Big lagoon				2+	140
Big lagoon				2+	171
Big lagoon				2+	151
Big lagoon				2+	131

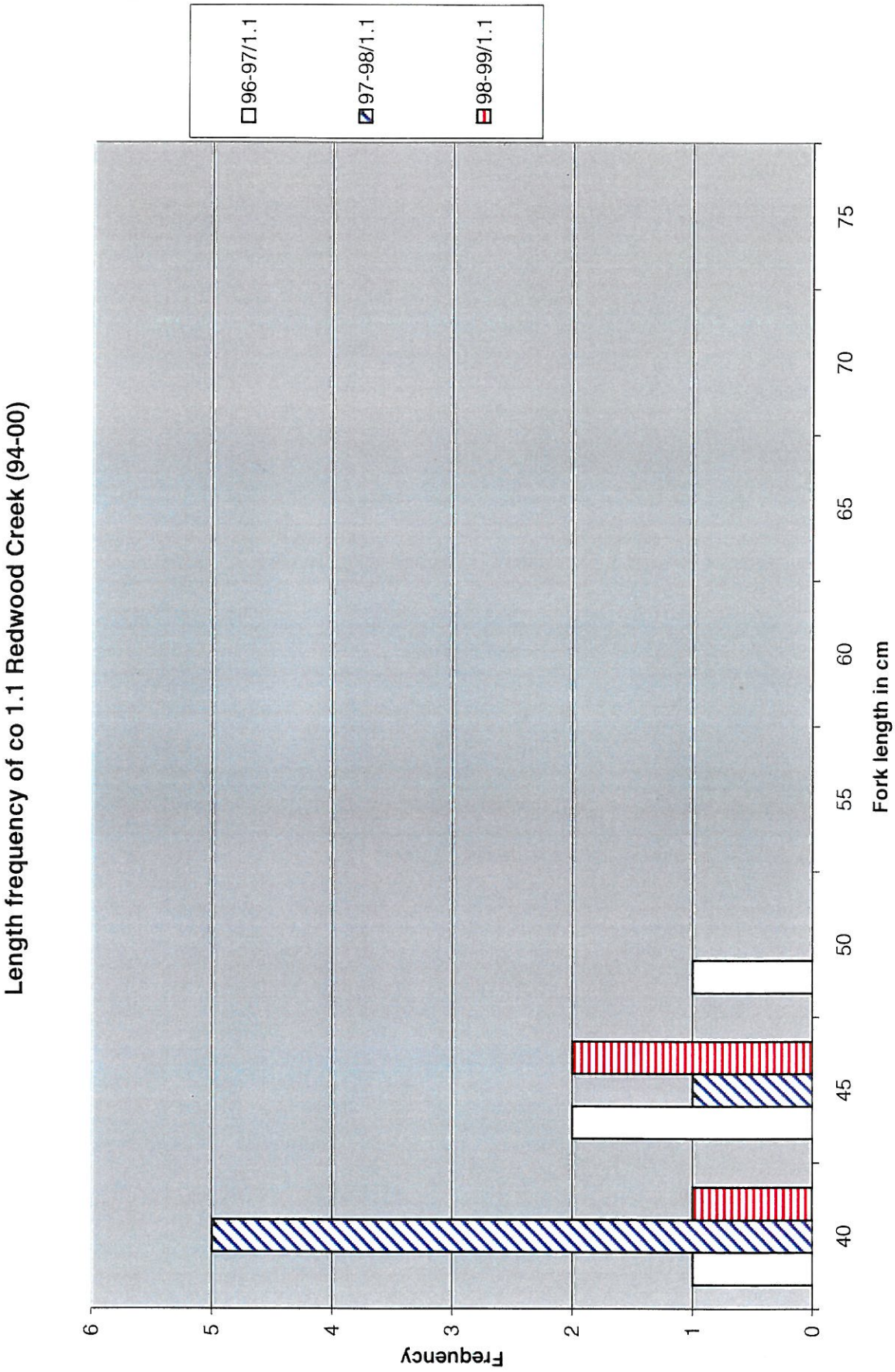
Big lagoon				2+	188
Big lagoon				2+	162
Big lagoon				2+	170
		1		3+	198
total	**all years**	**150**			

Table 14: FL of juvenile steelhead in Olema Creek (1998-1999)

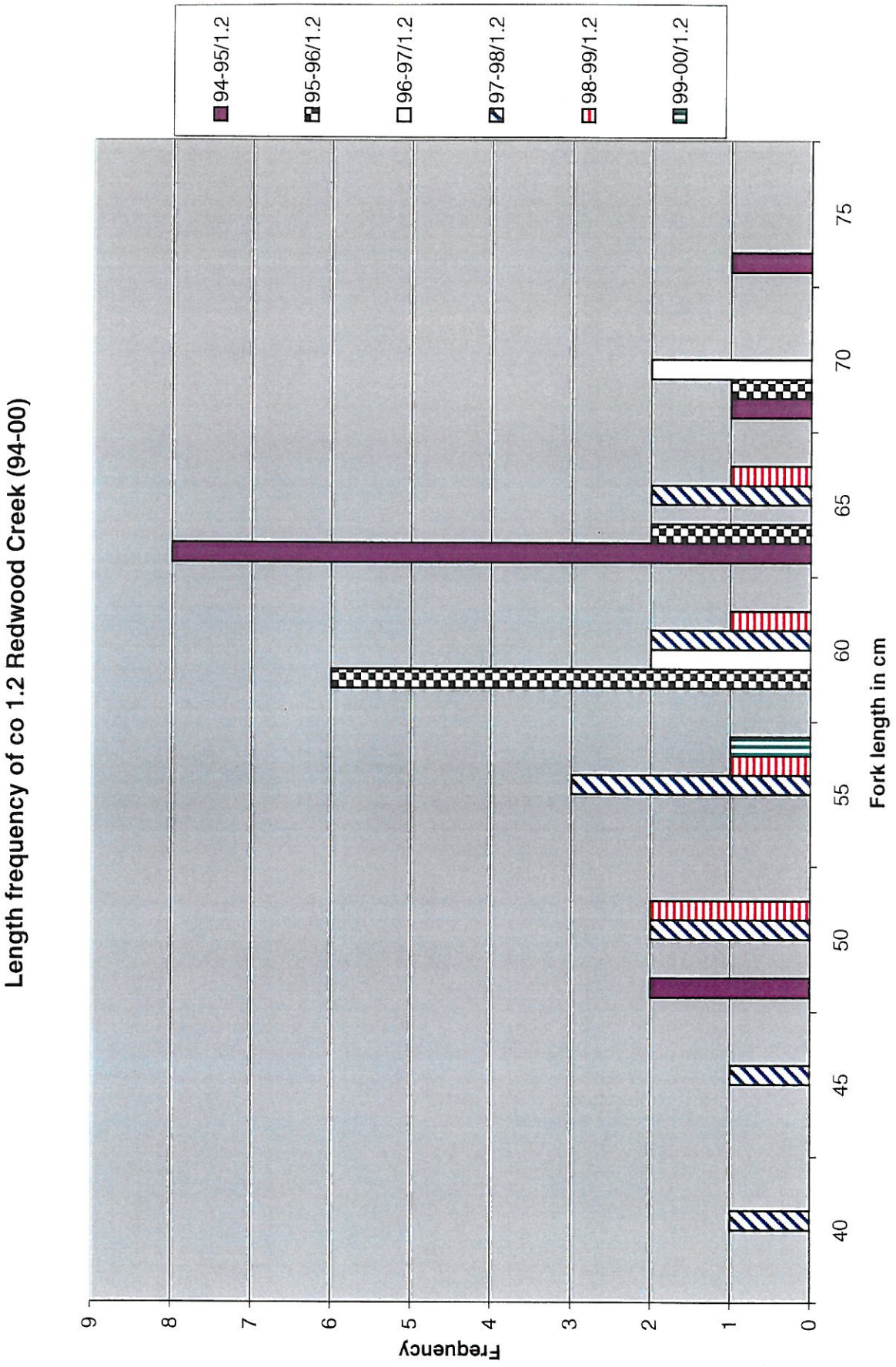
Olema	season/year	num. fish	age juv SH	FL (mm)
	fall 98	4	0+	116
			0+	114
			0+	94
			0+	105
		15	1+	144
			1+	145
			1+	120
			1+	129
			1+	143
			1+	143
			1+	125
			1+	139
			1+	106
			1+	122
			1+	135
			1+	134
			1+	115
			1+	123
			1+	130
		2	2+	192
			2+	140
	summer 99	1	0+	100
		2	1+	99
			1+	100
		2	2+	202
			2+	188
	fall 99	25	0+	90
			0+	89
			0+	100
			0+	101
			0+	92
			0+	85
			0+	95
			0+	91
			0+	99
			0+	92
			0+	92
			0+	92
			0+	83
			0+	79
			0+	88
			0+	91
			0+	103
			0+	93
			0+	104
			0+	102
			0+	95
			0+	99

			0+	91
			0+	103
			0+	91
		19	1+	107
			1+	103
			1+	111
			1+	150
			1+	105
			1+	113
			1+	116
			1+	94
			1+	100
			1+	98
			1+	100
			1+	98
			1+	95
			1+	104
			1+	103
			1+	125
			1+	100
			1+	99
			1+	106
		2	2+	160
			2+	173
total	**all years**	**72**		

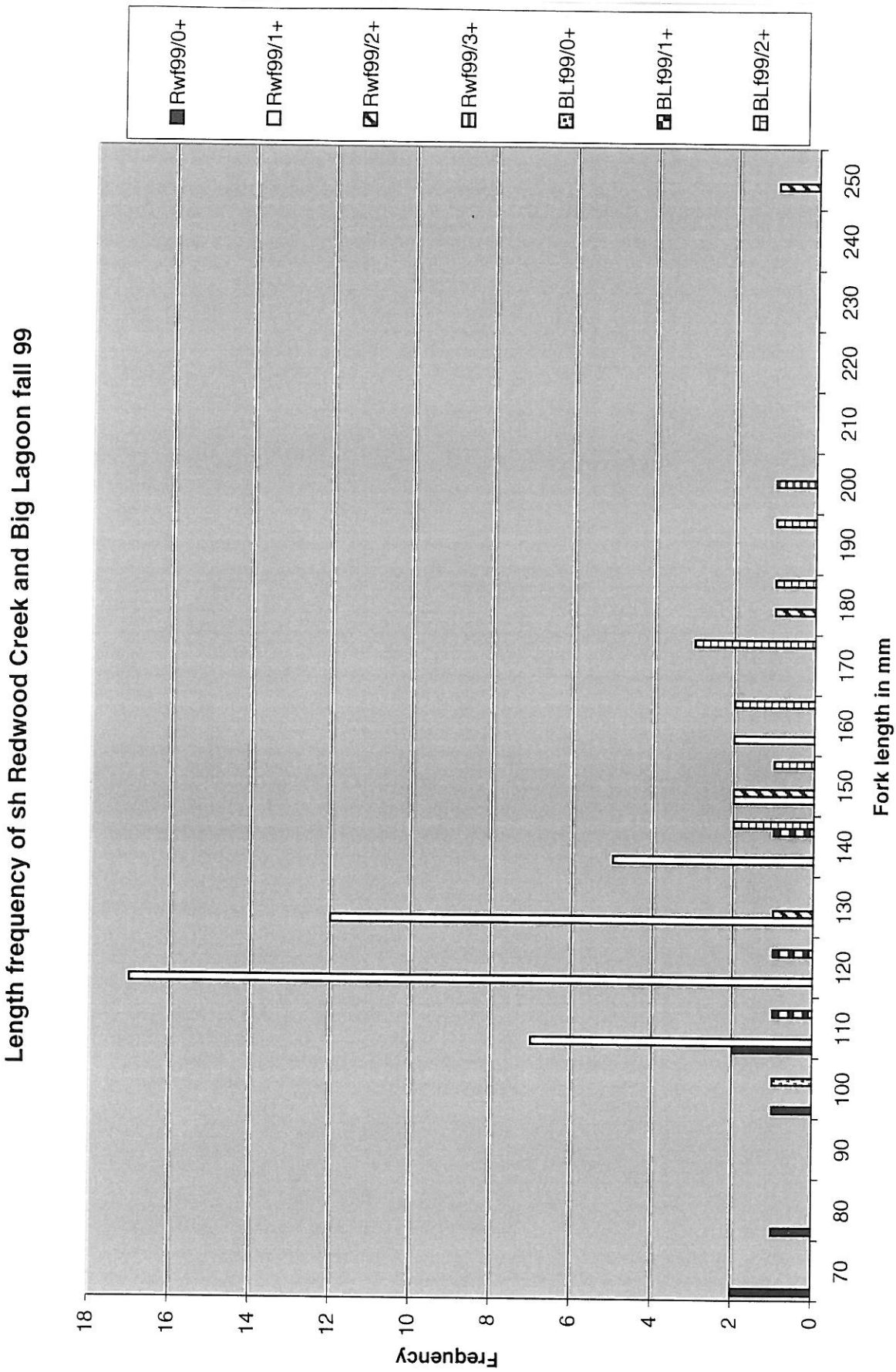
Graph 1: length frequency of coho 1.1 in Redwood Creek (1994-2000)



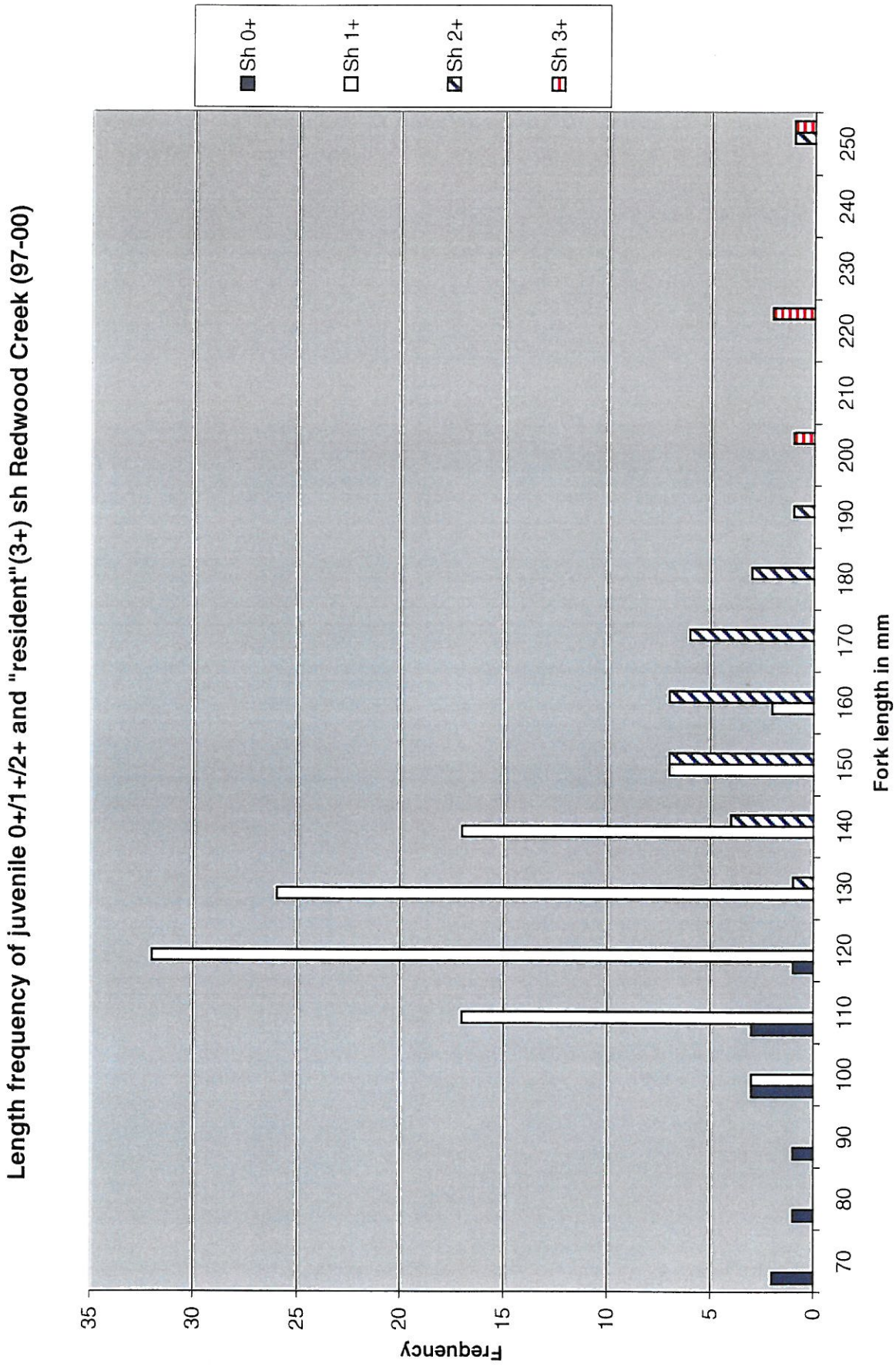
Graph 2: length frequency of coho 1.2 in Redwood Creek (1994-2000)



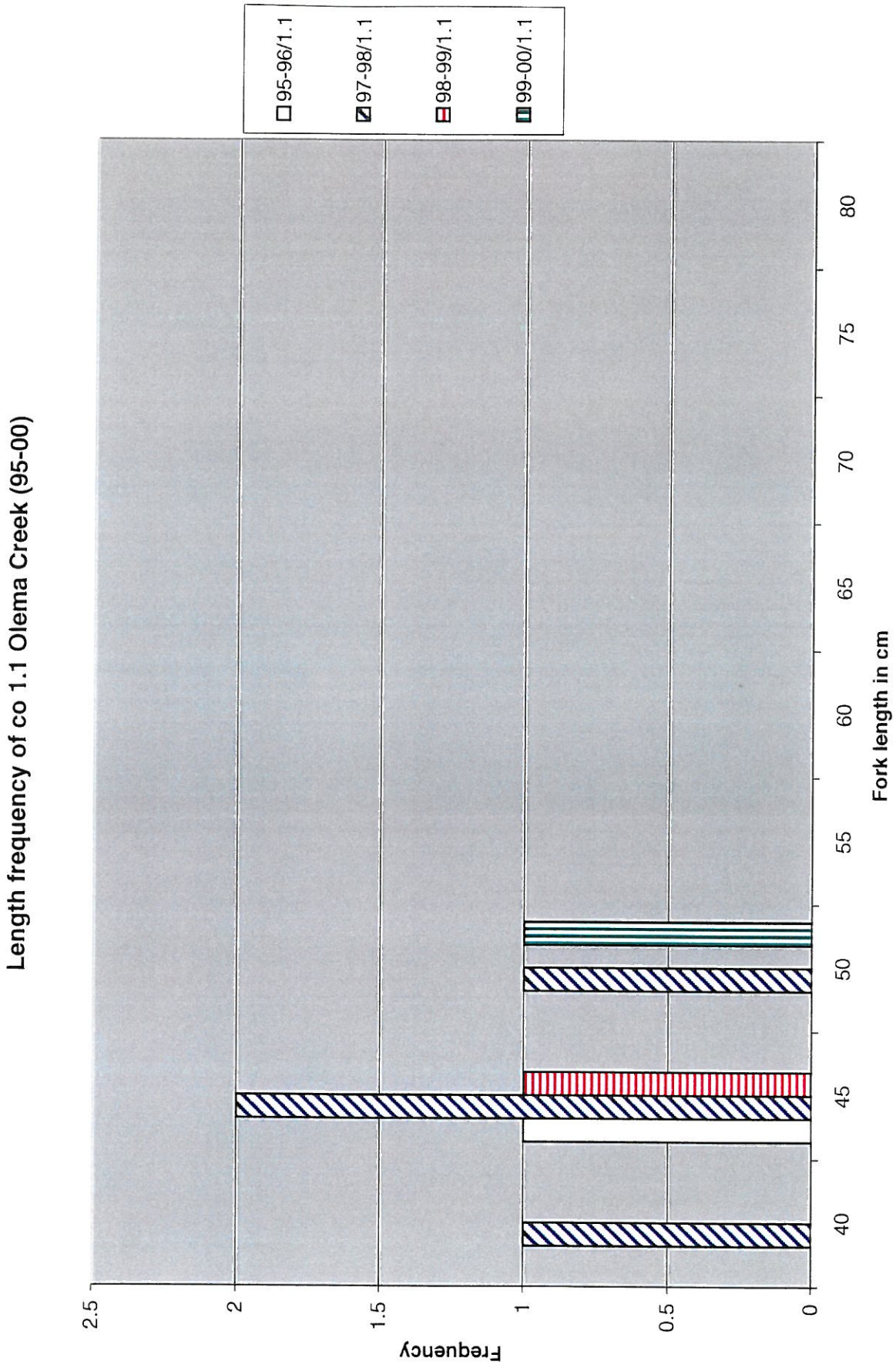
Graph 3: length frequency of juvenile and "resident" steelhead in Redwood Creek and Big Lagoon (fall 99)



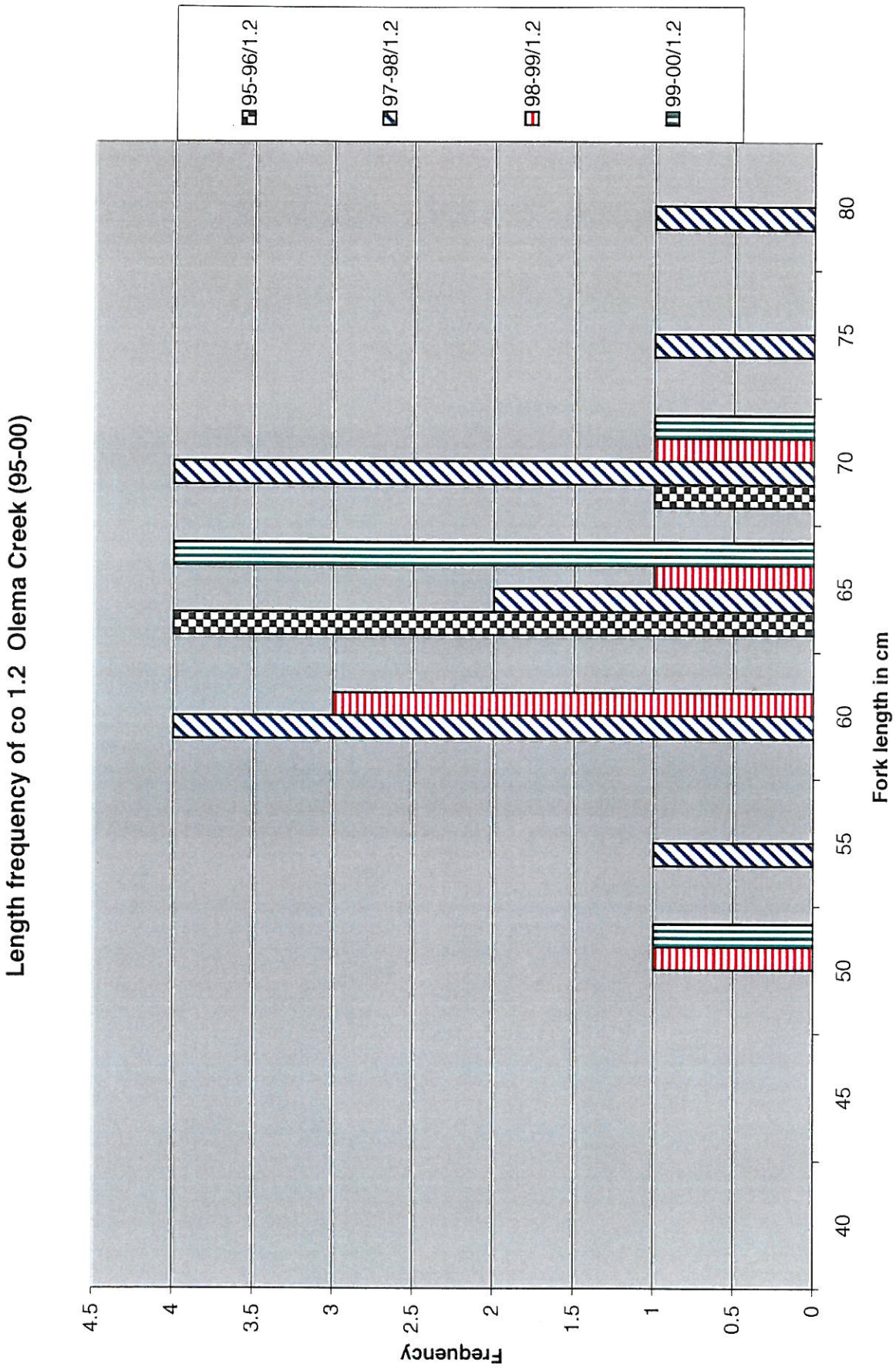
Graph 4: length frequency of steelhead 0+/1+/2+/3+ in Redwood Creek (1997-2000)



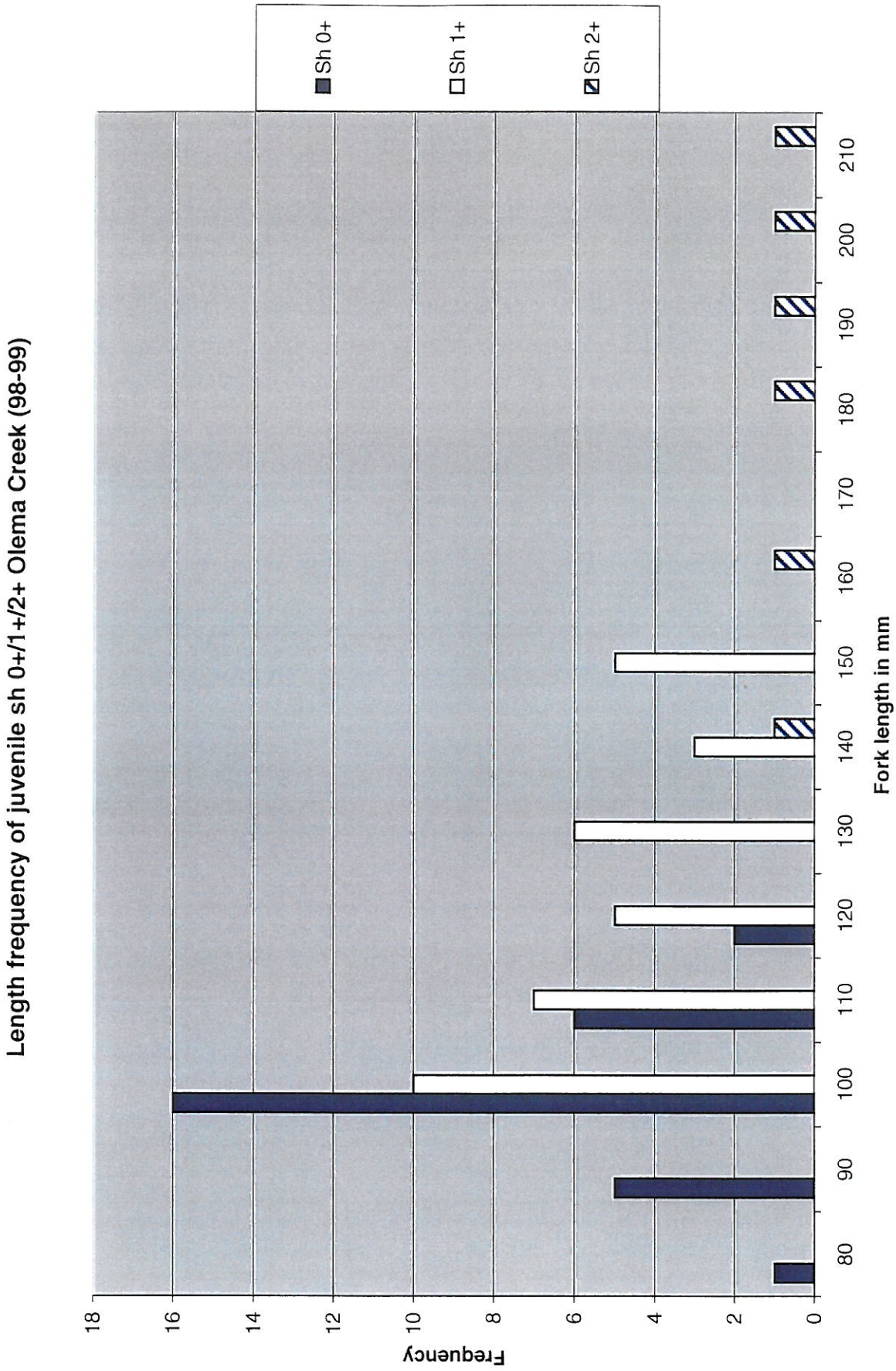
Graph 5: length frequency of coho 1.1 in Olema Creek (1995-2000)



Graph 6: length frequency of coho 1.2 in Olema Creek (1995-2000)



Graph 7: length frequency of juvenile steelhead 0+/1+/2+ in Olema Creek (1998-1999)



checked with Steve Gough
checked by Bill Jong

D. Datasheets of the fish aged for each creek:

FISH SCALE FORM (1)

Sampling Location: Redwood Species: Sh Equipment: Microfiche reader (Magnif 36x) Microscope

Reader: Rauber Anne-Laure Reading number: (1) 2 3 4 Reading date: 1/10/00 - 1/14/00

	ID	Sample Date	Fish length (Specify units)	Est. Age	Scale Radius	Length (~~cm~~ mm) to annuli: I	II	III	IV	V	Number of circuli (per annulus) <I	I-II	II-III	III-IV	IV-V	Notes (e.g., scale regen?) Fwater	Ocean
RW3 all reg	RW 4	10/23/98	170mm														
√ sc. 2	RW 5	10/23/98	138 mm	~ 2+	25mm	9mm	13mm	3mm								25 mm	
√ sc. 5.	RW 5	10/23/98	138 mm	~ 2+	25mm	9mm	12mm	4mm								25 mm	
√ sc. 7	RW 6	10/23/98	145 mm	~ 2+	31mm	11mm	12mm	8mm								31mm	
√ sc. 3	RW 6	10/23/98	145 mm	~ 2+	29mm	10mm	10mm	9mm								29mm	
√ sc. 7	RW 7	10/23/98	136 mm	~ 2+	25mm	13mm	8mm	4mm								25mm	
all. reg.	RW 8	10/23/98	124 mm														
sc. 5	RW 9	10/23/98	132 mm	~ 1+	26mm	12mm	14mm									26mm	
sc. 8	RW 9	10/23/98	132 mm	~ 1+	23mm	10mm	13mm									23mm	
√ sc 4.	RW 10	10/23/98	219 mm	~ 3+	36mm	12mm	9mm	9mm	6mm							36mm	
reg. sc. 3?	RW 12	10/23/98	217 mm	~ 3+	32mm	14mm	8mm	8mm	2mm							32mm	
all reg	RW 13	10/23/98	151 mm														
all reg	RW 14	10/23/98	138 mm														
reg. sc. 1	RW 15	10/23/98	128 mm	~ 1+	20mm	10mm	10mm									20mm	
sc. 5	RW 16	10/23/98	160 mm	~ 2+	30mm	11mm	8mm	11mm								30mm	
sc. 1	RW 17	1/30/98	148 mm	~ 1+	24mm	15mm	9mm									24mm	
reg sc 2	RW 19	1/30/98	109 mm	~1+	18mm	11mm	3mm									14mm	
sc. 1	RW 20	1/30/98	116 mm	~1+	21mm	17mm	9mm									11mm	
sc. 4	RW 21	1/30/98	155 mm	~2+	28mm	10mm	10mm	8mm								28mm	
sc. 1	RW 21	1/30/98	155 mm	~2+	27mm	11mm	11mm	5mm								27mm	
sc 2	RW 22	1/30/98	100 mm	~1+	15 mm	12mm	3mm									15 mm	
sc 2.	RW 23	1/30/98	101 mm	~1+	19mm	16mm	3mm									19mm	

COHO-STEELHEAD RESTORATION PROJECT (GOGA/PORE) FISH SCALE FORM

Sampling Location: Redwood Species: Sh Equipment: Microfiche reader (Magnif 36) Microscope

Reader: Rauber Anne-Laure Reading number: (1) 2 3 4 Reading date: 1/20/00 - 1/21/00

	ID	Sample Date	Fish length (Specify units)	Est. Age	Scale Radius	Length (cm) to annuli: I	II	III	IV	V	Number of circuli (per annulus) <I	I-II	II-III	III-IV	IV-V	Notes (e.g., scale regen?) Freshwat	Ocean
sc. 5	RW24	1/30/98	103mm	~1+	19mm	14mm	5mm									19mm	
sc 3.	RW25	1/30/98	111mm	~1+	19mm	16mm	3mm									19mm	
sc.2	RW26	1/23/98	50cm	1.2(3)	78mm	15mm	6mm=RO	49mm	8mm							15mm	63mm
sc.2	RW28	1/23/98	60cm	2.2(4)	109mm	12mm	13mm	42mm	42mm							25mm	84mm
sc.2	RW29	10/22/98	145mm	~1+	26mm	13mm	13mm									26mm	
all reg.	RW30	10/22/98	132mm														
sc. 5.	RW31	10/22/98	168mm	~2+	34mm	14mm	16mm	4mm								34mm	
sc.1	RW32	10/27/98	176mm	~2+	31mm	11mm	15mm	5mm								31mm	
sc 1	RW33	10/27/98	196mm	~2+	35mm	11mm	9mm	15mm								35mm	
sc.1	RW34	10/27/98	157mm	~2+	29mm	15mm	10mm	4mm								29mm	
all reg	RW35	10/27/98	155mm														
sc 1	RW36	10/20/98	131mm	~1+	23mm	11mm	12mm									23mm	
sc.2	RW37	10/26/98	170mm	~2+	27mm	10mm	14mm	3mm								27mm	
all. reg.	RW38	10/28/98	169mm														
sc 5	RW39	10/28/98	132mm	~1+	26mm	12mm	14mm									26mm	
sc. 4	RW40	10/28/98	131mm	~1+	22mm	12mm	10mm									22mm	
sc. 6	RW41	9/2/98	90mm	~0+	14mm	14mm										14mm	
! ✓ sc. 8	RW42	10/26/98	244mm	~3+	35mm	14mm	8mm	8mm	5mm		(resident!)					35mm	
sc, 4	RW43	10/22/98	145mm	~1+	26mm	13mm	13mm									26mm	
sc.2	RW59	—	131mm	~1+	22mm	12mm	10mm									22mm	
sc.6	RW60	10/26/98	131mm	~1+	22mm	12mm	10mm									22mm	
all reg.	RW61	10/27/98	134mm														

COHO-STEELHEAD RESTORATION PROJECT (GOGA/PORE)

FISH SCALE FORM

Sampling Location: Redwood Species: Sh Equipment: Microfiche reader (Magnif 36) Microscope

Reader: Rauber Anne Laure Reading number: (1) 2 3 4 Reading date: 1/21/00 - 1/26/00

	ID	Sample Date	Fish length (Specify units)	Est. Age	Scale Radius	Length (cm) to annuli: I	II	III	IV	V	Number of circuli (per annulus) <I	I-II	II-III	III-IV	IV-V	Notes (e.g., scale regen?) freshwater	Ocean	
sc. 1	RW 62	10/27/98	172 mm	~ 2+	30 mm	11 mm	9 mm	10 mm								30 mm		
sc 6	RW 63	10/27/98	147 mm	~ 2+	29 mm	13 mm	11 mm	5 mm								29 mm		
sc. 8 *	RW 64	10/27/98	132 mm	~ 1+	21 mm	12 mm	9 mm									21 mm		
sc. 8	RW 66	10/27/98	144 mm	~ 1+	26 mm	13 mm	13 mm									26 mm		
sc 2	RW 67	10/27/98	127 mm	~ 1+	20 mm	11 mm	9 mm									20 mm		
all reg.	RW 68	10/27/98	138 mm															
sc. 2	RW 69	10/26/98	138 mm	~ 1+	21 mm	10 mm	11 mm									21 mm		
sc 4	RW 70	10/26/98	121 mm	~ 1+	23 mm	15 mm	8 mm											
sc. 6	RW 71	10/26/98	160 mm	~ 2+	31 mm	13 mm	8 mm	10 mm								31 mm		
sc. 4	RW 72	10/28/98	124 mm	~ 1+	20 mm	13 mm	7 mm									20 mm		
	RW 73	10/28/98	158 mm	~ 2+	22 mm	8 mm	8 mm	6 mm								22 mm		
all reg	RW 74	10/26/98	146 mm															
sc. 3	RW 85	10/21/98	145 mm	~ 1+	21 mm	12 mm	9 mm									21 mm		
sc 2	RW 86	10/21/98	132 mm	~ 1+	24 mm	11 mm	13 mm									24 mm		
sc. 7	RW 87	10/21/99	117 mm	~ 1+	21 mm	15 mm	6 mm									21 mm		
sc 6	RW 88	10/21/99	104 mm	~ 0+	13 mm	13 mm										13 mm		
too dusty	RW 89	10/21/98	164 mm															
? reg sc 1	RW 90	10/21/98	113 mm	~ 0+	27 mm	27 mm										27 mm		
all reg.	RW 91	10/27/98	165 mm															
all reg.	RW 92	6/29/99	176 mm															
sc. 5	RW 144	6/24/99	130 mm	~ 1+	22 mm	13 mm	9 mm									22 mm		
sc 1	RW 146	6/24/99	117 mm	~ 1+	22 mm	13 mm	9 mm									22 mm		
sc. 1	RW 145	6/24/99	99 mm	~ 1+	25 mm	15 mm	10 mm									25 mm		
sc 1 *	RW 65	10/27/98	105 mm	~ 0+	14 mm	14 mm										14 mm		

COHO-STEELHEAD RESTORATION PROJECT (GOGA/PORE)

FISH SCALE FORM

④

Sampling Location: Redwood Species: Sh Equipment: Microfiche reader (Magnif 36) Microscope

Reader: Rauber Anne-Laure Reading number: ① 2 3 4 Reading date: 1/26/00

	ID	Sample Date	Fish length (Specify units)	Est. Age	Scale Radius	Length (cm) to annuli: I	II	III	IV	V	Number of circuli (per annulus) <I	I-II	II-III	III-IV	IV-V	Notes (e.g., scale regen?) freshwater	ocean
all reg. *	RW 147	6/24/99	123mm														
reg. sc.3	RW 149	6/24/99	133 mm	~1+	21mm	10mm	11mm									21mm	
** sc.1 → sc.4	RW 150	6/24/99	110mm	~1+	20mm	11mm	9mm									20mm	
	RW 153	6/24/99	103mm	~1+	18mm	10mm	8mm									18mm	
sc.4	RW 154	6/24/99	108 mm	~1+	18mm	12mm	6mm									18mm	
sc.4	RW 155	6/24/99	118 mm	~1+	21mm	10mm	11mm									21mm	
* sc 5	RW 157	6/24/99	153 mm	~2+	30mm	17mm	8mm	5mm								30mm	
sc.5	RW 158	6/24/99	122 mm	~1+	18mm	10mm	8mm									18mm	
sc.4	RW 159	6/28/99	115 mm	~1+	17mm	12mm	5mm									17mm	
sc 5.	RW 160	6/28/99	142mm	~2+	23mm	11mm	10mm	2mm								23mm	
sc.5	RW 161	6/28/99	124mm	~1+	21mm	12mm	9mm									21mm	
sc.4	RW 162	6/28/99	112mm	~1+	18mm	12mm	6mm									18mm	
sc.3	RW 163	6/28/99	111 mm	~1+	18mm	12mm	6mm									18mm	
164 (no scales) * sc.5	RW 165	6/28/99	119mm	~1+	19mm	10mm	9mm									19mm	
sc.6	RW 166	6/28/99	122mm	~1+	18mm	13mm	5mm									18mm	
167 * ⑤ sc.2	RW 168	6/28/99	129 mm	~1+	22mm	11mm	11mm									22mm	
✓ sc.3	RW 169	6/28/99	166 mm	~2+	30mm	16mm	11mm	3mm								30mm	
sc.1	RW 170	6/28/99	121 mm	~1+	22mm	13mm	9mm									22mm	
sc.2	RW 171	6/28/99	119mm	~1+	18mm	10mm	8mm									18mm	
sc.2	RW 172	6/28/99	127mm	~1+	22mm	13mm	9mm									22mm	
sc.3	RW 173	6/29/99	106 mm	~1+	18mm	10mm	8mm									18mm	
reg. sc 2	RW 174	6/29/99	130mm	~1+	25mm	14mm	11mm									25mm	
sc.4 *	RW 151	6/24/99	115 mm	~1+	18mm	13mm	5mm									18mm	
sc.4*	RW 148	6/24/99	113mm	~1+	18mm	11mm	7mm									18mm	
all reg	RW 152	6/24/99	139 mm														
sc.5	RW 151	6/24/99	117 mm	~1+	18	13mm	5mm									18	

Sampling Location: Olema Species: Sh Equipment: Microfiche reader (Magnif 36) Microscope

Reader: Rawber Anne-Laure Reading number: (1) 2 3 4 Reading date: 2/11/00 - 2/23/00

ID	Sample Date	Fish length (Specify units)	Est. Age	Scale Radius	Length (cm) to annuli: I	II	III	IV	V	Number of circuli (per annulus) ♀♂ x	I-II	II-III	III-IV	IV-V	Notes (e.g., scale regen?) Freshwater	Ocean
OL 34	12/20/97	60 cm	1.2(3)?	99 mm	23mm	30mm	46mm			♀					23mm	76 mm
OL 49	11/5/98	144 mm	~ 1+	25mm	14mm	11mm									21 mm	
OL 50	11/5/98	145 mm	~ 1+	20mm	12mm	8 mm									20mm	
OL 51	11/5/98	120 mm	~ 1+	27mm	18mm	9mm									27mm	
OL 52	11/5/98	116 mm	~ 0+	20mm	20mm										20mm	
OL 53	11/5/98	129 mm	~1+	23mm	18mm	5mm									23mm	
OL 54	11/5/98	143 mm	~ 1+	27mm	14mm	13mm									27mm	
OL 55	11/5/98	114mm	~ 0+	17mm	17mm										17mm	
OL 56	11/5/98	143 mm	~1+	22mm	15mm	7mm									22 mm	
OL 57	11/5/98	192 mm	~2+	33mm	14mm	14mm	5mm								33mm	
OL 58	11/5/98	125 mm	~1+	22mm	13mm	9mm									22mm	
OL 59	11/5/98	94 mm	~ 0+	13mm	13mm										13mm	
OL 60	11/5/98	165 mm	~ ?													
OL 61	11/5/98	139 mm	~1+	20mm	9mm	11mm									20mm	
OL 62	11/5/98	106 mm	~1+	18mm	10mm	8mm									18mm	
OL 63	11/5/98	122mm	~ 1+	25mm	12mm	13mm									25mm	
OL 64	11/5/98	135 mm	~ 1+	24mm	11mm	13mm									24mm	
OL 65	11/5/98	134 mm	~ 1+	17mm	10mm	7mm									17mm	
OL 66	11/5/98	115 mm	~ 1+	15 mm	7mm	8 mm									15 mm	
OL 68	11/5/98	155 mm														
OL 69	11/5/98	140mm	~ 2+	27mm	14mm	10mm	3mm								27mm	
OL 70	11/5/98	123mm	~ 1+ ?	17mm	14mm	3mm									17mm	

Figure 18: datasheet used to age the fish

Figure 19: fish scale of a 3 years old (1.2) coho

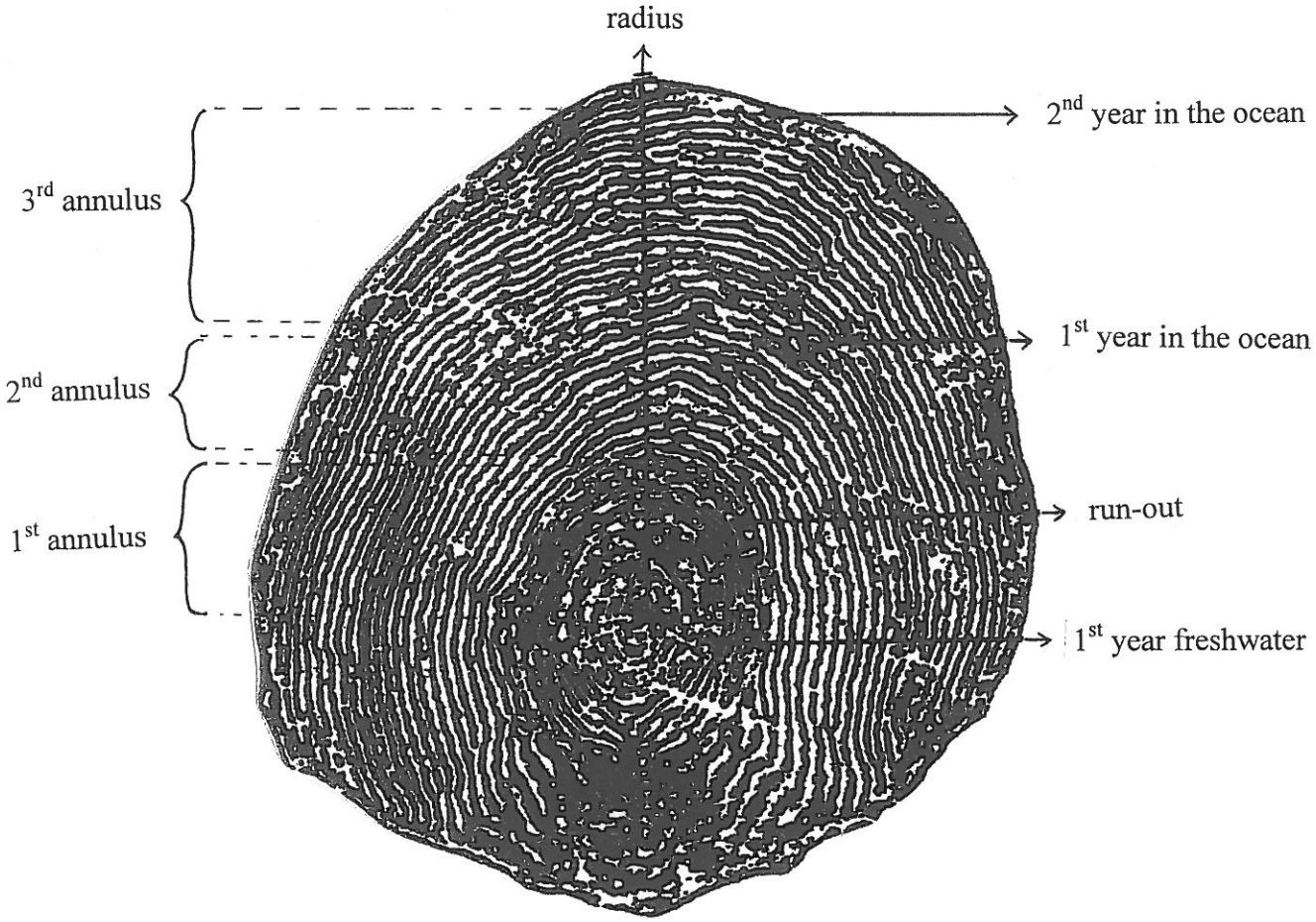


Figure 20: a crossing-over

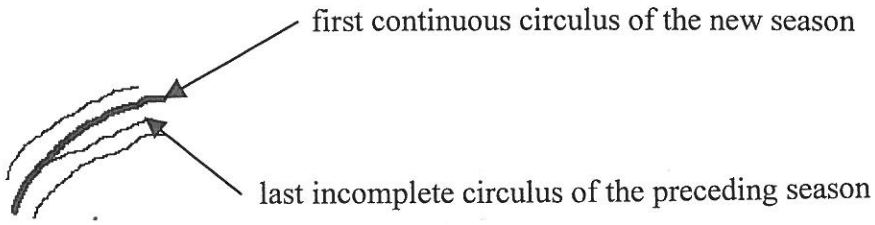


Figure 21: 2 different areas where a crossing-over can be found

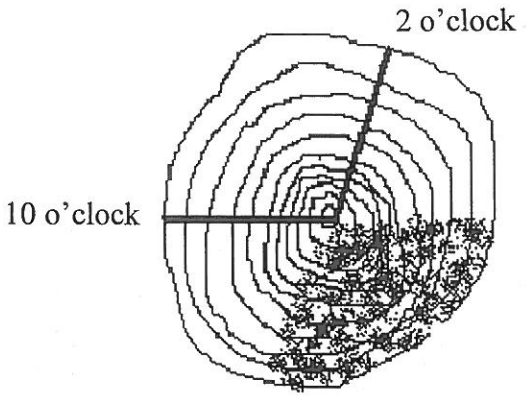


Figure 22: scale of a 1.1 coho with erosion

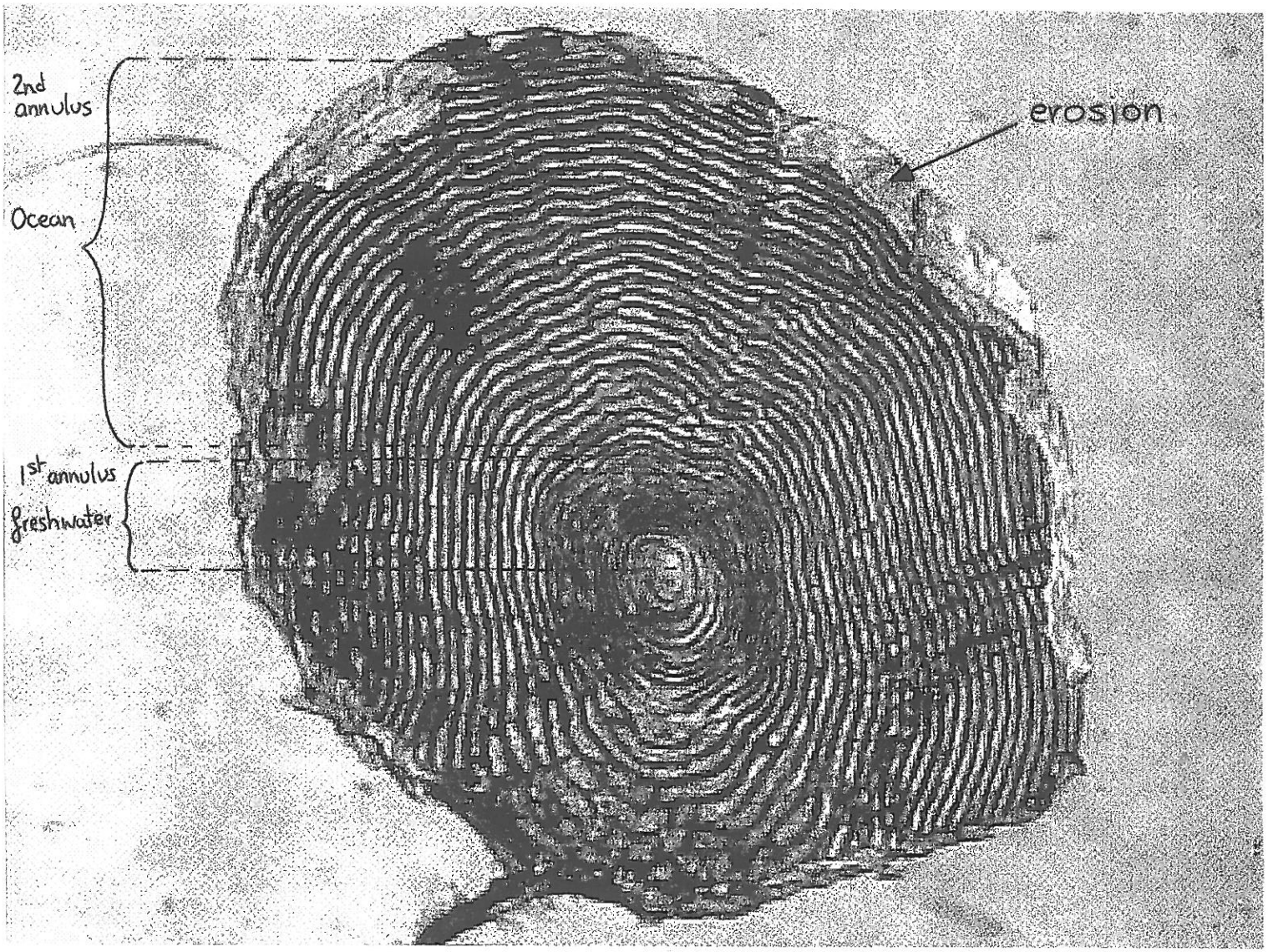


Figure 23: spawner survey datasheet

SPAWNER SURVEY DATA SHEET

Sheet #____ of ____

Stream:_____ Reach:_____ Date:__/__/__ Weather:_____

Start Time:_____ End Time:_____ Observers:_____ Recorder:_____

Tel:(__)_____ Water Temp: ^{0}C____ ^{0}F____ Water Clarity (cm):_____ Stage (ft.):_____

Location	Species			Live Fish		Carcasses				Redds			Comments
	CO	SH	?	Sex (M/F/?)	Len (cm)	Sex (M/F/?)	Len (cm)	Mark Code	Recap Code	Def./ ?	Len (m)	Wid (m)	(live fish or carcass condition, live fish spawning, tissue/scales)

Figure 24: coho male with its hooked upper and lower jaw and its red band (Redwood Creek)



Figure 25: illustration of male coho salmon showing the body locations for tissue and scale samples collection and its fork length (drawing by R. Pittard, 1990)

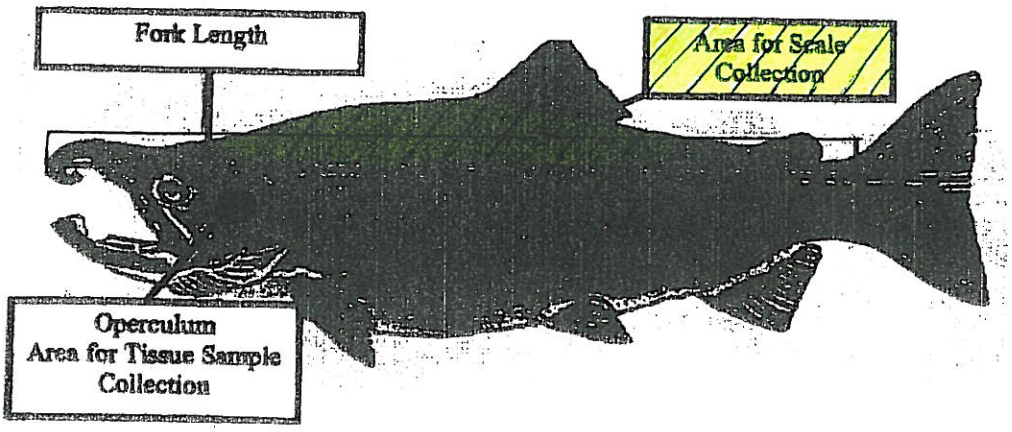


Figure 26: Darren Fong standing next to a redd located in a flatwater area (Redwood Creek)

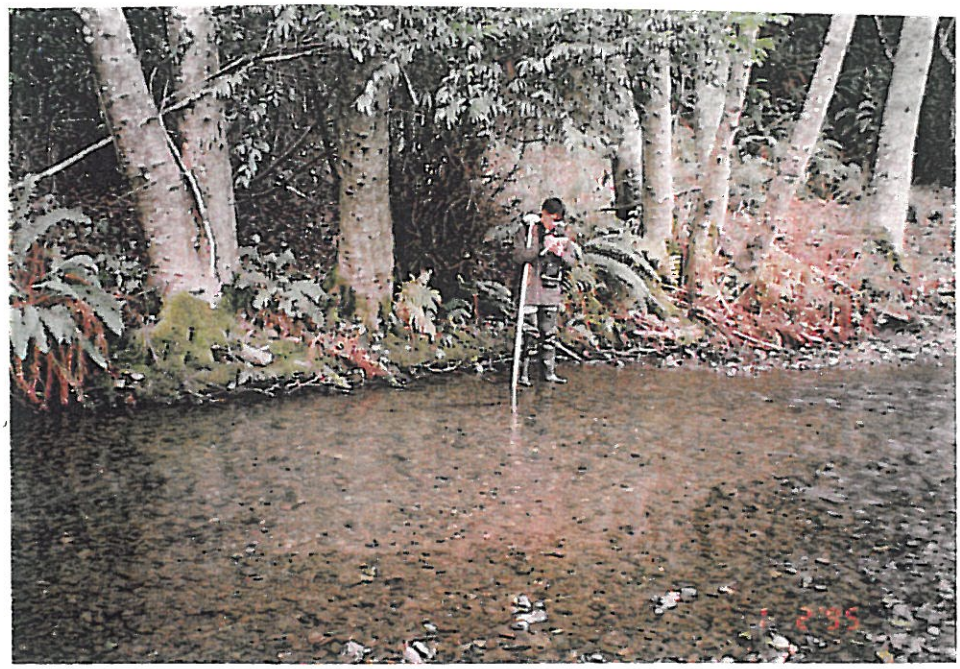


Figure 27: cross section of a redd (from Sandercock 1990)

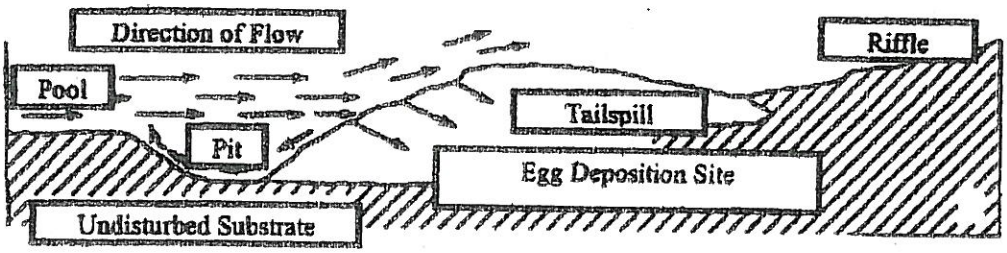


Figure 28: backpack electrofishing unit carried by someone doing an electrofishing survey (Redwood Creek)



Figure 29: juvenile coho

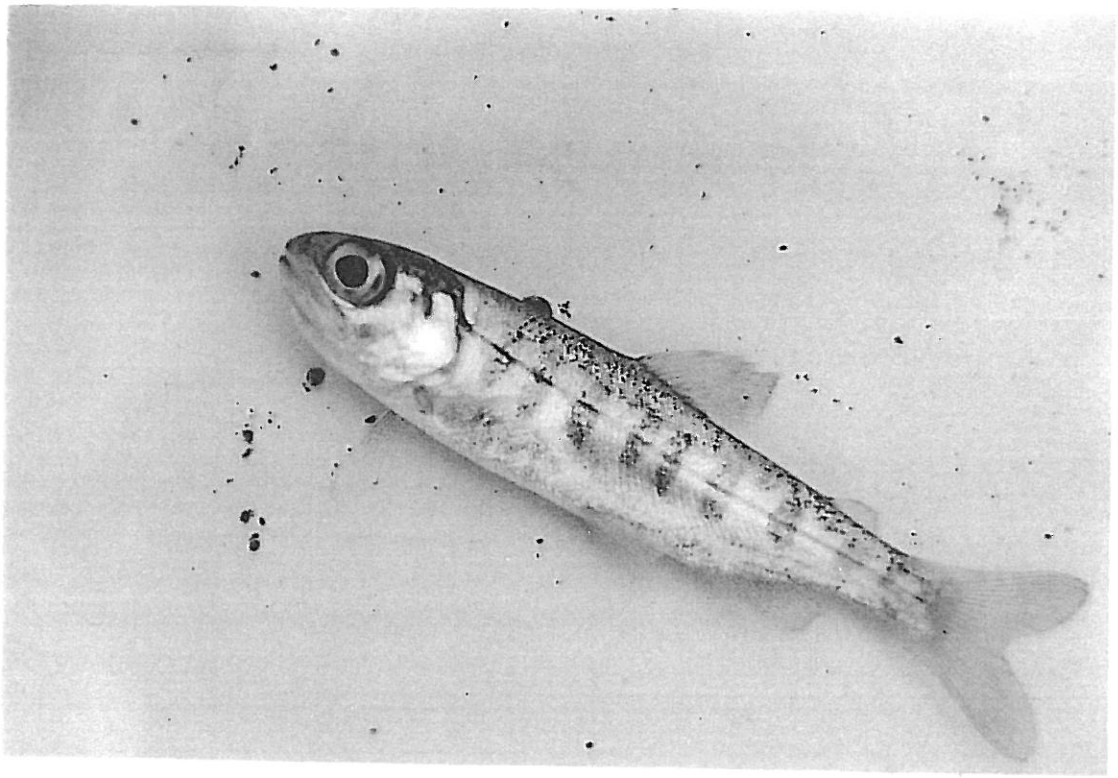


Figure 30: juvenile steelhead

