Outmigrant Trapping of Juvenile Salmonids in the Lower Stanislaus River Caswell State Park Site 1998

June 1999

U.S. Fish and Wildlife Service
Anadromous Fish Restoration Program
Stockton, California

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Prepared for

U.S. Fish and Wildlife Service
Anadromous Fish Restoration Program
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Appendix A by
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IntStats

EXECUTIVE SUMMARY

We operated two rotary screw traps side-by-side in the lower Stanislaus River near Caswell State Park from January 29 through July 16, 1998 to estimate the abundance of juvenile fall-run chinook salmon migrating out of the Stanislaus River during this time period. The abundance estimates are part of a coordinated monitoring effort on the Stanislaus River to better understand the relationship of salmonid population response to both physical habitat restoration measures and flow management actions currently underway

We estimated the capture efficiency of the traps by releasing 17 groups of marked hatchery chinook and 4 groups of marked natural chinook, about 1/4 mile upstream of the traps. Recovery rates of marked fish varied from 0.03% to 4.90%. Variation in capture efficiency for both traps combined was accounted for by a logistic regression on fish size, river flow, and turbidity. The 1998 regression model included trap efficiency release-recapture data from 1996, 1997, and 1998 at the Caswell site. The model developed in 1998 was different from the previously developed regression in three ways: (1) fish size was added as a predictor variable and found significant for 1998 data, (2) a turbidity threshold was added to the model, and (3) day-time releases were not used in the model. Outmigration indices for 1996 and 1997 were recalculated based on the new model.

The estimated numbers of juvenile chinook salmon migrating past the traps in the 1996, 1997, and 1998 sampling seasons including fry, parr, and smolts are as follows:

Year	Period Sampled	Number of Days Sampled	Total Catch	Total Est. Outmigration	95% Confidence Interval Lower	95% Confidence Interval Upper
1996	Feb 5 - Jul 2	142	2,468	95,000	69,000	121,000
1997	Mar 19 - Jun 27	98	2,357	54,000	41,000	66,000
1998	Jan 29 - Jul 16	150	19,894*	651,000	284,000	1,018,000

* Total catch for 1998 excludes catches on two days (9 fish total) in early January that are not included in the calculation of the total outmigration index

Although error bounds on estimates were large, there was no overlap in the chinook outmigration index between years. Outmigration was highest in 1998, followed by 1996. The 1997 outmigration estimate was the lowest of the 3 years, but it did not include fry. Even if the comparison between years is limited to fish passing after the mean length reached 80mm (the lower limit qualifying as smolts), the ranking of the years remained the same, with point estimates of total smolts being 65,000 in 1996, 49,000 in 1997, and 184,000 in 1998.

We classified outmigrants into three life history stages, corresponding to the extent of additional freshwater rearing they would likely require after passing the trap site. Fish with a 30 to 45mm fork length, just beginning their freshwater growth, and caught from January to mid March were classified as fry. Fry constituted about 44% of the estimated outmigrants in 1998. Fish with a 45 to 80 mm fork length, yet showing the silvery smolt appearance, and caught from early March through late April were classified as parr. Parr constituted about 28% of the estimated outmigrants in 1998. Fish with a 80 to 110 mm fork length were classified as smolts: Most smolts were silvery in appearance and were caught from late April through June. Smolts constituted about 28% of the estimated outmigrants in 1998. Lengths gradually increased over the course of sampling and ranged from about 35 mm in late January to about 100 mm in mid-June. Mean lengths were slightly smaller in 1998 than in previous years on the same dates. Three yearling chinook were caught during the month of March.

We captured 4 rainbow trout/steelhead in 1998, ranging in size from 228 to 299 mm. All of the fish showed advanced smolting characteristics.

Although passage estimates of chinook salmon fluctuated substantially between days, seasonal peaks were evident for fry, parr, and smolts. Outmigration of fry peaked in mid-February with a maximum catch of 2,509 (corresponds to an estimated outrmigrant index of 100,000) chinook on February 16. Outmigration of parr peaked about April 1 with a maximum

catch of 504 fish on March 26. Outmigration of smolts peaked broadly in mid-May with a maximum catch of 158 on May 15. Peak fry outmigration coincided with high flows in excess of 6,000 cfs; however, the relationship between smolt outmigration and flow was not as distinct. The number of chinook passing Caswell decreased in late May, with small numbers outmigrating in June. River flow and turbidity were unusually high in early January 1998, so significant numbers of fry probably outmigrated prior to the start of sampling. Small peaks in smolt outmigration occasionally coincided with periods of high turbidity, but no clear relationship was found. The relationship between fry passage and turbidity was more evident than that for smolts.

ACKNOWLEDGMENTS

The data reported here were gathered through the efforts of our field staff, Robert Fuller, Ryan Cuthbert, Ben Griffith, Gina Ladd, Tiffani Bergeron, Michael Justice, Ron Sandling and Ryan Fuller. We are grateful for their dedication and hard work.

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We thank Steve Felte and the Tri-Dam Board of Directors, as well as Wayne Marcus, Manager of Oakdale Irrigation District and Rick Martin, Manager of South San Joaquin Irrigation District who loaned equipment and manpower to help carry out this study.

We thank Tom Phillips at Pacific Tire and Wheel, Turlock, California for his contributions, including the loan of equipment.

We are grateful to B & B Farms who allowed us daily access to the river across their property. We are also grateful to the US Army Corps of Engineers (USACE) for granting us special access through their parks, and for their protective surveillance of our equipment. We are especially grateful to Peggy Brooks and Lisa Vacarro at the Knights Ferry USACE office for their continued support of all our activities throughout the year.

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INTRODUCTION

Factors regulating salmon production in the Stanislaus River are not fully understood. State and Federal restoration programs such as the Anadromous Fish Restoration Program under the Central Valley Project Improvement Act (CVPIA) continue to synthesize what is known about factors that regulate salmon production to develop adaptive management strategies to help guide ongoing restoration and management activities. Sampling of outmigrant juvenile salmon on the Stanislaus River near its confluence with the San Joaquin River is part of a coordinated monitoring effort on the Stanislaus to better understand salmon population response to flow and habitat conditions within the river. Operation of the Rotary Screw Traps (RST's) at Caswell has been funded by the CVPIA since 1995. The CVPIA of 1992 directs the Secretary of the Interior (Fish and Wildlife Service and the Bureau of Reclamation) to develop and implement a series of restoration programs for fish and wildlife purposes with the goal of at least doubling natural production of anadromous fish (from that estimated during a baseline period of 1967 to 1991) in Central Valley streams. Pursuant to the CVPIA, the juvenile salmon out-migration enumeration effort described in this report helps to inform two CVPIA programs. First is the Comprehensive Assessment and Monitoring Program (CAMP). The goal of CAMP's juvenile monitoring program is to assess the relative effectiveness of categories of anadromous fish restoration actions. Secondly, the water management activities on the Stanislaus authorized under Sections 3406 (b)(1-3) of the Act have identified a need for a monitoring effort that can help interpret the effects of existing and proposed water management activities on juvenile salmon production.

Sampling at the Caswell site is designed to develop an index of juvenile salmon production to characterize trends in juvenile life history characteristics and production in relation to environmental factors and management activities including water management and habitat restoration. This report provides a summary of previous years sampling activities at Caswell as well as the findings for 1998 relative to the three specific study objectives

identified below. A statistical model to estimate juvenile salmon production incorporates information from 1995 through 1998.

STUDY OBJECTIVES FOR 1998

Sampling at the Caswell site in 1998, reported here, had three objectives:

- Estimate the number of juvenile fall-run chinook salmon migrating out of the Stanislaus River in 1998, using a statistical model developed for the system,
- Determine the size and smolting characteristics of juvenile chinook salmon and rainbow trout/steelhead migrating out of the Stanislaus River,
- Identify factors that influence the time, size and number of juvenile chinook salmon and rainbow trout/steelhead migrating out of the Stanislaus River.

SUMMARY OF PREVIOUS MONITORING

Rotary screw traps have been used since 1993 to monitor timing and relative abundance of juvenile salmonids outmigrating from the Stanislaus River. Sampling has been conducted near Oakdale (RM 40.1) and near Caswell State Park (RM 8.6) by either California Department of Fish and Game (CDFG), US Fish and Wildlife Service (USFWS) or S.P. Cramer and Associates, Inc. (SPCA) (Table 1). Target species include fall-run chinook salmon and rainbow trout/steelhead. A summary of sampling in each past year follows.

In 1993, the first year of screw trap sampling in the Stanislaus River, one trap was fished at the Oakdale site for a portion of the outmigration period. The daily number of outmigrants was estimated from the results of two mark-recapture tests.

In 1994, one trap was operated at the Caswell site and no sampling occurred at the Oakdale site. Juvenile chinook catches were low in 1994, and no daily or seasonal abundance index was estimated.

Table 1. Date, location and number of rotary-screw traps operated in the Stanislaus River, 1993 - 1998.

Year	Trap Location	Number of Traps	Start Date	End Date	Flow-Year Type
1993	Oakdale	1	Apr 21	Jun 29	Low
1994	Caswell	1	Apr 23	May 26	Low
1995	Oakdale	1	Mar 18	Jul 1	Low
1995	Caswell	2	Mar 27	May 26	Low
1996	Oakdale	1	Feb 1	Jun 8	High
1996	Caswell	2	Feb 5	Jul 2	High
1997	Caswell	2	Mar 19	Jun 27	High
1998	Oakdale	1	Jan 26	Jul 15	High
1998	Caswell	2	Jan 8	Jul 16	High

In 1995, two traps were fished at the Caswell site. Catches of natural migrants were low, as were trap efficiencies estimated from recoveries of marked fish. However, since sampling was also conducted at Oakdale that year, it was possible to compare the size and timing of juvenile chinook between the upstream and downstream trapping locations. Catches were much higher at the Oakdale site. Screw trap efficiency was estimated there with the release of 20 groups of marked natural or hatchery chinook.

In 1996, two screw traps were fished at Caswell and one at Oakdale. Sampling began earlier this year with the goal of estimating the total number of juvenile chinook outmigrants. However, we began sampling at Oakdale and Caswell in early February, and found that fry were already migrating. We modified the trap set-up at Caswell to increase capture rates and

released 15 groups of marked fish to estimate trap efficiency. Recapture rates varied from 0 to 12.08% with variation in capture efficiency best accounted for by a logistic regression on turbidity.

Large differences in estimated passage at Oakdale and Caswell in 1996 suggested that there may have been high mortality of juvenile chinook in the 31.5 miles between the Oakdale and Caswell sites. However, focused study will be needed to estimate in-river survival rates and the potential underlying mechanisms.

In 1997, we fished two rotary screw traps at Caswell. No sampling occurred at Oakdale due to high flows. These high flows also delayed the initiation of sampling at Caswell from January 1 until mid-March.

DESCRIPTION OF STUDY AREA

The headwaters of the Stanislaus River originate on the western slope of the Sierra Nevada Mountains. The Stanislaus River and its tributaries flow southwest to the confluence with the San Joaquin River on the floor of the Central Valley (Figure 1). The San Joaquin River flows north and joins the Sacramento River in the Sacramento-San Joaquin Delta. The Stanislaus River is dammed at several locations for the purposes of flood control, power generation and water supply. Water uses include irrigation and municipal needs, as well as recreational activities and water quality control.

Goodwin Dam, approximately 58.4 river miles (RM) upstream from the San Joaquin River confluence, blocks the upstream migration of anadromous fish. The lower river supports fall-run chinook salmon spawning between the town of Riverbank (RM 34) and Goodwin Dam (RM 58.4).

Throughout this report, we reference river miles on the Stanislaus River. River miles were determined with a map wheel and 7.5 minute series USGS quadrangle maps, (Knights Ferry, 1987 and Oakdale, 1987). Trapping locations and key area landmarks are listed below along with the river mile location for each site:

Knights Ferry Bridge	RM 54.6
Orange Blossom Bridge (OBB)	RM 46.9
Highway 120/108 Bridge	RM 41.2
Oakdale Trapping Location	RM 40.1
Caswell Trapping Location	RM 8.6

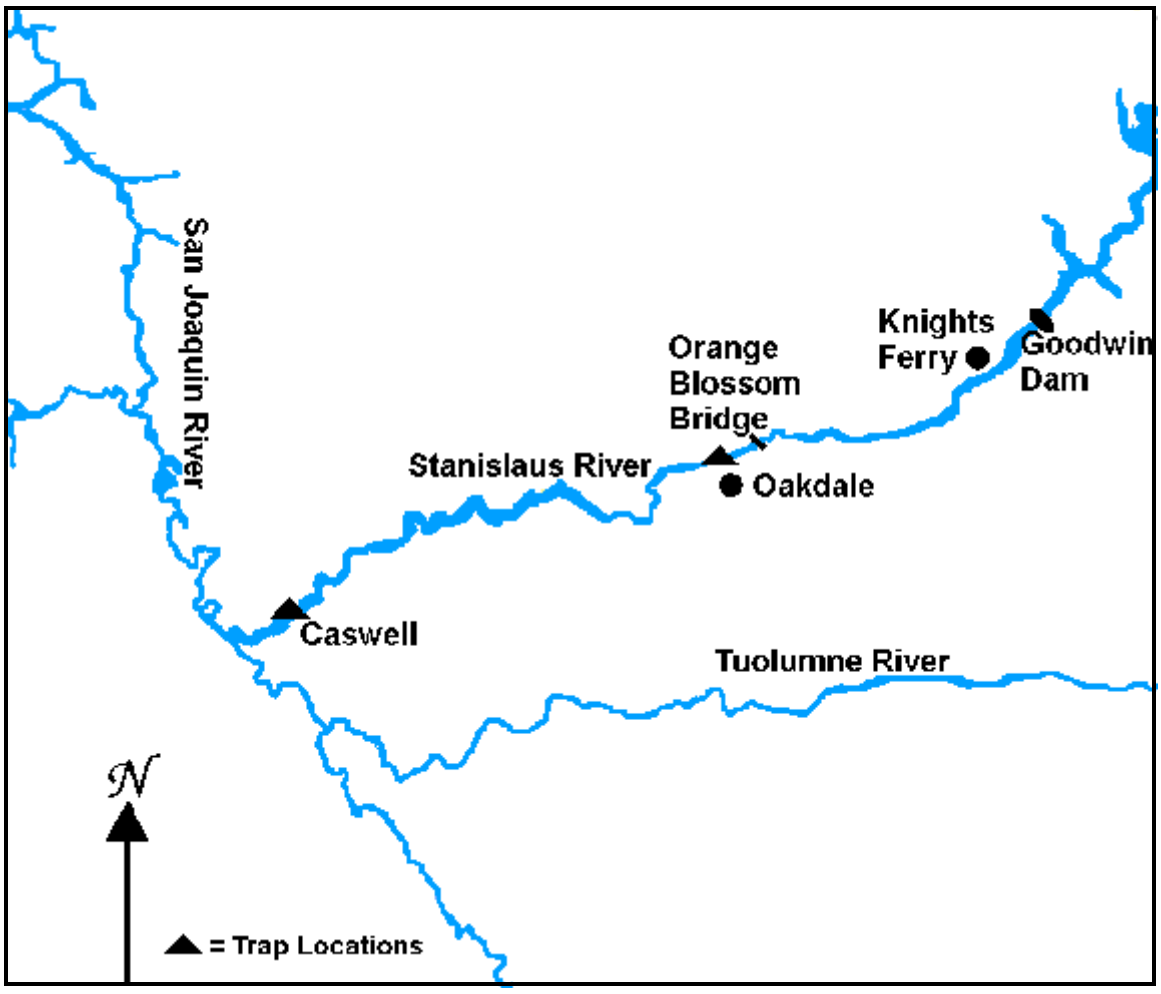


Figure 1. Location map of study area on the Stanislaus River.

METHODS

JUVENILE OUTMIGRANT MONITORING

Sampling Gear

We fished two rotary screw traps side-by-side in the mainstem of the lower Stanislaus River near Caswell State Park to sample juvenile salmonids as they migrated downstream. The screw traps, manufactured by E.G. Solutions in Eugene, Oregon, each consisted of a funnel shaped core suspended between two pontoons (Figure 2). Each trap was positioned in the current so that water entered the 8 ft wide funnel mouth. Water entered the funnel and struck the internal screw core, causing the funnel to rotate. As the funnel rotated, fish were trapped in pockets of water and forced rearward into a livebox, where captured fish could not escape.

Plastic mesh fence panels were placed in the rear of the south trap and side portions of the north trap liveboxes to provide fish with areas of refuge and to minimize stress and mortality. The fences consisted of ½ in. plastic mesh fastened to pipe frames. The mesh caught wood and plant debris while allowing fish to pass through.

Each trap was held in place with 1/4 inch cable fastened to large trees upstream on the north bank. The downstream force of the water on the traps kept the cables taught and near the water surface. Buoys marked the location of the cables for human safety. Although there is some recreational use of the river near the traps by small boats, canoes, and anglers in float tubes, the majority of river use in the vicinity of the State Park occurs downstream from the trap site.

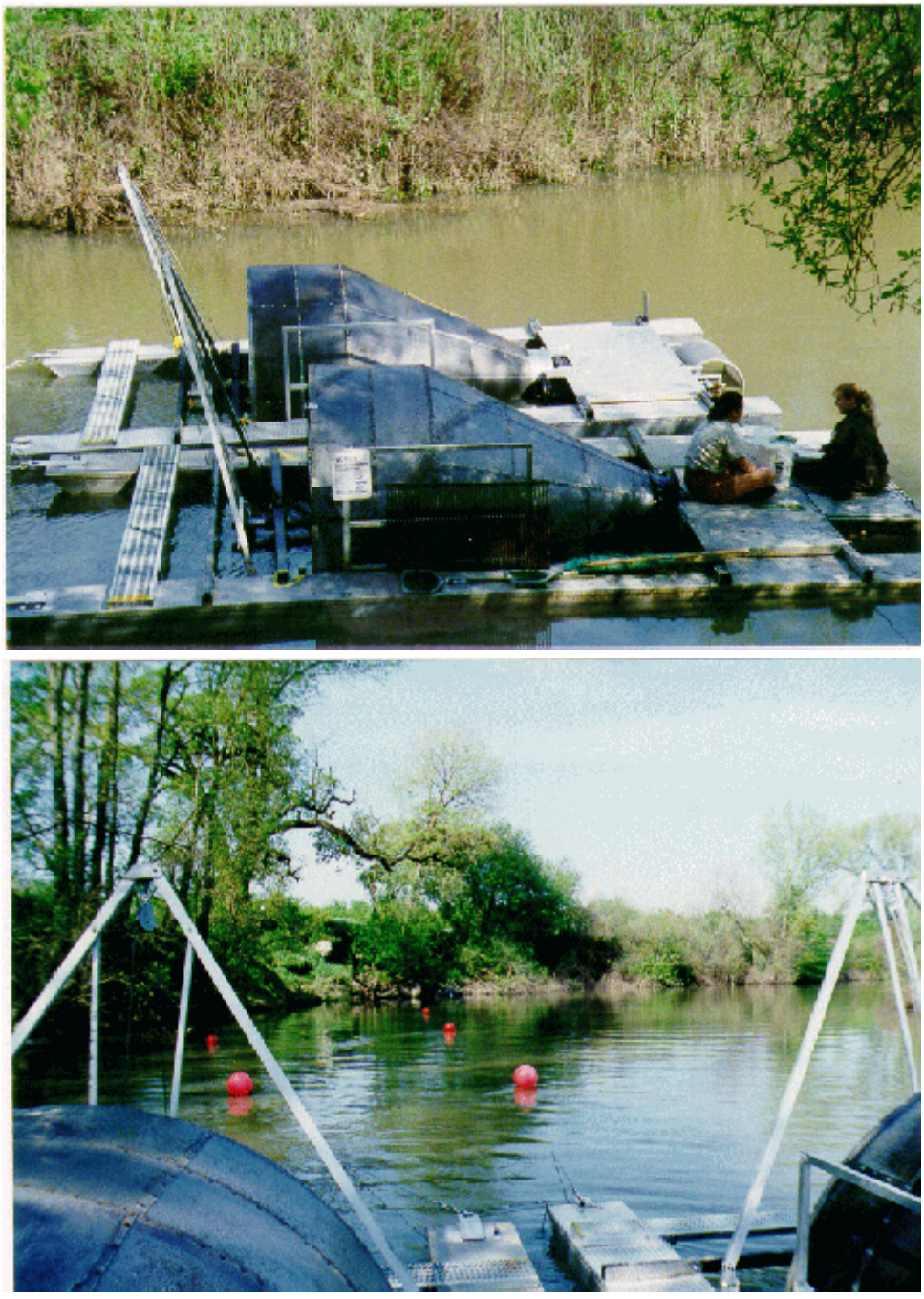


Figure 2. Photographs of the rotary screw traps fishing near Caswell State Park. The buoys marked the position of the cables to prevent entanglement with river users.

Trap Site Preparation

The Caswell trapping location was chosen by CDFG in 1994 since it was the farthest location downstream with adequate access to install and monitor the traps. In 1998, the traps fished in the same position as in 1996 and 1997, which was upstream approximately 100 yards from the site fished in 1994 and 1995. The trap nearest the left bank (looking upstream) was designated the north trap and the trap nearest the right bank was designated the south trap. These designations are the same as those used in the study in 1995, 1996 and 1997. A sandbag wall extending approximately 5 ft out from the north bank was constructed in 1996 to divert flow into the traps and thereby increase trap efficiency. This wall remains at the site. The north trap fished about 10 ft downstream of this wall and approximately 8 - 12 ft from the bank in an area where the velocity was highest.

Safety Measures

Although recreational use of the river in this area was relatively light, we took precautions to warn park visitors and river users of the inherent dangers associated with the presence of rotary screw traps. One sign with large letters was placed upstream from the traps to warn river users traveling downstream towards the traps. The sign was approximately 4 ft x 4 ft with reflective red letters on a white background. A flashing light, similar to ones seen on roadside construction signs, was also placed on the south trap to increase visibility at night. Reflective tape was applied to the A-frames of each trap to provide further warning.

To discourage people along the banks from swimming or floating towards the traps, numerous warning signs were also placed at conspicuous places along the north bank and on the north trap facing the north bank. The signs warned of drowning danger near the traps and cautioned park visitors with messages such as "keep out" and "private property". The signs were in English and Spanish.

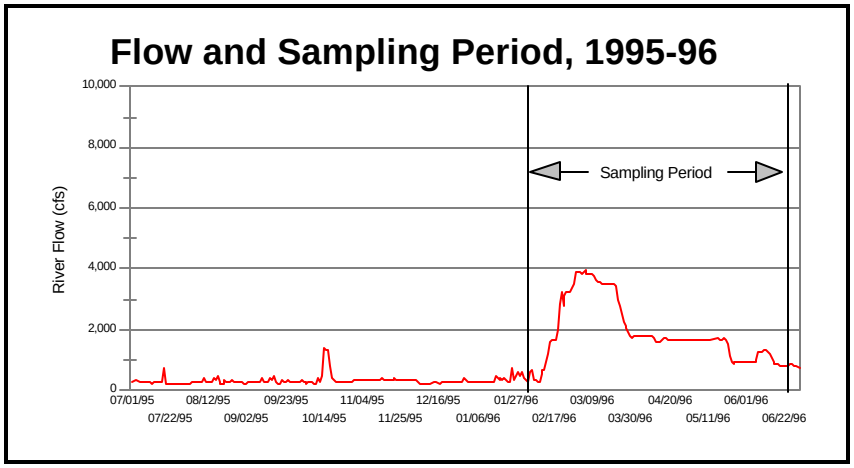
Trap Monitoring

We installed the rotary screw traps on January 7, and began monitoring catches the morning of January 8. Monitoring continued until July 16 and the traps were removed July 22. This was the longest period to be sampled thus far at the Caswell site, and the first to encompass the entire period of chinook salmon outmigration, typically January through June (Figure 3).

The traps were fished 24 hours per day, 7 days per week from January 29 to June 19. The traps were not sampled January 13 through January 28 due to unsafe conditions caused by high flows and heavy debris. Beginning on June 20, and continuing through the end of sampling, the traps were raised after every Friday morning check and lowered again Sunday evening due to heavy weekend recreational traffic on the river.

At times of high turbid flows and when we had recently released marked fish, we retrieved trap catches both in the morning and during the day to document daytime catches of juvenile chinook. Following the release of marked hatchery fish, we monitored the traps frequently until we were no longer recapturing marked fish.

During each trap check, we removed the contents of the liveboxes and identified and counted all fish captured. Random samples of 50 chinook and 20 of each other species were measured and their lengths recorded in millimeters. We also measured all rainbow trout/steelhead and yearling chinook.


Flow and Sampling Period, 1995-96
River Flow (cfs)
10,000
8,000
6,000
4,000
2,000
0
Sampling Period
07/01/95
08/12/95
09/23/95
11/04/95
12/16/95
01/27/96
03/09/96
04/20/96
06/01/96
07/22/95
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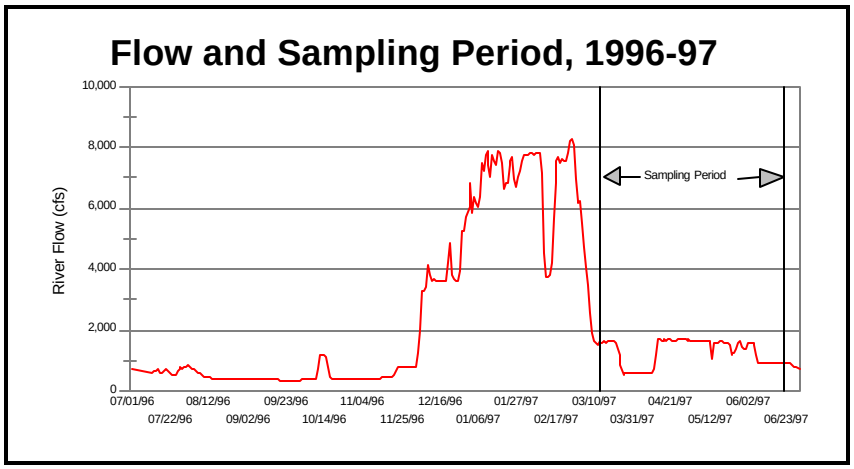
05/11/96
06/22/96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6,000
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2,000
0
Sampling Period
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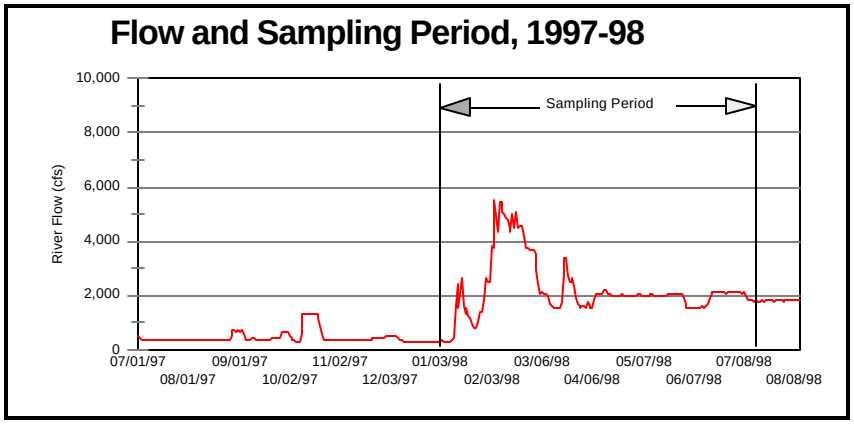
Flow and Sampling Period, 1997-98
River Flow (cfs)
10,000
8,000
6,000
4,000
2,000
0
Sampling Period
07/01/97
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03/06/98
05/07/98
07/08/98
08/01/97
10/02/97
12/03/97
02/03/98
04/06/98
06/07/98
08/08/98

Figure 3. Outmigration sampling period in relation to Stanislaus River flow at OBB during 1996, 1997, and 1998.

The traps were cleaned after all fish were recorded. When the river was carrying a high debris load, it was often necessary to clean the traps again in the afternoon to clear away debris accumulated against the funnel walls and in the liveboxes. Debris levels varied with changes in flow and weather conditions.

Smolt Appearance Rating

We recorded the external appearance of smolting characteristics for each chinook and rainbow trout/steelhead measured. Smolting appearance was rated on a scale of 1 to 3, with 1 an obvious fry (no scales, highly visible parr marks), and 3 an obvious smolt (silvery appearance, easily shed scales, blackened fin tips).

TRAP EFFICIENCY TESTS

Release Groups

Twenty one groups of marked chinook salmon (17 hatchery, 4 natural) were released to estimate trap efficiency (3 day, 18 night). The CDFG supplied the hatchery fish from the Merced River Fish Facility (MRFF). All efficiency groups were released at the same site used in 1996 and 1997 (1/4 mile upstream of the traps) with the exception of two groups that were released at new efficiency sites. The group designated C18 was released approximately 1/4 mile upstream from the standard site and the group designated C21 was released halfway between the standard release site and the traps. All groups were marked and held at our marking facility on the Stanislaus River near Oakdale until they were transported to their release sites the day prior to release. The number of fish in each group ranged from 656 to 3,820.

Trap efficiency was also tested using lemons to represent neutrally buoyant objects. Two lemon tests were conducted April 18 and May 10 in conjunction with releases of marked fish.

Holding Facility and Transport Method

Test fish for mark-recapture experiments were marked and held near Oakdale. Fish were held in net pens measuring 4 ft x 4 ft x 4 ft and 2 ft x 3 ft x 3 ft. The net pens consisted of 3/16 in. Delta mesh sewn onto frames constructed of ½ in. PVC pipe, which was drilled with small holes allowing it to fill with water so the pen would sink and rest on the river bottom. The net pens were locked inside a partially submerged chain-link dog kennel in an area of low water velocity to protect fish from predators and human disturbance. A tarp was placed over the top of the kennel to shade the pens. The fish were transported in a 200 gallon insulated aluminum transport tank and transferred to free standing net pens. The net pens were located at the release location so fish would not have to be moved at the time of release. Towels were placed on top of the nets to provide shade.

Marking Procedure

Juvenile chinook were marked by cold-brand or dye inoculation. Before marking, fish were anesthetized with MS-222 (Schoettger and Steucke 1970). Once anesthetized, the appropriate mark was applied. Fish were cold-branded by freezing a branding stick in a thermos of liquid nitrogen. Fish were placed into a PVC slide and the freeze brand was applied by placing the tip of the branding tool against the front/rear, right/left section of the body of the fish. Minimal pressure was applied for approximately 2 seconds. Each fish received only one mark. Fish were dye inoculated by placing the tip of the MadaJet against the caudal (top or bottom lobe), dorsal or anal fin (Hart and Pitcher 1969). Minimal pressure was applied as dye was injected into the fin rays. One mark was applied to each fish, and all

fish in a group received the same mark. Location of the mark was varied between groups so that each group could be uniquely identified. The dyes used were Alcian Blue and Alcian Green (Sigma Chemical Company, St. Louis, Missouri), chosen because they were known to provide a highly visible, long lasting mark.

Prerelease Sampling

Marked fish were sampled for mean length and mark retention. Fifty fish were randomly selected from each distinctly marked group and anesthetized. Mark retention was rated as present or absent. If any of these 50 were found to have no mark, an additional 50 fish were sampled. The proportion of fish found to have clear marks in each group was used to estimate the actual number of fish released using the following expression:

number released = proportion mark retention * number in group.

Release Procedure

Fish were released directly from the net pens in which they were held. A dip net was used to remove and release about 50 fish per minute. The time required to release each marked group ranged from 15 to 75 minutes. This release procedure was similar to the procedure used in 1996 and 1997. The gradual release of fish was intended to prevent the fish from behaving as a single school by dispersing them in time and space, to mimic the distribution of natural migrants. In 1996 and 1997, release of each mark group was separated by 15 minutes. In 1998, some mark groups (May 10, May 18) were released simultaneously. Also in 1998, groups were counted during prerelease sampling or during release to obtain the total number released, instead of simply subtracting mortalities from the total number marked, as was done in 1996 and 1997. These counts allowed for more accurate release numbers.

Fyke Net Sampling

To further evaluate screw trap efficiency rates and day/night movement of juveniles, fyke nets were deployed approximately 125 yards downstream of the screw traps for one day during the sampling period in 1998. The 150 ft long, 10 ft tall wing panels were constructed by connecting smaller 5 ft tall panels which ranged from 25-100 ft in length. The panels were first connected by zip-ties which did not hold during the first field test. The panels were then stitched together with 1/4 inch nylon rope.

Due to high flows, water velocities across the channel made it impossible to sample the entire river using fyke nets. Water velocities were high enough that the nets began to tear. To prevent the destruction of the nets, we reduced the cross-sectional area we were trying to sample, such that the nets only extended out about 10 ft from each bank. The two fyke nets sampled April 18 at a river flow of 1,996 cfs. Two groups of marked chinook (1 day, 1 night) were released approximately 1/4 mile upstream of the nets to estimate their efficiency. No fish were recaptured from either group. Due to its inefficiency, this sampling method was dropped, and is not discussed in the "RESULTS" section of this report.

MONITORING OF ENVIRONMENTAL FACTORS

Flow Measurements

Daily flow in the Stanislaus River was obtained from the California Data Exchange Center (CDEC). All flows cited in this report were measured at the Orange Blossom Bridge gage by the US Geological Survey (USGS). The flow data are daily means; instantaneous flows during freshets were higher. Depth-velocity profiles were taken in front of the traps.

Water velocity entering the traps was measured each day with a Global Flow Probe, manufactured by Global Water (Fair Oaks, CA). Daily average trap rotation speed for each trap was also recorded by measuring the time, in seconds, for three contiguous revolutions every morning. The average time per revolution for each trap was then calculated.

Water Temperature and Turbidity

Daily water temperature was measured with a mercury thermometer at the trap site. An Onset StowAway recording thermograph was also installed to record water temperature once per hour throughout the sampling season. Daily mean temperature was derived by averaging the hourly measurements.

Turbidity was measured each day with a LaMotte turbidity meter, Model 2008. A water sample was collected each morning and later tested at the field station. Turbidity was recorded in Nephelometric Turbidity Units (NTU's).

OAKDALE TRAPPING SITE

Rotary-screw trap sampling was conducted by S.P. Cramer and Associates under a separate contract at an upstream site near Oakdale site (RM 40.1) between January 26 and July 15.

STATISTICAL CONSIDERATIONS

The model used in this report to estimate smolt outmigration was independently developed by Doug Neeley of International Statistical Training and Technical Services. A complete report, including the model used to estimate smolt outmigration and statistical

reasoning, is contained in Appendix A. Excerpts from Appendix A are used in the body of this report.

RESULTS

OBJECTIVE 1: ESTIMATE THE NUMBER OF CHINOOK SALMON MIGRATING OUT OF THE STANISLAUS RIVER IN 1998

During the preparation of this report, Objective 1 was expanded to include a re-analysis of the 1996 and 1997 outmigration data. Additional trap efficiency tests in 1998, and the refinement of statistical procedures used to estimate the number of chinook passing Caswell each day of the sampling period, enabled us to make more precise passage estimates than those made in 1996 and 1997, as described in the following report sections. Table 2 summarizes results for the 1996-1998 trapping seasons.

Table 2. Summary of 1996-1998 trapping seasons.

Year	Period Sampled	Number of Days Sampled	Trap Catch		Total Catch	Total Est. Outmigration
			North	South		
1996	Feb 5 - Jul 2	142	795	1,673	2,468	95,000
1997	Mar 19 - Jun 27	98	408	1,949	2,357	54,000
1998	Jan 29 - Jul 16	150	3,049	16,845	19,894*	651,000

* Total catch for 1998 excludes catches on two days (9 fish total) in early January that are not included in the calculation of the total outmigration index

Trap Catches of Chinook Salmon

From January 29 to July 16 1998[1], we captured a total of 19,894 juvenile chinook in the screw traps compared to 2,468 in 1996 (Demko and Cramer 1997) and 2,357 in 1997(Demko and Cramer 1998) (Table 2). The south trap consistently captured more juvenile chinook (16,845) than the north trap (3,049) (Table 2), which also occurred in 1996 and 1997 (Demko and Cramer, 1997).

The traps operated 150 days of the 169 possible sampling days (beginning January 29), although catches were sometimes compromised due to fouling of the traps with debris.

Trap Efficiency Estimates

Twenty-one efficiency test releases were made on 7 days during the months of March, April, May, and June, 1998 (Table 3). A total of 17 groups of marked hatchery chinook and four groups of marked natural chinook were released about 1/4 mile upstream of the traps. Three releases took place during the day and the remainder after dark. Capture efficiency ranged from 0.03% - 4.90%.

[1] In 1998, counts were made on January 8, 9, 11, and 12 ; however, the period to the next count (January 29) was so long that the counts could not be used in estimating the cumulative count and its standard error. Leaving out these early counts had an unknown, but believed minimal effect on cumulative estimates since the total counts from these days were small: 6 on January 8, 0 on January 9, 0 on January 11, and 3 on January 12.

Table 3. Release data for all fish and neutrally buoyant objects (i.e. lemons) in 1998 trap efficiency tests.

Release Code	Release Date	Release Time	Release Stock	Release Number	Number Recaptured	Percent Recaptured
C 1	14-Mar	Night	Hatchery	1,033	35	3.4%
C 2	14-Mar	Night	Natural	2,149	101	4.7%
C 3	14-Mar	Night	Hatchery	1,049	45	4.3%
C 4	25-Mar	Night	Hatchery	1,128	32	2.8%
C 5	25-Mar	Night	Natural	877	43	4.9%
C 6	25-Mar	Night	Hatchery	1,254	34	2.7%
C 7	18-Apr	Day	Lemons	500	181	36.2%
C 8	18-Apr	Day	Natural	972	12	1.2%
C 9	18-Apr	Day	Hatchery	3,782	4	0.1%
C 10	18-Apr	Night	Hatchery	988	15	1.5%
C 11	18-Apr	Night	Hatchery	995	26	2.6%
C 12	10-May	Day	Lemons	230	84	36.5%
C 13	10-May	Day	Hatchery	2,943	1	0.0%
C 14	10-May	Night	Hatchery	649	4	0.6%
C 15	10-May	Night	Hatchery	1,009	8	0.8%
C 16	18-May	Night	Hatchery	1,020	31	3.0%
C 17	18-May	Night	Natural	1,102	16	1.5%
C 18*	04-Jun	Night	Hatchery	826	13	1.6%
C 19	04-Jun	Night	Hatchery	1,079	16	1.5%
C 20	04-Jun	Night	Hatchery	1,044	15	1.4%
C 21*	04-Jun	Night	Hatchery	1,003	20	2.0%
C 22	12-Jun	Night	Hatchery	791	6	0.8%
C 23	12-Jun	Night	Hatchery	1,000	4	0.4%

* These groups were not released from the standard efficiency site. C18 = 1/4 mile above standard, C21 = halfway between standard and traps.

Capture Efficiency Model

The daily outmigration index was calculated by dividing the number of chinook captured at Caswell each day by the predicted daily trap efficiency (proportion of released fish that were later recaptured):

$$\text{Outmigration Index} = \frac{\text{Count}}{\text{Efficiency}}$$

Daily counts from the two screw traps, referred to as the north and south traps, were available from February 6 through July 1, 1996[2], from March 19 through June 27, 1997, and from January 29 to July 16, 1998 (hereafter referred to as passage days). On 17 days during these monitoring periods for the 3 years combined, a total of 39 uniquely marked releases[2] were made at a fixed distance upstream from the Caswell screw traps for the purpose of estimating trap efficiency.

Trap efficiency releases were made in the same location, using the same release procedures, and within similar flow ranges in all years. Similarities between years allowed us to combine the efficiency test data for all 3 years in order to obtain the most accurate predictive relationship for trap efficiency. Combining data from all years also enabled better estimation of efficiency rates for time periods when tests were not conducted. It was assumed that capture efficiency rates varied similarly between years in relation to environmental variables.

Developing the 1998 Model

In order to predict the efficiency for each passage day, the efficiency estimates had to be related as a response (dependent variable) to predictor(s) (independent variables) that were measured every day the screw traps were operating. The predictor variables explored were flow (f) (in cubic feet per second, cfs) measured at OBB, fish size (s) (in millimeters, mm), and turbidity (t)(in nephelometric turbidity units, ntu). Efficiency (e), the proportion of released fish trapped per release, was related to the predictor variables using the logistic relation:

[2] The number of efficiency releases were: In 1996, 1 on Feb 14, 1 on Feb 19, 1 on March 22, 4 on April 6, 2 on May 2, 2 on May 10, 2 on May 26, and 2 on June 10; in 1997, 1 over a period from April 7 through 11 (denoted as April 9, mid-point day) and 4 releases on the night of May 28/29; and in 1998, 3 on March 14, 3 on March 25, 4 on April 18, 3 on May 10, 2 on May 18, 2 on June 4, and 2 on June 12. Of the 39 releases, 5 were day-time and 34 were night-time releases.

$$efficiency\ (e) = \frac{1}{1 + \exp^{[-b(0) - b(f)*f - b(s)*s - b(t)*t]}}$$

or, using the "logit" linear transform,

$$logit\ (e) = \ln\left[\frac{e}{1 - e}\right] = b(0) + b(f)*f + b(s)*s + b(t)*t + b(s)*s$$

In the above equations "exp" is the exponential function, "ln" is the natural log, "b(0)" is a coefficient associated with the intercept[3], and b(f), b(s), and b(t) are partial logistic regression coefficients relating the logit transform of efficiency to the indicated predictor variables. A major reason for choosing the logistic model is that the predicted efficiency can never be less than 0 and can never exceed 1 (100%). The logistic regression used here assumes that the underlying distribution of the number of captured fish is binomial when the model is accurate. Adjustments had to be made to the standard errors, variances, and covariances of the estimated coefficients because the residuals were not binomially distributed. Adjustment procedures are discussed in Appendix A.

Several changes were made when developing the models during 1998. The evaluated model for 1998 differed from that presented in 1996 and 1997 reports in three major ways:

1. Fish size was evaluated as a predictor variable. Flow and turbidity, but not fish size, were included as predictor variables in previous years. The original analysis of the 1996 data indicated that fish size did not increase the precision of the predictor, and that conclusion was not re-examined in 1997. However, a larger number of early

[3] Intercept value = $1/\{1+\exp^{-b(0)}\}$ when f = s = t = 0.

outmigrating fish were encountered in 1998, and inclusion of fish size resulted in a significant and substantial increase in precision of the 1998 predictor.

2. In this year's analysis, turbidity was only included when it exceeded 10 NTU. There was no turbidity threshold incorporated into previous years' analyses.

3. Day-time releases were not used to fit the data. In 1996, only two day-time releases were made, and both were made on the same day. In previous years' reports, these release data were included in the fit with those of the night-time releases. Three additional daytime releases, each on a different day, were made in 1998. Based on the large difference between daytime and night-time recovery rates, it was decided to exclude all five daytime releases from the fit, leaving 34 data points from all years. The reason for the day-release exclusion is discussed later.

Although we combined data from the two traps before calculating trap efficiency, we observed differences in the catches of the two traps. The number of fish caught in the north trap was significantly less than that in the south trap during 1998 ($P < 0.0001$, Table 4), similar to previous years. Additionally, the south trap tended to catch larger fry and parr (35-80 mm) ($P = 0.0016$) than the north trap, but the north trap tended to catch larger smolts (>80 mm) ($P = 0.0038$, Table 4). This switch in size bias as the fish grew larger suggests that fish of different sizes prefer different positions horizontally across the channel. The existence of such a size gradient indicates that sampling with multiple traps across the channel provides a more representative sample of all migrants than would a single trap at the Caswell site.

Table 4. Capture number and mean lengths of fish in north and south traps in 1998.

Period		Number Caught			Mean Lengths of Fish					
					North Trap		South Trap			
Beginning Date	Ending Date	North Trap c(N)	South Trap c(S)	Difference in logs {ln[c(N)-c(S)]}	Mean {m(N)}	(sample size)	Mean {m(S)}	(sample size)	Difference in means {m(N)-m(S)}	Weight for mean comparisons
01/08/98	01/28/98	4	5	-0.0969	34.25	4	35.8	5	-1.55	4
01/29/98	02/04/98	707	1993	-0.4501	35.74	224	36.39	180	-0.65	200
02/05/98	02/11/98	138	1042	-0.878	35.94	51	35.36	50	0.58	50
02/12/98	02/18/98	532	5034	-0.976	36.1	290	37.99	345	-1.89	315
02/19/98	02/25/98	198	1625	-0.9142	35.44	198	37.14	357	-1.7	255
02/26/98	03/04/98	161	630	-0.5925	37.09	161	39.42	327	-2.32	216
03/05/98	03/11/98	237	865	-0.5623	47.25	217	51.04	460	-3.79	295
03/12/98	03/18/98	151	790	-0.7187	50.45	141	53.74	396	-3.29	208
03/19/98	03/25/98	35	132	-0.5765	59.85	32	63.14	132	-3.29	52
03/26/98	04/01/98	124	976	-0.896	63.54	85	65.11	392	-1.56	140
04/02/98	04/08/98	125	1174	-0.9728	68.03	124	67	330	1.03	180
		Mean of difference in log counts =		-0.6940			Weighted[1] Mean =		-1.9022	
		Standard Error =		0.08193			Standard Error =		0.4449	
		t-Ratio (10 d.f.) =		-8.47			t-Ratio (10 d.f.) =		-4.28	
		Computed Type I Error Probability =		<0.0001			Computed Type I Error Probability =		0.0016	
04/09/98	04/15/98	38	305	-0.9045	71.05	38	72.27	264	-1.21	66
04/16/98	04/22/98	53	143	-0.4311	78.94	53	78.8	142	0.14	77
04/23/98	04/29/98	74	241	-0.5128	82.34	73	80.73	228	1.62	111
04/30/98	05/06/98	86	383	-0.6487	85.09	86	83.58	310	1.51	135
05/07/98	05/13/98	86	251	-0.4652	88.14	86	86.53	196	1.61	120
05/14/98	05/20/98	151	672	-0.6484	87.16	134	85.96	373	1.2	197
05/21/98	05/27/98	74	216	-0.4652	89.66	74	85.9	209	3.76	109
05/28/98	06/03/98	32	188	-0.769	92.03	32	89.72	188	2.31	55
06/04/98	06/10/98	21	125	-0.7747	94.05	21	93.39	116	0.66	36
06/11/98	06/17/98	24	49	-0.31	96.18	23	93.86	49	2.32	31
06/18/98	07/03/98	2	11	-0.7404	98.5	2	102.82	11	-4.32	3
		Mean of difference in log counts =		-0.6063			Weighted[1] Mean =		1.4481	
		Standard Error =		0.05497			Standard Error =		0.3865	
		t-Ratio (10 d.f.) =		-11.03			t-Ratio (10 d.f.) =		3.75	
		Computed Type I Error Probability =		<0.0001			Computed Type I Error Probability =		0.0038	

[1] Weights are harmonic means of the number of north- and south-trapped fish measured, 2/[1/n(N)+1/n(S)],to account fo differences in sample numbers within and among pairs

Recoveries of marked fish from efficiency tests also showed evidence of size differences in vulnerability to capture by the traps. There was no consistent difference in fish size between the marked fish that were released and those that were recovered when fish size was under 70 mm (Table 5). However, once the marked fish averaged over 70 mm, the mean lengths of recovered fish tended to be less than those of the fish released (Table 5). This indicates that the largest fish in each group were better able to avoid the traps, once the fish were over 70 mm fork length. This is a logical result, because swimming ability of juvenile

chinook increases with size. This size bias is adjusted for in our efficiency model by the inclusion of fish size as one of the predictor variables.

Table 5. Comparison of lengths of fish at release and recovery in 1998.

			Lengths of released (rel) and recovered (rec) fish					
			Released Fish		Recovered Fish		Difference	Weight
Date of Release	Fish Stock	Time of Release	Mean Length	(Sample size)	Mean Length	(Sample size)	in mean lengths	for mean comparisons
03/14/98	Hatchery	Night	55.2	50	54.1	35	1.1	41
03/14/98	Natural	Night	36.2	50	37.3	101	-1.1	67
03/14/98	Hatchery	Night	55.1	50	53.6	45	1.5	47
03/25/98	Hatchery	Night	41.1	50	41.8	32	-0.7	39
03/25/98	Natural	Night	52.4	50	48.1	43	4.3	46
03/25/98	Hatchery	Night	41.2	50	42.1	34	-0.9	40
04/18/98	Natural	Day	65.6	50	66	12	-0.4	19
04/18/98	Hatchery	Day	75.3	50	70.7	4	4.6	7
04/18/98	Hatchery	Night	74.6	50	70.3	15	4.3	23
04/18/98	Hatchery	Night	75.1	50	73.7	26	1.4	34
05/10/98	Hatchery	Day	87.7	50	83	1	4.7	2
05/10/98	Hatchery	Night	87.4	50	84.5	4	2.9	7
05/10/98	Hatchery	Night	86.4	50	86.3	8	0.1	14
05/18/98	Hatchery	Night	88.2	50	86.9	31	1.3	38
05/18/98	Natural	Night	88.8	50	83.6	16	5.2	24
06/04/98	Hatchery	Night	100.5	50	98.4	16	2.1	24
06/04/98	Hatchery	Night	98.6	50	97.7	15	0.9	23
06/12/98	Hatchery	Night	102.8	50	104.8	6	-2	11
06/12/98	Hatchery	Night	102.8	50	95.3	4	7.5	7
						Weighted[1] mean difference =	1.288	
						Standard error =	0.503	
						t-ratio (18 d.f.) =	2.56	
						Computed Type I Error probability =	0.0197	

[1] Weights are harmonic means of the number of released and recovered fish measured, 2/[1/n(rel)+1/n(rec)], to account for differences in sample numbers within and among pairs

Model Selection

The full model used to expand counts into daily estimates of total outmigrants included flow, fish-size, and turbidity coefficients for both the 1998 and the pooled 1996-1997 predictors (Appendix A). The signs of these coefficients indicated that, as flow increased, trap efficiency tended to decrease, and as the size of fish increased, trap efficiency tended

to decrease. The turbidity coefficient applied only when turbidity was 10 NTU or greater, otherwise turbidity was not used as a predictor. The positive turbidity coefficient indicated that as the turbidity increased above the threshold value of 10 NTU, trap efficiency increased. Given the models, we were able to substitute a given day's values of the predictor variables into the relationship to estimate the day's efficiency.

The coefficients for the 1998 data and the 1996/1997 data were fit separately, but the measure of variation (deviance) and the degrees of freedom were pooled (Appendix A). Flow did not make a significant contribution to the 1998 predictor, nor did turbidity. Turbidity was not significant because there were no turbidities at or above the threshold value of 10 NTU[4] in 1998 on days when efficiency releases were made. However, 10 NTU was exceeded on other days in the 1998 outmigration season, so the turbidity coefficient from 1996/1997 was used for those days. Both flow and turbidity contributed significantly to the 1996-1997 predictor, but fish size made no significant contribution to the 1996-1997 predictor. However, fish size made a significant contribution to the 1998 predictor.

Even though the coefficients were not consistently significantly different than zero over the two sets of years (1996/1997 and 1998), they were the same sign, so the decision was made to use the full model to avoid bias. Bias was possible because the within-year ranges of the predictor variables when releases were made were not representative of the within-year ranges for the whole of the outmigration. The coefficient estimates for both the full model and the reduced model (non-statistically significant predictor variables omitted) are presented in Appendix A.

Trap Efficiency Variables

[4]The threshold of 10 NTU means that turbidity less than this value had no effect, but turbidities above this threshold influence trap efficiency.

Day and Night Comparisons

On April 6, 1996 and on April 18 and May 10, 1998, there were day and night-time releases of marked fish. Efficiencies of day-time releases were generally near zero, and were significantly less than those of night releases (Appendix A, day efficiency = 0.002 and night efficiency = 0.016, P = 0.0001). The decision was made to drop day releases from the efficiency model, because the day-release efficiency would not have been representative of day passage. There were 9,172 fish released during the four day-time releases, and only two of the 17 were recovered during daytime; the other 15 were captured at night. The estimate would then be primarily an estimate of the proportion of day-released fish trapped at night, and would not be an estimate of day-time efficiency. The resulting night-time predictor of efficiency will likely contribute to an underestimate of day-time passage (expansion of counts by too large an efficiency will underestimate passage). However, detections of radio-tagged smolts in the Stanislaus River as they passed three fixed stations in 1998 confirmed that most fish moved during darkness or dim light (Demko et al. 1998).

Release Point Comparisons

In order to determine whether the release point influenced our estimation of efficiency, two other release points were tested on June 4, 1998: one point approximately ¼ mile upstream of the standard release point, and the other point approximately ¼ mile downstream. On this same day, there were two releases made from the standard release point. The estimated pooled efficiencies from these releases are given in Appendix A. There were no significant or substantial differences in these efficiencies. However, since the non-standard release points were not replicated over release days, they were not included in the logistic regression prediction to predict efficiency.

Trap Efficiency of Fish Compared to Neutrally Buoyant Objects

Data showing large differences in trap efficiency between day and night efficiency tests suggested that juvenile chinook may actively avoid trap capture when light allows visual perception of the trap. To test this, lemons were released at the standard release point, and the proportion of these lemons recaptured in the screw traps was monitored. Trap efficiencies from standard fish releases made on the same day were significantly and substantially less than those for lemons (Appendix A, fish efficiency = 0.01 and lemon efficiency • 0.36, P = 0.0013 for day and P < 0.0001 for night releases). If fish simply followed random surface movement and were not able to avoid the traps, a difference of this magnitude would not be expected.

Negative logit-to-flow coefficients suggest that the response is at least partially associated with the proportion of water entering the trap. However, the fact that 1) more fish are trapped at higher turbidity above a certain threshold, 2) the day-release efficiencies are much lower than night-release efficiencies, and 3) neutrally buoyant objects are more vulnerable to capture than fish suggest that juvenile salmon use visual cues to avoid trap capture.

Natural versus Hatchery Releases

In previous years, both hatchery and natural fish were used, but they were released on different days, precluding paired comparisons. However, in 1998, releases of fish were made from both sources on the same release days. Efficiencies for these paired sets are summarized in Appendix A. There were no significant differences in the efficiency estimates from these sets (Appendix A, pooled natural efficiency = 0.03 and hatchery efficiency = 0.02, P = 0.5).

1996, 1997 and 1998 Outmigration Indices

Interpolation

For some outmigration days, not all predictor variable values were available. Linear extrapolation between the nearest straddling values was used to estimate missing values for flow, fish size, and turbidity. Extrapolation methods for 1998 are different than those used in 1996 and 1997, and are discussed in Appendix A.

On some dates, there were also missing data for fish catch, either because the traps were not fishing or debris resulted in a stoppage. A different method for estimating missing values was used in 1998 and it was used to recompute missing catch values from 1996 and 1997. This method used the weighted mean of the five previous and five subsequent days true count (see Appendix A). Therefore, the missing values presented in Appendix A in this report for 1996 and 1997 will differ somewhat from those presented in previous reports.

Daily Outmigration

The recomputed daily outmigration indices for 1996, 1997, and 1998 are presented in Figure 4. The outmigration index is clearly greater in 1998 than in previous years. However, much of the increase occurred during February in 1998; the trap was not fished in 1997 until March 19. Although the trap sampled similar time frames in 1996 and 1998, sampling in 1997 started March 19 after most of the fry migration was complete. Large numbers of fry emigrated during February in both 1996 and 1998. Thus, meaningful comparisons of outmigrant abundance between years should be limited to similar life stages, such as fry (35-45 mm), parr (45-80 mm), and smolts (>80 mm).

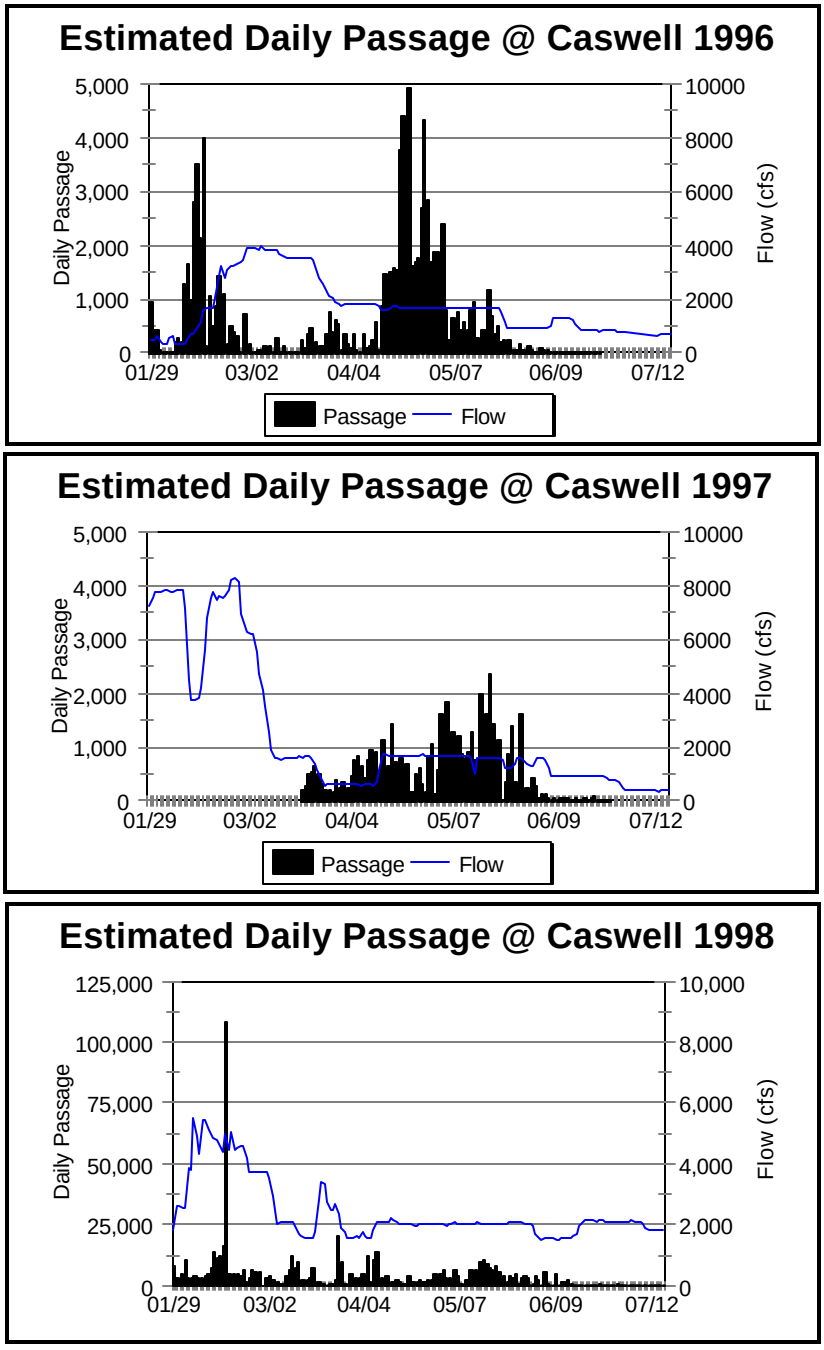


Figure 4. Comparison of 1996,1997, and 1998 outmigration indices.

The following are outmigration indices estimated to the nearest thousand using the full model for 1996, 1997, and 1998 with approximate 95% confidence intervals given in parentheses:

1996: 95,000[5](69,000 - 121,000)

1997: 54,000[6] (41,000 - 66,000)

1998: 651,000 (284,000 - 1,018,000)

We then divided the estimated number of outmigrants in each year into fry, parr and smolt life stages (Table 6). The abundance of all life stages in 1998 remained considerably greater than in 1996 and 1997. In order to divide outmigrants into these categories, we used the first three consecutive days that mean length exceed 45 mm or 80 mm to mark the dividing dates between fry-to-parr and parr-to-smolts, respectively. These criteria appeared to be biologically appropriate, because they were often reached on dates when there was either a sharp change in fish size or a sharp change in outmigrant abundance. The period of smolt outmigration was fully sampled in all three years, and smolt abundance in 1998 was roughly triple that in both 1996 and 1997 (Table 6).

Parr abundance was also sampled in all three years, but sampling started late in 1997 (March 19) when parr were already migrating. Thus, only smolt abundance in 1997 should be compared to other years. The abundance of parr was over 100 times greater in 1998 than in 1996. The low abundance of parr in 1996 was an unique characteristic of that year, which Demko and Cramer (1997) attributed to flows remaining constant at 1,700 - 1,800 cfs from March 29 to May 21.

[5] 1996 estimate was 105,000 in the 1997 report.

[6] 1997 estimate was 47,000 in the 1997 report.

Fry abundance in 1998 was also vastly greater than in 1996, the only other year sampled during the period when the fry life stage predominated (Table 6). Fry were already abundant on the first day of sampling in both 1996 and 1998, so we are uncertain of the total abundance of fry outmigrants in either year.

Table 6. Estimated abundance of chinook fry, parr, and smolts, and their dates of passage at Caswell, 1996 to 1998.

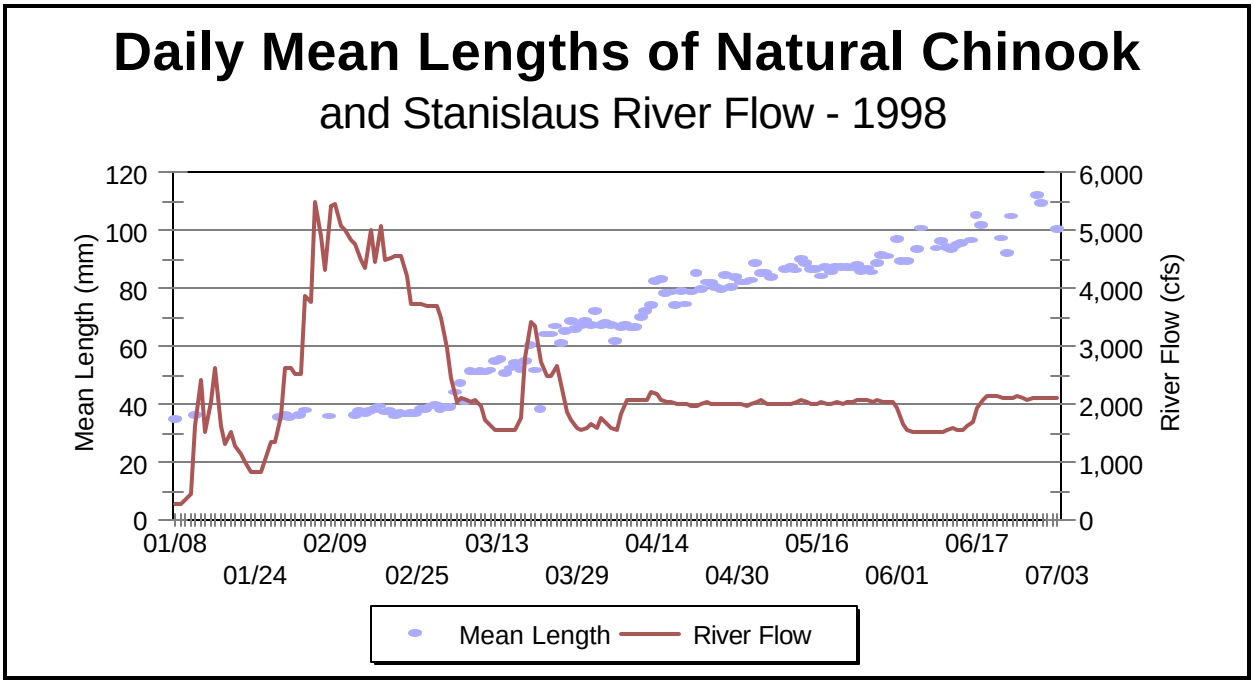
	Fry				Fingerling				Smolt			
			95% Confidence				95% Confidence				95%Confidence	
Year	Dates	Estimate	Interval		Dates	Estimate	Interval		Dates	Estimate	Interval	
1996	2/6-3/20	28,653	9,176	41,830	3/21-3/31	1,465	625	2,305	4/1 - 7/1	65,083	48,172	81,994
1997	-				3/19 - 4/1*	4,724	3,339	6,109	4/2 - 6/27	48,861	37,151	60,571
1998	1/29-3/5	287,801	(49,018)	624,620	3/8 - 4/21	179,448	117,137	241,759	4/22-7/7	183,935	114,651	253,219

* Mean length was already 64.5 mm on the first day of sampling

OBJECTIVE 2: DETERMINE THE SIZE AND SMOLTING CHARACTERISTICS OF JUVENILE CHINOOK SALMON AND RAINBOW TROUT/STEELHEAD MIGRATING OUT OF THE STANISLAUS RIVER

Length at Outmigration

The mean lengths of juvenile chinook gradually increased over the course of sampling, ranging from about 35 mm at the start of sampling (late January) to about 95 mm in mid-June (Figure 5). The gradual increase in mean lengths over time in 1998 was similar to the pattern seen in 1996 and 1997 after the third week of March (Figure 5). Mean lengths were slightly smaller by date in 1998 compared to those in 1996 and 1997 (Figure 5).



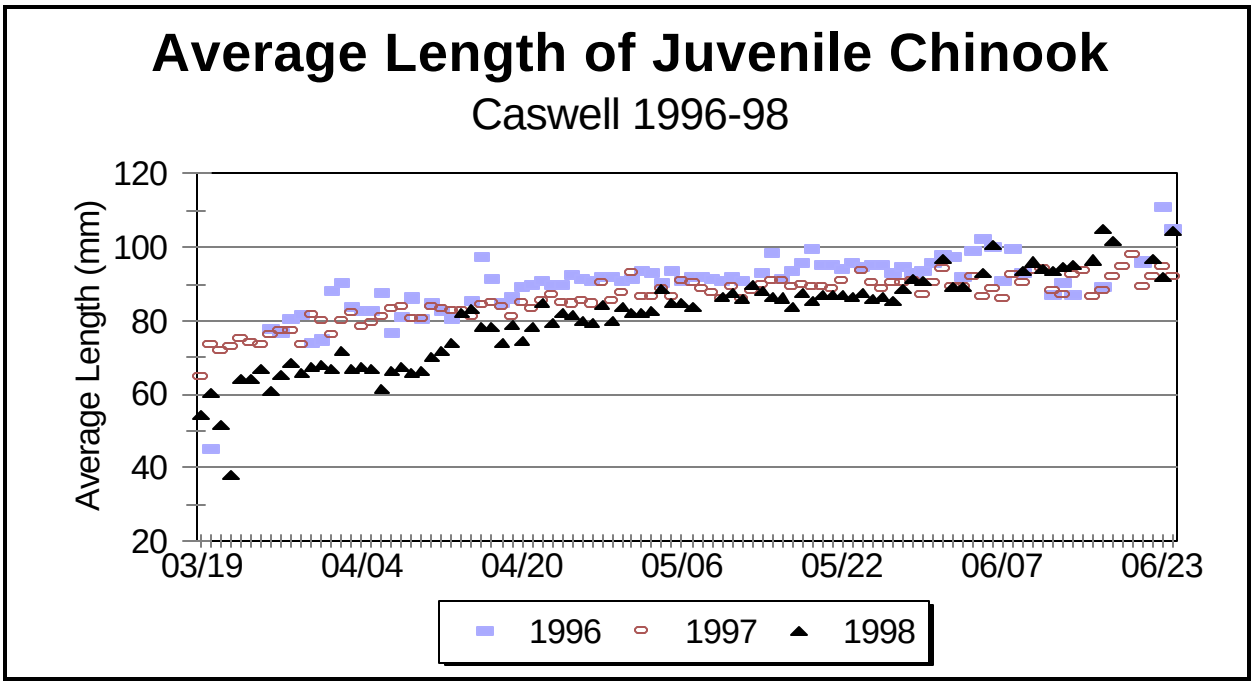
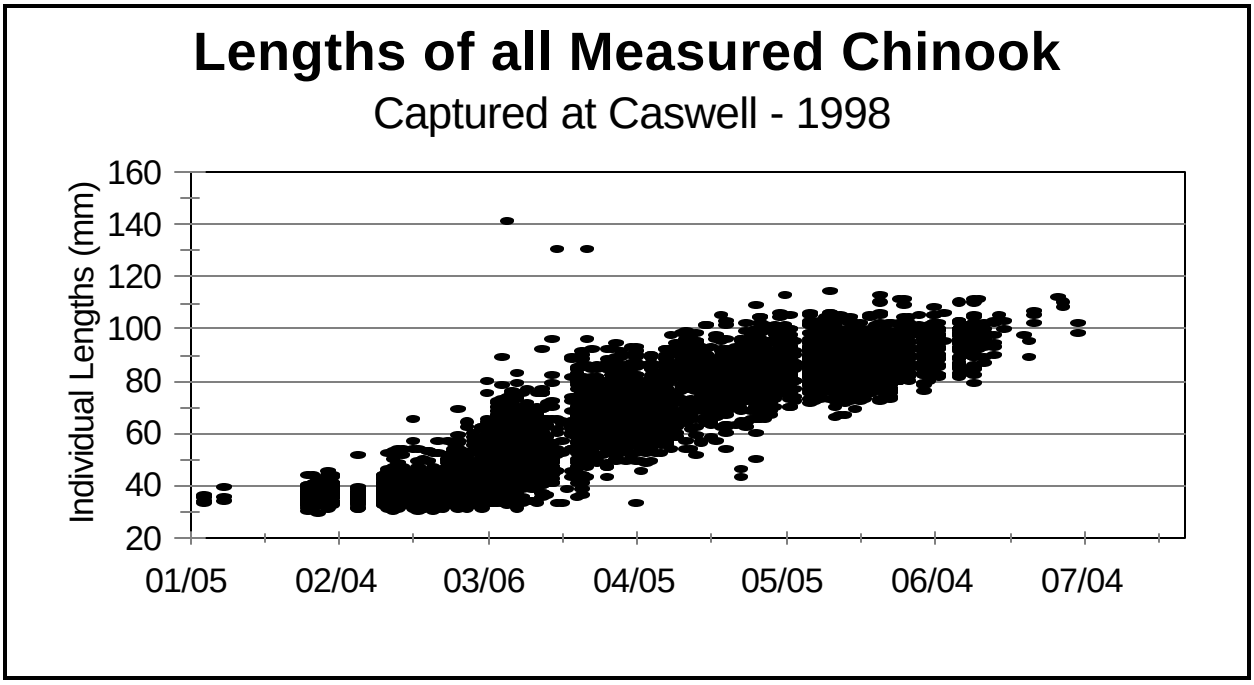


Figure 5. Mean lengths of chinook captured at Caswell in 1996, 1997, and 1998.

Unlike in 1997, we were able to start sampling in late January in 1998 and captured a major portion of the fry outmigration (<45mm). Fry outmigration peaked during February coinciding with high flows produced by heavy winter rains. As indicated by increasing mean lengths, fry emergence ended later in March in 1996 (3/19) than in 1998 (3/5). Increases in mean length in 1998 were more gradual compared to 1996, when mean length increased sharply from 45 mm to ~75 mm in one week.

The length frequency distribution for the 1998 season, developed from measurements of 50 chinook daily, shows a different pattern than in either 1996 or 1997. In both 1996 and 1997, smolt lengths were most frequently 90-99 mm, while in 1998, they were most frequently 80-89 mm (Figure 6). Additionally, chinook in each 10 mm interval from 40 to 79 mm were equally common in 1998, but were uncommon in previous years. Finally, fry < 40 mm were the most common size of migrant in 1998, but not in 1996. Three yearling chinook ranging in size from 130 mm to 141 mm, were also captured in March of 1998, but are not shown in Figure 6.



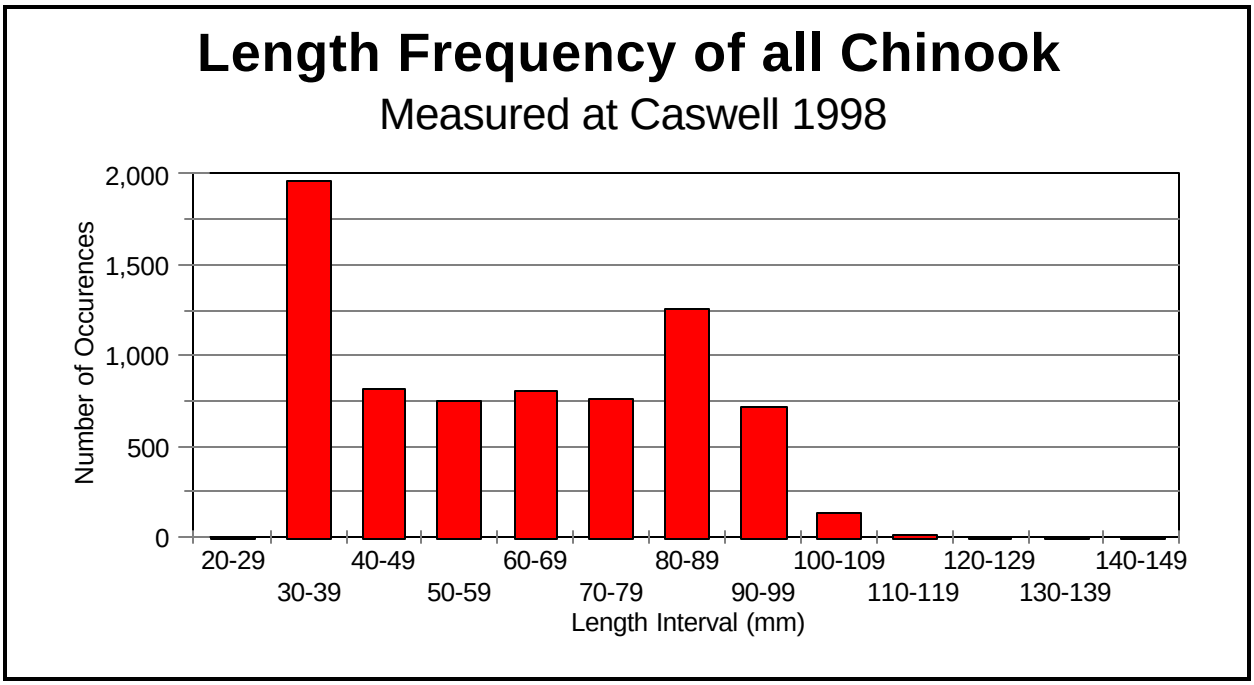


Figure 6. Scatter plot and length-frequency histogram of all chinook measured at Caswell in 1998.

During the sampling season, we captured 4 rainbow trout/steelhead at Caswell, ranging in size from 228 to 299 mm (Figure 7).

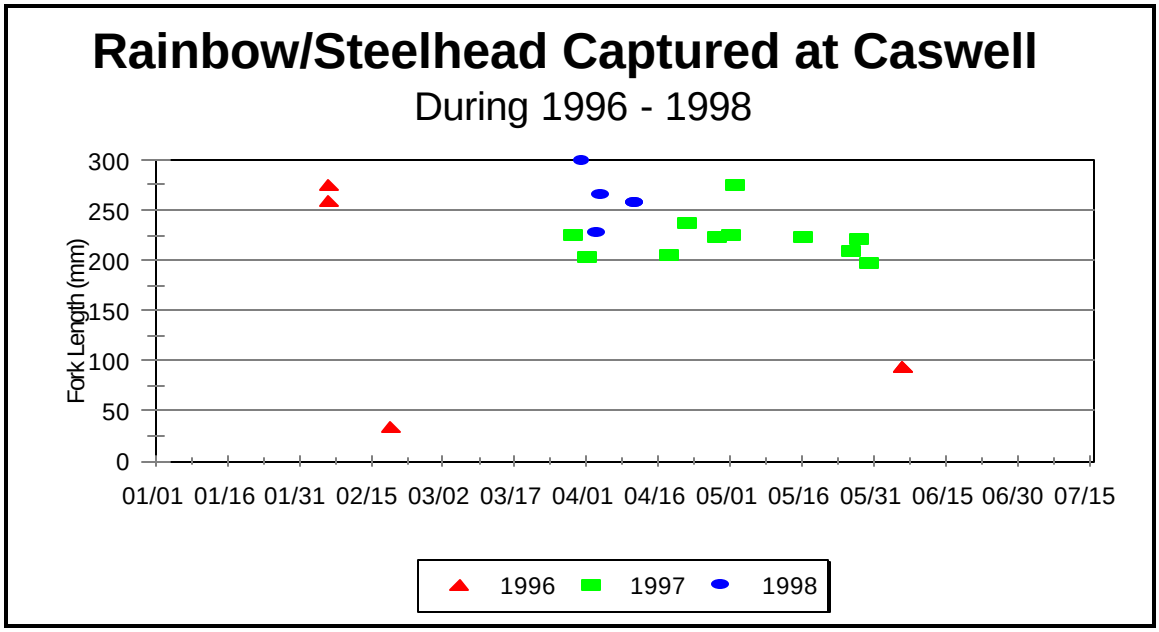
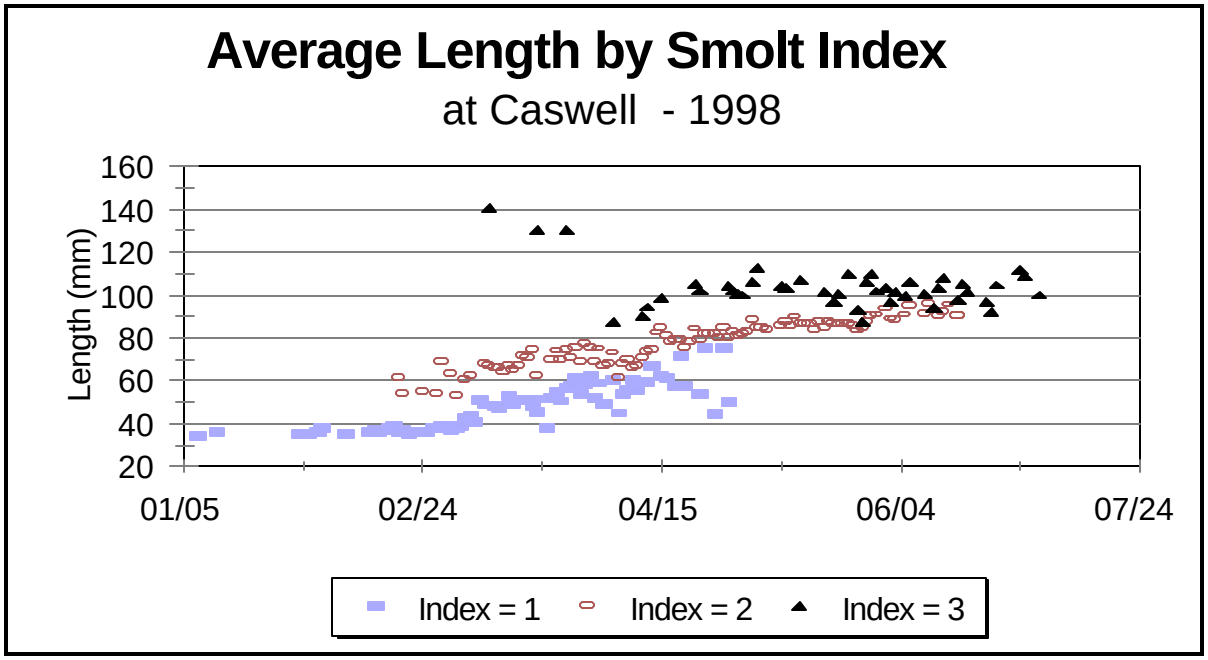


Figure 7. Lengths of all rainbow trout/steelhead captured at Caswell in 1996, 1997, and 1998.

Smolt Appearance Index

The external appearance of smolt characteristics among chinook captured in the traps started to increase at the end of February (Figure 8), when the daily mean smolt index gradually increased from 1 to 2. Individual fish with a score of 2 appeared through late April and ranged up to 75 mm (Figure 8). Fish that appeared intermediated between a parr and smolt appeared from late February to mid-June and ranged in size from 55 to 95 mm. Fish that were distinctly smolts (index = 3) were nearly all over 90 mm and began appearing the second week in April (Figure 8).



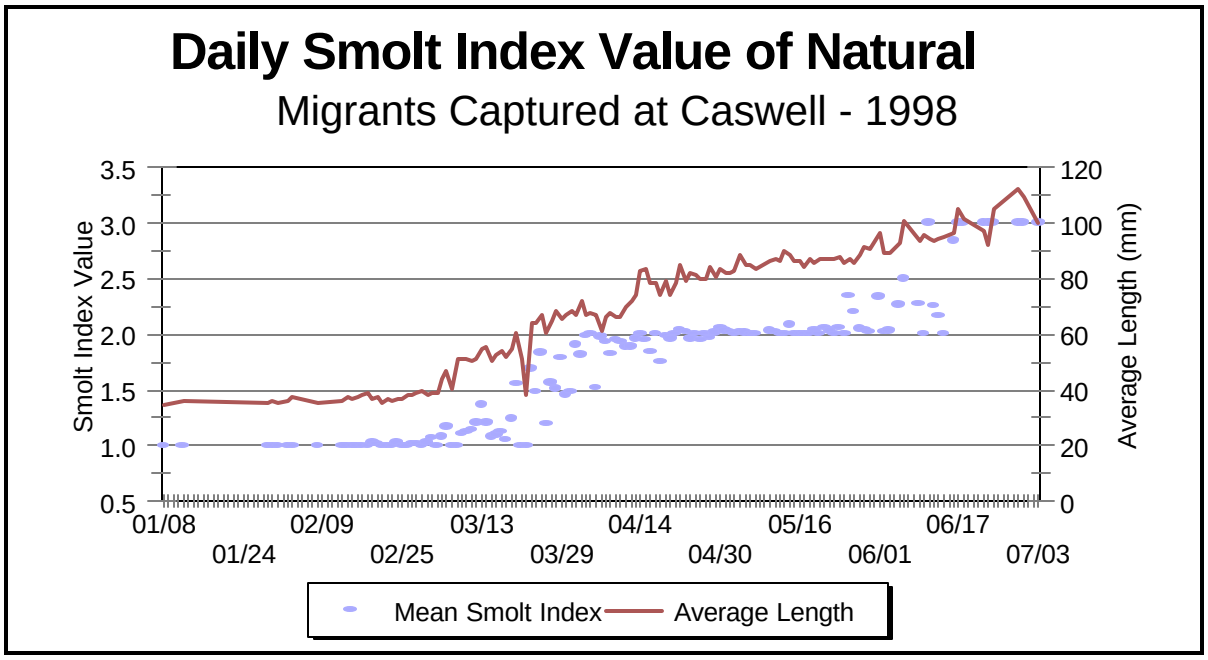


Figure 8. Mean daily smolt index value of natural chinook captured in the Caswell screw traps during 1998, and lengths of juvenile chinook by individual smolt index value .

All rainbow trout/steelhead captured in 1998 showed advanced smolting characteristics and were rated as “3's” in our smolting index. Fish were in the same size range and caught at approximately the same time as rainbow trout/steelhead caught in 1997 (see Figure 7).

OBJECTIVE 3: IDENTIFY FACTORS THAT INFLUENCE THE TIMING , SIZE, AND NUMBER OF JUVENILE CHINOOK SALMON AND RAINBOW TROUT/STEELHEAD MIGRATING OUT OF THE STANISLAUS RIVER

Effect of Streamflow on Chinook Salmon Outmigration

Elevated streamflow corresponded with the peak of chinook fry passage in 1998. Fry passage peaked during extremely high flows in early February. Heavy rains produced by the El Nino winter increased flows to over 4,500 cfs in February. It is not known, however, if elevated flows affected the timing of fry outmigration. It is likely that a portion of the fry outmigration was missed in the early part of January prior to the start of sampling (Figure 9).

Large fluctuations in flow during mid-March through early April may have been responsible for stimulating outmigration of parr (45-80 mm). Flows were stable during this period in 1996 and only 1,464 chinook were estimated to have emigrated as parr. This contrasted sharply with 1998 when over 179,000 chinook were estimated to have migrated as parr during March 8 through April 21. The large emigration of parr in 1998 may also have been stimulated by competition from the high abundance of juveniles. The extent to which resource limitations such as space or food played a role in this contrasting parr migration pattern is unknown. Additional years of rotary screw trap sampling will be needed to evaluate the probable causes for different life history strategies among years.

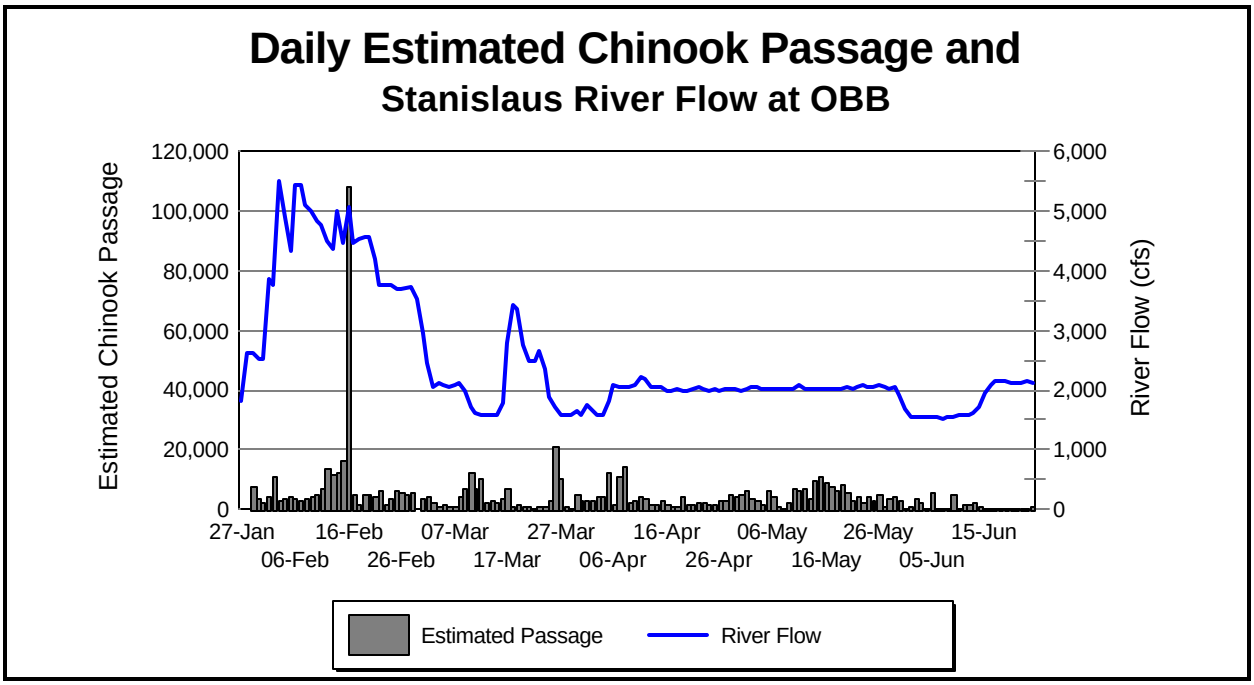


Figure 9. Estimated daily downstream passage of juvenile chinook at Caswell and Stanislaus River flow at Orange Blossom Bridge.

Effect of Turbidity and Temperature on Chinook Salmon Outmigration

Fry passage peaked when turbidity levels were high (over 10 NTU) during February. Small peaks in smolt outmigration occasionally coincided with high turbidity, but not exclusively (Figure 10). The correspondence of fry passage with high turbidity was stronger than that for smolts, but data are not sufficient to evaluate turbidity effects on the timing of fry outmigration.

Temperature increased slowly from 10 C to 17 C during the outmigration period (January-June). Fluctuations in outmigration did not appear to correspond with changes in temperature.

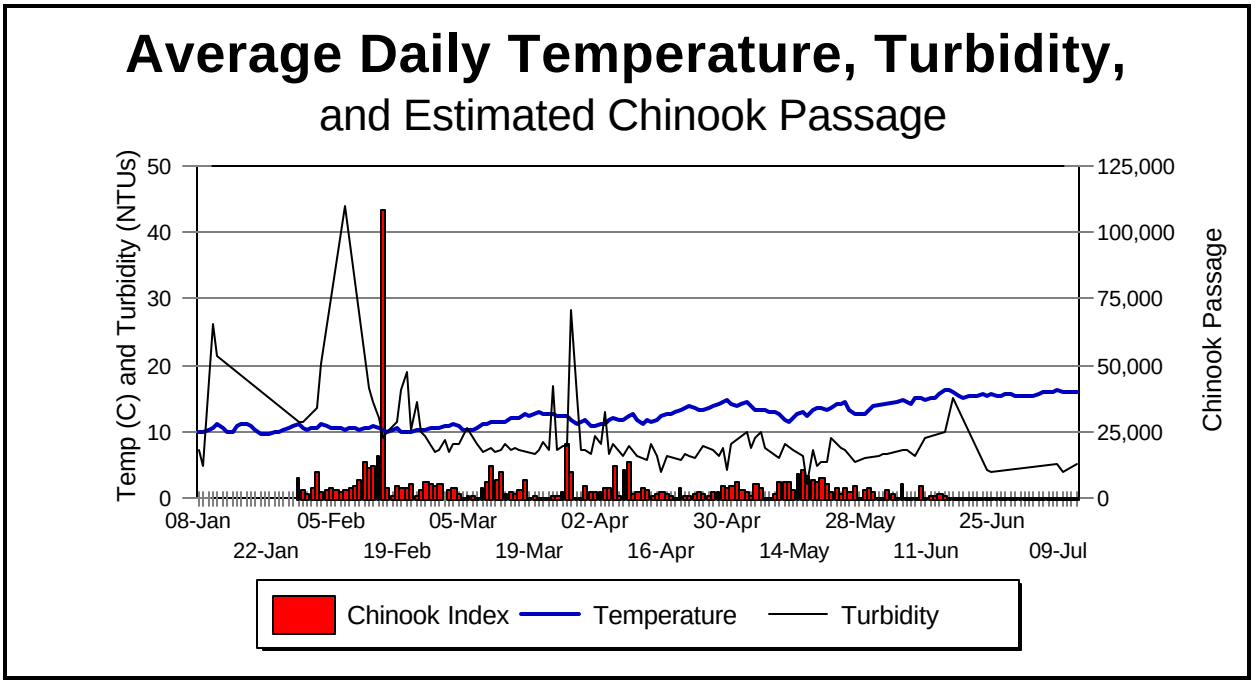


Figure 10. Daily estimated juvenile chinook passage at Caswell, in relation to temperature and turbidity, 1998.

CONCLUSIONS

1. Juvenile chinook passing the Caswell site during the 1998 sampling season were estimated as follows.

   Fry: 287,801 between January 29 and March 7.

   Parr: 179,448 between March 8 and April 21.

   Smolts: 183,935 between April 22 and July 7.

2. The estimated abundance of each life stage of juvenile chinook outmigrant in 1998 was greater than estimated in 1996 and 1997. The 1998 outmigration index for smolts was roughly triple that in either 1996 or 1997. Outmigration of parr (45-80 mm), which was inconsequential in 1996 and 1997, constituted 28% of the outmigrants in 1998. Although abundance of fry in 1998 was about 10-fold greater than in 1996, the only other year in which the fry life stage was sampled, the comparison between years has unknown accuracy, because the full period of fry migration was not sampled.

3. The majority of juvenile chinook outmigrated as fry in 1998. The single daily count of 2,509 on February 16 was expanded to an estimate of 108,109 fry passing on that day, which far exceeded the peak smolt count of 158 on May 15 that expanded to 10,793 smolts.

4. Mean lengths of chinook increased from <40 mm through March 7 up to 100 mm by mid-June. Mean lengths during April and May in 1998 were about 10 mm less than in 1996 and 5 mm less than in 1997.

5. Similar to previous years, several rainbow trout/steelhead were captured during the 1998 season. All showed advanced smolting characteristics indicating that at least a nominal portion of the rainbow trout population express downstream migratory characteristics. Additional investigation is needed to better understand the extent of this life history form.

RECOMMENDATIONS

1. Monitoring of juvenile salmonid outmigration should continue annually at both the Oakdale and Caswell sites to monitor long-term trends in juvenile production and the environmental factors that shape migration patterns in the Stanislaus River.

2. A new trap installation procedure should be evaluated, and implemented, if possible. The current system is ineffective for sampling during the typical high flows in January and February, when a large number of fry may migrate out of the river. An overhead cable system similar to the one used at Oakdale would enable the traps to sample during more high flow days early in the sampling season.

3. Because a significant proportion of juvenile chinook may outmigrate from the lower Stanislaus River as fry or parr, as in 1998, their distribution, habitat use, and survival in the lower Stanislaus River, and in the San Joaquin River and Delta should be investigated.

REFERENCES

Demko, D.B. and S.P. Cramer. 1997. Effects of pulse flows on juvenile chinook migration in the Stanislaus River. Annual Report for 1996. Prepared by S.P. Cramer & Associates, Inc. for Oakdale Irrigation District, Oakdale, CA, and South San Joaquin Irrigation District, Manteca, CA.

Demko, D.B. and S.P. Cramer. 1997. Outmigration trapping of juvenile salmonids in the lower Stanislaus River, Caswell State Park site 1996. Prepared by S.P. Cramer & Associates, Inc. for U.S. Fish and Wildlife Service, Stockton, CA.

Demko, D.B. and S.P. Cramer. 1998. Outmigration trapping of juvenile salmonids in the lower Stanislaus River, Caswell State Park site 1997. Prepared by S.P. Cramer & Associates, Inc. for U.S. Fish and Wildlife Service, Stockton, CA.

Demko, D.B., C. Gemperle, S.P. Cramer and A. Phillips. 1998. Evaluation of juvenile chinook behavior, migration rate and location of mortality in the Stanislaus River through the use of radio tracking. Prepared for Tridam Project.

Hart, P.J.B. and T.J. Pitcher. 1969. Field trials of fish marking using jet inoculator. J. Fish Biol. 1;383-385.

Schoettger, R.A. and E.W. Steucke. 1970. Synergic mixtures of MS-222 and quinaldine as anesthetics for rainbow trout and northern pike. The Progressive Fish-Culturist. Oct. 1970:202-205

APPENDICES

A. Statistical review of 1996 -98 Caswell screw trapping data.

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The daily screw-trap count at Caswell was expanded by dividing it by the predicted daily trapping efficiency (predicted proportion of fish trapped) to estimate the daily outmigration index:

$$\text{outmigration index } (o) = \frac{\text{count } (c)}{\text{efficiency } (e)}$$

Predicted Trapping Efficiency

Daily counts from two screw traps, referred to as the north and south traps, were available from February 6 through July 1, 1996; from March 19 through June 27, 1997; and from January 29 to July 16, 1998[7] (hereafter referred to as passage days). On 17 days during these monitoring periods, a total of 39 uniquely marked releases[8] were made at a fixed distance upriver from Caswell screw traps for the purpose of estimating trapping efficiency. Estimated efficiencies were simply the proportions of the released fish that were later trapped. In order to predict the efficiency for each passage day, the efficiency estimates had to be related as a response or "dependent" variable to predictor or "independent" variables that were measured on every day that the screw traps were operating. Substituting a given day's values of the predictor variables into the predictive relation would then provide an estimate of that day's efficiency.

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7 In 1998, there were counts made on January 9, 11, and 12 ; however, the period to the next count (January 29) was so long that the counts could not be used in estimating the cumulative count and its standard error. Leaving these early assessment day counts out would have had minimal effect on cumulative estimates since the total count from these three early assessment days were small: 0 on January 9, 0 on January 11, and 3 on January 12.

8 The number of standard efficiency releases were: In 1996, 1 on Feb 14, 1 on Feb 19, 1 on March 22, 4 on April 6, 2 on May 2, 2 on May 10, 2 on May 26, and 2 on June 10; in 1997, 1 over a period from April 7 through 11 (denoted as April 9, mid-point day) and 4 releases on the night of May 28/29; and in 1998, 3 on March 14, 3 on March 25, 4 on April 18, 3 on May 10, 2 on May 18, 2 on June 4, and 2 on June 12. Of the 39 releases, 5 were day-time and 34 were night-time releases.

The predictor variables explored were flow (f in cubic feet per second, cfs) measured at Orange Blossom Bridge (OBB), fish size (s in millimeters, mm), and turbidity (t in nephelometric turbidity units, ntu). Efficiency (e), the proportion of released fish trapped per release, was related to the predictor variables using the logistic:

$$efficiency\ (e) = \frac{1}{1 + \exp^{[-b(0) - b(f)*f - b(s)*s - b(t)*t]}}$$

or, using the "logit" linear transform,

$$logit\ (e) = \ln\left[\frac{e}{1 - e}\right] = b(0) + b(f)*f + b(s)*s + b(t)*t + b(s)*s$$

In the above equations "exp" is the exponential function, "ln" is the natural log, "b(0)" is a coefficient associated with the intercept[9], and b(f), b(s), and b(t) are partial logistic regression coefficients relating the logit transform of efficiency to the indicated predictor variables. A major reason for choosing the logistic model is that the predicted efficiency can never be less than 0 and can never exceed 1 (100%). The logistic regression used assumes that the underlying distribution of the number of captured fish is binomial when the model is accurate. Adjustments to the standard errors, variances, and covariances of the estimated coefficients for failure of the residuals to be binomially distributed had to be made, the adjustment procedures being discussed in Appendix A.1.

Model changes from previous reports: The evaluated model differed from that presented in previous reports in three major ways.

1. Fish size was included as a predictor variable. Flow and turbidity, but not fish size, were included as predictor variables in previous reports. The original analysis of the 1996 data indicated that fish size did not increase the precision of the predictor, and since 1997 involved only two release dates, inclusion of additional predictor variables was not explored further that year. However, a larger number of early outmigrating fish were encountered in 1998, and inclusion of fish size resulted in a significant and substantial increase in the 1998 predictor's precision.

2. In this year's analysis, turbidity was only included when it was at least 10 ntu but was excluded when it was less than 10 ntu. There was no turbidity threshold incorporated into previous years' analyses; the whole turbidity domain was included in previous fits.

[9] Intercept value = $1/\{1+\exp^{-b(0)}\}$ when f = s = t = 0.

3. Day-time releases were not used to fit the data. In 1996 only two day-time releases were made, and both were made on the same day. In previous years' reports, these releases' data were included with those of the night-time releases in the fit. Three additional day-time releases were made in 1998, one on one day and two on another, and based on an analysis of the recoveries, it was decided to exclude all five day-time releases from the fit, leaving 34 data points from all years for the fit. The reason for the day-release exclusion is discussed later.

Predictor Variables: For some outmigration days, not all predictor variable values were available. Linearly extrapolated values from the nearest straddling values were used to estimate the missing values of flow, fish size, and turbidity, the extrapolation being based on the number of days separating the missing value from the straddling values. For example, if there was a flow of 1000 cfs on Day 4 and there was a flow of 1200 cfs on Day 9 and if there were no intervening measures, then the missing values for Day 5 through Day 8 would be computed as follows:

Day 4: 1000 (actual)

Missing Value for day i =
[(days from Day j)(Day i value)+(days from Day i)*(Day j value)]/(Day j - Day i)*

Day 5: [(9-5)*1000 + (5-4)*1200]/(9-4) = [4*1000 + 1*1200]/(9-4) = 1040
Day 6: [(9-6)*1000 + (6-4)*1200]/(9-4) = [3*1000 + 2*1200]/(9-4) = 1080
Day 7: [(9-7)*1000 + (7-4)*1200]/(9-4) = [2*1000 + 3*1200]/(9-4) = 1120
Day 8: [(9-8)*1000 + (8-4)*1200]/(9-4) = [1*1000 + 4*1200]/(9-4) = 1160

Day 9: 1200 (actual)

This missing-value-substitution method is different than that used in previous years because there were longer runs of missing values in 1998, especially for turbidity. For consistency, this same method was then used to recompute missing values of flow and turbidity from previous years; therefore, some of the predictor variable values given in this report differ from those given in previous reports.

Response Variable: The trapping efficiency was based on combined recoveries over the north and south trap. Based on log transformations, the number of fish caught in the north trap is significantly less than that in the south trap ($P < 0.0001$, Table A.1). This same tendency held in previous years. There is evidence of a differential size bias between fish trapped in the north and south traps in 1998, and that bias is associated with the actual size of the fish. For fish with average length less than 70 mm (caught before April 9), north-trap fish

tend to be smaller than south-trap fish (P = 0.0016, Table A.1); whereas for fish with average length greater than 70 mm (caught on or after April 9), north-trap fish tend to be larger (P = 0.0038, Table A.1). Based on released fish, there is evidence of size bias of fish entering the traps in 1998, the mean length of recovered fish tending to be smaller than that of released fish (P = 0.0197, Table A.2). The degrees to which these biases might effect the accuracies of predicted efficiency and fish count are unknown.

Selected Model: A formal analytical partitioning of the variability associated with the fit is presented in Appendix A.2. Based on the analysis, it was decided to fit the 1998 data set separately from the 1996 and 1997 sets. This was done because there was a significant difference between the pooled 1996-1997 and the 1998 responses (P = 0.015, Appendix A.2).

It turned out that flow did not make a significant contribution to the 1998 predictor; nor did turbidity, but that may have been because there were no turbidities at or above the threshold values in 1998 on the days when efficiency releases were being made. The threshold value was exceeded in 1998, but this was early in the outmigration season when there were no efficiency releases being made. Both flow and turbidity did significantly contribute to the 1996-1997 predictor, but, as was the case in earlier analyses, fish size made no significant contribution to the 1996-1997 predictor. However, fish size did make a significant contribution to the 1998 predictor.

Table A.3.a presents the full model--the flow, fish-size, and turbidity coefficients for both the 1998 and the pooled 1996-1997 predictors. Although the flow coefficient was not significantly different from 0 for the 1998 data set, the sign of the coefficient is the same (negative) as that for the 1996-97 data set. Similarly, the non-significant fish-size coefficient for the 1996-97 data set is the same sign (negative) as that for the 1998 data set. The negative signs indicate that, as flow increases, the trapping efficiency tends to decrease, and as the size of fish increases, the trapping efficiency tends to decrease. The positive turbidity coefficient indicates that as the turbidity increases above the threshold value, trapping efficiency increases. In Table A.3.a., the 1996-1997 turbidity coefficient is also given as a surrogate for the 1998 coefficient.

Table A.3.b gives the reduced model--reestimated coefficients after removing predictor variables associated with non-significant coefficients in the full model.

Tables A.4.a. and A.4.b. present the predicted values and associated residuals based on the coefficients given in respective Tables A.3.a. and A.3.b. An approximate z-test of residuals (Pearson's standardized residuals) based on the binomial indicates that 26% of the standardized residuals from Table A.4.a and 44% of the standardized distribution residuals from Table A.4.b have absolute values exceeding 1.96. If the distributions around the fit were actually binomial, then only approximately 5% of the standardized residuals' absolute values

would be expected to exceed 1.96. Other evidence exists, and is discussed in Appendix A.1, that the data are not binomially distributed. Because of the failure of the binomial to hold, adjustments to estimated standard errors, variances and covariances had to made. The method of adjustment is discussed in Appendix A.1. The adjusted standard errors and variances are the ones given in Tables A.3.a. and A.3.b.

The standard error of the outmigration index proved to be so large that we decided to partition the outmigration according to size at the date of outmigration to get more precise estimates within some of the size groups. The size groupings, referred to as fry, fingerling, and smolt, are defined below with corresponding dates of passage for the respective size groupings.

	Approximate Size Range (mm)	1996 Date Domain		1997 Date Domain		1998 Date Domain	
Fry	less than 45	02/06/96	03/20/96	no data		01/29/98	03/07/98
Fingerlings	45 - 80	03/21/96	03/31/96	03/19/97	04/01/97	03/08/98	04/21/98
Smolt	more than 80	04/01/96	06/16/96	04/02/97	06/27/97	04/22/98	07/07/98

For the 1998 model, the difference between fingerling and fry as one group and smolt as another group accounted for most of the reduced model's size predictor variable (model given in Table A.3.b). The modified reduced model applied to the three groups is given in Table A.3.c., the size predictor being omitted for the 1998 predictor.

It is likely that flow, fish size, and turbidity did affect trapping efficiency in all years. Therefore, since all of the coefficients in the full model (Table A.3.a) were of the right sign even though they were not all significantly different than zero, the full model was used for expanding counts to obtain outmigration estimates.

Table A.1. Capture number and mean lengths (mm) of fish trapped in north and south screw traps at Caswell, 1997.

Period		Number Caught			Mean Lengths of Fish					
				Difference	North Trap		South Trap		Difference	Weight
Beginning Date	Ending Date	North Trap c(N)	South Trap c(S)	in logs {ln[c(N)-c(S)]}	Mean {m(N)}	(sample size)	Mean {m(S)}	(sample size)	in means {m(N)-m(S)}	for mean comparisons
01/08/98	01/28/98	4	5	-0.0969	34.25	4	35.8	5	-1.55	4
01/29/98	02/04/98	707	1993	-0.4501	35.74	224	36.39	180	-0.65	200
02/05/98	02/11/98	138	1042	-0.878	35.94	51	35.36	50	0.58	50
02/12/98	02/18/98	532	5034	-0.976	36.1	290	37.99	345	-1.89	315
02/19/98	02/25/98	198	1625	-0.9142	35.44	198	37.14	357	-1.7	255
02/26/98	03/04/98	161	630	-0.5925	37.09	161	39.42	327	-2.32	216
03/05/98	03/11/98	237	865	-0.5623	47.25	217	51.04	460	-3.79	295
03/12/98	03/18/98	151	790	-0.7187	50.45	141	53.74	396	-3.29	208
03/19/98	03/25/98	35	132	-0.5765	59.85	32	63.14	132	-3.29	52
03/26/98	04/01/98	124	976	-0.896	63.54	85	65.11	392	-1.56	140
04/02/98	04/08/98	125	1174	-0.9728	68.03	124	67	330	1.03	180
		Mean of difference in log counts =		-0.6940			Weighted[1] Mean =		-1.9022	
		Standard Error =		0.08193			Standard Error =		0.4449	
		t-Ratio (10 d.f.) =		-8.47			t-Ratio (10 d.f.) =		-4.28	
		Computed Type I Error Probability =		<0.0001			Computed Type I Error Probability =		0.0016	
04/09/98	04/15/98	38	305	-0.9045	71.05	38	72.27	264	-1.21	66
04/16/98	04/22/98	53	143	-0.4311	78.94	53	78.8	142	0.14	77
04/23/98	04/29/98	74	241	-0.5128	82.34	73	80.73	228	1.62	111
04/30/98	05/06/98	86	383	-0.6487	85.09	86	83.58	310	1.51	135
05/07/98	05/13/98	86	251	-0.4652	88.14	86	86.53	196	1.61	120
05/14/98	05/20/98	151	672	-0.6484	87.16	134	85.96	373	1.2	197
05/21/98	05/27/98	74	216	-0.4652	89.66	74	85.9	209	3.76	109
05/28/98	06/03/98	32	188	-0.769	92.03	32	89.72	188	2.31	55
06/04/98	06/10/98	21	125	-0.7747	94.05	21	93.39	116	0.66	36
06/11/98	06/17/98	24	49	-0.31	96.18	23	93.86	49	2.32	31
06/18/98	07/03/98	2	11	-0.7404	98.5	2	102.82	11	-4.32	3
		Mean of difference in log counts =		-0.6063			Weighted[1] Mean =		1.4481	
		Standard Error =		0.05497			Standard Error =		0.3865	
		t-Ratio (10 d.f.) =		-11.03			t-Ratio (10 d.f.) =		3.75	
		Computed Type I Error Probability =		<0.0001			Computed Type I Error Probability =		0.0038	

[1] Weights are harmonic means of the number of north- and south-trapped fish measured, 2/[1/n(N)+1/n(S)],to account fo differences in sample numbers within and among pairs

Table A.2. Comparisons in lengths (mm) of fish at times of release and recovery (Caswell, 1996).

			Lengths of released (rel) and recovered (rec) fish					
			Released Fish		Recovered Fish		Difference	Weight
Date of Release	Fish Stock	Time of Release	Mean Length	(Sample size)	Mean Length	(Sample size)	in mean lengths	for mean comparisons
03/14/98	Hatchery	Night	55.2	50	54.1	35	1.1	41
03/14/98	Natural	Night	36.2	50	37.3	101	-1.1	67
03/14/98	Hatchery	Night	55.1	50	53.6	45	1.5	47
03/25/98	Hatchery	Night	41.1	50	41.8	32	-0.7	39
03/25/98	Natural	Night	52.4	50	48.1	43	4.3	46
03/25/98	Hatchery	Night	41.2	50	42.1	34	-0.9	40
04/18/98	Natural	Day	65.6	50	66	12	-0.4	19
04/18/98	Hatchery	Day	75.3	50	70.7	4	4.6	7
04/18/98	Hatchery	Night	74.6	50	70.3	15	4.3	23
04/18/98	Hatchery	Night	75.1	50	73.7	26	1.4	34
05/10/98	Hatchery	Day	87.7	50	83	1	4.7	2
05/10/98	Hatchery	Night	87.4	50	84.5	4	2.9	7
05/10/98	Hatchery	Night	86.4	50	86.3	8	0.1	14
05/18/98	Hatchery	Night	88.2	50	86.9	31	1.3	38
05/18/98	Natural	Night	88.8	50	83.6	16	5.2	24
06/04/98	Hatchery	Night	100.5	50	98.4	16	2.1	24
06/04/98	Hatchery	Night	98.6	50	97.7	15	0.9	23
06/12/98	Hatchery	Night	102.8	50	104.8	6	-2	11
06/12/98	Hatchery	Night	102.8	50	95.3	4	7.5	7
						Weighted[1] mean difference =	1.288	
						Standard error =	0.503	
						t-ratio (18 d.f.) =	2.56	
						Computed Type I Error probability =	0.0197	

[1] Weights are harmonic means of the number of released and recovered fish measured, 2/[1/n(rel)+1/n(rec)], to account

Table A.3.a. Estimated coefficients and associated statistics for the 1998 and 1996-1997 full model logistic efficiency predictors.

	1998 Logistic Coefficient Estimates				1996-97 Logistic Coefficient Estimates			
Coefficient	Estimate (b)	Standard Error (SE)	"t"-ratio (b/SE)	Computed P	Estimate (b)	Standard Error (SE)	"t"-ratio (b/SE)	Computed P
"Intercept" [b(0)]	-1.743	0.6047	-2.88	0.0076	-1.751	0.4596	-3.81	0.0007
Flow [b(f)]	-0.0002255	0.000238	-0.95	0.3523	-0.0008313	0.0001700	-4.89	0.0000
Size [b(s)]	-0.02326	0.004949	-4.70	0.0001	-0.005780	0.0050994	-1.13	0.2670
Turbidity [b(t); t>10]	0.07198	0.015054	4.78	0.0001	0.07198	0.01505	4.78	0.0001
	Coefficient Variances-Covariances (based on 27 pooled degrees of freedom)				**Coefficient Variances-Covariances (based on 27 pooled degrees of freedom)**			
	b(0)	b(f)	b(s)	b(t)	b(0)	b(f)	b(s)	b(t)
b(0)	3.657E-01				2.112E-01			
b(f)	-1.250E-04	5.677E-08			-3.873E-05	2.889E-08		
b(s)	-1.905E-03	2.458E-07	2.449E-05		-1.969E-03	-1.987E-08	2.600E-05	
b(t)	0.000E+00	0.000E+00	0.000E+00	2.266E-04	-4.189E-03	-2.719E-07	5.265E-05	2.266E-04

Table A.3.b. Estimated coefficients and associated statistics for the 1998 and 1996-1997 reduced model logistic efficiency predictors.

	1998 Logistic Coefficient Estimates				1996-97 Logistic Coefficient Estimates			
Coefficient	Estimate (b)	Standard Error (SE)	"t"-ratio (b/SE)	Computed P	Estimate	Standard Error (SE)	"t"-ratio (b/SE)	Computed P
"Intercept" [b(0)]	-2.251E+00	3.038E-01	-7.41	0.0000	-2.183E+00	2.570E-01	-8.50	0.0000
Flow [b(f)]					-8.400E-04	1.761E-04	-4.77	0.0000
Size [b(s)]	-2.216E-02	4.891E-03	-4.53	0.0001				
Turbidity [b(t); t>10]					8.350E-02	1.107E-02	7.54	0.0000
	Coefficient Variances-Covariances (based on 29 pooled degrees of freedom)				**Coefficient Variances-Covariances** (based on 29 pooled degrees of freedom)			
	b(0)	b(f)	b(s)	b(t)	b(0)	b(f)	b(s)	b(t)
b(0)	9.226E-02				6.604E-02			
b(f)					-4.300E-05	3.102E-08		
b(s)	-1.396E-03		2.392E-05					
b(t)					-1.263E-04	-2.913E-07		1.226E-04

Table A.3.c. Estimated coefficients and associated statistics for the 1998 and 1996-1997 modified reduced model logistic efficiency predictors when run is partitioned into fry, fingerling, and smolt (1998 partitioning removes affect of size)

Fry/Fingerling 98			Smolt-98		
	Estimate	S.E.		Estimate	S.E.
b(0)	-3.31852	0.12623	b(0)	-4.32994	0.22686
Mean*	0.03494	0.01484	Mean*	0.013	0.05014

* Mean Estimate = 1/[1+exp(-Coefficient)]
= (total recoveries)/(adjusted total released))
Mean S.E. = {Coefficient^4*exp[B(0)}^{2}*Variance[B(0)]}^{½}

1996-1997				
Coefficient	Estimate	S.E.	t-ratio	P
Intercept [b(0)]	-2.18321	0.27009		
Flow [b(f)]	-0.00084	0.00019	-4.5382	0
Turbidity [b(t),t>10]	0.0835	0.00516	16.18996	0

Variance-Covariances of Coefficients (based on 29 pooled degrees of freedom)			
	b(0)	b(f)	b(t)
b(0)	7.295E-02		
b(t)	-4.750E-05	3.426E-08	
b(f)	-1.395E-04	-3.217E-07	1.354E-04

b(0)	
b(0)	0.01593

b(0)	
b(0)	0.05147

Table A.4.a. Predictor variables, estimated efficiencies, full-model-based predicted values, and residuals for the standard release sets.

Release Date	Flow (f) {CFS}	Mean Size	Turbidity (t) {NTU}	Adjusted number released[1] {N}	Estimated trapping efficiency {p}	Predicted value[2] {P}	Residual (not standardized) {p-P}	Approximate z-ratio based on binomial (Pearson's residuals) {(p-P)/[P(1-P)/N]^{½}}
02/14/96	1179	34.3	14.7	1324	0.1208	0.1334	-0.0126	-1.35
02/19/96	2014	33.8	10.5	1100	0.0555	0.0539	0.0015	0.23
03/22/96	3413	42.7	7.3	1097	0.0137	0.0079	0.0058	2.17
04/06/96	1791	67.4	5.9	746	0.0295	0.0258	0.0036	0.63
04/06/96	1791	70.2	5.9	748	0.0107	0.0254	-0.0147	-2.56
05/02/96	1680	76.1	10.2	1979	0.0763	0.0545	0.0218	4.27
05/02/96	1680	75.5	10.2	1990	0.0442	0.0547	-0.0105	-2.05
05/10/96	1667	74.2	8.7	2242	0.0223	0.0275	-0.0052	-1.50
05/10/96	1667	76.1	8.7	2341	0.0252	0.0272	-0.0020	-0.60
05/26/96	921	71.7	6.8	2374	0.0670	0.0506	0.0163	3.63
05/26/96	921	72.7	6.8	2298	0.0544	0.0504	0.0040	0.88
06/10/96	1279	91.6	9.0[3]	1559	0.0276	0.0341	-0.0065	-1.42
06/10/96	1279	90.5	9.0[3]	1981	0.0298	0.0343	-0.0045	-1.11
04/09/97[4]	599[4.1]	82.5	8.4[4.2]	182	0.0165	0.0615	-0.0450	-2.53
05/28/97[5]	1608	71.3	9.6[6]	1905	0.0273	0.0293	-0.0020	-0.52
05/28/97[5]	1608	71.9	9.6[6]	1444	0.0242	0.0292	-0.0050	-1.12
05/28/97[5]	1608	72.5	9.6[6]	1433	0.0209	0.0291	-0.0082	-1.84

05/28/97 [5]	1608	73.3	9.6 [6]	1817	0.0363	0.0290	0.0073	1.86
03/14/98	1577	54.1	8.1	1033	0.0339	0.0337	0.0002	0.04
03/14/98	1577	37.3	8.1	2149	0.0470	0.0490	-0.0020	-0.42
03/14/98	1577	53.6	8.1	1049	0.0429	0.0340	0.0089	1.58
03/25/98	2657	41.8	7.2	1128	0.0284	0.0351	-0.0067	-1.22
03/25/98	2657	48.1	7.2	877	0.0490	0.0304	0.0186	3.21
03/25/98	2657	42.1	7.2	1254	0.0271	0.0348	-0.0077	-1.49
04/18/98	1996	70.3	6.3	988	0.0152	0.0213	-0.0061	-1.33
04/18/98	1996	73.7	6.3	995	0.0261	0.0197	0.0064	1.46
05/10/98	2005	84.5	6.567	649	0.0062	0.0154	-0.0092	-1.90
05/10/98	2005	86.3	6.567	1009	0.0079	0.0147	-0.0068	-1.79
05/18/98	2023	86.9	7.4	1020	0.0304	0.0145	0.0159	4.26
05/18/98	2023	83.6	7.4	1102	0.0145	0.0156	-0.0011	-0.29
06/04/98	1527	98.4	6.9	1079	0.0148	0.0124	0.0024	0.72
06/04/98	1527	97.7	6.9	1044	0.0144	0.0126	0.0018	0.51
06/12/98	1593	104.8	9.525	791	0.0076	0.0106	-0.0030	-0.82
06/12/98	1593	95.3	9.525	1000	0.0040	0.0131	-0.0091	-2.54

[1] Number released multiplied by estimated pre-release survival

[2] For 1996-97: 1/{1+exp[-b(0)- b(f)*f- b(t)*t]},b(0)=-1.751,b(f)=-0.0008313,b(s) =-0.00578, and , only for t >=10,

[3] For 1998: 1/{1+exp[-b(0)- b(f)*f- b(t)*t]}, b(0)=-1.743, b(f)=-0.0002255, b(s) =-0.02326, and, only for t >=10,

[4] 6.8 used in previous reports instead of 9.0 due to different method of estimating missing values

[4.1] Release dates were 4/7/97-4/11/97 but releases indistinguishable in terms of marks; therefore release dates were pooled and predictor variables (f and t) were based on mid-point date, 4/9/97

[4.2] 596 used in previous report instead of 599 due to different method of computing from multiple release dates

[5] 8.3 used in previous report instead of 8.4 due to different method of computing from multiple release dates

[6] Release actually made after midnight; whereas all other night-time releases made before midnight; predictor variables based on 5/28/97 but did not differ substantially from those of 5/27/97

9.8 erroneously used in previous report instead of 9.6

Table A.4.b. Predictor variables, estimated efficiencies, reduced-model-based predicted values, and residuals for the standard release sets.

Release Date	Flow (f) {CFS}	Mean Size	Turbidity (t) {NTU}	Adjusted number released[1] {N}	Estimated trapping efficiency {p}	Predicted value[2] {P}	Residual (not standardized) {p-P}	Approximate z-ratio based on binomial (Pearson's residuals) {(p-P)/[P(1-P)/N]$^{1/2}$}
02/14/96	1179	34.3	14.7	1324	0.1208	0.1250	-0.0042	-0.46
02/19/96	2014	33.8	10.5	1100	0.0555	0.0475	0.0079	1.24
03/22/96	3413	42.7	7.3	1097	0.0137	0.0064	0.0073	3.04
04/06/96	1791	67.4	5.9	746	0.0295	0.0244	0.0051	0.90
04/06/96	1791	70.2	5.9	748	0.0107	0.0244	-0.0137	-2.43
05/02/96	1680	76.1	10.2	1979	0.0763	0.0605	0.0158	2.95
05/02/96	1680	75.5	10.2	1990	0.0442	0.0605	-0.0163	-3.05
05/10/96	1667	74.2	8.7	2242	0.0223	0.0270	-0.0047	-1.38
05/10/96	1667	76.1	8.7	2341	0.0252	0.0270	-0.0018	-0.54
05/26/96	921	71.7	6.8	2374	0.0670	0.0494	0.0176	3.95
05/26/96	921	72.7	6.8	2298	0.0544	0.0494	0.0050	1.10
06/10/96	1279	91.6	9.0 [3]	1559	0.0276	0.0371	-0.0095	-1.98
06/10/96 [4]	1279	90.5	9.0 [3]	1981	0.0298	0.0371	-0.0073	-1.71
04/09/97 [4]	599 [4.1]	82.5	8.4 [4.2]	182	0.0165	0.0638	-0.0473	-2.61
05/28/97 [5]	1608	71.3	9.6 [6]	1905	0.0273	0.0284	-0.0011	-0.28

05/28/97[5]	1608	71.9	9.6[6]	1444	0.0242	0.0284	-0.0041	-0.95
05/28/97[5]	1608	72.5	9.6[6]	1433	0.0209	0.0284	-0.0074	-1.69
05/28/97[5]	1608	73.3	9.6[6]	1817	0.0363	0.0284	0.0080	2.04
03/14/98	1577	54.1	8.1	1033	0.0339	0.0308	0.0031	0.58
03/14/98	1577	37.3	8.1	2149	0.0470	0.0440	0.0030	0.67
03/14/98	1577	53.6	8.1	1049	0.0429	0.0311	0.0118	2.20
03/25/98	2657	41.8	7.2	1128	0.0284	0.0400	-0.0117	-2.00
03/25/98	2657	48.1	7.2	877	0.0490	0.0350	0.0140	2.26
03/25/98	2657	42.1	7.2	1254	0.0271	0.0398	-0.0127	-2.29
04/18/98	1996	70.3	6.3	988	0.0152	0.0217	-0.0065	-1.40
04/18/98	1996	73.7	6.3	995	0.0261	0.0201	0.0060	1.34
05/10/98	2005	84.5	6.567	649	0.0062	0.0159	-0.0098	-1.99
05/10/98	2005	86.3	6.567	1009	0.0079	0.0153	-0.0074	-1.91
05/18/98	2023	86.9	7.4	1020	0.0304	0.0151	0.0153	4.00
05/18/98	2023	83.6	7.4	1102	0.0145	0.0162	-0.0017	-0.45
06/04/98	1527	98.4	6.9	1079	0.0148	0.0118	0.0031	0.94
06/04/98	1527	97.7	6.9	1044	0.0144	0.0119	0.0024	0.72
06/12/98	1593	104.8	9.525	791	0.0076	0.0102	-0.0026	-0.74
06/12/98	1593	95.3	9.525	1000	0.0040	0.0126	-0.0086	-2.43

[1]
[2] Number released multiplied by estimated pre-release survival
For 1996-97: 1/(1+exp[-b(0)- b(f)*f- b(t)*t)], b(0)=-2.183, b(f)=-0.0008400, and only for t >=10, b(t)=0.08530
[3] For 1998: 1/[1+exp(-b(0)- b(s)*s)], b(0)=-2.251, b(s)=-0.02216
[4] 6.8 used in previous reports instead of 9.0 due to different method of estimating missing values
Release dates were 4/7/97-4/11/97 but releases indistinguishable in terms of marks; therefore release dates were pooled and predictor variables (f and t) based on mid-point date, 4/9/97
[4.1] 596 used in previous report instead of 599 due to different method of computing from multiple release dates
[4.2] 8.3 used in previous report instead of 8.4 due to different method of computing from multiple release dates
[5] Release actually made after midnight; whereas all other night-time releases made before midnight; predictor variables based on 5/28/97 but did not differ substantially from those of 5/27/97
[6] 9.8 erroneously used in previous report instead of 9.6

Efficiency Testing

Day and Night Comparisons

On April 6, 1996 and on April 18 and May 10, 1998, there were day- and evening/night-release sets. Recapture efficiencies of day-time releases were significantly and substantially less efficient than those of night releases (Table A.5: pooled day e = 0.002 and night e = 0.016, P = 0.0001) indicating that fish released during the day are less likely to be trapped than those released at night. The decision was made to drop day releases because the day-release efficiency would not have been representative of day passage. Out of the total of 9172 fish released in the day time, only 17 were recovered; however, 16 of those 17 were captured at night. The estimate would then be primarily an estimate of the proportion of day-released fish trapped at night, and would not be an estimate of day-time efficiency. This and the fact that the day-release efficiency is substantially less than that at night, suggests that many of the day-released fish pass during the day but are trapped at a much smaller efficiency than estimated. But, since the day-release estimate is substantially less than that of fish released at night, the day-

release estimate is not an estimate of night-time efficiency, either. For this reason, the day releases were excluded from the efficiency fit. The resulting night-time predictor of efficiency will likely contribute to an under-projection of day-time passage (expansion of counts by too large an efficiency will underestimate passage).

Release Point Comparisons

In order to determine whether the release point was optimum for efficiency estimation, two other release points were tested on June 4, 1998: one point approximately ¼ mile upstream of the standard release point, and the other point approximately ¼ mile downstream. On this same day, there were two releases made from the standard release point. The estimated pooled efficiencies from these releases are given in Table A.5. There were no significant or substantial differences in these efficiencies. However, since the non-standard release points were not replicated over release days, they were not included in the logistic regression prediction of efficiency.

Fish trapping efficiency against a floating standard

One question posed was whether fish trapping is a purely random surface-movement event. To test this, lemons were released at the standard release point, and the proportion of these lemons that were entrained in the screw traps was computed. Trapping efficiencies from standard fish releases made on the same day were significantly and substantially less than those for lemons (Table A.5: fish e = 0.01 and lemon e • 0.36, P = 0.0013 for day and P < 0.0001 for night releases). If fish simply followed random surface movement and were oblivious to the traps, one would not expect a difference of this magnitude. Fish may either tend to swim lower in the column, to swim around the trap, or both.

Negative logit-to-flow coefficients suggest that the response is at least partially associated with the proportion of water entering the trap. However, the fact that more fish are trapped under higher turbidity above a certain level and the fact that the day-release efficiencies are lower than night-release efficiencies suggest that there are also visual cues leading to trap avoidance.

River-Run- versus Hatchery-Releases

In previous years both hatchery fish and river-run ("natural") fish were used, but they were used on different days, precluding paired comparisons. However, in 1998 there were release sets of both sources of fish made on common release days. The efficiencies for these paired sets are summarized in Table A.5. There were no substantial or significant differences in the efficiency estimates from these sets (Table A.5: pooled "natural" e = 0.03 and hatchery e = 0.02, P = 0.5).

Table A.5. Statistical comparisons among efficiency test groups

Date	Release Type	Time of Day	Adjusted Number Released	Number Recovered	Efficiency Estimate
		DAY VERSUS NIGHT COMPARISONS			
04/06/96	Standard location: Fish	Night (pooled)	1494	30	0.0201
		Day (pooled)	1475	0	0.0000
04/18/98	Standard location: Fish	Night (pooled)	1983	41	0.0207
		Day (pooled)	4754	16	0.0034
05/10/98	Standard location: Fish	Night (pooled)	1658	12	0.0072
		Day	2943	1	0.0003
Pooled over all appropriate releases		Night (pooled)	5135	83	0.0162
		Day (pooled)	9172	17	0.0019
				t-ratio[1] (Night versus Day) =	4.73
				Within release-day degrees of freedom =	21
				2-sided Probability =	0.0001
[1] t-ratio based square root of F-ratio generated from logistic regression using residual based on variation among releases within release days--non-standard release omitted.					
		COMPARISON AMONG RELEASE POSITIONS			
06/04/98	Standard Location: Fish	Night (pooled)	2123	31	0.0146
	1/4 mile upstream: Fish	Night	826	13	0.0157
	1/4 mile downstream: Fish	Night	1003	20	0.0199
				t-ratio[2] (Upstream versus Standard) =	0.13
				Within release-day degrees of freedom =	17
				2-sided Probability =	0.8967
				t-ratio[2] (Downstream versus Standard) =	0.58
				Within release-day degrees of freedom =	17
				2-sided Probability =	0.5684
[2] t-ratio based square root of F-ratio generated from logistic regression using residual based on variation among releases within release days--day releases and lemon releases omitted.					

Table A.5. (continued) Statistical comparisons among efficiency test groups

Date	Release Type	Time of Day	Adjusted Number Released	Number Recovered	Efficiency Estimate
		COMPARISONS AMONG RELEASE POINTS			
04/18/98	Standard location: Fish	Day	972	12	0.0123
	Standard location: Lemons	Day	500	181	0.3620
				t-ratio[3] (Lemon versus Fish within Day Releases) =	8.58

				Within release-day degrees of freedom =	2
				2-sided Probability =	0.0133
05/10/98	Standard location: Fish	Night (pooled)	1658	12	0.0072
	Standard location: Lemons	Night	230	84	0.3652
			t-ratio[4] (Lemon versus Fish within Night Releases) =		9.54
				Within release-day degrees of freedom =	17
				2-sided Probability =	0.0000

[3] t-ratio based square root of F-ratio generated from logistic regression using residual based on variation among releases within release days-- night, upstream, and downstream releases omitted.

[4] t-ratio based square root of F-ratio generated from logistic regression using residual based on variation among releases within release days-- day, upstream, and downstream releases omitted.

NATURAL (RIVER RUN) VERSUS HATCHERY RELEASES

03/14/98	Standard location: Fish	Natural	2149	101	0.0470
		Hatchery (pooled)	2082	80	0.0384
03/25/98	Standard location: fish	Natural	877	43	0.0490
		Hatchery (pooled)	2382	66	0.0277
04/18/98	Standard location: fish	Natural	972	12	0.0123
		Hatchery (pooled)	5765	45	0.0078
05/18/98	Standard location: fish	Natural	1102	16	0.0145
		Hatchery (pooled)	1020	31	0.0304
Pooled over all appropriate releases		Natural	5100	172	0.0337
		Hatchery (pooled)	11249	222	0.0197
				t-ratio[5] (Night versus Day) =	0.68
				Within release-day degrees of freedom =	21
				2-sided Probability =	0.5063

[5] t-ratio based square root of F-ratio generated from logistic regression using residual based on variation among releases within release days--non-standard release omitted.

Outmigration Index Estimation

Substituting the efficiency-to-flow predictor for a given day (day i) into the outmigration index estimation equation gives:

$$\hat{c}(i) = \frac{c(i)}{\hat{e}(i)} = \frac{c(i)}{\frac{1}{1+\exp^{[-b(0)-b(1)*f(i)-b(2)*s(i)-b(3)*t(i)]}}}$$

$$= c(i) * [1+\exp^{[-b(0)-b(1)*f(i)-b(2)*s(i)-b(3)*t(i)]}]$$

Methods of interpolating missing values of flow, fish size, and turbidity used in predicting efficiency were discussed earlier. There were also days when counts were missing. A different method for estimating missing counts is used here than was used in the past. In the past the missing count value was based on a linear function relating the mean of a log transform of actual counts from proximal days to the difference between the turbidity on the day when the count was missing and the mean of turbidities from the proximal days when there were counts. The relation between the counts and turbidity turned out to be inconsistent over years. The missing value computation in 1998 was the weighted mean of the five previous and five subsequent days' true counts and no adjustment was made for turbidity:

$$\hat{c}(i) = e^{\left[\frac{w(1)*(\ln[c(i+1)+1]+\ln[c(i-1)+1])+\ldots+w(5)*(\ln[c(i+5)+1]+\ln[c(i-5)+1])}{2*\Sigma w(i)}\right]} - 1$$

wherein $w(i) = 0$ *if* $c(i)$ *missing,* $w(i) = 6-i$ *otherwise*

Thus, when no proximal values are missing, the weight of the most proximal value is the highest [w(1) = 5] and of the most distal [w(5) = 1] is the lowest. The estimate was based on the fact that the correlations between the log-transforms of count on day i and count on day i + j tended to drop linearly as j (the number of lag days) increased. The correlations were as follows: r(i,i+1) = 0.79, r(i,i+2) = 0.74, r(i,i+3) = 0.73, r(i,i+4) = 0.72, and r(i,i+5) = 0.64; the linear correlation between r(i,i+j) and j was -0.94; suggesting that using a weight based simply on the number of lag days was adequate. Since the counts could vary greatly from day to day, it was deemed inappropriate to use computations based simply on adjacent days. The decision to terminate at 5 lag days for mean computation was somewhat subjective. The correlation between the log count at day i and day i+j did not

dramatically change until after eight lag days[10]. This same procedure was used to recompute missing count values from 1996 and 1997; therefore, the missing values presented in Appendices A.3 and A.4 in this report for those years will differ somewhat from those presented in previous reports.

Daily Outmigration

The recomputed outmigration indices for 1996, 1997, and 1998 are given in Figure A.1 based on the full model prediction. Because of the variability in the daily index values, the graphic presentation had to be on the log scale (Figure A.1). The outmigration index is clearly greater in 1998 than in previous years. However, much of the increase is seen earlier in the 1998 season, and the trap was not fished in 1997 until March 19. By that date in 1998 the counts were already on the decline (Figure A.1), and in 1996 a substantial number of fish had already passed by that date.

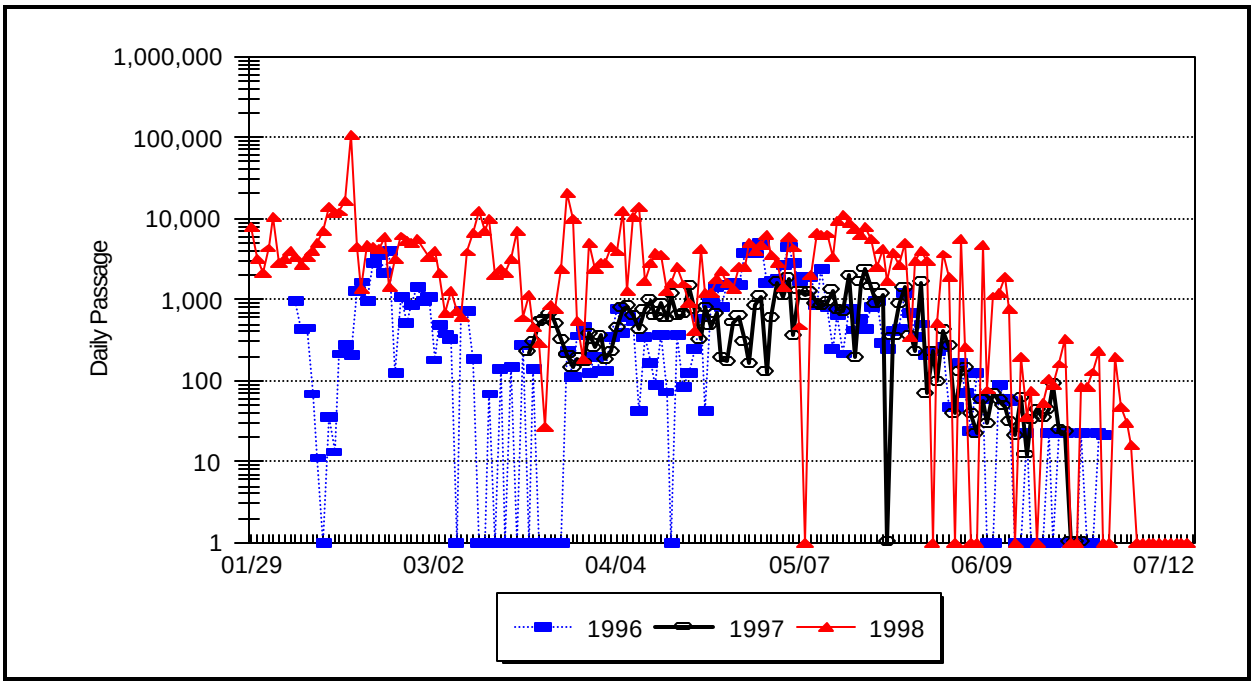


Figure A.1. Computed daily outmigration index by day in 1996, 1997, and 1998

The reestimated cumulative outmigration indices for 1996 and 1997 and the estimated cumulative outmigration index for 1998 are given along with approximate 95%

[10] *r(i,i+1) = 0.79, r(i,i+2) = 0.74, r(i,i+3) = 0.73, r(i,i+4) = 0.72, and r(i,i+5) = 0.64, r(i,i+6) = 0.65, r(i,i+7) = 0.65, r(i,i+8) = 0.63, r(i,i+9) = 0.58, and r(i,i+10) = 0.54*

confidence limits in Figures A.2.a, A.2.b, and A.2.c., respectively. The revised estimated 1996, 1997, 1998 final cumulative outmigration indices (and approximate 95% confidence intervals) for the full model (Table A.3.a) are:

1996:	95 thousand[11]	(69 thousand - 121 thousand)
1997:	54 thousand[12]	(41 thousand - 66 thousand)
1998:	651 thousand	(284 thousand - 1,018 thousand)

Because of the high variability, attention is focused on the confidence limits. The broad confidence limits given above and in Figure A.2.c. indicate the uncertainty of the 1998 full-model estimate,. Even so, referring to the final outmigration estimate, the 1998 lower limit (248 thousand) exceeded the 1996 upper limit (121 thousand) and exceeded the 1997 upper limit (66 thousand). This highly conservative test indicates that the 1998 monitored outmigration far exceeds those of the two previous years. Further the 1996 lower limit (69 thousand) also exceeds the 1997 upper limit (66 thousand), indicating that the monitored 1996 outmigration exceeded the 1997 monitored outmigration.

Appendix A.3 presents 1996 revised flows, fish sizes, turbidities, screw-trap counts, and efficiency-to-flow predictions, as well as associated full-model daily and cumulative outmigration index estimates and their approximate standard errors. Appendices A.4 and A.5 respectively present the 1997 and 1998 values of the same variables.

NOTE:The final outmigration index based on the reduced model (Table A.3.b) are:

1996:	96 thousand	(67 thousand - 126 thousand)
1997:	49 thousand	(40 thousand - 58 thousand)
1998:	818 thousand	(616 thousand - 1,019 thousand)

The 1998 confidence interval under the reduced model is considerably narrower than that under the full model; however, the reduced model may be biased.

The outmigration index estimates based on applying the coefficients from the full model (Table A.3.a) and from the modified reduced model (Table A.3.c) to the different size classes (fry, fingerling, and smolt) are presented in Table A.6. Because of potential bias associated with the reduced model, the full model is recommended for predicting outmigration for now, but efforts should be undertaken in the future to make releases over a broader domain of turbidity and flow.

[11] 1996 estimate was 105 thousand in the 1997 report.

[12] 1997 estimate was 47 thousand in the 1997 report.

Table A.6. Estimated cumulative passage, associated standard errors, approximate confidence intervals, and "coefficient of variation" (CV)

	Full Model					Modified Reduced Model				
	Estimate (Est)	SE	95% Conf. Limits		CV = Est/SE	Estimate (Est)	SE	95% Conf. Limits		CV = Est/SE
1996										
Fry	28,653	9,937	9,176	41,830	0.35	35,078	11,284	12,961	57,195	0.32
Fingerling	1,465	429	625	2,305	0.29	1,456	436	601	2,311	0.30
Smolt	65,083	8,628	48,172	81,994	0.13	59,906	6,902	46,379	73,433	0.12
TOTAL	95,201	13,306	69,122	121,280	0.14	96,440	15,687	65,695	127,186	0.16
1997										
Fry	not monitored					not monitored				
Fingerling	4,724	707	3,339	6,109	0.15	4,285	542	3,223	5,346	0.13
Smolt	48,861	5,975	37,151	60,571	0.12	45,051	4,583	36,068	54,033	0.10
TOTAL	53,585	6,324	41,191	65,980	0.12	49,336	4,698	40,128	58,543	0.10
1998										
Fry	287,801	171,846	(49,018)	624,620	0.60	571,080	96,096	382,732	759,428	0.17
Fingerling	179,448	31,791	117,137	241,759	0.17	142,954	25,672	92,638	193,271	0.18
Smolt	183,935	35,349	114,651	253,219	0.19	211,428	49,643	114,128	308,728	0.23
TOTAL	651,185	187,280	284,116	1,018,253	0.19	925,462	121,601	687,124	1,163,799	0.13

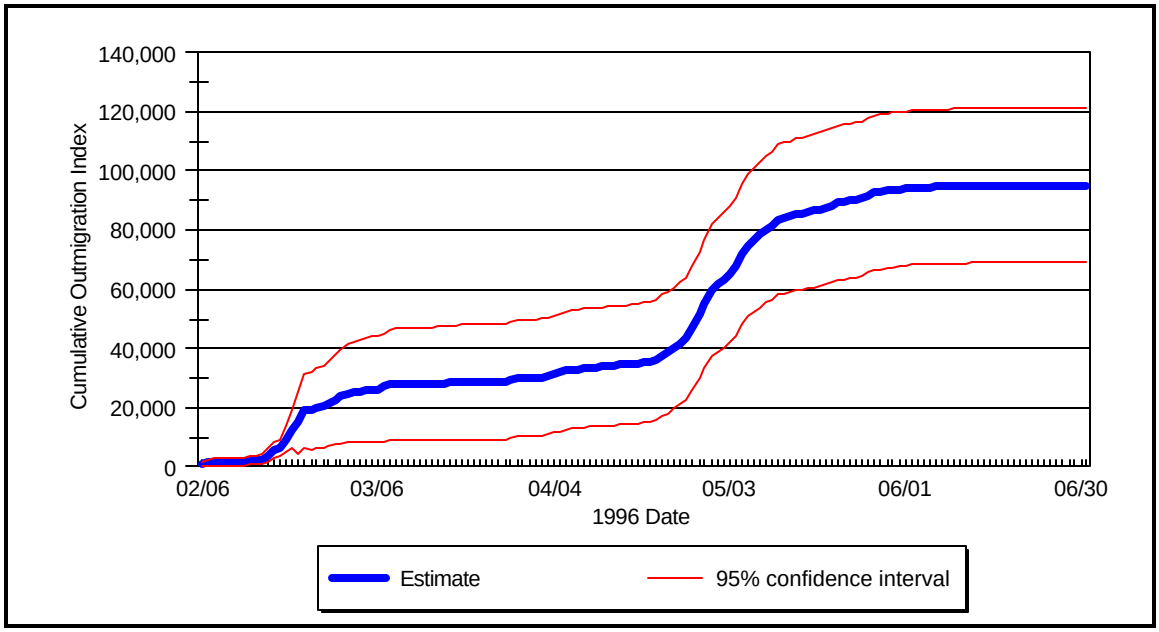


Figure A.2.a. 1996 estimated cumulative outmigration.

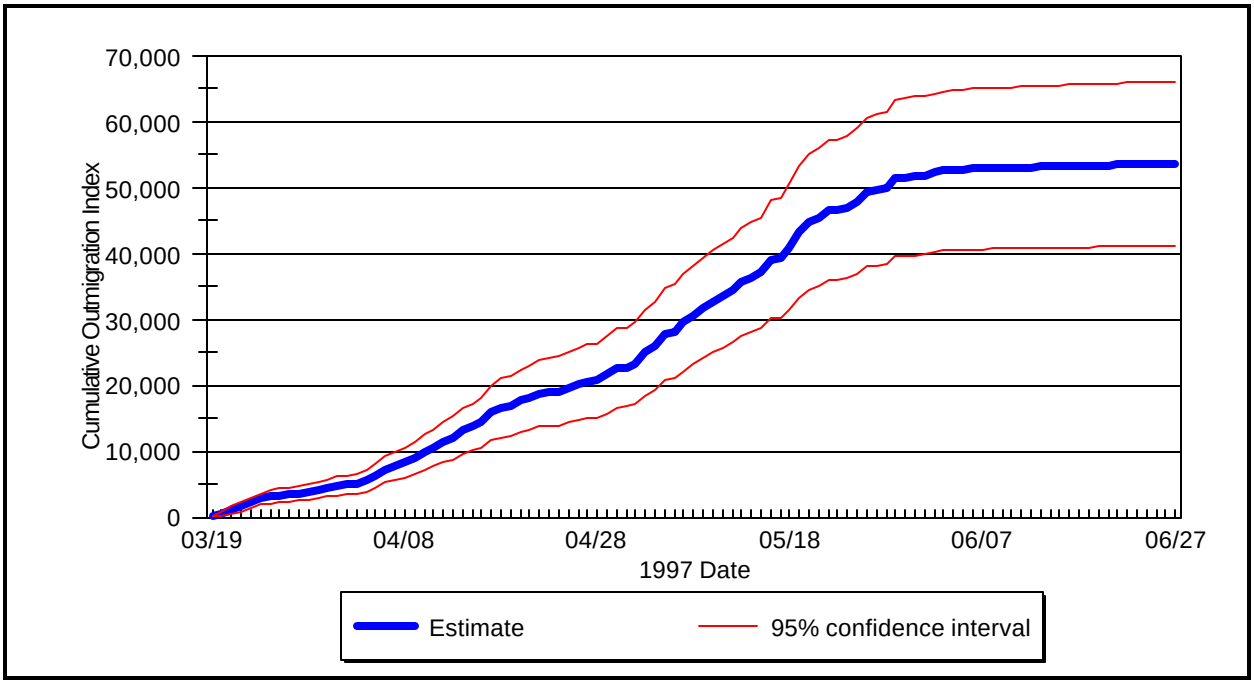


Figure A.2.b. 1997 estimated cumulative outmigration.

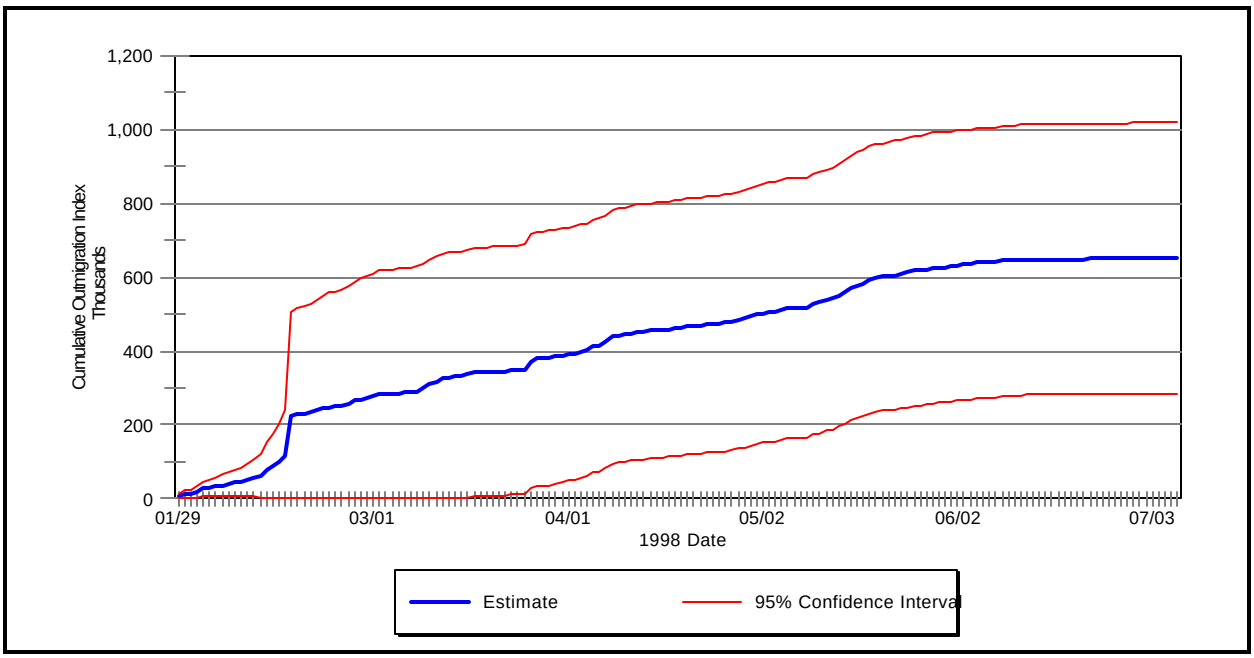


Figure A.2.c. 1998 estimated cumulative outmigration.

Appendix A.1. Standard Error for Cumulative Outmigration Index

In the following discussion, I use upper case letters to represent parameter values and corresponding lower case letters to represent their estimates.

The population daily outmigration index is

$$O_i = \frac{C_i}{E_i}$$

wherein O_i is the true daily outmigration index on day i, C_i is that day's expected count, and E_i is the true trap efficiency for that day. The true cumulative outmigration index is simply the daily index values added over days:

$$\Sigma_i O_i = \Sigma_i \frac{C_i}{E_i}$$

Substituting lower case letters for upper case letters gives the form of the estimated daily outmigration index

$$o_i = \frac{c_i}{e_i}$$

and the cumulative index

$$\Sigma_i o_i = \Sigma_i \frac{c_i}{e_i}$$

The variance of this cumulative passage is

$$S^2 [\Sigma_i o_i] = \Sigma_i Var[\frac{c_i}{e_i}] + \Sigma_i \Sigma_{i' \neq i} Cov [\frac{c_i}{e_i}, \frac{c_{i'}}{e_{i'}}]$$

wherein Var is the variance of the daily outmigration index (day i) and Cov is the covariance between indices from different days (days i and i'). The standard error, SE, is the square root of the variance, S^2. I discuss in order: 1) $Var[c_i/e_i]$, 2) $Cov[(c_i/e_i),(c_{i'}/e_{i'})]$, 3) the variance and covariances of the estimated coefficients required for $Var[c_i/e_i]$ and $Cov[(c_i/e_i),(c_{i'}/e_{i'})]$, and 4) approximated confidence limits.

1. Var[c_i/e_i]

The variance of c_i/e_i can be approximated by variance of the ratio

$$Var\left[\frac{c_i}{e_i}\right] = \frac{C_i^2 * Var[e_i]}{E_i^4} + \frac{Var[c_i]}{E_i^2} - 2 * \frac{C_i * Cov[c_i, e_i]}{E_i^3}$$

The methods used to estimate the components in the above equation are now discussed.

1.a. Estimates of C_i and E_i.

C_i and E_i, the actual parametric (population) values, are estimated by c_i and e_i, respectively. The substitution of c_i and e_i raised to powers 2, 3, and 4 for the corresponding powers of C_i and E_i do lead to biases, but no attempt was made to adjust for those biases or to assess the relative magnitude or direction of those biases.

1.b. Estimate of Var[e_i]

Recalling from the main appendix, the efficiency predictor is

$$e_i = \frac{1}{1 + \exp^{th_i}} \quad \text{wherein} \quad th_i = -b(0) - b(f) * f_i - b(s) * s_i - b(t) * t_i$$

The asymptotic form of the estimated variance of e_i can be developed by multiplying the variance-covariance matrix of the b's by the vector of the first derivatives of e_i above with respect to the b's and post multiplying by the transpose of that vector (delta method), giving:

$$Var[e_i] =$$
$$E_i^4 * [\exp^{th_i}]^2 * Var[b(0) + b(f) * f_i + b(s) * s_i + b(t) * t_i]$$

1.c. Estimate of Var[c_i]

The variance in the count was approximated by taking the variance among the count of that day and the count(s) from immediately adjacent days.

$$Var[c(i)] = \frac{[c(i-1)-\bar{c}(i)]^2 + [c(i)-\bar{c}(i)]^2 + [c(i+1)-\bar{c}(i)]^2}{n-1}$$

wherein

$$\bar{c}(i) = \text{mean of } c(i-1),\ c(i),\ c(i+1)$$

and wherein n = 3 if there are two adjacent days (usual case) and n = 2 if there is only one adjacent day (first and last day of trapping).

1.d. Estimate of Cov[c_i, e_i]

The count and the predicted efficiency can be regarded as independent since they were based on different fish and since there is no reason to believe the capture of a given released fish used to estimate efficiency affected the probability of capturing a river-run fish used to estimate c_i. Therefore

$$Cov[c_i, e_i] = 0$$

2. Cov[(c_i/e_i),($c_{i'}/e_{i'}$)]

There is a covariance between outmigration indices from different days. The covariance is not equal to zero because the equations for predicting e_i and $e_{i'}$ used the same coefficients estimates, b(0), b(f), b(s), and b(t). The covariance was developed using a delta method analogous to that used for Var[e_i], the asymptotic covariance being

$$Cov\left[\frac{c_i}{e_i}, \frac{c_{i'}}{e_{i'}}\right] =$$

$$c_i c_{i'}(\exp^{fh_i}\exp^{fh_{i'}}) * Cov\ \{\ [b(0)+b(f)*f_i+b(s)*s_i+b(t)*t_i],[b(0)+b(f)*f_{i'}+b(s)*s_{i'}+b(t)*t_{i'}]$$

This estimated covariance is driven by the magnitude of the variance of the coefficients, which is very high for the Caswell efficiencies and by the magnitude of the various multipliers. In 1998, when trap counts were very high, these covariances were huge, and since these covariances are accumulated over all pairs of days irrespective of order [(169 passage days)*(169 -1) = 28392 pairs in 1998], the variance of the cumulative outmigration can be, and in 1998 was, extremely large.

3. Estimating Variance of Coefficients and Covariances between Coefficients

Logistic regression was used to obtain the estimates of coefficients and their variances and covariances. However, the variances and covariances generated assumes that the distribution of residuals is binomial, meaning the expected ratio of the deviance to degrees of freedom (Dev/D.F.) is 1. When this is not the case, the variance and covariance estimates presented in logistic regression packages are underestimated and need to be expanded.

The full model residual Dev/DF = 123.61/27 = 4.58 significantly ($P < 0.0001$) and substantially exceeded 1. Further, as indicated in the main Appendix A, more than 26% of the full-model's and 44% of the reduced model's absolute values of the standardized residuals exceeded 1.96; approximately 5% would be expected to exceed 1.96 using the normal approximation of the binomial. Either the distribution of efficiency is not binomial or the predictor variables do not adequately explain the variability. Therefore, the computer-output binomially-based variances and covariances were expanded (multiplied) by Dev/D.F. to obtain better estimates of the true variances and covariances.

It should be noted that the failure of the distribution to be binomially distributed is not primarily due to a failure of the model to effectively account for among-day variability. An analysis of variance on lack of fit was conducted using variability among releases made on the same day as the basis of comparison (within-day residual, Appendix A.2). This within-day variation is largely unaffected by the model since the releases being compared experienced the same in-river conditions (e.g., flow and turbidity). The within-day Dev/DF is 3.46, still significantly and substantially greater than 1 ($P < 0.0001$ based on a chi-square test on Dev = 58.78 and DF = 17). Further, the variation associated with the lack of fit for both the full and reduced model, although greater than the within-day variation, is not significantly greater as measured by the F-ratio ($P = 0.12$ and 0.13 for the full and reduced models, respectively, Appendix A.2).

4. Confidence Intervals

The $100*(1-\alpha)$ confidence intervals of estimates were approximated using

$$\text{estimate} \pm z(\alpha)*\text{SE(estimate)}$$

wherein $z(\alpha)$ is the two-sided standardized normal deviate associated with confidence probability $1-\alpha$ and SE is the standard error or square root of the variance of the estimate. This approximation is based on an assumed normal distribution of the estimate. The fact that the confidence interval for the full model includes 0 throughout much of the outmigration period may reflect the failure of the normal distribution to hold. This failure may be due in part to the small number of release days used to fit the efficiency's logistic response (10 days in 1996-97 and 7 days in 1998).

Appendix A.2. Analysis of Variation Associated with Efficiency Predictors: Turbidity (t), Flow, and Fish Size

Source	Deviance[1] (Dev)	Degrees of Freedom (DF)	Dev/DF Ratio[2]	F-Ratio Value	Computed P
Turbidity (t) Threshold Selection Using Model 3 (below) [other predictors: flow (f), fish size (s) and t]					
t>=4	206.79	27	7.66		
t>=5	206.79	27	7.66		
t>=6	203.22	27	7.53		
t>=7	214.77	27	7.95		
t>=8	217.79	27	8.07		
t>=9	191.06	27	7.08		
Selected: f,s,t>=10	123.61	27	**4.58**	**(minimum Dev/DF)**	
f,s,t>=11	218.09	27	8.08		
f,s,t>=12	218.09	27	8.08		
f,s,t (no threshold)	204.6	27	7.58		
Model 1: Common Coefficients over Years (1996, 1997, 1998 pooled)					
f, s, t >10	464.73	3	154.91	33.54	0.0000
f (unadjusted)	113.16	1	113.16	24.50	0.0000
s (unadjusted	145.73	1	145.73	31.55	0.0000
t > 10 (t>10 unadjusted)	275.86	1	275.86	59.73	0.0000
f (adj for s,t>10)	141.19	1	141.19	30.57	0.0000
s (adj for f,t>10)	98.83	1	98.83	21.40	0.0000
t > 10 (adj for f,s)	97.41	1	97.41	21.09	0.0000
Model 2: Separate Year Coefficients (1996,1997,1998 Separately Fit)					
Difference From Model 1	71.89	6	11.98	2.59	0.0000
Model 3: 1996, 1997 pooled; 1998 separate from 1996 and 1997					
Difference from Model 2	12.76	3	4.25	0.92	0.0152
Model 4: Size 1997-1996 and Flow 1998 Dropped					
Difference from Model 3	10.04	2	5.02	1.09	0.0151
Residual Model 2 basis of F-test	110.85	24	4.62		
Residual Model 1	182.74	30	6.09		
Residual Model 3	123.61	27	4.58		
Residual Model 4	133.65	29	4.61		
Lack of Fit (LOF[3])					
Model 1 Bias	123.96	13	9.54	2.76	0.0261
Model 2 Bias	52.07	7	7.44	2.15	0.0934
Model 3 Bias	64.83	10	6.48	1.87	0.1220
Model 4 Bias	74.87	12	6.24	1.80	0.1293
Within-day residual[4]	58.78	17	3.46		

[1] Analogous to sums of squares in analysis of variance
[2] Analogous to mean square in analysis of variance
[3] LOF Dev (and DF) = [Residual for model] - [Within-day residual]
[4] Source of denominator "mean square" for LOF

Appendix A.3. Flow, turbidity, screw-trap count, and predicted screw-trap efficiency and daily and cumulative outmigration index values based on full-model trapping efficiency-to-flow relation, Caswell, 1996.

	OBB Flow (cfs)	Fish Size (mm)		Turbidity (ntu)					Daily Passage		Cumulative Passage	
Date							Count	Efficiency	Estimate	SE	Estimate	SE
02/06	355	34.92		3.70	*	**	89	0.09552	932	423	932	423
02/07	320	34.51	*	3.70		**	42	0.09827	427	293	1359	564
02/08	306	34.10		7.60		**	44	0.09952	442	210	1801	666
02/09	300	34.37		10.80			13	0.19439	67	113	1868	683
02/10	516	34.64		14.00			2	0.20221	10	35	1878	685
02/11	678	34.90		12.00			0	0.16075	0	19	1878	685
02/12	681	35.17		13.50			6	0.17527	34	18	1912	688
02/13	913	35.03	*	14.80			2	0.16148	12	87	1925	694
02/14	1179	34.90	*	14.70			28	0.13299	211	118	2135	714
02/15	1595	34.76		15.70			29	0.10453	277	78	2413	724
02/16	1648	34.77	*	11.70			16	0.07728	207	183	2620	755
02/17	1652	34.77	*	9.40		**	44	0.03471	1268	668	3887	1101
02/18	1650	34.78	*	6.00		**	57	0.03477	1640	414	5527	1360
02/19	2014	34.78		10.50			52	0.05363	970	248	6496	1447
02/20	2841	34.84	*	9.03	*	**	37	0.01320	2803	1192	9299	2203
02/21	3223	34.89	*	7.57	*	**	33.78	* 0.00964	3503	1413	12803	3317
02/22	2797	34.95	*	6.10		**	29.05	* 0.01368	2124	3518	14927	5250
02/23	3093	35.00		13.80			113	0.02844	3974	2339	18901	6270
02/24	3245	35.18	*	13.60			3	0.02477	121	2358	19022	6721
02/25	3232	35.37	*	12.40			24	0.02298	1044	569	20066	6940
02/26	3271	35.55		12.10			11	0.02178	505	343	20571	7051
02/27	3341	37.17	*	10.80			16	0.01860	860	329	21431	7245
02/28	3481	38.78	*	9.90		**	11	0.00762	1443	936	22874	7719
02/29	3894	40.40		7.80		**	5	0.00537	931	742	23806	8071
03/01	3897	34.83		8.10		**	6	0.00553	1085	711	24891	8496
03/02	3866	36.36	*	6.48	*	**	1	0.00562	178	459	25068	8575
03/03	3856	37.89	*	4.85	*	**	2.76	* 0.00562	492	281	25560	8762
03/04	3836	39.42	*	3.23	*	**	2.10	* 0.00566	370	199	25931	8901
03/05	3975	40.94	*	1.60		**	2	0.00501	328	271	26258	9031
03/06	3850	42.47	*	5.90		**	0	0.00550	0	365	26258	9038
03/07	3847	44.00		9.00		**	4	0.00547	732	539	26990	9319
03/08	3842	42.80	*	4.50		**	4	0.00553	724	456	27713	9597
03/09	3849	41.60	*	5.70		**	1	0.00553	181	385	27894	9674
03/10	3782	40.40	*	7.00		**	0	0.00589	0	98	27894	9674
03/11	3641	39.20	*	5.10		**	0	0.00666	0	87	27894	9675
03/12	3584	38.00		10.50			1	0.01486	67	46	27961	9695
03/13	3552	41.00	*	8.00		**	0	0.00710	0	81	27961	9695
03/14	3489	44.00		5.40		**	1	0.00735	136	96	28097	9741
03/15	3529	47.50	*	5.60		**	0	0.00697	0	83	28097	9742
03/16	3524	51.00		6.00		**	1	0.00686	146	102	28243	9789
03/17	3519	44.50	*	5.60		**	0	0.00715	0	140	28243	9790
03/18	3530	38.00		7.60		**	2	0.00735	272	194	28515	9889
03/19	3522	41.50	*	6.50		**	0	0.00725	0	138	28515	9890
03/20	3503	45.00		5.80		**	1	0.00722	138	97	28654	9937
03/21	3509	50.42	*	5.50		**	0	0.00697	0	83	28654	9938
03/22	3413	67.00	*	7.30		**	0	0.00686	0	0	28654	9938
03/23	3010	61.25	*	5.70		**	0	0.00988	0	0	28654	9938

Date	OBB Flow (cfs)		Fish Size (mm)		Turbidity (ntu)			Count	Efficiency	Daily Passage Estimate	Daily Passage SE	Cumulative Passage Estimate	Cumulative Passage SE
03/24	2761		66.67	*	4.50	**		0	0.01176	0	0	28654	9938
03/25	2539		72.08	*	6.00	**		0	0.01368	0	169	28654	9939
03/26	2226		77.50		5.10	**		4	0.01713	233	122	28887	9965
03/27	2125		76.50		5.70	**		2	0.01871	107	135	28994	9976
03/28	2024		80.43		5.30	**		7	0.01987	352	209	29346	10005
03/29	1896		81.70		8.00	**		10	0.02189	457	169	29803	10033
03/30	1790		74.00		7.70	**		3	0.02492	120	145	29924	10042
03/31	1748		74.80		7.40	**		5	0.02567	195	49	30118	10054
04/01	1794		88.00		6.50	**		3	0.02295	131	53	30249	10058
04/02	1791		90.00		3.00	**		3	0.02275	132	128	30381	10062
04/03	1794		84.00		6.50	**		8	0.02348	341	327	30722	10082
04/04	1788		82.94		6.00	**		18	0.02373	758	245	31480	10118
04/05	1809		82.78		6.20	**		9	0.02335	385	197	31865	10138
04/06	1791		87.50		5.90	**		14	0.02307	607	134	32472	10160
04/07	1780		76.92		5.10	**		13	0.02471	526	297	32998	10196
04/08	1779		81.00		4.20	**		1	0.02417	41	249	33040	10201
04/09	1775		86.17		6.50	**		8	0.02355	340	154	33379	10214
04/10	1776		80.75		4.20	**		4	0.02426	165	127	33544	10223
04/11	1791		85.00		4.60	**		2	0.02340	85	154	33630	10228
04/12	1731		82.56		9.90	**		9	0.02491	361	166	33991	10244
04/13	1598		80.50		5.20	**		2	0.02806	71	169	34062	10248
04/14	1595		83.00	*	9.70	**		0	0.02774	0	191	34062	10249
04/15	1599		85.50		5.70	**		10	0.02726	367	197	34429	10258
04/16	1656		97.50		9.30	**		2	0.02433	82	179	34511	10260
04/17	1706		91.33		7.20	**		3	0.02419	124	87	34635	10262
04/18	1711		84.67		6.30	**		6	0.02502	240	251	34875	10274
04/19	1679		86.20		5.20	**		15	0.02545	589	285	35464	10293
04/20	1670		89.00		5.60	**		1	0.02524	40	424	35504	10303
04/21	1675		89.77		4.70	**		22	0.02503	879	710	36383	10344
04/22	1673		91.08		6.00	**		36	0.02488	1447	387	37830	10376
04/23	1668		89.65		6.40	**		20	0.02519	794	401	38624	10401
04/24	1673		89.66		7.80	**		38	0.02508	1515	457	40138	10445
04/25	1676		92.23		5.70	**		39	0.02466	1581	187	41720	10477
04/26	1676		91.19		5.10	**		38	0.02481	1532	1327	43251	10597
04/27	1662		90.97		5.90	**		95	0.02512	3781	1556	47033	10799
04/28	1668		91.68		6.90	**		109	0.02490	4377	651	51410	10937
04/29	1684		91.89		9.10	**		89	0.02455	3625	783	55035	11087
04/30	1683		91.02		9.40	**		121	0.02469	4900	1744	59935	11410
05/01	1684		91.21		9.80	*	**	40	0.02465	1623	1656	61558	11599
05/02	1680		93.40		10.20			84	0.04958	1694	597	63253	11598
05/03	1659		92.88		9.80	**		44	0.02491	1766	832	65019	11701
05/04	1674		90.47		9.90	**		67	0.02495	2685	1313	67704	11902
05/05	1662		93.48		9.20	**		107	0.02477	4320	1015	72024	12140
05/06	1640		90.80		8.40	**		73	0.02560	2852	1309	74875	12349
05/07	1664		92.10		9.20	**		42	0.02492	1685	696	76560	12458
05/08	1650		91.91		9.00	**		47	0.02523	1863	242	78423	12558
05/09	1663		91.36		8.80	**		47	0.02505	1876	636	80299	12680
05/10	1667		90.57		8.70	**		21	0.02508	837	797	81137	12754
05/11	1653		91.84		9.00	**		60	0.02518	2383	946	83519	12923
05/12	1644		91.08		8.80	**		20	0.02548	785	1103	84304	13015
05/13	1655	*	92.02	*	6.80	**		6	0.02512	239	288	84543	13033
05/14	1666	*	92.95		7.10	**		16	0.02477	646	257	85189	13074
05/15	1676	*	98.20		6.90	**		5	0.02384	210	311	85399	13091
05/16	1687	*	91.21		7.30	**		19	0.02458	773	302	86172	13143

Date	OBB Flow (cfs)		Fish Size (mm)		Turbidity (ntu)			Count	Efficiency	Daily Passage Estimate	Daily Passage SE	Cumulative Passage Estimate	Cumulative Passage SE
05/17	1698		93.70		7.10		**	10	0.02403	416	195	86588	13172
05/18	1658		95.79		6.10		**	14	0.02453	571	119	87159	13207
05/19	1693		99.50		6.20		**	10	0.02335	428	203	87587	13236
05/20	1697		95.00		5.80		**	19	0.02387	796	297	88383	13291
05/21	1670		95.45		5.40		**	23	0.02434	945	341	89328	13356
05/22	1525		94.12		6.40		**	8	0.02758	290	306	89618	13373
05/23	1151		95.89		7.90		**	9	0.03689	244	152	89862	13374
05/24	936		94.61		9.80		**	18	0.04411	408	144	90270	13365
05/25	901		95.10		8.90		**	20	0.04523	442	427	90712	13360
05/26	921		95.02		6.80		**	52	0.04453	1168	402	91880	13338
05/27	955		93.26		6.60		**	30	0.04377	685	435	92565	13333
05/28	958		94.57		7.40		**	15	0.04335	346	179	92911	13329
05/29	935		92.95		8.30		**	22	0.04455	494	160	93405	13320
05/30	935		93.33		7.90		**	9	0.04446	202	165	93608	13318
05/31	939		95.90		8.60		**	10	0.04369	229	35	93836	13314
06/01	945		98.00		9.80		**	10	0.04298	233	37	94069	13310
06/02	939		97.27		7.70		**	11	0.04336	254	120	94323	13306
06/03	933		92.00		6.80		**	2	0.04485	45	116	94367	13306
06/04	936		99.00		6.60		**	2	0.04305	46	67	94414	13305
06/05	933		102.00		8.30		**	7	0.04244	165	68	94579	13302
06/06	929		100.00		7.40		**	3	0.04305	70	72	94648	13301
06/07	976		91.00		7.90		**	1	0.04359	23	35	94671	13301
06/08	1281		99.25		8.60		**	4	0.03262	123	50	94794	13304
06/09	1275		93.00		8.78	*	**	2	0.03394	59	59	94853	13305
06/10	1279		91.00	*	8.97	*	**	0	0.03421	0	34	94853	13306
06/11	1300		89.00	*	9.15	*	**	0	0.03402	0	51	94853	13306
06/12	1308		87.00		9.33	*	**	3	0.03418	88	45	94941	13308
06/13	1292		90.00		9.52	*	**	2	0.03405	59	18	94999	13310
06/14	1200		87.00		9.70		**	2	0.03727	54	31	95053	13310
06/15	1077		87.67	*	8.80		**	0	0.04097	0	28	95053	13310
06/16	928		88.33	*	8.30		**	0	0.04595	0	13	95053	13310
06/17	848		89.00		7.50		**	1	0.04878	21	12	95074	13310
06/18	850		90.75	*	4.90		**	0	0.04824	0	12	95074	13310
06/19	844		92.50	*	5.30		**	0	0.04800	0	0	95074	13310
06/20	829		94.25	*	6.70		**	0	0.04811	0	12	95074	13310
06/21	821		96.00		6.00		**	1	0.04795	21	12	95094	13309
06/22	833		103.50	*	5.60		**	0	0.04557	0	13	95094	13309
06/23	811		111.00		5.70		**	1	0.04450	22	14	95117	13309
06/24	825		105.00		5.30		**	1	0.04549	22	13	95139	13308
06/25	842		101.33	*	5.00		**	0	0.04579	0	13	95139	13308
06/26	852		97.67	*	4.80		**	0	0.04636	0	12	95139	13308
06/27	831		94.00		5.40		**	1	0.04810	21	12	95160	13307
06/28	815		99.00	*	5.60		**	0	0.04739	0	12	95160	13307
06/29	776		104.00	*	6.40		**	0	0.04755	0	12	95160	13307
06/30	757		109.00		6.70		**	1	0.04696	21	13	95181	13307
07/01	752		101.00		6.70	*	**	1	0.04927	20	4	95201	13306

*Missing value estimate

**Turbidity value less than threshold value of 10 and was not used in prediction equation

Appendix A.4. Flow, turbidity, screw-trap count, and predicted screw-trap efficiency and daily and cumulative outmigration index values based on full-model trapping efficiency to turbidity relation, Caswell, 1997.

							Daily Passage		Cumulative Passage	
Date	OBB Flow (cfs)		Fish Size (mm)	Turbidity (ntu)		Count	Efficiency	Estimate	SE	Estimate	SE
03/19	1,618		64.47	11.80		15	0.06790	221	32	221	32
03/20	1,631		73.29	10.40		17	0.05831	292	192	512	199
03/21	1,645		71.77	12.80		35	0.06837	512	173	1024	280
03/22	1,558		73.06	11.10		36	0.06479	556	132	1580	338
03/23	1,362		74.85	10.80		48	0.07320	656	118	2236	401
03/24	1,175		73.98	10.60		42	0.08375	502	116	2737	456
03/25	876		73.53	10.20		32	0.10247	312	77	3050	488
03/26	524		76.10	12.10		30	0.14734	204	54	3253	514
03/27	621		77.05	14.00		22	0.15382	143	40	3396	536
03/28	595		77.18	13.40		28	0.15094	186	45	3582	563
03/29	601		73.43	10.70		21	0.12955	162	40	3744	584
03/30	605		81.78	8.70	**	23	0.06142	374	95	4118	607
03/31	616		79.73	10.10		30	0.11952	251	105	4369	650
04/01	618		76.27	10.80		45	0.12694	354	112	4724	708
04/02	614		80.18	10.50	*	22	0.12248	180	104	4903	742
04/03	597		82.26	10.20		27	0.12040	224	51	5128	779
04/04	599		78.50	9.40	**	28	0.06281	446	200	5574	830
04/05	602		79.19	8.70	**	48	0.06243	769	230	6342	911
04/06	597		81.02	9.30	**	51	0.06205	822	158	7164	992
04/07	590		83.18	6.30	**	39	0.06167	632	224	7797	1079
04/08	602		83.54	7.80	**	26	0.06097	426	178	8223	1138
04/09	599		80.76	8.40	**	46	0.06205	741	296	8964	1249
04/10	598		80.42	8.80	**	60	0.06221	964	235	9929	1370
04/11	589		83.84	8.40	**	37	0.06150	602	208	10531	1456
04/12	730		83.37	7.80	**	49	0.05521	888	163	11418	1558
04/13	1,164		82.86	10.30		45	0.07898	570	180	11988	1629
04/14	1,711		82.78	12.50		68	0.05996	1134	339	13122	1736
04/15	1,707		81.32	12.50		37	0.06063	610	314	13732	1812
04/16	1,651		84.22	11.20		37	0.05710	648	459	14380	1927
04/17	1,668		84.68	11.30		81	0.05658	1431	491	15812	2119
04/18	1,684		83.63	12.00		43	0.05893	730	524	16541	2259
04/19	1,680		80.86	13.90		22	0.06821	323	228	16864	2309
04/20	1,695		85.02	13.40		51	0.06374	800	289	17664	2429
04/21	1,685		83.36	12.40		28	0.06059	462	208	18126	2494
04/22	1,668		85.39	11.40		38	0.05675	670	277	18796	2593
04/23	1,679		86.80	11.00		10	0.05433	184	305	18980	2634
04/24	1,682	*	85.00	10.50		9	0.05291	170	183	19150	2661
04/25	1,686		84.54	10.00		26	0.05110	509	247	19659	2730
04/26	1,691		85.16	10.30		32	0.05178	618	196	20277	2811
04/27	1,716		84.53	10.10		15	0.05025	299	285	20575	2860
04/28	1,685		90.00	9.90	**	4	0.02479	161	348	20736	2889
04/29	1,686		85.57	9.20	**	21	0.02540	827	477	21563	2951
04/30	1,680		87.56	8.90	**	27	0.02524	1070	507	22633	3034
05/01	1,682		93.00	9.40	**	3	0.02444	123	491	22756	3081
05/02	1,672		86.60	9.70	**	15	0.02554	587	784	23343	3201
05/03	1,653		86.33	9.50	**	42	0.02598	1617	544	24960	3307
05/04	1,648		88.71	9.30	**	28	0.02574	1088	399	26048	3384
05/05	1,659		86.26	9.40	**	47	0.02586	1817	757	27865	3544

	OBB	Fish Size		Turbidity				Daily Passage		Cumulative Passage	
Date	Flow (cfs)	(mm)		(ntu)		Count	Efficiency	Estimate	SE	Estimate	SE
05/06	1,633	91.00		8.90	**	9	0.02572	350	745	28215	3643
05/07	1,653	90.53		9.00	**	32	0.02537	1261	512	29476	3754
05/08	1,636	88.41		9.20	**	29	0.02603	1114	129	30591	3818
05/09	1,662	87.65		8.80	**	31	0.02560	1211	205	31802	3890
05/10	1,652	86.13		9.10	**	23	0.02603	884	221	32685	3943
05/11	1,639	89.33		8.90	**	21	0.02583	813	105	33498	3997
05/12	1,642	86.04		8.80	**	24	0.02625	914	295	34412	4058
05/13	1,581	88.14		8.60	**	35	0.02726	1284	241	35696	4147
05/14	1,038	89.61		8.70	**	31	0.04181	741	216	36438	4208
05/15	1,571	90.89		9.00	**	19	0.02706	702	622	37140	4306
05/16	1,613	90.73		9.40	**	52	0.02618	1987	947	39127	4552
05/17	1,602	89.20		9.30	**	5	0.02664	188	930	39314	4659
05/18	1,616	89.78		8.90	**	42	0.02625	1600	1115	40914	4901
05/19	1,621	89.36		9.10	**	62	0.02621	2366	550	43280	5095
05/20	1,598	88.95		9.20	**	38	0.02676	1420	749	44700	5249
05/21	1,600	88.43		9.00	**	23	0.02680	858	293	45558	5318
05/22	1,607	91.07		9.08	* **	30	0.02625	1143	611	46701	5443
05/23	1,506	92.33	*	9.15	* **	0	0.02829	0	534	46701	5469
05/24	1,218	93.58		9.23	* **	12	0.03542	339	443	47040	5516
05/25	1,233	90.45		9.30	**	31	0.03561	871	555	47910	5610
05/26	1,224	88.58		9.40	**	51	0.03624	1407	569	49317	5738
05/27	1,398	90.27		9.70	**	11	0.03122	352	791	49670	5820
05/28	1,608	90.17		9.60	**	6	0.02636	228	740	49897	5884
05/29	1,615	90.59		9.80	**	42	0.02615	1606	860	51503	6070
05/30	1,468	87.00		9.50	**	2	0.03005	67	725	51570	6117
05/31	1,395	90.43		9.40	**	7	0.03127	224	88	51794	6135
06/01	1,386	94.00		9.50	**	3	0.03087	97	130	51891	6145
06/02	1,594	89.45		9.30	**	11	0.02677	411	155	52302	6178
06/03	1,603	89.29		9.70	**	7	0.02660	263	172	52565	6200
06/04	1,611	92.00		10.20		2	0.05276	38	55	52603	6205
06/05	1,609	86.57		10.50		7	0.05555	126	62	52729	6220
06/06	1,547	88.75		10.30		8	0.05686	141	53	52869	6237
06/07	1,194	86.00		11.10		3	0.08004	37	41	52907	6241
06/08	949	92.50		11.50		2	0.09562	21	22	52928	6244
06/09	907	90.17		12.60		6	0.10723	56	23	52984	6251
06/10	924	93.67		12.90		3	0.10602	28	21	53012	6255
06/11	917	93.86		12.50		7	0.10376	67	26	53080	6265
06/12	913	88.00		12.60		6	0.10796	56	15	53135	6271
06/13	915	86.80		12.30		5	0.10640	47	17	53182	6277
06/14	908	92.33		11.90		3	0.10129	30	16	53212	6281
06/15	905	93.50		12.10		2	0.10221	20	21	53231	6284
06/16	908	86.33		11.15	*	6	0.09954	60	29	53292	6290
06/17	903	88.00		10.20		1	0.09311	11	27	53302	6292
06/18	896	92.00		10.70		3	0.09470	32	17	53334	6296
06/19	898	94.50		11.00		4	0.09517	42	11	53376	6302
06/20	912	98.00		10.60		3	0.09008	33	10	53409	6306
06/21	921	89.25		10.50		4	0.09306	43	11	53452	6312
06/22	916	92.00		9.80	**	4	0.04546	88	28	53540	6319
06/23	918	94.50		10.10		2	0.08839	23	18	53563	6322
06/24	925	92.00		9.60	**	1	0.04514	22	22	53585	6324
06/25	917	92.00	*	10.30		0	0.09081	0	6	53585	6324
06/26	882	92.00	*	10.70		0	0.09571	0	0	53585	6324
06/27	792	92.00	*	11.40		0	0.10710	0	0	53585	6324

*Missing value estimate

Date	OBB Flow (cfs)	Fish Size (mm)	Turbidity (ntu)	Count	Efficiency	Daily Passage Estimate	Daily Passage SE	Cumulative Passage Estimate	Cumulative Passage SE
**Turbidity value less than threshold value of 10 and was not used in prediction equation									

Appendix A.5. Flow, turbidity, screw-trap count, and predicted screw-trap efficiency and daily and cumulative outmigration index values based on full-model trapping efficiency to turbidity relation, Caswell, 1998.

Fry

Date	OBB Flow (cfs)	Fish Size (mm)	Turbidity (ntu)	Count	Predicted Efficiency	Daily Passage Estimate	Daily Passage SE	Cumulative Passage Estimate	Cumulative Passage SE
01/29/98	1,806	35.41	11.5	802	0.10465	7,663	3,850	7,663	3,850
01/30/98	2,623	35.79	11.6	286	0.08847	3,233	3,784	10,896	5,566
01/31/98	2,629	35.22	12.3	195	0.09363	2,083	1,358	12,979	5,906
02/01/98	2,526	35.53	13	427.73	0.09942	4,302	4,762	17,281	7,938
02/02/98	2,524	35.84	13.7	1085	0.10339	10,494	4,760	27,776	10,240
02/03/98	3,854	37.65	20.3	332	0.11639	2,852	3,651	30,628	11,496
02/04/98	3,767	37.25	25.06	512.07	0.16036	3,193	1,790	33,821	12,495
02/05/98	5,497	36.85	29.82	617.7	0.15529	3,978	3,288	37,799	14,600
02/06/98	4,915	36.45	34.58	759.13	0.22961	3,306	2,280	41,105	16,340
02/07/98	4,333	36.05	39.34	850.62	0.32577	2,611	1,594	43,716	17,557
02/08/98	5,434	35.65	44.1	1180	0.34894	3,382	2,373	47,098	19,536
02/09/98	5,460	35.74	38.6	1057.41	0.26357	4,012	3,007	51,110	22,153
02/10/98	5,095	35.83	33.1	1003.05	0.20699	4,846	3,437	55,956	25,262
02/11/98	5,004	35.91	27.6	1041.97	0.1518	6,864	5,173	62,820	29,783
02/12/98	4,850	36	22.1	1498.57	0.11068	13,539	9,597	76,359	38,492
02/13/98	4,772	36.09	16.6	897	0.07841	11,439	8,813	87,798	45,793
02/14/98	4,508	37.4	14.7	849	0.07097	11,962	7,278	99,760	52,635
02/15/98	4,358	36.51	12.1	1022	0.06271	16,297	17,194	116,057	63,103
02/16/98	5,003	37.32	0	2509	0.02321	108,109	91,035	224,166	142,301
02/17/98	4,468	37.86	10	227	0.05158	4,401	26,641	228,567	147,098
02/18/98	5,064	39.05	10.8	62	0.0467	1,328	2,560	229,895	147,989
02/19/98	4,481	37.04	11.6	273	0.05839	4,676	3,762	234,571	150,530
02/20/98	4,530	37.41	16.5	352	0.07963	4,421	2,791	238,991	152,971
02/21/98	4,566	35.55	18.9	393	0.09626	4,083	2,546	243,074	155,246
02/22/98	4,571	36.59	10.4	316	0.05332	5,927	4,519	249,001	158,592
02/23/98	4,201	36.33	14.7	110	0.07744	1,421	1,540	250,421	159,292
02/24/98	3,746	36.51	10.1	191	0.06236	3,063	1,508	253,484	160,502
02/25/98	3,746	36.53	0	188	0.03113	6,039	2,591	259,523	162,775
02/26/98	3,751	37.96	0	159	0.03011	5,280	2,317	264,803	164,778
02/27/98	3,700	38.17	0	149	0.03031	4,916	2,022	269,719	166,595
02/28/98	3,709	39.16	0	162	0.02958	5,477	2,533	275,196	168,641
03/01/98	3,713	39.38	0	97	0.02941	3,299	1,756	278,495	169,880
03/02/98	3,508	38.24	0	123	0.03156	3,898	1,627	282,393	171,176
03/03/98	2,967	38.95	0	74	0.03494	2,118	1,475	284,511	171,650
03/04/98	2,450	38.96	0	27	0.03909	691	612	285,201	171,731
03/05/98	2,048	43.98	0	49	0.03812	1,286	391	286,487	171,776
03/06/98	2,106	46.85	10.6	52	0.07276	715	243	287,202	171,830

Fry

Date	OBB Flow (cfs)	Fish Size (mm)	Turbidity (ntu)	Count	Predicted Efficiency	Daily Passage Estimate	Daily Passage SE	Cumulative Passage Estimate	Cumulative Passage SE
03/07/98	2,071	40.48	0	25	0.04101	610	472	287,811	171,854

Fingerlings

Date	OBB Flow (cfs)	Fish Size (mm)	Turbidity (ntu)	Count	Predicted Efficiency	Daily Passage Estimate	Daily Passage SE	Cumulative Passage Estimate	Cumulative Passage SE
03/08/98	2,059	51.18	0	124	0.03235	3,833	2,054	3,833	2,054
03/09/98	2,089	50.89	0	216	0.03235	6,677	4,307	10,510	4,835
03/10/98	1,974	51.4	0	394	0.03279	12,014	3,201	22,524	6,044
03/11/98	1,721	50.73	0	242	0.03518	6,879	2,387	29,403	6,755
03/12/98	1,620	51.43	0	352	0.0354	9,944	4,262	39,346	8,415
03/13/98	1,577	54.59	0	68	0.03328	2,043	4,858	41,389	9,826
03/14/98	1,577	55.56	0	77	0.03257	2,364	363	43,754	9,965
03/15/98	1,574	50.41	0	78	0.03658	2,132	570	45,886	10,116
03/16/98	1,570	52.25	0	108	0.03513	3,074	2,459	48,960	10,606
03/17/98	1,569	54.01	0	238	0.03378	7,046	3,391	56,005	11,577
03/18/98	1,768	51.85	0	20	0.03396	589	3,633	56,595	12,170
03/19/98	2,798	54.62	0	29	0.02546	1,139	466	57,734	12,191
03/20/98	3,413	60.44	0	9	0.01948	462	646	58,196	12,200
03/21/98	3,365	51.5	0	7	0.02412	290	199	58,486	12,201
03/22/98	2,744	38	0	1	0.03747	27	245	58,513	12,204
03/23/98	2,499	63.89	0	19	0.02203	862	1,232	59,375	12,287
03/24/98	2,491	63.98	17.1	54	0.07159	754	340	60,129	12,310
03/25/98	2,657	66.83	0	48	0.0199	2,412	13,155	62,542	18,048
03/26/98	2,351	60.71	0	504	0.02447	20,600	9,792	83,142	21,030
03/27/98	1,883	65.09	0	244	0.02455	9,938	8,682	93,079	23,111
03/28/98	1,728	68.32	28.4	85	0.15736	540	775	93,619	23,144
03/29/98	1,593	65.71	15.4	14	0.07429	188	746	93,808	23,164
03/30/98	1,561	67.3	0	123	0.02507	4,907	2,288	98,715	23,469
03/31/98	1,582	68.24	0	59	0.02442	2,416	1,431	101,130	23,616
04/01/98	1,645	67	0	71	0.02478	2,866	443	103,996	23,747
04/02/98	1,580	72.02	0	62	0.02242	2,765	1,085	106,761	23,899
04/03/98	1,758	66.97	0	105	0.02418	4,342	3,575	111,103	24,368
04/04/98	1,649	67.67	12.9	227	0.05948	3,816	1,871	114,919	24,633
04/05/98	1,580	67.04	0	302	0.02511	12,027	5,678	126,946	25,883
04/06/98	1,561	61.3	0	37	0.02871	1,289	4,921	128,235	26,420
04/07/98	1,822	66.54	0	254	0.02408	10,548	6,136	138,783	27,669
04/08/98	2,080	67.35	0	312	0.02233	13,970	6,650	152,753	29,147
04/09/98	2,065	65.95	0	39	0.02313	1,686	6,506	154,439	29,956
04/10/98	2,062	66.36	0	66	0.02293	2,878	950	157,317	30,128
04/11/98	2,066	70.02	0	79	0.02108	3,747	559	161,064	30,345
04/12/98	2,069	71.92	0	71	0.02018	3,519	1,541	164,583	30,590
04/13/98	2,206	74.04	0	24	0.01865	1,287	1,452	165,870	30,701
04/14/98	2,182	82.4	0	25	0.01549	1,614	610	167,484	30,809
04/15/98	2,066	83.08	0	39	0.01565	2,493	637	169,976	30,979
04/16/98	2,051	78.23	0	27	0.01754	1,539	694	171,516	31,088
04/17/98	2,035	78.38	0	16	0.01754	912	560	172,428	31,154
04/18/98	1,996	73.88	0	8	0.01961	408	1,838	172,836	31,235
04/19/98	1,996	78.97	0	74	0.01746	4,239	2,077	177,075	31,589
04/20/98	2,008	74.43	0	23	0.01931	1,191	1,563	178,266	31,708
04/21/98	1,979	78.38	0	21	0.01776	1,182	188	179,448	31,791

Smolts

Date	OBB Flow (cfs)	Fish Size (mm)	Turbidity (ntu)	Count	Predicted Efficiency	Daily Passage Estimate	Daily Passage SE	Cumulative Passage Estimate	Cumulative Passage SE
04/22/98	1,982	84.93	0	27	0.01528	1,767	629.86	1,767	630
04/23/98	2,009	79.36	0	39	0.01725	2,261	537.73	4,028	941
04/24/98	2,057	81.92	0	26	0.0161	1,615	610.44	5,643	1,259
04/25/98	2,016	81.68	0	22	0.01634	1,347	681.76	6,989	1,559
04/26/98	1,992	80.07	0	42	0.01704	2,465	804.64	9,454	1,974
04/27/98	2,005	79.68	0	44	0.01714	2,567	1145.81	12,021	2,519
04/28/98	1,998	84.12	0	75	0.01551	4,836	1311.47	16,857	3,323
04/29/98	2,004	80.19	0	67	0.01695	3,953	645.02	20,810	3,827
04/30/98	2,014	83.7	0	72	0.0156	4,614	1401.68	25,424	4,645
05/01/98	2,019	82	0	101	0.01621	6,232	1699.35	31,656	5,695
05/02/98	1,972	81.98	0	57	0.01638	3,479	1880.26	35,135	6,436
05/03/98	2,008	82.71	0	45	0.01598	2,815	731.05	37,951	6,855
05/04/98	2,049	88.72	10	39	0.02794	1,396	1050.4	39,347	7,153
05/05/98	2,063	84.84	0	90	0.01504	5,985	1986.3	45,332	8,247
05/06/98	2,011	84.83	0	65	0.01522	4,272	2611.89	49,603	9,241
05/07/98	2,016	83.67	10.2	15	0.03198	469	1069.11	50,072	9,369
05/08/98	2,020	84.59	0	0	0.01527	0	994.06	50,072	9,422
05/09/98	2,025	85.51	0	30.36	0.01493	2,033	3267.83	52,105	10,253
05/10/98	2,005	86.43	0	95	0.01469	6,468	2668.03	58,573	11,461
05/11/98	2,004	87.35	0	88	0.01438	6,118	1125.61	64,690	12,391
05/12/98	2,033	86.04	0	94	0.01473	6,382	2132.34	71,073	13,489
05/13/98	2,088	89.84	0	45	0.01333	3,375	3371.41	74,448	14,445
05/14/98	2,027	88.35	0	133	0.01399	9,509	4591.23	83,956	16,530
05/15/98	2,017	86.46	0	158	0.01464	10,793	2150.62	94,750	18,215
05/16/98	2,019	86.21	0	132	0.01472	8,970	2196.98	103,719	19,676
05/17/98	2,028	84.03	0	113	0.01544	7,319	1856.62	111,038	20,829
05/18/98	2,023	87.32	0	89	0.01433	6,209	1554.79	117,247	21,872
05/19/98	2,016	85.33	0	118	0.01503	7,853	1887.36	125,100	23,149
05/20/98	2,027	87	0	80	0.01443	5,545	2979.06	130,646	24,229
05/21/98	2,010	87.08	0	37	0.01445	2,560	1555.87	133,205	24,695
05/22/98	2,036	87.19	0	59	0.01434	4,116	1413.13	137,321	25,409
05/23/98	2,033	86.68	0	25	0.01451	1,723	1287.42	139,044	25,724
05/24/98	2,061	87.75	0	53	0.01407	3,766	1213.36	142,810	26,385
05/25/98	2,077	85.72	0	40	0.01469	2,723	1164.33	145,532	26,854
05/26/98	2,067	86.7	0	71	0.0144	4,931	2459.96	150,463	27,778
05/27/98	2,060	85.4	0	5	0.01486	337	2225.14	150,800	27,922
05/28/98	2,086	88.73	0	41	0.01368	2,996	1857.33	153,796	28,505
05/29/98	2,035	91.31	0	51	0.01305	3,909	914.35	157,706	29,224
05/30/98	2,034	90.92	0	39	0.01317	2,962	2106.36	160,668	29,832
05/31/98	2,053	93.79	0	0	0.01227	0	1711.17	160,668	29,881
06/01/98	1,929	96.67	0	6	0.01181	508	2508.6	161,176	30,086
06/02/98	1,671	89.07	0	54	0.01489	3,626	1744.17	164,802	30,686
06/03/98	1,551	89	0	29	0.01532	1,893	1800.78	166,696	31,016
06/04/98	1,527	91.06	0	0	0.01469	0	2610.98	166,696	31,126
06/05/98	1,537	93.12	0	76	0.01398	5,436	3275.75	172,132	32,160
06/06/98	1,531	100.5	0	3	0.01182	254	3642.52	172,386	32,413
06/07/98	1,536	98.23	0	0	0.01244	0	139.27	172,386	32,414
06/08/98	1,539	95.95	0	0	0.01309	0	2909.94	172,386	32,544
06/09/98	1,515	93.68	0	66	0.01387	4,759	2903.37	177,144	33,437
06/10/98	1,528	96	0	1	0.01311	76	2608.96	177,220	33,552
06/11/98	1,557	93.93	0	15	0.01366	1,098	654.8	178,318	33,741
06/12/98	1,593	93.5	0	16	0.01369	1,169	467.66	179,487	33,940
06/13/98	1,564	94.54	0	25	0.01345	1,859	683.07	181,346	34,263
06/14/98	1,565	95.3	0	10	0.01322	757	965.56	182,102	34,408
06/15/98	1,621	95.9	10.2	0	0.02646	0	190.24	182,102	34,409
06/16/98	1,697	96.5	12.7	6	0.03057	196	118.5	182,299	34,445

Smolts

Date	OBB Flow (cfs)	Fish Size (mm)	Turbidity (ntu)	Count	Predicted Efficiency	Daily Passage Estimate	Daily Passage SE	Cumulative Passage Estimate	Cumulative Passage SE
06/17/98	1,947	105	15.2	1	0.02845	35	93.72	182,334	34,453
06/18/98	2,082	101.5	13.66	2	0.02684	75	43.95	182,408	34,469
06/19/98	2,146	100.38	12.11	0	0.02436	0	41.22	182,408	34,469
06/20/98	2,154	99.25	10.57	1.16	0.02238	52	32.69	182,460	34,480
06/21/98	2,132	98.13	0	1.11	0.01092	102	24.81	182,562	34,501
06/22/98	2,127	97	0	1	0.01121	89	52.99	182,651	34,519
06/23/98	2,119	92	0	2	0.0126	159	85.83	182,809	34,549
06/24/98	2,130	104.67	0	3	0.00939	319	182.92	183,129	34,624
06/25/98	2,155	106.14	0	0	0.00903	0	191.81	183,129	34,625
06/26/98	2,105	107.6	0	0	0.00883	0	45.12	183,129	34,625
06/27/98	2,094	109.07	0	0.69	0.00856	81	51.15	183,209	34,645
06/28/98	2,110	110.53	0	0.67	0.00824	81	32.39	183,291	34,665
06/29/98	2,120	112	0	1	0.00795	126	94.65	183,417	34,698
06/30/98	2,120	109	0	2	0.00852	235	134.64	183,651	34,757
07/01/98	2,112	106	0	0	0.00915	0	126.25	183,651	34,757
07/02/98	2,112	103	0	0	0.0098	0	117.82	183,651	34,757
07/03/98	2,116	100	0	2	0.01049	191	109.4	183,842	34,799
07/04/98	2,115	100	0	0.49	0.01049	47	88.94	183,889	34,809
07/05/98	2,125	100	0	0.32	0.01047	30	16.97	183,919	34,815
07/06/98	2,097	100	0	0.17	0.01054	16	15.5	183,935	34,819
07/07/98	2,077	100	0	0	0.01058	0	11.35	183,935	34,819

1. Daily natural chinook catch at Caswell, 1998.

Natural Chinook captured at Caswell (1:30pm to 1:29pm)

Date	North Trap	South Trap	Combined Traps	Date	North Trap	South Trap	Combined Traps	Date	North Trap	South Trap	Combined Traps
01/08	4	2	6	03/13	14	54	68	05/16	26	106	132
01/09	0	0	0	03/14	17	60	77	05/17	19	94	113
01/10	ns	ns	ns	03/15	23	55	78	05/18	16	73	89
01/11	0	0	0	03/16	23	85	108	05/19	45	73	118
01/12	0	3	3	03/17	32	206	238	05/20	15	65	80
01/13	ns	ns	ns	03/18	5	15	20	05/21	10	27	37
01/14	ns	ns	ns	03/19	8	21	29	05/22	10	49	59
01/15	ns	ns	ns	03/20	6	3	9	05/23	23	2	25
01/16	ns	ns	ns	03/21	3	4	7	05/24	11	42	53
01/17	ns	ns	ns	03/22	1	0	1	05/25	6	34	40
01/18	ns	ns	ns	03/23	8	11	19	05/26	14	57	71
01/19	ns	ns	ns	03/24	4	50	54	05/27	0	5	5
01/20	ns	ns	ns	03/25	5	43	48	05/28	4	37	41
01/21	ns	ns	ns	03/26	68	436	504	05/29	12	39	51
01/22	ns	ns	ns	03/27	3	241	244	05/30	6	33	39
01/23	ns	ns	ns	03/28	7	78	85	05/31	0	0	0
01/24	ns	ns	ns	03/29	14	0	14	06/01	6	0	6
01/25	ns	ns	ns	03/30	16	107	123	06/02	4	50	54
01/26	ns	ns	ns	03/31	0	59	59	06/03	0	29	29
01/27	ns	ns	ns	04/01	16	55	71	06/04	0	0	0
01/28	ns	ns	ns	04/02	10	52	62	06/05	10	66	76
01/29	186	616	802	04/03	10	95	105	06/06	1	2	3
01/30	32	254	286	04/04	18	209	227	06/07	0	0	0
01/31	193	2	195	04/05	22	280	302	06/08	0	0	0
02/01	ns	ns	ns	04/06	8	29	37	06/09	9	57	66
02/02	37	1,048	1,085	04/07	28	226	254	06/10	1	0	1
02/03	259	73	332	04/08	29	283	312	06/11	4	11	15
02/04	ns	ns	ns	04/09	6	33	39	06/12	0	16	16
02/05	ns	ns	ns	04/10	11	55	66	06/13	16	9	25
02/06	ns	ns	ns	04/11	12	67	79	06/14	1	9	10
02/07	ns	ns	ns	04/12	2	69	71	06/15	0	0	0
02/08	138	1,042	1,180	04/13	1	23	24	06/16	2	4	6
02/09	ns	ns	ns	04/14	1	24	25	06/17	1	0	1
02/10	ns	ns	ns	04/15	5	34	39	06/18	0	2	2
02/11	ns	ns	ns	04/16	5	22	27	06/19	0	0	0
02/12	ns	ns	ns	04/17	3	13	16	06/20	ns	ns	ns
02/13	64	833	897	04/18	5	3	8	06/21	ns	ns	ns
02/14	156	693	849	04/19	24	50	74	06/22	0	1	1
02/15	104	918	1,022	04/20	3	20	23	06/23	1	1	2
02/16	158	2,351	2,509	04/21	10	11	21	06/24	0	3	3
02/17	49	178	227	04/22	3	24	27	06/25	0	0	0
02/18	1	61	62	04/23	8	31	39	06/26	0	0	0
02/19	30	243	273	04/24	10	16	26	06/27	ns	ns	ns
02/20	29	323	352	04/25	11	11	22	06/28	ns	ns	ns
02/21	50	343	393	04/26	5	37	42	06/29	0	1	1
02/22	22	294	316	04/27	11	33	44	06/30	1	1	2
02/23	19	91	110	04/28	17	58	75	07/01	0	0	0
02/24	22	169	191	04/29	12	55	67	07/02	0	0	0

Date	North Trap	South Trap	Combined Traps	Date	North Trap	South Trap	Combined Traps	Date	North Trap	South Trap	Combined Traps
02/25	26	162	188	04/30	17	55	72	07/03	0	2	2
02/26	32	127	159	05/01	15	86	101	07/04	ns	ns	ns
02/27	25	124	149	05/02	14	43	57	07/05	ns	ns	ns
02/28	23	139	162	05/03	7	38	45	07/06	ns	ns	ns
03/01	24	73	97	05/04	6	33	39	07/07	0	0	0
03/02	21	102	123	05/05	8	82	90	07/08	0	0	0
03/03	24	50	74	05/06	19	46	65	07/09	0	0	0
03/04	12	15	27	05/07	15	0	15	07/10	0	0	0
03/05	14	35	49	05/08	0	0	0	07/11	ns	ns	ns
03/06	22	30	52	05/09	ns	ns	ns	07/12	ns	ns	ns
03/07	21	4	25	05/10	13	82	95	07/13	0	0	0
03/08	27	97	124	05/11	33	55	88	07/14	0	0	0
03/09	55	161	216	05/12	21	73	94	07/15	ns	ns	ns
03/10	58	336	394	05/13	4	41	45	07/16	0	0	0
03/11	40	202	242	05/14	10	123	133	Totals	3,053	16,850	19,903
03/12	37	315	352	05/15	20	138	158				

ns = not sampling

2. Length frequencies by Julian week for all chinook measured at Caswell, 1998.

Length	Julian Week																												
Interval	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	totals	
20-29					1																							1	0.01%
30-39		9			369	100	520	489	346	93	26	6		1														1,959	27.17%
40-49					34		106	56	113	274	181	34	11	6			2											817	11.33%
50-59						1	9	9	25	237	180	86	84	76	35	7	2											751	10.42%
60-69								1	4	83	96	97	131	216	113	29	19	7		4								800	11.10%
70-79										21	18	37	94	103	74	64	100	107	36	71	34	3		1				763	10.58%
80-89										2	1	18	33	44	55	67	124	194	148	266	152	102	32	12	1			1,251	17.35%
90-99											1	3	5	8	25	25	49	69	78	146	85	97	80	43	2		1	717	9.95%
100-109																3	5	18	20	19	10	16	24	13	5	1	1	135	1.87%
110-119																		1		1	2	2	1	3		2		12	0.17%
120-129																												0	0.00%
130-139												1	1															2	0.03%
140-149										1																		1	0.01%
Totals	0	9	0	0	404	101	635	555	488	711	503	282	359	454	302	195	301	396	282	507	283	220	137	72	8	3	2	7,209	

3. Daily chinook number measured and mean length for each trap.

Number of chinook measured and mean lengths for each trap (1pm to 12:59pm)

	North Trap		South Trap		Combined Traps	
Date	# Meas.	Mean Len.	# Meas.	Mean Len.	# Meas.	Mean Len.
01/08/98	4	34.25	2	35.5	6	34.67
01/09/98	-	-	-	-	-	-
01/10/98	ns	-	ns	-	ns	-
01/11/98	-	-	-	-	-	-
01/12/98	-	-	3	36	3	36
01/13/98	ns	-	ns	-	ns	-
01/14/98	ns	-	ns	-	ns	-
01/15/98	ns	-	ns	-	ns	-
01/16/98	ns	-	ns	-	ns	-
01/17/98	ns	-	ns	-	ns	-
01/18/98	ns	-	ns	-	ns	-
01/19/98	ns	-	ns	-	ns	-
01/20/98	ns	-	ns	-	ns	-
01/21/98	ns	-	ns	-	ns	-
01/22/98	ns	-	ns	-	ns	-
01/23/98	ns	-	ns	-	ns	-
01/24/98	ns	-	ns	-	ns	-
01/25/98	ns	-	ns	-	ns	-
01/26/98	ns	-	ns	-	ns	-
01/27/98	ns	-	ns	-	ns	-
01/28/98	ns	-	ns	-	ns	-
01/29/98	50	35.08	50	35.74	100	35.41
01/30/98	32	35.31	50	36.1	82	35.79
01/31/98	50	35.22	-	-	50	35.22
02/01/98	ns	-	ns	-	ns	-
02/02/98	37	35.78	50	35.88	87	35.84
02/03/98	55	37.02	30	38.8	85	37.65
02/04/98	ns	-	ns	-	ns	-
02/05/98	ns	-	ns	-	ns	-
02/06/98	ns	-	ns	-	ns	-
02/07/98	ns	-	ns	-	ns	-
02/08/98	51	35.94	50	35.36	101	35.65
02/09/98	ns	-	ns	-	ns	-
02/10/98	ns	-	ns	-	ns	-
02/11/98	ns	-	ns	-	ns	-
02/12/98	ns	-	ns	-	ns	-
02/13/98	50	35.6	50	36.58	100	36.09
02/14/98	56	37.07	70	37.66	126	37.4
02/15/98	54	35.89	71	36.99	125	36.51
02/16/98	80	36.10	84	38.49	164	37.32
02/17/98	49	35.67	50	40.00	99	37.86
02/18/98	1	39	20	39.05	21	39.05
02/19/98	30	35.27	53	38.04	83	37.04
02/20/98	29	35.9	51	38.27	80	37.41
02/21/98	50	34.78	50	36.32	100	35.55
02/22/98	22	36.05	51	36.82	73	36.59
02/23/98	19	34.68	50	36.96	69	36.33
02/24/98	22	35.32	52	37.02	74	36.51
02/25/98	26	36.54	50	36.52	76	36.53
02/26/98	32	35.91	53	39.21	85	37.96
02/27/98	25	36.8	53	38.81	78	38.17
02/28/98	23	37.57	54	39.83	77	39.16
03/01/98	24	37.42	52	40.29	76	39.38

	North Trap		South Trap		Combined Traps	
Date	# Meas.	Mean Len.	# Meas.	Mean Len.	# Meas.	Mean Len.
03/02/98	21	36.05	50	39.16	71	38.24
03/03/98	24	38.12	50	39.34	74	38.95
03/04/98	12	39.08	15	38.87	27	38.96
03/05/98	14	36.86	35	46.83	49	43.98
03/06/98	22	44.59	30	48.5	52	46.85
03/07/98	21	40.52	4	40.25	25	40.48
03/08/98	27	47.15	70	52.73	97	51.18
03/09/98	55	49.31	100	51.76	155	50.89
03/10/98	38	50.5	121	51.68	159	51.4
03/11/98	40	50.02	100	51.01	140	50.73
03/12/98	37	49.73	120	51.95	157	51.43
03/13/98	14	52.5	54	55.13	68	54.59
03/14/98	17	54	51	56.08	68	55.56
03/15/98	13	45.23	36	52.28	49	50.41
03/16/98	23	49.65	50	53.44	73	52.25
03/17/98	32	51.69	70	55.07	102	54.01
03/18/98	5	47.2	15	53.4	20	51.85
03/19/98	8	47.38	21	57.38	29	54.62
03/20/98	6	64.5	3	52.33	9	60.44
03/21/98	-	-	4	51.5	4	51.5
03/22/98	1	38	-	-	1	38
03/23/98	8	60.25	11	66.55	19	63.89
03/24/98	4	67.75	50	63.68	54	63.98
03/25/98	5	71.6	43	66.28	48	66.83
03/26/98	29	54.86	142	61.91	171	60.71
03/27/98	3	58.67	50	65.48	53	65.09
03/28/98	7	71.57	50	67.86	57	68.32
03/29/98	14	65.71	-	-	14	65.71
03/30/98	16	69.38	50	66.64	66	67.3
03/31/98	-	-	50	68.24	50	68.24
04/01/98	16	68.94	50	66.38	66	67
04/02/98	10	76.7	50	71.08	60	72.02
04/03/98	10	67	50	66.96	60	66.97
04/04/98	17	69.12	50	67.18	67	67.67
04/05/98	22	67.09	51	67.02	73	67.04
04/06/98	8	60.75	29	61.45	37	61.3
04/07/98	28	67.25	50	66.14	78	66.54
04/08/98	29	68.24	50	66.84	79	67.35
04/09/98	6	67	33	65.76	39	65.95
04/10/98	11	67.73	50	66.06	61	66.36
04/11/98	12	71.17	50	69.74	62	70.02
04/12/98	2	70	50	72	52	71.92
04/13/98	1	67	23	74.35	24	74.04
04/14/98	1	89	24	82.12	25	82.4
04/15/98	5	80.6	34	83.44	39	83.08
04/16/98	5	86.6	21	76.24	26	78.23
04/17/98	3	76	13	78.92	16	78.38
04/18/98	5	73.8	3	74	8	73.88
04/19/98	24	79.71	50	78.62	74	78.97
04/20/98	3	75.67	20	74.25	23	74.43
04/21/98	10	76.5	11	80.09	21	78.38
04/22/98	3	83	24	85.17	27	84.93
04/23/98	8	82.38	31	78.58	39	79.36
04/24/98	9	81.78	16	82	25	81.92
04/25/98	11	82.64	11	80.73	22	81.68
04/26/98	5	85.4	37	79.35	42	80.07
04/27/98	11	78.55	33	80.06	44	79.68

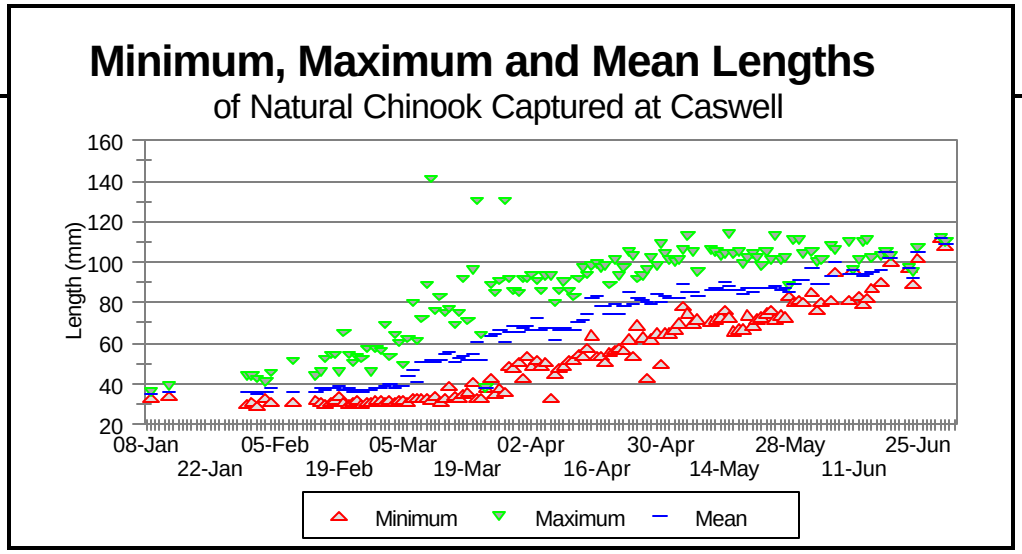
	North Trap		South Trap		Combined Traps	
Date	# Meas.	Mean Len.	# Meas.	Mean Len.	# Meas.	Mean Len.
04/28/98	17	84	50	84.16	67	84.12
04/29/98	12	82.33	50	79.68	62	80.19
04/30/98	17	87.41	50	82.44	67	83.7
05/01/98	15	84.87	50	81.14	65	82
05/02/98	14	80.93	43	82.33	57	81.98
05/03/98	7	83.43	38	82.58	45	82.71
05/04/98	6	87.67	33	88.91	39	88.72
05/05/98	8	88.75	50	84.22	58	84.84
05/06/98	19	84.53	46	84.96	65	84.83
05/07/98	15	83.67	-	-	15	83.67
05/08/98	-	-	-	-	-	-
05/09/98	ns	-	ns	-	ns	-
05/10/98	13	90.69	50	85.32	63	86.43
05/11/98	33	89.03	55	86.35	88	87.35
05/12/98	21	87.95	50	85.24	71	86.04
05/13/98	4	90.25	41	89.8	45	89.84
05/14/98	10	87.3	50	88.56	60	88.35
05/15/98	20	86.4	51	86.49	71	86.46
05/16/98	26	88.31	50	85.12	76	86.21
05/17/98	19	83.89	50	84.08	69	84.03
05/18/98	16	89.62	50	86.58	66	87.32
05/19/98	28	84.57	72	85.62	100	85.33
05/20/98	15	92.4	50	85.38	65	87
05/21/98	10	91.5	27	85.44	37	87.08
05/22/98	10	87.4	49	87.14	59	87.19
05/23/98	23	87.43	2	78	25	86.68
05/24/98	11	95.09	42	85.83	53	87.75
05/25/98	6	90.67	34	84.85	40	85.72
05/26/98	14	88.93	50	86.08	64	86.7
05/27/98	-	-	5	85.4	5	85.4
05/28/98	4	97.75	37	87.76	41	88.73
05/29/98	12	89	39	92.03	51	91.31
05/30/98	6	94	33	90.36	39	90.92
05/31/98	-	-	-	-	-	-
06/01/98	6	96.67	-	-	6	96.67
06/02/98	4	85.5	50	89.36	54	89.07
06/03/98	-	-	29	89	29	89
06/04/98	-	-	ns	-	-	-
06/05/98	10	94.3	65	92.94	75	93.12
06/06/98	1	95	1	106	2	100.5
06/07/98	-	-	-	-	-	-
06/08/98	-	-	-	-	-	-
06/09/98	9	93.44	50	93.72	59	93.68
06/10/98	1	96	-	-	1	96
06/11/98	4	93.75	11	94	15	93.93
06/12/98			16	93.5	16	93.5
06/13/98	15	96.47	9	91.33	24	94.54
06/14/98	1	98	9	95	10	95.3
06/15/98	-	-	-	-	-	-
06/16/98	2	93.5	4	98	6	96.5
06/17/98	1	105			1	105
06/18/98	-	-	2	101.5	2	101.5
06/19/98	-	-	-	-	-	-
06/20/98	ns	-	-	-	-	-
06/21/98	ns	-	-	-	-	-
06/22/98	-	-	1	97	1	97
06/23/98	1	89	1	95	2	92

	North Trap		South Trap		Combined Traps	
Date	**# Meas.**	**Mean Len.**	**# Meas.**	**Mean Len.**	**# Meas.**	**Mean Len.**
06/24/98	-	-	3	104.67	3	104.67
06/25/98	-	-	ns	-	-	-
06/26/98	-	-	-	-	-	-
06/27/98	ns	-	ns	-	ns	-
06/28/98	ns	-	ns	-	ns	-
06/29/98	-	-	1	112	1	112
06/30/98	1	108	1	110	2	109
07/01/98	-	-	ns	-	-	-
07/02/98	-	-	-	-	-	-
07/03/98	-	-	2	100	2	100
07/04/98	ns	-	ns	-	ns	-
07/05/98	ns	-	ns	-	ns	-
07/06/98	ns	-	ns	-	ns	-
07/07/98	-	-	-	-	-	-
07/08/98	-	-	-	-	-	-
07/09/98	-	-	-	-	-	-
07/10/98	-	-	-	-	-	-
07/11/98	ns	-	ns	-	ns	-
07/12/98	ns	-	ns	-	ns	-
07/13/98	-	-	-	-	-	-
07/14/98	-	-	-	-	-	-
07/15/98	ns	-	ns	-	ns	-
07/16/98	-	-	-	-	-	-
Totals	**2,149**		**5,060**		**7,209**	

4. Daily minimum, maximum and mean lengths of natural chinook captured at Caswell 1998.

Date	# Meas.	Min	Max	Mean	Date	# Meas.	Min	Max	Mean
01/08/98	6	33	36	34.67	04/13/98	24	58	94	74.04
01/09/98	-	-	-	-	04/14/98	25	64	98	82.40
01/10/98	-	-	-	-	04/15/98	39	54	99	83.08
01/11/98	-	-	-	-	04/16/98	26	54	97	78.23
01/12/98	3	34	39	36.00	04/17/98	16	51	98	78.38
01/13/98	-	-	-	-	04/18/98	8	56	89	73.88
01/14/98	-	-	-	-	04/19/98	74	57	101	78.97
01/15/98	-	-	-	-	04/20/98	23	58	93	74.43
01/16/98	-	-	-	-	04/21/98	21	57	97	78.38
01/17/98	-	-	-	-	04/22/98	27	62	105	84.93
01/18/98	-	-	-	-	04/23/98	39	54	103	79.36
01/19/98	-	-	-	-	04/24/98	25	69	92	81.92
01/20/98	-	-	-	-	04/25/98	22	63	93	81.68
01/21/98	-	-	-	-	04/26/98	42	43	96	80.07
01/22/98	-	-	-	-	04/27/98	44	62	102	79.68
01/23/98	-	-	-	-	04/28/98	67	65	98	84.12
01/24/98	-	-	-	-	04/29/98	62	50	109	80.19
01/25/98	-	-	-	-	04/30/98	67	65	104	83.70
01/26/98	-	-	-	-	05/01/98	65	65	101	82.00
01/27/98	-	-	-	-	05/02/98	57	67	100	81.98
01/28/98	-	-	-	-	05/03/98	45	70	101	82.71
01/29/98	100	30	44	35.41	05/04/98	39	78	106	88.72
01/30/98	82	31	44	35.79	05/05/98	58	75	113	84.84
01/31/98	50	29	42	35.22	05/06/98	65	70	105	84.83
02/01/98	-	-	-	-	05/07/98	15	72	95	83.67
02/02/98	87	33	41	35.84	05/08/98	-	-	-	-
02/03/98	85	31	45	37.65	05/09/98	-	-	-	-
02/04/98	-	-	-	-	05/10/98	63	71	106	86.43
02/05/98	-	-	-	-	05/11/98	88	72	105	87.35
02/06/98	-	-	-	-	05/12/98	71	73	103	86.04
02/07/98	-	-	-	-	05/13/98	45	76	104	89.84
02/08/98	101	31	51	35.65	05/14/98	60	73	114	88.35
02/09/98	-	-	-	-	05/15/98	71	66	104	86.46
02/10/98	-	-	-	-	05/16/98	76	67	105	86.21
02/11/98	-	-	-	-	05/17/98	69	67	99	84.03
02/12/98	-	-	-	-	05/18/98	66	74	102	87.32
02/13/98	100	32	44	36.09	05/19/98	100	69	104	85.33
02/14/98	126	31	46	37.40	05/20/98	65	72	102	87.00
02/15/98	125	30	52	36.51	05/21/98	37	73	98	87.08
02/16/98	164	31	54	37.32	05/22/98	59	75	105	87.19
02/17/98	99	32	54	37.86	05/23/98	25	76	101	86.68
02/18/98	21	34	46	39.05	05/24/98	53	72	113	87.75
02/19/98	83	31	65	37.04	05/25/98	40	74	101	85.73
02/20/98	80	30	54	37.41	05/26/98	64	73	102	86.70
02/21/98	100	31	50	35.55	05/27/98	5	83	88	85.40
02/22/98	73	32	53	36.59	05/28/98	41	80	111	88.73
02/23/98	69	30	52	36.33	05/29/98	51	81	111	91.31
02/24/98	74	31	57	36.51	05/30/98	39	80	104	90.92
02/25/98	76	31	46	36.53	05/31/98	-	-	-	-
02/26/98	85	32	57	37.96	06/01/98	6	85	105	96.67
02/27/98	78	32	56	38.17	06/02/98	54	76	100	89.07
02/28/98	77	31	69	39.16	06/03/98	29	80	101	89.00
03/01/98	76	32	53	39.38	06/04/98	-	-	-	-
03/02/98	71	31	64	38.24	06/05/98	75	81	108	93.12

Date	# Meas.	Min	Max	Mean	Date	# Meas.	Min	Max	Mean
03/03/98	74	32	60	38.95	06/06/98	2	95	106	100.50
03/04/98	27	32	49	38.96	06/07/98	-	-	-	-
03/05/98	49	31	62	43.98	06/08/98	-	-	-	-
03/06/98	52	33	80	46.85	06/09/98	59	81	110	93.68
03/07/98	25	33	61	40.48	06/10/98	1	96	96	96.00
03/08/98	97	33	72	51.18	06/11/98	15	83	101	93.93
03/09/98	155	33	89	50.89	06/12/98	16	79	110	93.50
03/10/98	159	32	141	51.40	06/13/98	24	82	111	94.54
03/11/98	140	34	76	50.73	06/14/98	10	87	102	95.30
03/12/98	157	31	83	51.43	06/15/98	-	-	-	-
03/13/98	68	33	75	54.59	06/16/98	6	90	103	96.50
03/14/98	68	39	77	55.56	06/17/98	1	105	105	105.00
03/15/98	49	34	69	50.41	06/18/98	2	100	103	101.50
03/16/98	73	33	75	52.25	06/19/98	-	-	-	-
03/17/98	102	35	92	54.01	06/20/98	-	-	-	-
03/18/98	20	36	71	51.85	06/21/98	-	-	-	-
03/19/98	29	41	96	54.62	06/22/98	1	97	97	97.00
03/20/98	9	33	130	60.44	06/23/98	2	89	95	92.00
03/21/98	4	33	64	51.50	06/24/98	3	102	107	104.67
03/22/98	1	38	38	38.00	06/25/98	-	-	-	-
03/23/98	19	43	89	63.89	06/26/98	-	-	-	-
03/24/98	54	35	85	63.98	06/27/98	-	-	-	-
03/25/98	48	38	91	66.83	06/28/98	-	-	-	-
03/26/98	171	36	130	60.71	06/29/98	1	112	112	112.00
03/27/98	53	49	92	65.09	06/30/98	2	108	110	109.00
03/28/98	57	48	86	68.32	07/01/98	-	-	-	-
03/29/98	14	51	85	65.71	07/02/98	-	-	-	-
03/30/98	66	43	92	67.30	07/03/98	2	98	102	100.00
03/31/98	50	54	92	68.24	07/04/98	-	-	-	-
04/01/98	66	49	94	67.00	07/05/98	-	-	-	-
04/02/98	60	52	91	72.02	07/06/98	-	-	-	-
04/03/98	60	49	86	66.97	07/07/98	-	-	-	-
04/04/98	67	51	93	67.67	07/08/98	-	-	-	-
04/05/98	73	33	93	67.04	07/09/98	-	-	-	-
04/06/98	37	45	80	61.30	07/10/98	-	-	-	-
04/07/98	78	48	86	66.54	07/11/98	-	-	-	-
04/08/98									-
04/09/98									-
04/10/98									-
04/11/98									-
04/12/98									-

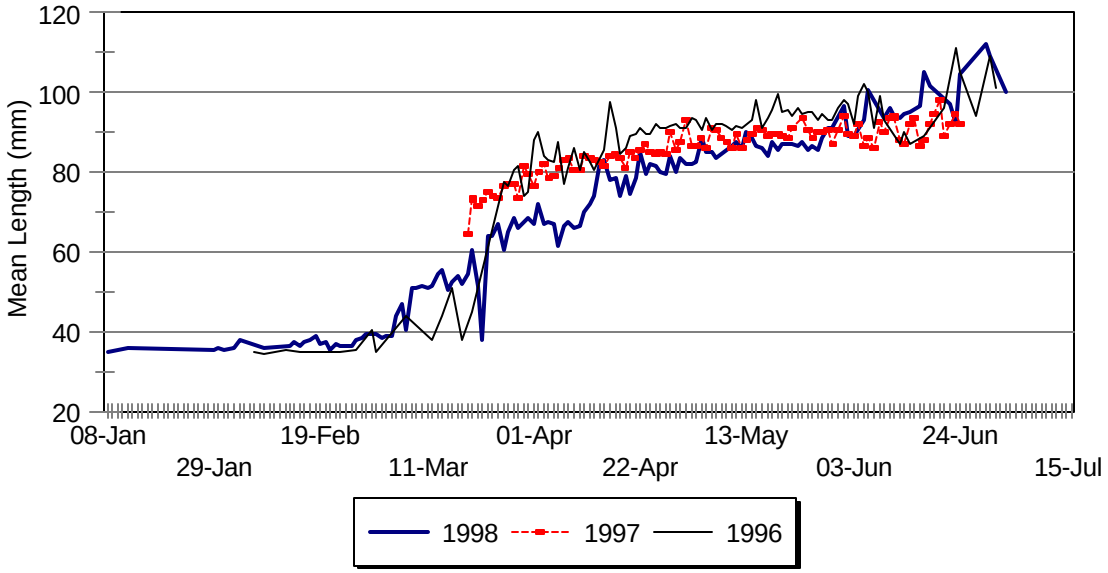


5. Daily chinook mean lengths for the 1996, 1997, and 1998 sampling seasons.

	Combined Mean Length				Combined Mean Length				Combined Mean Length		
Date	1998	1997	1996	Date	1998	1997	1996	Date	1998	1997	1996
08-Jan	34.67	-	-	12-Mar	51.43	-	38.00	15-May	86.46	90.89	98.20
09-Jan	-	-	-	13-Mar	54.59	-	-	16-May	86.21	90.73	91.21
10-Jan	-	-	-	14-Mar	55.56	-	44.00	17-May	84.03	89.20	93.70
11-Jan	-	-	-	15-Mar	50.41	-	-	18-May	87.32	89.78	95.79
12-Jan	36.00	-	-	16-Mar	52.25	-	51.00	19-May	85.33	89.36	99.50
13-Jan	-	-	-	17-Mar	54.01	-	-	20-May	87.00	88.95	95.00
14-Jan	-	-	-	18-Mar	51.85	-	38.00	21-May	87.08	88.43	95.45
15-Jan	-	-	-	19-Mar	54.62	64.47	-	22-May	87.19	91.07	94.12
16-Jan	-	-	-	20-Mar	60.44	73.29	45.00	23-May	86.68	-	95.89
17-Jan	-	-	-	21-Mar	51.50	71.77	-	24-May	87.75	93.58	94.61
18-Jan	-	-	-	22-Mar	38.00	73.06	-	25-May	85.72	90.45	95.10
19-Jan	-	-	-	23-Mar	63.89	74.85	-	26-May	86.70	88.58	95.02
20-Jan	-	-	-	24-Mar	63.98	73.98	-	27-May	85.40	90.27	93.26
21-Jan	-	-	-	25-Mar	66.83	73.53	-	28-May	88.73	90.17	94.57
22-Jan	-	-	-	26-Mar	60.71	76.37	77.50	29-May	91.31	90.59	92.95
23-Jan	-	-	-	27-Mar	65.09	77.05	76.50	30-May	90.92	87.00	93.33
24-Jan	-	-	-	28-Mar	68.32	77.18	80.43	31-May	-	90.43	95.90
25-Jan	-	-	-	29-Mar	65.71	73.43	81.70	01-Jun	96.67	94	98.00
26-Jan	-	-	-	30-Mar	67.30	81.78	74.00	02-Jun	89.07	89.45	97.27
27-Jan	-	-	-	31-Mar	68.24	79.73	74.80	03-Jun	89.00	89.29	92.00
28-Jan	-	-	-	01-Apr	67.00	76.27	88.00	04-Jun	-	92	99.00
29-Jan	35.41	-	-	02-Apr	72.02	80.18	90.00	05-Jun	93.12	86.57	102.00
30-Jan	35.79	-	-	03-Apr	66.97	82.26	84.00	06-Jun	100.50	88.75	100.00
31-Jan	35.22	-	-	04-Apr	67.67	78.50	82.94	07-Jun	-	86	91.00
01-Feb	-	-	-	05-Apr	67.04	79.19	82.78	08-Jun	-	92.5	99.25
02-Feb	35.84	-	-	06-Apr	61.30	81.02	87.50	09-Jun	93.68	90.17	93.00
03-Feb	37.65	-	-	07-Apr	66.54	83.18	76.92	10-Jun	96.00	93.67	-
04-Feb	-	-	-	08-Apr	67.35	83.54	81.00	11-Jun	93.93	93.86	-
05-Feb	-	-	-	09-Apr	65.95	80.76	86.17	12-Jun	93.50	88	87.00
06-Feb	-	-	34.92	10-Apr	66.36	80.42	80.75	13-Jun	94.54	86.8	90.00
07-Feb	-	-	-	11-Apr	70.02	83.84	85.00	14-Jun	95.30	92.33	87.00
08-Feb	35.65	-	34.10	12-Apr	71.92	83.37	82.56	15-Jun	-	93.5	-
09-Feb	-	-	-	13-Apr	74.04	82.86	80.50	16-Jun	96.50	86.33	-
10-Feb	-	-	-	14-Apr	82.40	82.78	-	17-Jun	105.00	88	89.00
11-Feb	-	-	-	15-Apr	83.08	81.32	85.50	18-Jun	101.50	92	-
12-Feb	-	-	35.17	16-Apr	78.23	84.22	97.50	19-Jun	-	94.5	-
13-Feb	36.09	-	-	17-Apr	78.38	84.68	91.33	20-Jun	-	98	-
14-Feb	37.40	-	-	18-Apr	73.88	83.63	84.67	21-Jun	-	89.25	96.00
15-Feb	36.51	-	34.76	19-Apr	78.97	80.86	86.20	22-Jun	97.00	92	-
16-Feb	37.32	-	-	20-Apr	74.43	85.02	89.00	23-Jun	92.00	94.5	111.00
17-Feb	37.86	-	-	21-Apr	78.38	83.36	89.77	24-Jun	104.67	92	105.00
18-Feb	39.05	-	-	22-Apr	84.93	85.39	91.08	25-Jun	-	-	-
19-Feb	37.04	-	34.78	23-Apr	79.36	86.80	89.65	26-Jun	-	-	-
20-Feb	37.41	-	-	24-Apr	81.92	85.00	89.66	27-Jun	-	-	94.00
21-Feb	35.55	-	-	25-Apr	81.68	84.54	92.23	28-Jun	-	-	-
22-Feb	36.59	-	-	26-Apr	80.07	85.16	91.19	29-Jun	112.00	-	-
23-Feb	36.33	-	35.00	27-Apr	79.68	84.53	90.97	30-Jun	109.00	-	109.00
24-Feb	36.51	-	-	28-Apr	84.12	90.00	91.68	01-Jul	-	-	101.00
25-Feb	36.53	-	-	29-Apr	80.19	85.57	91.89	02-Jul	-	-	-
26-Feb	37.96	-	35.55	30-Apr	83.70	87.56	91.02	03-Jul	100.00	-	-
27-Feb	38.17	-	-	01-May	82.00	93.00	91.21	04-Jul	-	-	-
28-Feb	39.16	-	-	02-May	81.98	86.60	93.40	05-Jul	-	-	-
29-Feb	**x**	**x**	40.40	03-May	82.71	86.33	92.88	06-Jul	-	-	-

	Combined Mean Length				Combined Mean Length				Combined Mean Length		
Date	**1998**	**1997**	**1996**	**Date**	**1998**	**1997**	**1996**	**Date**	**1998**	**1997**	**1996**
01-Mar	39.38	-	34.83	04-May	88.72	88.71	90.47	07-Jul	-	-	-
02-Mar	38.24	-	-	05-May	84.84	86.26	93.48	08-Jul	-	-	-
03-Mar	38.95	-	-	06-May	84.83	91.00	90.80	09-Jul	-	-	-
04-Mar	38.96	-	-	07-May	83.67	90.53	92.10	10-Jul	-	-	-
05-Mar	43.98	-	-	08-May	-	88.52	91.91	11-Jul	-	-	-
06-Mar	46.85	-	-	09-May	-	87.65	91.36	12-Jul	-	-	-

Daily Chinook Mean Length 1996 to 1998



6. Daily smolt index values for all chinook rated during 1998.

	ST004N				ST004S				Combined			
Date2	# 1	# 2	# 3	Mean	# 1	# 2	# 3	Mean Index	# 1	# 2	# 3	Mean Index
01/08/98	4			1.00	2			1.00	6			1.00
01/09/98												
01/10/98												
01/11/98												
01/12/98					3			1.00	3			1.00
01/13/98												
01/14/98												
01/15/98												
01/16/98												
01/17/98												
01/18/98												
01/19/98												
01/20/98												
01/21/98												
01/22/98												
01/23/98												
01/24/98												
01/25/98												
01/26/98												
01/27/98												
01/28/98												
01/29/98	50			1.00	50			1.00	100			1.00
01/30/98	32			1.00	50			1.00	82			1.00
01/31/98	50			1.00					50			1.00
02/01/98												
02/02/98	37			1.00	50			1.00	87			1.00
02/03/98	55			1.00	30			1.00	85			1.00
02/04/98												
02/05/98												
02/06/98												
02/07/98												
02/08/98	51			1.00	50			1.00	101			1.00
02/09/98												
02/10/98												
02/11/98												
02/12/98												
02/13/98	50			1.00	50			1.00	100			1.00
02/14/98	56			1.00	70			1.00	126			1.00
02/15/98	54			1.00	71			1.00	125			1.00
02/16/98	30			1.00	84			1.00	114			1.00
02/17/98	99			1.00	50			1.00	149			1.00
02/18/98	1			1.00	20			1.00	21			1.00
02/19/98	30			1.00	51	2		1.04	81	2		1.02
02/20/98	29			1.00	50	1		1.02	79	1		1.01
02/21/98	50			1.00	50			1.00	100			1.00
02/22/98	22			1.00	51			1.00	73			1.00
02/23/98	19			1.00	50			1.00	69			1.00
02/24/98	22			1.00	50	2		1.04	72	2		1.03

	ST004N				ST004S				Combined			
Date2	# 1	# 2	# 3	Mean	# 1	# 2	# 3	Mean Index	# 1	# 2	# 3	Mean Index
02/25/98	26			1.00	50			1.00	76			1.00
02/26/98	32			1.00	53			1.00	85			1.00
02/27/98	25			1.00	52	1		1.02	77	1		1.01
02/28/98	22	1		1.04	54			1.00	76	1		1.01
03/01/98	24			1.00	52			1.00	76			1.00
03/02/98	21			1.00	48	2		1.04	69	2		1.03
03/03/98	24			1.00	45	5		1.10	69	5		1.07
03/04/98	12			1.00	15			1.00	27			1.00
03/05/98	14			1.00	31	4		1.11	45	4		1.08
03/06/98	21	1		1.05	22	8		1.27	43	9		1.17
03/07/98	21			1.00	4			1.00	25			1.00
03/08/98	27			1.00	70			1.00	97			1.00
03/09/98	53	2		1.04	85	15		1.15	138	17		1.11
03/10/98	34	4		1.11	107	13	1	1.12	141	17	1	1.12
03/11/98	36	4		1.10	84	16		1.16	120	20		1.14
03/12/98	33	4		1.11	92	28		1.23	125	32		1.20
03/13/98	9	5		1.36	34	20		1.37	43	25		1.37
03/14/98	16	1		1.06	38	13		1.25	54	14		1.21
03/15/98	13			1.00	32	4		1.11	45	4		1.08
03/16/98	22	1		1.04	44	6		1.12	66	7		1.10
03/17/98	30	2		1.06	59	11		1.16	89	13		1.13
03/18/98	5			1.00	14	1		1.07	19	1		1.05
03/19/98	8			1.00	14	7		1.33	22	7		1.24
03/20/98	3	2	1	1.67	2	1		1.33	5	3	1	1.56
03/21/98					4			1.00	4			1.00
03/22/98	1			1.00					1			1.00
03/23/98	3	5		1.63	3	8		1.73	6	13		1.68
03/24/98	2	2		1.50	26	24		1.48	28	26		1.48
03/25/98	1	4		1.80	7	36		1.84	8	40		1.83
03/26/98	25	4		1.14	113	28	1	1.21	138	32	1	1.20
03/27/98	1	2		1.67	22	28		1.56	23	30		1.57
03/28/98	3	4		1.57	25	25		1.50	28	29		1.51
03/29/98	3	11		1.79					3	11		1.79
03/30/98	7	9		1.56	29	21		1.42	36	30		1.45
03/31/98					26	24		1.48	26	24		1.48
04/01/98	1	15		1.94	5	45		1.90	6	60		1.91
04/02/98	2	8		1.80	9	41		1.82	11	49		1.82
04/03/98		10		2.00	1	49		1.98	1	59		1.98
04/04/98		17		2.00		50		2.00		67		2.00
04/05/98	14	6	2	1.45	25	24	2	1.55	39	30	4	1.52
04/06/98		8		2.00	1	28		1.97	1	36		1.97
04/07/98		28		2.00	5	45		1.90	5	73		1.94
04/08/98	3	26		1.90	11	39		1.78	14	65		1.82
04/09/98	2	4		1.67		33		2.00	2	37		1.95
04/10/98	2	9		1.82	2	48		1.96	4	57		1.93
04/11/98	5	6	1	1.67	7	39	4	1.94	12	45	5	1.89
04/12/98		2		2.00	8	40	2	1.88	8	42	2	1.88
04/13/98	1			1.00		23		2.00	1	23		1.96
04/14/98		1		2.00		24		2.00		25		2.00
04/15/98		5		2.00	3	30	1	1.94	3	35	1	1.95
04/16/98		5		2.00	4	17		1.81	4	22		1.85
04/17/98		3		2.00		13		2.00		16		2.00

	ST004N				ST004S				Combined			
Date2	# 1	# 2	# 3	Mean	# 1	# 2	# 3	Mean Index	# 1	# 2	# 3	Mean Index
04/18/98	1	4		1.80	1	2		1.67	2	6		1.75
04/19/98	1	23		1.96		50		2.00	1	73		1.99
04/20/98		3		2.00	1	19		1.95	1	22		1.96
04/21/98		10		2.00		11		2.00		21		2.00
04/22/98		3		2.00		23	1	2.04		26	1	2.04
04/23/98		7	1	2.13	1	29	1	2.00	1	36	2	2.03
04/24/98	1	8		1.89		16		2.00	1	24		1.96
04/25/98		11		2.00		11		2.00		22		2.00
04/26/98		5		2.00	2	35		1.95	2	40		1.95
04/27/98		11		2.00		33		2.00		44		2.00
04/28/98		17		2.00	2	48		1.96	2	65		1.97
04/29/98		10	2	2.17	1	49		1.98	1	59	2	2.02
04/30/98		16	1	2.06		47	3	2.06		63	4	2.06
05/01/98		15		2.00		48	2	2.04		63	2	2.03
05/02/98		14		2.00		42	1	2.02		56	1	2.02
05/03/98		7		2.00		38		2.00		45		2.00
05/04/98		6		2.00		32	1	2.03		38	1	2.03
05/05/98		8		2.00		49	1	2.02		57	1	2.02
05/06/98		19		2.00		46		2.00		65		2.00
05/07/98		15		2.00						15		2.00
05/08/98												
05/09/98												
05/10/98		11	2	2.15		50		2.00		61	2	2.03
05/11/98		31	2	2.06		55		2.00		86	2	2.02
05/12/98		21		2.00		50		2.00		71		2.00
05/13/98		4		2.00		41		2.00		45		2.00
05/14/98		9	1	2.10		46	4	2.08		55	5	2.08
05/15/98		20		2.00		51		2.00		71		2.00
05/16/98		26		2.00		50		2.00		76		2.00
05/17/98		19		2.00		50		2.00		69		2.00
05/18/98		16		2.00		50		2.00		66		2.00
05/19/98		28		2.00		68	4	2.06		96	4	2.04
05/20/98		15		2.00		50		2.00		65		2.00
05/21/98		8	2	2.20		27		2.00		35	2	2.05
05/22/98		9	1	2.10		48	1	2.02		57	2	2.03
05/23/98		23		2.00		2		2.00		25		2.00
05/24/98		9	2	2.18		41	1	2.02		50	3	2.06
05/25/98		6		2.00		34		2.00		40		2.00
05/26/98		8	6	2.43		34	16	2.32		42	22	2.34
05/27/98						4	1	2.20		4	1	2.20
05/28/98		3	1	2.25		36	1	2.03		39	2	2.05
05/29/98		12		2.00		37	2	2.05		49	2	2.04
05/30/98		6		2.00		32	1	2.03		38	1	2.03
05/31/98												
06/01/98		4	2	2.33						4	2	2.33
06/02/98		4		2.00		49	1	2.02		53	1	2.02
06/03/98						28	1	2.03		28	1	2.03
06/04/98												
06/05/98		7	3	2.30		48	17	2.26		55	20	2.27
06/06/98		1		2.00			1	3.00		1	1	2.50
06/07/98												
06/08/98												

	ST004N				ST004S				Combined			
Date2	# 1	# 2	# 3	Mean	# 1	# 2	# 3	Mean Index	# 1	# 2	# 3	Mean Index
06/09/98		6	3	2.33		37	13	2.26		43	16	2.27
06/10/98		1		2.00						1		2.00
06/11/98			4	3.00			11	3.00			15	3.00
06/12/98						12	4	2.25		12	4	2.25
06/13/98		11	4	2.27		9		2.00		20	4	2.17
06/14/98		1		2.00		9		2.00		10		2.00
06/15/98												
06/16/98		1	1	2.50			4	3.00		1	5	2.83
06/17/98			1	3.00							1	3.00
06/18/98							2	3.00			2	3.00
06/19/98												
06/20/98												
06/21/98												
06/22/98							1	3.00			1	3.00
06/23/98			1	3.00			1	3.00			2	3.00
06/24/98							3	3.00			3	3.00
06/25/98												
06/26/98												
06/27/98												
06/28/98												
06/29/98							1	3.00			1	3.00
06/30/98			1	3.00			1	3.00			2	3.00
07/01/98												
07/02/98												
07/03/98							2	3.00			2	3.00
07/04/98												
07/05/98												
07/06/98												
07/07/98												
07/08/98												
07/09/98												
07/10/98												
07/11/98												
07/12/98												
07/13/98												
07/14/98												
07/15/98												
07/16/98												

7. Non-salmonids captured in the Caswell screw traps during 1998.

Code	Common name	Scientific name	Code	Common name	Scientific name
AFBH	Anal fin blue - hatchery	Not applicable	PL	Pacific lamprey	*Lampetra tridentata*
AFBN	Anal fin blue - natural	Not applicable	PRS	Prickly sculpin	*Cottus asper*
AFGH	Anal fin green - hatchery	Not applicable	RBT	Rainbow trout	*Onchorhyncus mykiss*
BCBH	Bottom caudal blue - hatchery	Not applicable	RES	Redear sunfish	*Lepomis microlophus*
BCGH	Bottom caudal green - hatchery	Not applicable	RFS	Riffle sculpin	*Cottus gulosus*
BGS	Bluegill	*Lepomis microlophus*	RSN	Red shiner	*Notropis lutrensis*
BKB	Black bullhead	*Ictalurus melas*	SSQ	Sacramento squawfish	*Ptychochelius grandis*
BKS	Black crappie	*Pomoxis nigromaculatus*	SSU	Sacramento sucker	*Catostomus occidentalis*
BRB	Brown bullhead	*Ictalurus nebulosus*	SMB	Smallmouth bass	*Micropterus dolomieui*
BRFN	Bar right front - natural	Not applicable	SP	Sacramento perch	*Archoplites interruptus*
BRRN	Bar right rear - natural	Not applicable	STB	Striped bass	*Morone saxatilis*
C	Carp	*Cyprinus carpio*	TCBH	Top caudal blue - hatchery	Not applicable
CHNF	Chinook salmon	*Onchorhyncus tshawytscha*	TCBN	Top caudal blue - natural	Not applicable
DFGH	Dorsal fin green - hatchery	Not applicable	TCGH	Top caudal green - hatchery	Not applicable
GF	Goldfish	*Carasius auratus*	TCGN	Top caudal green - natural	Not applicable
GSF	Green sunfish	*Lepomis cyanellus*	TFS	Threadfin shad	*Dorosoma petenense*
HH	Hardhead	*Mylopharodon conocephalus*	TP	Tule perch	*Hysterocarpus traski*
LAM	Lamprey - unidentified species	Not applicable	UNID	Unidentified species	Not applicable
LMB	Largemouth bass	*Micropterus salmoides*	WHC	White catfish	*Ictalurus catus*
MQK	Mosquitofish	*Gambusia affinis*	WHS	White crappie	*Pomoxis annularis*
			YEB	Yellow bullhead	*Ictalurus natalis*

Date	BGS	BKB	BKS	BRB	C	GF	GSF	HH	LAM	LMB	MQK	PL	PRS	RES	RFS	RSN	SSQ	SSU	SMB	SP	STB	TFS	TP	UNID	WHC	WHS	YEB
01/08/98									6			3													1		
01/09/98									8																		
01/10/98																											
01/11/98									153													2					
01/12/98									258	1	1							1				6					
01/13/98																											
01/14/98																											
01/15/98																											
01/16/98																											
01/17/98																											
01/18/98																											
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01/24/98																											
01/25/98																											
01/26/98																											
01/27/98																											
01/28/98																											
01/29/98			1								2							1								1	
01/30/98			1								1											2				1	
01/31/98																						1					
02/01/98																											
02/02/98		1																1				1				1	
02/03/98																											
02/04/98																											
02/05/98																											
02/06/98																											
02/07/98																											
02/08/98															1		13		2			2					4
02/09/98																											
02/10/98																											
02/11/98																											
02/12/98																											

Date	BGS	BKB	BKS	BRB	C	GF	GSF	HH	LAM	LMB	MQK	PL	PRS	RES	RFS	RSN	SSQ	SSU	SMB	SP	STB	TFS	TP	UNID	WHC	WHS	YEB
02/13/98		1	3												1		15	2								3	
02/14/98			1										1				18	2	1							2	
02/15/98	1		1		1												21										
02/16/98	1	1	2														32	1									
02/17/98	1																5										
02/18/98																											
02/19/98																	3									1	
02/20/98																	11										
02/21/98	1						1										20							1			
02/22/98							1										5	1						1			
02/23/98			1														4										
02/24/98	1													1			6	3									
02/25/98																	13								1		
02/26/98			1						1								3										
02/27/98			1												1		5										
02/28/98																	7					1					
03/01/98																	3										
03/02/98																	3										
03/03/98																	7	2									
03/04/98																	2										
03/05/98																	25	1									
03/06/98									2			1					11	1						1			
03/07/98										1		2					6										
03/08/98																	3	1						1	1		
03/09/98									1							2	51	1									
03/10/98						1					1						60										
03/11/98																	60	3									
03/12/98						1											62	3									
03/13/98	2								1								31	1									
03/14/98	1					1				1				1			79	5					1	1			
03/15/98						1											20	1						2			
03/16/98											1						36	2									
03/17/98	1						1										12										
03/18/98																	16							3			
03/19/98														1			12							2			
03/20/98											1						4	1						1			
03/21/98						1											3	3							1		
03/22/98																								1			
03/23/98																	7	3						1	1		
03/24/98																	1	1	1								
03/25/98																	6							1			
03/26/98																											
03/27/98	1										1						4	3									
03/28/98			1														5										
03/29/98																											
03/30/98											1						8										
03/31/98																	6	1						1			
04/01/98																	4										
04/02/98									1								7		1								
04/03/98																	3										
04/04/98																	1										
04/05/98																	2										
04/06/98																	2										
04/07/98									1								2							1			
04/08/98								2									23	1									
04/09/98																	3										
04/10/98			1														12										
04/11/98																	27	2									
04/12/98									1		2						22	1									
04/13/98								1									4										
04/14/98																	5									1	
04/15/98											1						7	3							1		
04/16/98									1		1						5	2									
04/17/98	1			1				1									5	1									
04/18/98																	2										
04/19/98						1					1						1										
04/20/98																	2	1								1	
04/21/98											1						1							1			

Date	BGS	BKB	BKS	BRB	C	GF	GSF	HH	LAM	LMB	MQK	PL	PRS	RES	RFS	RSN	SSQ	SSU	SMB	SP	STB	TFS	TP	UNID	WHC	WHS	YEB
04/22/98				1							1						4	1	1							1	
04/23/98																	2					1					
04/24/98																											
04/25/98																	2										
04/26/98																	1	1									
04/27/98																	1										
04/28/98														1			3										
04/29/98																	1	1	1								
04/30/98							1										2										
05/01/98			1								1						4								2		
05/02/98																	2					1			1		
05/03/98																	2										
05/04/98																	4										
05/05/98											3						7										
05/06/98																	4									1	
05/07/98																											
05/08/98																											
05/09/98																											
05/10/98																	43	1		1		2					
05/11/98			1														2					1					
05/12/98		2															18								1		
05/13/98	1									2							2					1					
05/14/98		1															14		1			1					
05/15/98				1								1					37										
05/16/98																	16										
05/17/98		1		1					1		2						25					1		1			
05/18/98																	13	1									
05/19/98				1							1						4										
05/20/98																	6										
05/21/98																	1										
05/22/98																	1										
05/23/98																											
05/24/98							1										4					1		2			
05/25/98																	5								1		
05/26/98																	4										
05/27/98	1									1														1			
05/28/98		1								3							7				1		1				
05/29/98	1																4										
05/30/98									1	1							5	3								1	
05/31/98																											
06/01/98				1																							
06/02/98	2																4					1	1				
06/03/98			2						1	2							8					1		1			
06/04/98	1								1								10										
06/05/98	1		1							1							1		1								
06/06/98																						1					
06/07/98																											
06/08/98																											
06/09/98			1							2	1						9					7		2	1		
06/10/98																	1										
06/11/98																	2							2		2	
06/12/98			1														1					1					
06/13/98																	1										
06/14/98																					1	1					
06/15/98																											
06/16/98																											
06/17/98																											
06/18/98										1						1	3							1	1		
06/19/98																											
06/20/98																											
06/21/98																											
06/22/98																	2	1	1				1	1			
06/23/98	1									2							3	1	20				1				
06/24/98		1	39							1							5										
06/25/98										1									10								
06/26/98																											
06/27/98																											
06/28/98																											

Date	BGS	BKB	BKS	BRB	C	GF	GSF	HH	LAM	LMB	MQK	PL	PRS	RES	RFS	RSN	SSQ	SSU	SMB	SP	STB	TFS	TP	UNID	WHC	WHS	YEB
06/29/98																	1	1	1						1		
06/30/98			1							1							1					1					
07/01/98	1																						1			1	
07/02/98																											
07/03/98			4														3		1			1					
07/04/98																											
07/05/98																											
07/06/98																											
07/07/98			31							1															1	1	
07/08/98										1																	
07/09/98			16							1							3										
07/10/98	1																										
07/11/98																											
07/12/98																											
07/13/98																											
07/14/98																											
07/15/98			2														1										
07/16/98			11							1													1				
Totals	21	9	125	6	1	6	5	4	438	25	24	7	1	4	3	3	1173	67	42	1	2	38	7	30	15	18	4

8. Number measured and mean lengths of non-salmonids captured, 1998.

	BGS		BKB		BKS		BRB		C		GF		GSF		HH		LAM		LMB		MQK		PL		PRS	
Date	**#**	**Avg**	**#**	**Avg**	**#**	**Avg**	**#**	**Avg**	**#**	**Avg**	**#**	**Avg**	**#**	**Avg**	**#**	**Avg**	**#**	**Avg**	**#**	**Avg**	**#**	**Avg**	**#**	**Avg**	**#**	**Avg**
01/08/98																	6	97					3	124		
01/09/98																										
01/10/98																										
01/11/98																										
01/12/98																			1	53	1	35				
01/13/98																										
01/14/98																										
01/15/98																										
01/16/98																										
01/17/98																										
01/18/98																										
01/19/98																										
01/20/98																										
01/21/98																										
01/22/98																										
01/23/98																										
01/24/98																										
01/25/98																										
01/26/98																										
01/27/98																										
01/28/98																										
01/29/98					1	89															2	24				
01/30/98					1	84															1	30				
01/31/98																										
02/01/98																										
02/02/98			1	175																						
02/03/98																										
02/04/98																										
02/05/98																										
02/06/98																										
02/07/98																										
02/08/98																										
02/09/98																										
02/10/98																										
02/11/98																										
02/12/98																										
02/13/98			1	97	3	51																				
02/14/98					1	140																			1	60
02/15/98	1	103			1	32			1	255																
02/16/98	1	120	1	202	2	86																				
02/17/98	1	52																								
02/18/98																										
02/19/98																										
02/20/98																										

	BGS		BKB		BKS		BRB		C		GF		GSF		HH		LAM		LMB		MQK		PL		PRS	
Date	#	Avg	#	Avg	#	Avg	#	Avg	#	Avg	#	Avg	#	Avg	#	Avg	#	Avg	#	Avg	#	Avg	#	Avg	#	Avg
02/21/98	1	153											1	76												
02/22/98													1	48												
02/23/98					1	140																				
02/24/98	1	61																								
02/25/98																										
02/26/98					1	71											1	140								
02/27/98					1	65																				
02/28/98																										
03/01/98																										
03/02/98																										
03/03/98																										
03/04/98																										
03/05/98																										
03/06/98																	2	95					1	145		
03/07/98																			1	50			2	118		
03/08/98																										
03/09/98																										
03/10/98											1	285									1	35				
03/11/98																										
03/12/98											1	205														
03/13/98	2	145															1	95								
03/14/98	1	122									1	254							1	50						
03/15/98											1	176														
03/16/98																					1	32				
03/17/98	1	27											1	37												
03/18/98																										
03/19/98																										
03/20/98																					1	41				
03/21/98											1	300														
03/22/98																										
03/23/98																										
03/24/98																										
03/25/98																										
03/26/98																										
03/27/98	1	35																			1	26				
03/28/98					1	83																				
03/29/98																										
03/30/98																					1	39				
03/31/98																										
04/01/98																										
04/02/98																										
04/03/98																										
04/04/98																										
04/05/98																										
04/06/98																										
04/07/98																										
04/08/98															2	42										
04/09/98																										
04/10/98					1	83																				
04/11/98																										
04/12/98																	1	105			2	33				
04/13/98															1	41										
04/14/98																										
04/15/98																					1	33				
04/16/98																					1	27				
04/17/98	1	60					1	167							1	38										
04/18/98																										
04/19/98											1	295									1	33				
04/20/98																										
04/21/98																					1	24				
04/22/98							1	122													1	30				
04/23/98																										
04/24/98																										
04/25/98																										
04/26/98																										
04/27/98																										
04/28/98																										
04/29/98																										

	BGS		BKB		BKS		BRB		C		GF		GSF		HH		LAM		LMB		MQK		PL		PRS	
Date	#	Avg	#	Avg	#	Avg	#	Avg	#	Avg	#	Avg	#	Avg	#	Avg	#	Avg	#	Avg	#	Avg	#	Avg	#	Avg
04/30/98													1	100												
05/01/98					1	122															1	35				
05/02/98																										
05/03/98																										
05/04/98																										
05/05/98																					3	36				
05/06/98																										
05/07/98																										
05/08/98																										
05/09/98																										
05/10/98																										
05/11/98					1	75																				
05/12/98			2	163																						
05/13/98	1	111																	2	145						
05/14/98			1	150																						
05/15/98							1	140															1	450		
05/16/98																										
05/17/98			1	115			1	241													2	37				
05/18/98																										
05/19/98							1	120													1	25				
05/20/98																										
05/21/98																										
05/22/98																										
05/23/98																										
05/24/98													1	54												
05/25/98																										
05/26/98																										
05/27/98	1	95																	1	29						
05/28/98			1	224															3	26						
05/29/98	1	98																								
05/30/98																			1	27						
05/31/98																										
06/01/98							1	137																		
06/02/98	2	97																								
06/03/98					2	38													2	31						
06/04/98	1	41																								
06/05/98	1	122			1	92													1	30						
06/06/98																										
06/07/98																										
06/08/98																										
06/09/98					1	112													2	29	1	24				
06/10/98																										
06/11/98																										
06/12/98					1	112																				
06/13/98																										
06/14/98																										
06/15/98																										
06/16/98																										
06/17/98																										
06/18/98																			1	32						
06/19/98																										
06/20/98																										
06/21/98																										
06/22/98																										
06/23/98	1	153																	2	33						
06/24/98			1	135	39	29													1	36						
06/25/98																			1	35						
06/26/98																										
06/27/98																										
06/28/98																										
06/29/98																										
06/30/98					1	99													1	36						
07/01/98	1	150																								
07/02/98																										
07/03/98					4	60																				
07/04/98																										
07/05/98																										
07/06/98																										

	BGS		BKB		BKS		BRB		C		GF		GSF		HH		LAM		LMB		MQK		PL		PRS	
Date	#	Avg	#	Avg	#	Avg	#	Avg	#	Avg	#	Avg	#	Avg	#	Avg	#	Avg	#	Avg	#	Avg	#	Avg	#	Avg
07/07/98					31	41													1	21						
07/08/98																			1	22						
07/09/98					16	39													1	22						
07/10/98	1	175																								
07/11/98																										
07/12/98																										
07/13/98																										
07/14/98																										
07/15/98					2	45																				
07/16/98					11	49													1	40						

	RES		RFS		RSN		SSQ		SSU		SMB		SP		STB		TFS		TP		UNID		WHC		WHS		YEB	
Date	#	Avg	#	Avg	#	Avg	#	Avg	#	Avg	#	Avg	#	Avg	#	Avg	#	Avg	#	Avg	#	Avg	#	Avg	#	Avg	#	Avg
01/08/98																							1	70				
01/09/98																												
01/10/98																												
01/11/98																	2	93										
01/12/98									1	32							6	92										
01/13/98																												
01/14/98																												
01/15/98																												
01/16/98																												
01/17/98																												
01/18/98																												
01/19/98																												
01/20/98																												
01/21/98																												
01/22/98																												
01/23/98																												
01/24/98																												
01/25/98																												
01/26/98																												
01/27/98																												
01/28/98																												
01/29/98									1	63															1	79		
01/30/98																	2	105							1	26		
01/31/98																	1	85										
02/01/98																												
02/02/98									1	41							1	118							1	46		
02/03/98																												
02/04/98																												
02/05/98																												
02/06/98																												
02/07/98																												
02/08/98			1	109			13	47			2	35					2	95									4	145
02/09/98																												
02/10/98																												
02/11/98																												
02/12/98																												
02/13/98			1	94			15	49	2	40															3	58		
02/14/98							18	47	2	43	1	42													2	69		
02/15/98							16	46																				
02/16/98							23	48	1	44																		
02/17/98							5	73																				
02/18/98																												
02/19/98							3	44																	1	58		
02/20/98							11	44																				
02/21/98							13	52													1	27						
02/22/98							5	47	1	60											1	29						
02/23/98							4	39																				
02/24/98	1	155					6	39	3	52																		
02/25/98							13	47															1	220				
02/26/98							3	47																				
02/27/98			1	85			5	47																				
02/28/98							7	43									1	90										
03/01/98							3	52																				
03/02/98							3	40																				

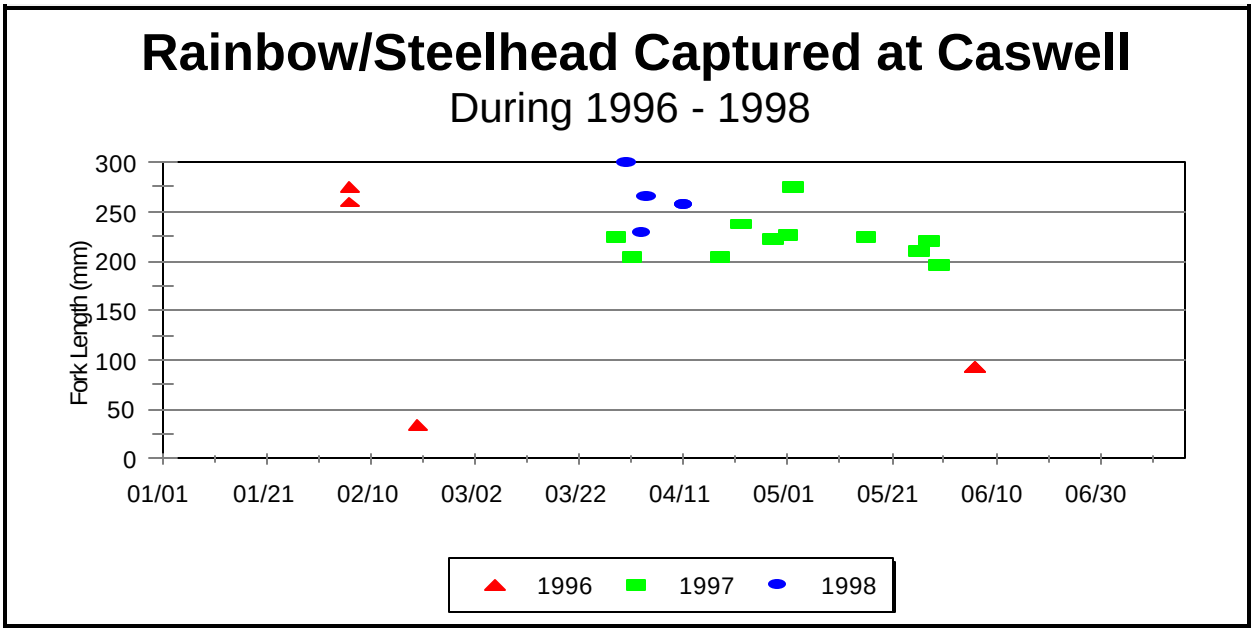
	RES		RFS		RSN		SSQ		SSU		SMB		SP		STB		TFS		TP		UNID		WHC		WHS		YEB	
Date	#	Avg	#	Avg	#	Avg	#	Avg	#	Avg	#	Avg	#	Avg	#	Avg	#	Avg	#	Avg	#	Avg	#	Avg	#	Avg	#	Avg
03/03/98							7	39	2	42																		
03/04/98							2	39																				
03/05/98							22	58	1	42																		
03/06/98							11	44	1	48																		
03/07/98							6	53																				
03/08/98							3	37	1	53											1	30	1	36				
03/09/98					2	48	23	48																				
03/10/98							21	50																				
03/11/98							22	57	3	54																		
03/12/98							11	52	3	48																		
03/13/98							21	50	1	46																		
03/14/98	1	196					55	49	5	44									1	99	1	31						
03/15/98							20	50	1	71											2	29						
03/16/98							26	47	2	42																		
03/17/98							12	46																				
03/18/98							16	46													3	27						
03/19/98	1	195					12	42													2	27						
03/20/98							4	42	1	45											1	26						
03/21/98									1	42													1	205				
03/22/98																					1	33						
03/23/98							7	46	3	42											1	29	1	164				
03/24/98							1	42	1	36	1	35																
03/25/98							6	69													1	43						
03/26/98																												
03/27/98							4	50	3	41																		
03/28/98							5	63																				
03/29/98																												
03/30/98							8	44																				
03/31/98							6	51	1	63											1	40						
04/01/98							3	56																				
04/02/98							7	51			1	32																
04/03/98							3	52																				
04/04/98							1	72																				
04/05/98							2	55																				
04/06/98							2	52																				
04/07/98							2	45													1	42						
04/08/98							20	61	1	51																		
04/09/98							3	50																				
04/10/98							12	47																				
04/11/98							20	56	2	52																		
04/12/98							20	61	1	56																		
04/13/98							4	48																				
04/14/98							5	49																	1	34		
04/15/98							7	68	3	41													1	125				
04/16/98							5	56	2	48																		
04/17/98							5	53	1	45																		
04/18/98							2	67																				
04/19/98							1	47																				
04/20/98							2	44	1	35															1	235		
04/21/98							1	32													1	24						
04/22/98							4	59	1	43	1	32													1	26		
04/23/98							2	35									1	98										
04/24/98																												
04/25/98							2	68																				
04/26/98							1	35	1	45																		
04/27/98							1	58																				
04/28/98	1	22					3	53																				
04/29/98							1	68	1	44	1	40																
04/30/98							2	50																				
05/01/98							4	60															2	213				
05/02/98							2	60									1	100					1	213				
05/03/98							2	93																				
05/04/98							4	61																				
05/05/98							7	68																				
05/06/98							4	52																	1	43		
05/07/98																												
05/08/98																												
05/09/98																												

	RES		RFS		RSN		SSQ		SSU		SMB		SP		STB		TFS		TP		UNID		WHC		WHS		YEB	
Date	#	Avg	#	Avg	#	Avg	#	Avg	#	Avg	#	Avg	#	Avg	#	Avg	#	Avg	#	Avg	#	Avg	#	Avg	#	Avg	#	Avg
05/10/98							41	56	1	50			1	150			2	105										
05/11/98							2	48									1	91										
05/12/98							18	62															1	214				
05/13/98							2	53									1	73										
05/14/98							14	67			1	61					1	90										
05/15/98							21	66																				
05/16/98							16	69																				
05/17/98							21	57									1	103			1	140						
05/18/98							13	60	1	42																		
05/19/98							4	62																				
05/20/98							6	48																				
05/21/98							1	58																				
05/22/98							1	40																				
05/23/98																												
05/24/98							4	49									1	105			2	110						
05/25/98							5	84															1	178				
05/26/98							4	48																				
05/27/98																					1	57						
05/28/98							7	54							1	201			1	155								
05/29/98							4	57																				
05/30/98							5	41	3	24															1	35		
05/31/98																												
06/01/98																												
06/02/98							4	69									1	96	1	172								
06/03/98							8	54									1	135										
06/04/98							10	54																				
06/05/98							1	39			1	33																
06/06/98																	1	105										
06/07/98																												
06/08/98																												
06/09/98							9	48									7	101			2	29	1	163				
06/10/98							1	50																				
06/11/98							2	54																	2	42		
06/12/98							1	60																				
06/13/98							1	52																				
06/14/98															1	205	1	122										
06/15/98																												
06/16/98																												
06/17/98																												
06/18/98					1	83	3	34													1	32	1	193				
06/19/98																												
06/20/98																												
06/21/98																												
06/22/98							2	73	1	25	1	29							1	122	1	25						
06/23/98							3	38	1	33	20	31							1	45								
06/24/98							5	48																				
06/25/98											10	32																
06/26/98																												
06/27/98																												
06/28/98																												
06/29/98							1	31	1	26	1	29											1	225				
06/30/98							1	55									1	100										
07/01/98																			1	43					1	37		
07/02/98																												
07/03/98							3	69			1	105					1	100										
07/04/98																												
07/05/98																												
07/06/98																												
07/07/98																							1	40	1	75		
07/08/98																												
07/09/98							3	64																				
07/10/98																												
07/11/98																												
07/12/98																												
07/13/98																												
07/14/98																												
07/15/98							1	46																				
07/16/98																			1	58								

9. Rainbow/steelhead captured in the Stanislaus River by SPCA 1993 - 1998.

Date	Number	Fork Length	Smolt Index	Sampling Location	Date	Number	Fork Length	Smolt Index	Sampling Location
04/22/93	1	nd	nd	Oakdale	02/06/96	1	275	3	Caswell
04/26/93	1	nd	nd	Oakdale	02/06/96	1	260	3	Caswell
04/27/93	1	nd	nd	Oakdale	02/19/96	1	34	1	Caswell
05/02/93	3	nd	nd	Oakdale	06/06/96	1	94	2	Caswell
05/12/93	1	nd	nd	Oakdale					
05/18/93	1	nd	nd	Oakdale	03/29/97	1	225	3	Caswell
05/29/93	1	nd	nd	Oakdale	04/01/97	1	204	3	Caswell
06/08/93	1	nd	nd	Oakdale	04/18/97	1	205	3	Caswell
					04/22/97	1	238	3	Caswell
03/22/95	1	200	3	Oakdale	04/28/97	1	223	3	Caswell
03/22/95	1	150	3	Oakdale	05/01/97	1	226	3	Caswell
03/22/95	1	200	1	Oakdale	05/02/97	1	275	3	Caswell
03/22/95	1	255	1	Oakdale	05/16/97	1	224	3	Caswell
03/24/95	1	242	1	Oakdale	05/26/97	1	210	3	Caswell
03/26/95	1	240	1	Oakdale	05/28/97	1	221	3	Caswell
03/27/95	1	217	3	Oakdale	05/30/97	1	197	3	Caswell
03/27/95	1	321	3	Oakdale					
03/28/95	1	245	3	Oakdale	01-27-98	1	283	3	Oakdale
03/31/95	1	248	3	Oakdale	03-08-98	1	270	3	Oakdale
04/01/95	1	230	3	Oakdale	03-08-98	1	225	3	Oakdale
04/02/95	1	258	3	Oakdale	03-09-98	1	220	3	Oakdale
04/03/95	1	256	3	Oakdale	03-26-98	1	250	3	Oakdale
04/04/95	1	227	1	Oakdale	03-26-98	1	218	3	Oakdale
04/05/95	1	233	3	Oakdale	03-31-98	1	299	3	Caswell
04/06/95	1	219	3	Oakdale	04-03-98	1	228	3	Caswell
04/07/95	1	203	3	Oakdale	04-04-98	1	265	3	Caswell
04/09/95	1	224	3	Oakdale	04-04-98	1	243	3	Oakdale
04/10/95	1	193	3	Oakdale	04-04-98	1	247	3	Oakdale
04/11/95	1	252	3	Oakdale	04-09-98	1	215	3	Oakdale
04/13/95	1	227	3	Oakdale	04-11-98	1	257	3	Caswell
04/14/95	1	213	3	Oakdale	04-20-98	1	215	3	Oakdale
05/11/95	1	288	3	Oakdale	04-25-98	1	250	3	Oakdale
					04-25-98	1	250	3	Oakdale
02/04/96	1	34	1	Oakdale	05-11-98	1	227	3	Oakdale
02/06/96	1	356	3	Oakdale	05-12-98	1	230	3	Oakdale
02/12/96	1	270	3	Oakdale	05-13-98	1	243	3	Oakdale
02/12/96	1	49	1	Oakdale	05-27-98	1	256	3	Oakdale
02/12/96	1	58	1	Oakdale	06-16-98	1	76	2	Oakdale
02/26/96	1	320	1	Oakdale	06-18-98	1	66	2	Oakdale
03/06/96	1	45	1	Oakdale	07-08-98	1	106	3	Oakdale
03/06/96	1	55	1	Oakdale	07-08-98	1	95	2	Oakdale
03/09/96	1	35	1	Oakdale					
04/05/96	1	218	3	Oakdale					
04/07/96	1	230	3	Oakdale					
04/07/96	1	292	3	Oakdale					
05/18/96	1	238	3	Oakdale					

nd = no data
Smolt Index: 1 = obvious parr; 3 obvious smolt
All sampling conducted with rotary screw traps.
1993: One trap fishing at Oakdale.
1994: No sampling at Oakdale; CDFG sampled at Caswell. (rnb/stl catch unknown)
1995: One trap fishing at Oakdale; two at Caswell.
1997: No trap at Oakdale; two at Caswell.


Rainbow/Steelhead Captured at Caswell
During 1996 - 1998
Fork Length (mm)
300
250
200
150
100
50
0
01/01
01/21
02/10
03/02
03/22
04/11
05/01
05/21
06/10
06/30
1996
1997
1998

10. Yearling chinook catches at Caswell during 1998.

Station	Date	Time	Length (mm)	Smolt Index
ST004S	10-Mar-98	745	141	3
ST004N	20-Mar-98	1000	130	3
ST004S	26-Mar-98	830	130	3

11. Number and date of recapture for all marked fish captured at Caswell, 1998.

Date	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11 C12	C13	C14	C15	C16	C17	C18	C19	C20	C21	C22	C23	CF1	CF2	KF1	KF2 O1	O2	O5
01/08/98	-	-	-	-	-	-	-	-	-	-	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	-	-
01/09/98	-	-	-	-	-	-	-	-	-	-	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	-	-
01/10/98	-	-	-	-	-	-	-	-	-	-	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	-	-
01/11/98	-	-	-	-	-	-	-	-	-	-	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	-	-
01/12/98	-	-	-	-	-	-	-	-	-	-	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	-	-
01/13/98	-	-	-	-	-	-	-	-	-	-	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	-	-
01/14/98	-	-	-	-	-	-	-	-	-	-	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	-	-
01/15/98	-	-	-	-	-	-	-	-	-	-	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	-	-
01/16/98	-	-	-	-	-	-	-	-	-	-	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	-	-
01/17/98	-	-	-	-	-	-	-	-	-	-	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	-	-
01/18/98	-	-	-	-	-	-	-	-	-	-	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	-	-
01/19/98	-	-	-	-	-	-	-	-	-	-	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	-	-
01/20/98	-	-	-	-	-	-	-	-	-	-	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	-	-
01/21/98	-	-	-	-	-	-	-	-	-	-	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	-	-
01/22/98	-	-	-	-	-	-	-	-	-	-	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	-	-
01/23/98	-	-	-	-	-	-	-	-	-	-	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	-	-
01/24/98	-	-	-	-	-	-	-	-	-	-	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	-	-
01/25/98	-	-	-	-	-	-	-	-	-	-	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	-	-
01/26/98	-	-	-	-	-	-	-	-	-	-	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	-	-
01/27/98	-	-	-	-	-	-	-	-	-	-	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	-	-
01/28/98	-	-	-	-	-	-	-	-	-	-	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	-	-
01/29/98	-	-	-	-	-	-	-	-	-	-	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	-	-
01/30/98	-	-	-	-	-	-	-	-	-	-	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	-	-
01/31/98	-	-	-	-	-	-	-	-	-	-	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	-	-
02/01/98	-	-	-	-	-	-	-	-	-	-	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	-	-
02/02/98	-	-	-	-	-	-	-	-	-	-	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	-	-
02/03/98	-	-	-	-	-	-	-	-	-	-	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	-	-
02/04/98	-	-	-	-	-	-	-	-	-	-	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	-	-
02/05/98	-	-	-	-	-	-	-	-	-	-	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	-	-
02/06/98	-	-	-	-	-	-	-	-	-	-	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	-	-
02/07/98	-	-	-	-	-	-	-	-	-	-	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	-	-
02/08/98	-	-	-	-	-	-	-	-	-	-	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	-	-
02/09/98	-	-	-	-	-	-	-	-	-	-	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	-	-
02/10/98	-	-	-	-	-	-	-	-	-	-	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	-	-
02/11/98	-	-	-	-	-	-	-	-	-	-	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	-	-
02/12/98	-	-	-	-	-	-	-	-	-	-	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	-	-
02/13/98	-	-	-	-	-	-	-	-	-	-	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	-	-
02/14/98	-	-	-	-	-	-	-	-	-	-	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	-	-
02/15/98	-	-	-	-	-	-	-	-	-	-	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	-	-
02/16/98	-	-	-	-	-	-	-	-	-	-	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	-	-
02/17/98	-	-	-	-	-	-	-	-	-	-	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	-	-
02/18/98	-	-	-	-	-	-	-	-	-	-	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	-	-
02/19/98	-	-	-	-	-	-	-	-	-	-	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	-	-
02/20/98	-	-	-	-	-	-	-	-	-	-	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	-	-
02/21/98	-	-	-	-	-	-	-	-	-	-	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	-	-
02/22/98	-	-	-	-	-	-	-	-	-	-	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	-	-
02/23/98	-	-	-	-	-	-	-	-	-	-	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	-	-
02/24/98	-	-	-	-	-	-	-	-	-	-	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	-	-
02/25/98	-	-	-	-	-	-	-	-	-	-	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	-	-
02/26/98	-	-	-	-	-	-	-	-	-	-	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	-	-
02/27/98	-	-	-	-	-	-	-	-	-	-	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	-	-
02/28/98	-	-	-	-	-	-	-	-	-	-	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	-	-
03/01/98	-	-	-	-	-	-	-	-	-	-	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	-	-
03/02/98	-	-	-	-	-	-	-	-	-	-	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	-	-
03/03/98	-	-	-	-	-	-	-	-	-	-	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	-	-
03/04/98	-	-	-	-	-	-	-	-	-	-	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- 2	-	-
03/05/98	-	-	-	-	-	-	-	-	-	-	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	-	-
03/06/98	-	-	-	-	-	-	-	-	-	-	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	-	-
03/07/98	-	-	-	-	-	-	-	-	-	-	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	-	-
03/08/98	-	-	-	-	-	-	-	-	-	-	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	-	-
03/09/98	-	-	-	-	-	-	-	-	-	-	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	-	-
03/10/98	-	-	-	-	-	-	-	-	-	-	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	-	-
03/11/98	-	-	-	-	-	-	-	-	-	-	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	-	-
03/12/98	-	-	-	-	-	-	-	-	-	-	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	-	-
03/13/98	-	-	-	-	-	-	-	-	-	-	- -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- -	-	-

Date	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	C13	C14	C15	C16	C17	C18	C19	C20	C21	C22	C23	CF1	CF2	KF1	KF2	O1	O2	O5
03/14/98	30	100	33	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
03/15/98	5	1	12	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
03/16/98	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
03/17/98	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
03/18/98	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
03/19/98	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
03/20/98	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
03/21/98	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
03/22/98	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
03/23/98	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
03/24/98	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
03/25/98	-	-	-	32	43	32	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
03/26/98	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
03/27/98	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
03/28/98	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-
03/29/98	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
03/30/98	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
03/31/98	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
04/01/98	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
04/02/98	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
04/03/98	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
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04/07/98	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
04/08/98	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
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04/11/98	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
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04/14/98	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
04/15/98	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-
04/16/98	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
04/17/98	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
04/18/98	-	-	-	-	-	-	181	11	4	15	25	-	-	-	-	-	-	-	-	-	-	-	-	6	47	-	-	-	-	-
04/19/98	-	-	-	-	-	-		1			1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
04/20/98	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
04/21/98	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
04/22/98	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
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04/24/98	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
04/25/98	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
04/26/98	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
04/27/98	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
04/28/98	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
04/29/98	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
04/30/98	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
05/01/98	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
05/02/98	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
05/03/98	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
05/04/98	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	1
05/05/98	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-
05/06/98	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
05/07/98	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
05/08/98	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
05/09/98	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
05/10/98	-	-	-	-	-	-	-	-	-	-	-	84	1	4	8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
05/11/98	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
05/12/98	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
05/13/98	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
05/14/98	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-
05/15/98	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-
05/16/98	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
05/17/98	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
05/18/98	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	31	16	-	-	-	-	-	-	-	-	-	-	-	-	-
05/19/98	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
05/20/98	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Date	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	C13	C14	C15	C16	C17	C18	C19	C20	C21	C22	C23	CF1	CF2	KF1	KF2	O1	O2	O5
05/21/98	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
05/22/98	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-
05/23/98	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
05/24/98	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
05/25/98	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
05/26/98	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
05/27/98	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
05/28/98	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
05/29/98	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
05/30/98	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
05/31/98	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
06/01/98	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
06/02/98	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
06/03/98	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
06/04/98	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	13	16	15	1	-	-	-	-	-	-	-	-	-
06/05/98	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	19	-	-	-	-	-	-	-	-	-
06/06/98	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
06/07/98	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
06/08/98	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
06/09/98	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
06/10/98	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
06/11/98	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
06/12/98	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	6	3	-	-	-	-	-	-	-
06/13/98	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-
06/14/98	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
06/15/98	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
06/16/98	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
06/17/98	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
06/18/98	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
06/19/98	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
06/20/98	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
06/21/98	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
06/22/98	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
06/23/98	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
06/24/98	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
06/25/98	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
06/26/98	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
06/27/98	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
06/28/98	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
06/29/98	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
06/30/98	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
07/01/98	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
07/02/98	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
07/03/98	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
07/04/98	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
07/05/98	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
07/06/98	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
07/07/98	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
07/08/98	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
07/09/98	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
07/10/98	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
07/11/98	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
07/12/98	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
07/13/98	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
07/14/98	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
07/15/98	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
07/16/98	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Totals	35	101	45	32	43	34	181	12	4	15	26	84	1	4	8	31	16	13	16	15	20	6	4	6	47	1	6	2	1	1

C = released at Caswell; CF = released at Caswell for fyke net efficiency; O = released at Oakdale; KF = released at Knights Ferrry

12. Mean lengths of marked chinook recaptured at Caswell, 1998.

	North Trap		South Trap		Combined Traps	
Mark	**# Meas.**	**Mean**	**# Meas.**	**Mean**	**# Meas.**	**Mean**
C1	13	53.31	22	54.55	35	54.1
C2	30	35.87	71	37.94	101	37.3
C3	16	53.69	29	53.48	45	53.6
C4	21	41.57	11	42.36	32	41.8
C5	16	45.44	27	49.70	43	48.1
C6	13	42.00	21	42.24	34	42.2
C7	-	-	-	-	-	-
C8	1	60.00	11	66.55	12	66.0
C9	1	75.00	3	69.33	4	70.8
C10	6	72.00	9	69.22	15	70.3
C11	5	71.60	21	74.19	26	73.7
C12	-	-	-	-	-	-
C13	1	83.00	-	-	1	83.0
C14	1	83.00	3	85.00	4	84.5
C15	2	85.50	6	86.50	8	86.3
C16	9	85.22	22	87.59	31	86.9
C17	4	83.25	12	83.75	16	83.6
C18	-	-	13	99.31	13	99.3
C19	1	103.00	15	98.13	16	98.4
C20	1	107.00	14	97.00	15	97.7
C21	1	97.00	19	98.68	20	98.6
C22	4	103.25	2	108.00	6	104.8
C23	4	95.25	-	-	4	95.3
CF1	1	79.00	5	75.40	6	76.0
CF2	27	74.15	20	74.85	47	74.5
KF1	-	-	1	78.00	1	78.0
KF2	-	-	6	88.67	6	88.7
O1	2	36.00	-	-	2	36.0
O2	-	-	1	71	1	71.0
O5	-	-	1	85.00	1	85.0

The number measured is same as the number recaptured (all recaptured fish were mesured).
"CF" represents the two groups released to evaluate fyke net efficiency.
"O" represents fish released at Oakdale and recaptured at Caswell.
Groups C& and C12 were lemons used to evaluate river hydraulics.

13. Physical data collected at Caswell during 1998.

Date	Flow at OBB	Turbidity (NTUs)	Hand-held Temp (F)	Daily Mean Temp (C)	Daily Mean Temp (F)	Weather Code
08-Jan-98	273	7.2	49.5	9.93	49.87	CLD
09-Jan-98	273	4.8	44.5	10.02	50.04	CLD
10-Jan-98	365	ns	ns	10.41	50.74	ns
11-Jan-98	450	26.4	45.5	10.79	51.42	RAN
12-Jan-98	1619	21.4	46.4	11.21	52.18	CLD
13-Jan-98	2419	ns	ns	10.65	51.17	ns
14-Jan-98	1532	ns	ns	10.03	50.05	ns
15-Jan-98	2038	ns	ns	10.15	50.27	ns
16-Jan-98	2612	ns	ns	10.85	51.53	ns
17-Jan-98	1618	ns	ns	11.35	52.43	ns
18-Jan-98	1313	ns	ns	11.29	52.32	ns
19-Jan-98	1521	ns	ns	10.87	51.57	ns
20-Jan-98	1274	ns	ns	10.36	50.65	ns
21-Jan-98	1160	ns	ns	9.81	49.66	ns
22-Jan-98	996	ns	ns	9.68	49.42	ns
23-Jan-98	843	ns	ns	9.76	49.57	ns
24-Jan-98	833	ns	ns	9.99	49.98	ns
25-Jan-98	825	ns	ns	10.10	50.18	ns
26-Jan-98	1036	ns	ns	10.49	50.88	ns
27-Jan-98	1366	ns	ns	10.78	51.40	ns
28-Jan-98	1365	nd	nd	10.98	51.76	nd
29-Jan-98	1806	11.5	50	11.13	52.03	RAN
30-Jan-98	2623	11.6	49.5	10.68	51.22	CLD
31-Jan-98	2629	nd	49.5	10.51	50.92	CLD
01-Feb-98	2526	nd	nd	10.61	51.10	CLD
02-Feb-98	2524	13.7	50	10.75	51.35	RAN
03-Feb-98	3854	20.3	50	11.12	52.02	RAN
04-Feb-98	3767	ns	ns	10.89	51.60	ns
05-Feb-98	5497	ns	ns	10.70	51.26	ns
06-Feb-98	4915	ns	ns	10.67	51.21	ns
07-Feb-98	4333	nd	nd	10.61	51.10	CLD
08-Feb-98	5434	44.1	49.8	10.25	50.45	CLD
09-Feb-98	5460	ns	ns	10.54	50.97	ns
10-Feb-98	5095	ns	ns	10.55	50.99	ns
11-Feb-98	5004	ns	ns	10.47	50.85	ns
12-Feb-98	4850	nd	nd	10.66	51.19	RAN
13-Feb-98	4772	16.6	49	10.69	51.24	CLD
14-Feb-98	4508	14.7	51	10.99	51.78	CLD
15-Feb-98	4358	12.1	50.5	10.76	51.37	CLR
16-Feb-98	5003	9.2	50	10.27	50.49	CLD
17-Feb-98	4468	10	50	10.12	50.22	CLR
18-Feb-98	5064	nd	nd	10.49	50.88	CLD
19-Feb-98	4481	11.6	50.2	10.62	51.12	CLD
20-Feb-98	4530	16.5	50	10.17	50.31	CLR
21-Feb-98	4566	18.9	49	10.06	50.11	CLD
22-Feb-98	4571	10.4	50	10.14	50.25	CLR
23-Feb-98	4201	14.7	51	10.37	50.67	RAN
24-Feb-98	3746	10.1	50	10.38	50.68	CLR
25-Feb-98	3746	9.5	50.5	10.42	50.76	CLR
26-Feb-98	3751	nd	50.5	10.76	51.37	CLR

Date	Flow at OBB	Turbidity (NTUs)	Hand-held Temp (F)	Daily Mean Temp (C)	Daily Mean Temp (F)	Weather Code
27-Feb-98	3700	7	50	10.74	51.33	CLD
28-Feb-98	3709	7.3	50	10.77	51.39	CLD
01-Mar-98	3713	8.8	45.2	10.84	51.51	CLR
02-Mar-98	3508	7	51	11.07	51.93	CLR
03-Mar-98	2967	8.1	51.5	11.37	52.47	CLR
04-Mar-98	2450	8.3	51	11.03	51.85	CLR
05-Mar-98	2048	9.5	49	10.49	50.88	CLD
06-Mar-98	2106	10.6	49.5	10.23	50.41	CLR
07-Mar-98	2071	nd	49	10.32	50.58	CLD
08-Mar-98	2059	8.3	50	10.54	50.97	CLR
09-Mar-98	2089	7	51	11.11	52.00	CLR
10-Mar-98	2098	nd	50	11.21	52.18	CLD
11-Mar-98	1974	7.5	51	11.53	52.75	CLR
12-Mar-98	1721	7	51	11.53	52.75	CLR
13-Mar-98	1620	7.3	50	11.46	52.63	CLD
14-Mar-98	1577	8.1	49	11.52	52.74	CLR
15-Mar-98	1574	7.4	51	12.06	53.71	CLR
16-Mar-98	1570	7.5	53	12.17	53.91	CLD
17-Mar-98	1569	7.2	54	12.23	54.01	CLR
18-Mar-98	1768	nd	nd	12.67	54.81	CLR
19-Mar-98	2798	nd	52	12.49	54.48	CLR
20-Mar-98	3413	6.6	51	--	--	CLD
21-Mar-98	3365	7.4	53.5	13.06	55.51	CLR
22-Mar-98	2744	8.5	53.5	12.72	54.90	CLD
23-Mar-98	2499	7.2	52	12.62	54.72	CLR
24-Mar-98	2491	17.1	53	12.80	55.04	CLD
25-Mar-98	2657	7.2	52	12.36	54.25	CLD
26-Mar-98	2351	8	52	12.43	54.37	CLR
27-Mar-98	1883	7.8	52	12.43	54.37	CLD
28-Mar-98	1728	28.4	53	11.77	53.19	CLR
29-Mar-98	1593	15.4	50	11.24	52.23	CLD
30-Mar-98	1561	7.3	50	11.49	52.68	CLR
31-Mar-98	1582	7.4	51	11.80	53.24	CLD
01-Apr-98	1645	6.8	50.5	11.07	51.93	CLD
02-Apr-98	1580	9.5	50.5	11.00	51.80	CLD
03-Apr-98	1758	8.4	52	11.10	51.98	RAN
04-Apr-98	1649	12.9	51	11.24	52.23	CLD
05-Apr-98	1580	6.7	47.5	11.70	53.06	CLD
06-Apr-98	1561	8.3	48	12.10	53.78	CLD
07-Apr-98	1822	nd	52	11.97	53.55	CLD
08-Apr-98	2080	6.3	52	11.93	53.47	CLR
09-Apr-98	2065	7.9	53.5	12.41	54.34	CLR
10-Apr-98	2062	nd	54	12.69	54.84	CLD
11-Apr-98	2066	6.5	50.5	11.97	53.55	RAN
12-Apr-98	2069	nd	51	11.37	52.47	CLR
13-Apr-98	2206	5.8	51	11.95	53.51	CLR
14-Apr-98	2182	8.1	50	11.64	52.95	CLR
15-Apr-98	2066	6.3	51	11.75	53.15	CLR
16-Apr-98	2051	4.1	52	12.31	54.16	CLR
17-Apr-98	2035	6.5	50	12.66	54.79	CLR
18-Apr-98	1996	nd	nd	12.82	55.08	CLR
19-Apr-98	1996	nd	nd	13.15	55.67	CLR

Date	Flow at OBB	Turbidity (NTUs)	Hand-held Temp (F)	Daily Mean Temp (C)	Daily Mean Temp (F)	Weather Code
20-Apr-98	2008	5.9	48	13.40	56.12	CLR
21-Apr-98	1979	6.6	50	13.76	56.77	CLR
22-Apr-98	1982	6.5	52	14.00	57.20	CLR
23-Apr-98	2009	6	50	13.57	56.43	CLR
24-Apr-98	2057	6.9	48	13.21	55.78	CLR
25-Apr-98	2016	7.9	52	13.36	56.05	CLR
26-Apr-98	1992	nd	55.5	13.51	56.32	CLR
27-Apr-98	2005	7.3	54	13.94	57.09	CLR
28-Apr-98	1998	6.5	nd	14.22	57.60	CLR
29-Apr-98	2004	7.5	nd	14.54	58.17	CLR
30-Apr-98	2014	4.5	58	14.71	58.48	CLR
01-May-98	2019	8.1	58	14.38	57.88	CLR
02-May-98	1972	nd	55.5	13.96	57.13	CLD
03-May-98	2008	nd	53	14.17	57.51	CLD
04-May-98	2049	10	nd	14.42	57.96	CLD
05-May-98	2063	7.6	52	13.93	57.07	CLD
06-May-98	2011	9.3	52	13.38	56.08	CLD
07-May-98	-	10.2	52	13.27	55.89	CLR
08-May-98	-	7.7	52	13.37	56.07	CLD
09-May-98	2025	nd	ns	13.14	55.65	ns
10-May-98	2005	nd	46	13.19	55.74	CLR
11-May-98	2004	6	52	12.80	55.04	CLD
12-May-98	2033	8.4	52	11.79	53.22	CLD
13-May-98	2088	nd	48	11.60	52.88	CLD
14-May-98	2027	7.2	52	12.25	54.05	CLD
15-May-98	2017	nd	51	12.68	54.82	CLR
16-May-98	2019	6.3	52	12.92	55.26	CLD
17-May-98	2028	2.1	52	12.43	54.37	CLR
18-May-98	2023	7.4	52	13.24	55.83	CLR
19-May-98	2016	4.9	54	13.57	56.43	CLR
20-May-98	2027	5.4	58	13.52	56.34	CLR
21-May-98	2010	5.4	56	13.44	56.19	CLR
22-May-98	2036	9.1	58	13.74	56.73	CLR
23-May-98	2033	nd	56	14.19	57.54	CLD
24-May-98	2061	7.7	60	14.39	57.90	CLR
25-May-98	2077	7.2	58	14.49	58.08	CLD
26-May-98	2067	nd	54	13.48	56.26	CLR
27-May-98	2060	5.5	58	12.88	55.18	CLR
28-May-98	2086	nd	58	12.71	54.88	CLD
29-May-98	2035	6	54	12.66	54.79	CLR
30-May-98	2034	nd	56	13.42	56.16	CLR
31-May-98	2053	nd	nd	14.02	57.24	CLR
01-Jun-98	1929	6.4	60	--	--	CLR
02-Jun-98	1671	6.7	54	--	--	CLD
03-Jun-98	1551	6.7	nd	--	--	CLD
04-Jun-98	1527	nd	54	--	--	CLR
05-Jun-98	1537	nd	nd	14.63	58.33	CLR
06-Jun-98	1531	7.3	nd	14.73	58.51	CLR
07-Jun-98	1536	7.3	nd	14.66	58.39	CLD
08-Jun-98	1539	nd	58	14.36	57.85	CLR
09-Jun-98	1515	6.4	58	15.07	59.13	CLD
10-Jun-98	1528	nd	nd	15.31	59.56	CLD

Date	Flow at OBB	Turbidity (NTUs)	Hand-held Temp (F)	Daily Mean Temp (C)	Daily Mean Temp (F)	Weather Code
11-Jun-98	1557	9.3	nd	14.87	58.77	CLD
12-Jun-98	1593	nd	60	15.06	59.11	CLR
13-Jun-98	1564	nd	60	15.12	59.22	CLR
14-Jun-98	1565	nd	60	15.74	60.33	CLR
15-Jun-98	1621	10.2	62	16.43	61.57	CLR
16-Jun-98	1697	nd	60	16.41	61.54	CLR
17-Jun-98	1947	15.2	60	16.00	60.80	CLR
18-Jun-98	2082	nd	59.5	15.43	59.77	CLR
19-Jun-98	2146	nd	58	15.23	59.41	CLR
20-Jun-98	2154	ns	ns	15.54	59.97	CLR
21-Jun-98	2132	ns	ns	15.48	59.86	ns
22-Jun-98	2127	nd	56	15.57	60.03	CLR
23-Jun-98	2119	nd	55	15.74	60.33	CLR
24-Jun-98	2130	4.4	58	15.58	60.04	CLR
25-Jun-98	2155	4.1	58	15.64	60.15	CLR
26-Jun-98	2105	nd	56	15.48	59.86	CLR
27-Jun-98	2094	ns	ns	15.61	60.10	ns
28-Jun-98	2110	nd	ns	15.67	60.21	ns
29-Jun-98	2120	nd	58	15.88	60.58	CLR
30-Jun-98	2120	nd	56	15.56	60.01	CLR
01-Jul-98	2112	nd	55	15.41	59.74	CLR
02-Jul-98	2112	nd	62	15.33	59.59	CLR
03-Jul-98	2116	nd	58	15.36	59.65	CLR
04-Jul-98	2115	ns	ns	15.50	59.90	ns
05-Jul-98	2125	ns	ns	15.91	60.64	ns
06-Jul-98	2097	nd	ns	16.05	60.89	ns
07-Jul-98	2077	nd	59.5	16.04	60.87	CLR
08-Jul-98	2110	nd	59.5	16.17	61.11	CLR
09-Jul-98	2009	5.3	60	16.30	61.34	CLR
10-Jul-98	1861	4.2	58	16.00	60.80	CLR
11-Jul-98	1830	ns	ns	16.00	60.80	ns
12-Jul-98	1828	nd	ns	16.09	60.96	ns
13-Jul-98	1810	5.2	60	16.08	60.94	CLR
14-Jul-98	1799	nd	58	--	--	CLR
15-Jul-98	1808	4.8	60	--	--	CLR
16-Jul-98	1805	4.6	62	--	--	CLR

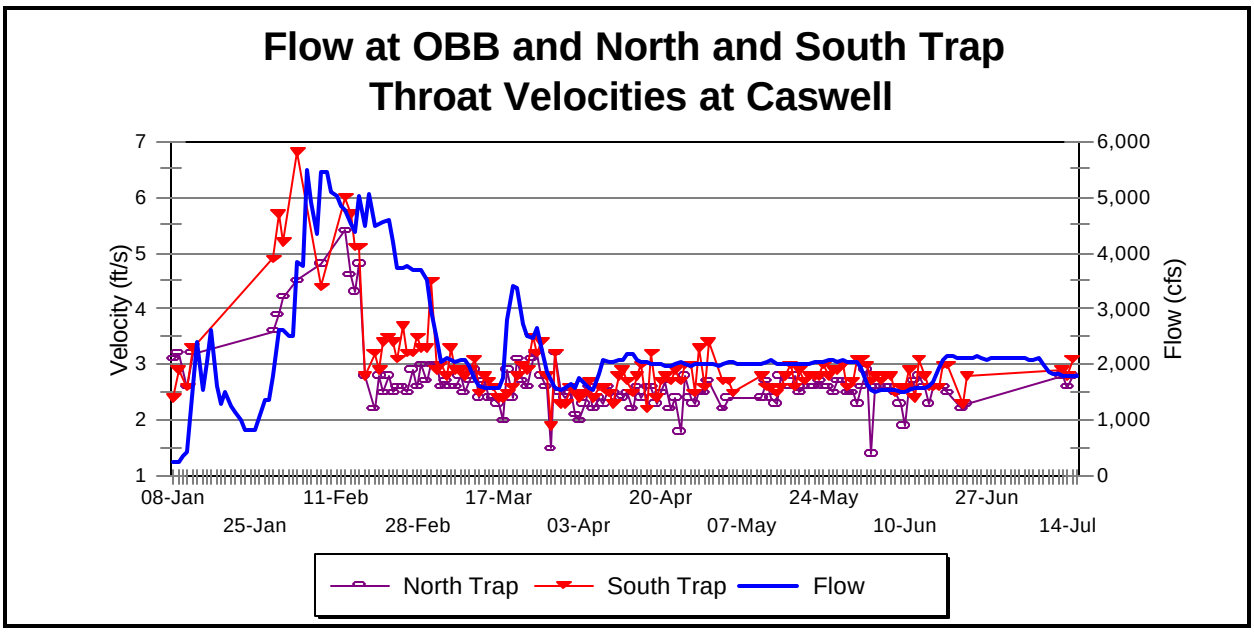
14. Daily water velocity and time per revolution for each trap at Caswell, 1998.

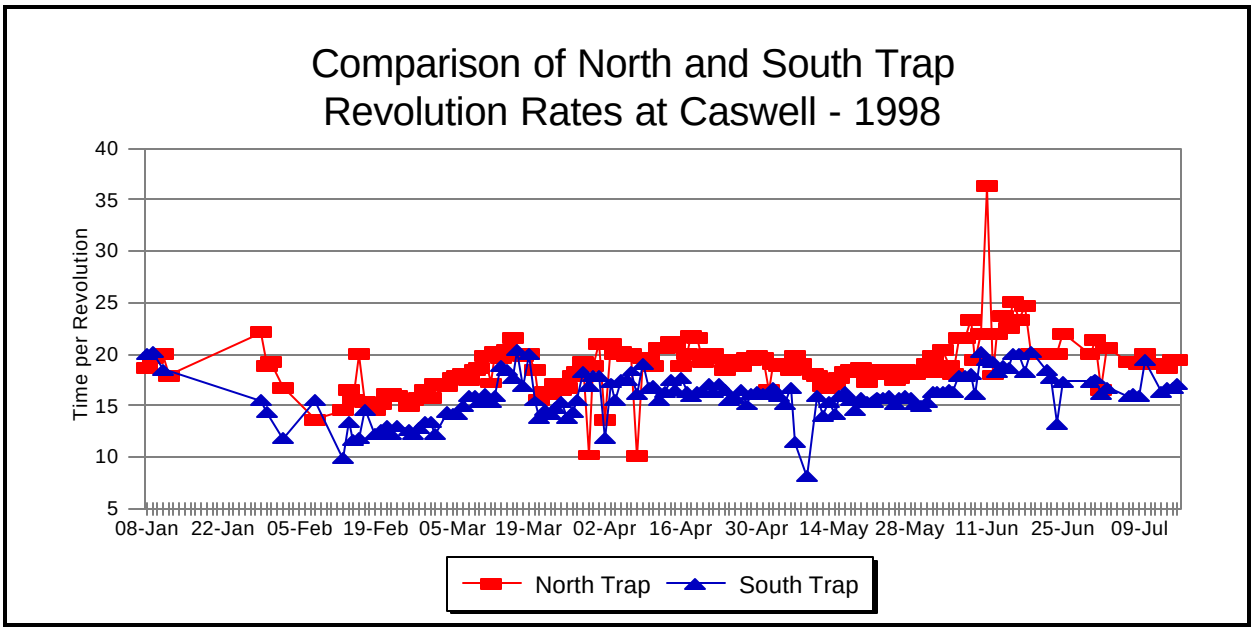
	North Trap				South Trap				
Date	Time/ Rev Before	Time/ Rev After	Average Time/ Rev	Water Velocity	Time/ Rev Before	Time/ Rev After	Average Time/ Rev	Water Velocity	Flow at OBB
08-Jan	19.2	18.2	18.7	3.1	20.2	19.8	20.0	2.4	273
09-Jan	nd	19.7	19.7	3.2	nd	20.2	20.2	2.9	273
10-Jan	ns	ns	ns	ns	ns	ns	ns	ns	365
11-Jan	20.0	20.0	20.0	2.6	20.0	17.0	18.5	2.6	450
12-Jan	nd	17.9	17.9	3.2	nd	nd	nd	3.3	1619
13-Jan	ns	ns	ns	ns	ns	ns	ns	ns	2419
14-Jan	ns	ns	ns	ns	ns	ns	ns	ns	1532
15-Jan	ns	ns	ns	ns	ns	ns	ns	ns	2038
16-Jan	ns	ns	ns	ns	ns	ns	ns	ns	2612
17-Jan	ns	ns	ns	ns	ns	ns	ns	ns	1618
18-Jan	ns	ns	ns	ns	ns	ns	ns	ns	1313
19-Jan	ns	ns	ns	ns	ns	ns	ns	ns	1521
20-Jan	ns	ns	ns	ns	ns	ns	ns	ns	1274
21-Jan	ns	ns	ns	ns	ns	ns	ns	ns	1160
22-Jan	ns	ns	ns	ns	ns	ns	ns	ns	996
23-Jan	ns	ns	ns	ns	ns	ns	ns	ns	843
24-Jan	ns	ns	ns	ns	ns	ns	ns	ns	833
25-Jan	ns	ns	ns	ns	ns	ns	ns	ns	825
26-Jan	ns	ns	ns	ns	ns	ns	ns	ns	1036
27-Jan	ns	ns	ns	ns	ns	ns	ns	ns	1366
28-Jan	nd	nd	nd	nd	nd	nd	nd	nd	1365
29-Jan	nd	22.1	22.1	3.6	nd	15.5	15.5	4.9	1806
30-Jan	nd	18.9	18.9	3.9	nd	14.3	14.3	5.7	2623
31-Jan	nd	19.2	19.2	4.2	nd	nd	nd	5.2	2629
01-Feb	ns	ns	ns	ns	ns	ns	ns	ns	2526
02-Feb	nd	16.7	16.7	nd	nd	11.8	11.8	nd	2524
03-Feb	nd	nd	nd	4.5	nd	nd	nd	6.8	3854
04-Feb	ns	ns	ns	ns	ns	ns	ns	ns	3767
05-Feb	ns	ns	ns	ns	ns	ns	ns	ns	5497
06-Feb	ns	ns	ns	ns	ns	ns	ns	ns	4915
07-Feb	ns	ns	ns	ns	ns	ns	ns	ns	4333
08-Feb	nd	13.6	13.6	4.8	nd	15.5	15.5	4.4	5434
09-Feb	ns	ns	ns	ns	ns	ns	ns	ns	5460
10-Feb	ns	ns	ns	ns	ns	ns	ns	ns	5095
11-Feb	ns	ns	ns	ns	ns	ns	ns	ns	5004
12-Feb	ns	ns	ns	ns	ns	ns	ns	ns	4850
13-Feb	nd	14.5	14.5	5.4	nd	9.9	9.9	6	4772
14-Feb	nd	16.5	16.5	4.6	nd	13.5	13.5	5.7	4508
15-Feb	16.3	14.7	15.5	4.3	12.0	11.2	11.6	5.1	4358
16-Feb	19.8	20.1	20.0	4.8	11.9	11.7	11.8	5.1	5003
17-Feb	15.1	15.5	15.3	2.8	16.8	12.5	14.7	2.8	4468
18-Feb	ns	ns	ns	ns	ns	ns	ns	ns	5064
19-Feb	nd	14.5	14.5	2.2	nd	12.2	12.2	3.2	4481
20-Feb	13.3	17.0	15.2	2.8	13.2	12.1	12.7	2.9	4530
21-Feb	16.1	nd	16.1	2.5	13.1	nd	13.1	3.4	4566
22-Feb	16.2	16.2	16.2	2.8	12.3	12.3	12.3	3.5	4571
23-Feb	15.9	15.9	15.9	2.5	13.0	13.0	13.0	3.4	4201
24-Feb	nd	nd	nd	2.6	nd	nd	nd	3.1	3746
25-Feb	15.0	15.0	15.0	2.6	12.7	12.7	12.7	3.7	3746

	North Trap				South Trap				
Date	Time/ Rev Before	Time/ Rev After	Average Time/ Rev	Water Velocity	Time/ Rev Before	Time/ Rev After	Average Time/ Rev	Water Velocity	Flow at OBB
26-Feb	15.6	15.6	15.6	2.5	12.3	12.3	12.3	3.2	3751
27-Feb	15.2	16.4	15.8	2.9	12.8	13.0	12.9	3.2	3700
28-Feb	16.5	16.5	16.5	2.6	13.4	13.4	13.4	3.5	3709
01-Mar	15.8	15.8	15.8	3	14.0	12.6	13.3	3.3	3713
02-Mar	17.1	17.1	17.1	2.7	12.2	12.2	12.2	3.3	3508
03-Mar	17.0	17.0	17.0	3	nd	nd	nd	4.5	2967
04-Mar	16.9	16.9	16.9	3	14.3	14.3	14.3	2.9	2450
05-Mar	18.1	17.1	17.6	2.6	14.1	14.2	14.2	3	2048
06-Mar	17.8	17.8	17.8	2.7	14.2	14.2	14.2	2.8	2106
07-Mar	18.1	18.1	18.1	2.6	15.0	15.0	15.0	3.3	2071
08-Mar	17.5	17.5	17.5	2.6	15.9	15.9	15.9	2.9	2059
09-Mar	18.4	18.4	18.4	2.8	15.9	15.9	15.9	2.9	2089
10-Mar	18.7	18.7	18.7	2.5	15.4	15.4	15.4	2.8	2098
11-Mar	19.8	19.8	19.8	2.7	16.2	16.2	16.2	2.9	1974
12-Mar	17.2	17.2	17.2	2.9	15.4	15.4	15.4	3.1	1721
13-Mar	20.2	20.2	20.2	2.4	16.0	16.0	16.0	2.5	1620
14-Mar	19.6	19.6	19.6	2.7	18.9	nd	18.9	2.8	1577
15-Mar	20.4	20.4	20.4	2.4	18.4	18.4	18.4	2.7	1574
16-Mar	23.3	19.8	21.6	2.4	18.8	16.7	17.8	2.6	1570
17-Mar	20.0	20.0	20.0	2.3	20.3	20.3	20.3	2.4	1569
18-Mar	20.0	19.8	19.9	2	17.1	16.6	16.9	2.4	1768
19-Mar	20.0	20.0	20.0	2.9	20.0	20.0	20.0	2.5	2798
20-Mar	20.1	16.7	18.4	2.4	15.7	15.2	15.5	2.6	3413
21-Mar	14.7	16.3	15.5	3.1	13.3	14.3	13.8	2.8	3365
22-Mar	17.0	15.7	16.4	2.7	15.2	13.9	14.6	3	2744
23-Mar	16.1	16.1	16.1	2.6	14.1	14.1	14.1	2.9	2499
24-Mar	17.1	17.1	17.1	3.1	14.7	14.7	14.7	3.5	2491
25-Mar	16.2	16.7	16.5	3.2	15.1	15.7	15.4	3.2	2657
26-Mar	17.3	16.2	16.8	2.8	14.5	13.2	13.9	3.4	2351
27-Mar	18.1	17.6	17.9	2.6	13.8	14.9	14.4	2.8	1883
28-Mar	18.2	nd	18.2	1.5	15.6	nd	15.6	1.9	1728
29-Mar	19.3	nd	19.3	3.2	18.2	nd	18.2	3.2	1593
30-Mar	10.2	nd	10.2	2.5	16.9	nd	16.9	2.3	1561
31-Mar	nd	18.8	18.8	2.4	17.8	nd	17.8	2.3	1582
01-Apr	21.7	20.4	21.0	2.5	18.0	17.9	18.0	2.6	1645
02-Apr	12.9	14.1	13.5	2.1	12.4	11.3	11.9	2.5	1580
03-Apr	21.1	nd	21.1	2	17.2	nd	17.2	2.4	1758
04-Apr	20.0	nd	20.0	2.3	15.5	nd	15.5	2.5	1649
05-Apr	20.3	20.1	20.2	2.6	17.5	17.3	17.4	2.7	1580
06-Apr	19.4	20.3	19.8	2.2	17.2	17.6	17.4	2.4	1561
07-Apr	20.0	nd	20.0	2.4	18.4	nd	18.4	2.6	1822
08-Apr	10.0	nd	10.0	2.3	16.1	nd	16.1	2.6	2080
09-Apr	nd	19.6	19.6	2.6	19.1	nd	19.1	2.5	2065
10-Apr	19.5	19.8	19.7	2.5	17.3	16.0	16.7	2.3	2062
11-Apr	18.8	nd	18.8	2.4	17.1	16.8	17.0	2.8	2066
12-Apr	21.2	19.9	20.5	2.4	14.2	16.9	15.5	2.9	2069
13-Apr	21.1	20.2	20.6	2.5	16.8	16.0	16.4	2.7	2206
14-Apr	21.3	nd	21.3	2.2	17.4	nd	17.4	2.5	2182
15-Apr	22.5	19.5	21.0	2.6	16.8	16.3	16.6	2.8	2066
16-Apr	18.9	nd	18.9	2.4	17.8	nd	17.8	3	2051
17-Apr	20.0	nd	20.0	2.6	16.4	nd	16.4	2.2	2035

	North Trap				South Trap				
Date	Time/ Rev Before	Time/ Rev After	Average Time/ Rev	Water Velocity	Time/ Rev Before	Time/ Rev After	Average Time/ Rev	Water Velocity	Flow at OBB
18-Apr	21.8	nd	21.8	2.6	15.8	nd	15.8	3.2	1996
19-Apr	21.6	nd	21.6	2.3	16.4	nd	16.4	2.4	1996
20-Apr	19.2	nd	19.2	2.5	16.2	nd	16.2	2.7	2008
21-Apr	20.0	nd	20.0	2.7	17.0	nd	17.0	2.8	1979
22-Apr	20.1	nd	20.1	2.2	16.3	nd	16.3	2.7	1982
23-Apr	20.2	18.9	19.5	2.4	18.1	16.2	17.1	2.9	2009
24-Apr	19.1	17.7	18.4	1.8	17.3	15.9	16.6	2.7	2057
25-Apr	19.5	nd	19.5	2.8	15.5	nd	15.5	3	2016
26-Apr	19.3	nd	19.3	2.4	15.8	nd	15.8	3	1992
27-Apr	19.5	17.9	18.7	2.3	16.8	16.1	16.4	2.5	2005
28-Apr	19.7	19.7	19.7	2.5	15.0	15.1	15.1	3.3	1998
29-Apr	20.0	18.7	19.4	2.5	16.2	16.2	16.2	2.6	2004
30-Apr	19.9	19.5	19.7	2.7	16.5	16.1	16.3	3.4	2014
01-May	19.8	19.7	19.7	nd	16.8	15.4	16.1	nd	2019
02-May	16.5	nd	16.5	nd	16.2	nd	16.2	nd	1972
03-May	19.3	18.6	19.0	2.2	17.6	15.7	16.7	2.7	2008
04-May	19.3	18.6	18.9	2.4	16.4	15.6	16.0	2.7	2049
05-May	19.9	18.1	19.0	nd	16.2	14.2	15.2	2.5	2063
06-May	19.7	17.4	18.6	nd	17.5	15.9	16.7	nd	2011
07-May	20.0	19.7	19.8	nd	11.4	11.4	11.4	nd	-
08-May	20.1	18.0	19.1	nd	nd	nd	nd	nd	-
09-May	ns	ns	ns	ns	nd	16.2	8.1	nd	2025
10-May	18.0	nd	18.0	nd	ns	ns	ns	ns	2005
11-May	18.1	17.4	17.8	2.4	16.3	15.6	15.9	2.8	2004
12-May	17.0	16.6	16.8	2.7	14.3	13.8	14.0	2.6	2033
13-May	17.1	16.2	16.6	2.4	15.8	15.1	15.4	2.6	2088
14-May	17.4	16.7	17.1	2.3	14.2	13.9	14.1	2.5	2027
15-May	18.0	17.2	17.6	2.8	16.4	15.4	15.9	2.6	2017
16-May	18.5	18.1	18.3	2.6	16.4	16.1	16.3	2.8	2019
17-May	18.7	18.4	18.6	2.6	16.2	14.9	15.6	3	2028
18-May	18.3	18.2	18.3	2.8	15.0	14.2	14.6	2.6	2023
19-May	18.9	18.6	18.8	2.5	15.7	15.6	15.7	2.9	2016
20-May	17.5	17.2	17.4	2.6	15.3	15.2	15.3	2.7	2027
21-May	18.8	18.3	18.6	2.6	15.4	15.3	15.3	2.8	2010
22-May	18.6	17.9	18.2	2.6	16.1	15.6	15.8	2.8	2036
23-May	17.9	18.2	18.1	2.7	15.7	nd	15.7	2.8	2033
24-May	18.8	18.1	18.4	2.6	15.9	15.8	15.9	3	2061
25-May	17.6	17.3	17.5	2.6	15.3	15.2	15.2	2.8	2077
26-May	18.5	17.0	17.7	2.5	16.2	15.3	15.7	2.9	2067
27-May	18.8	18.3	18.5	2.7	16.3	15.5	15.9	2.9	2060
28-May	18.0	18.0	18.0	2.7	16.1	15.4	15.7	3	2086
29-May	18.3	17.8	18.1	2.5	16.5	14.0	15.3	2.6	2035
30-May	18.4	18.2	18.3	2.5	16.2	13.7	15.0	2.7	2034
31-May	nd	19.1	19.1	2.3	nd	15.3	15.3	3.1	2053
01-Jun	20.0	19.6	19.8	2.6	16.6	15.9	16.2	3.1	1929
02-Jun	18.3	nd	18.3	2.9	16.3	nd	16.3	3	1671
03-Jun	23.3	17.3	20.3	1.4	17.6	15.1	16.4	2.7	1551
04-Jun	nd	18.9	18.9	2.6	nd	16.5	16.5	2.8	1527
05-Jun	18.0	nd	18.0	2.6	16.3	nd	16.3	2.7	1537
06-Jun	23.7	19.3	21.5	2.6	19.1	16.6	17.9	2.8	1531
07-Jun	23.0	20.0	21.5	2.6	18.3	17.4	17.9	2.8	1536

	North Trap				South Trap				
Date	Time/ Rev Before	Time/ Rev After	Average Time/ Rev	Water Velocity	Time/ Rev Before	Time/ Rev After	Average Time/ Rev	Water Velocity	Flow at OBB
08-Jun	23.3	nd	23.3	2.5	18.9	17.1	18.0	2.5	1539
09-Jun	19.5	19.2	19.4	2.3	16.2	15.9	16.1	2.6	1515
10-Jun	24.3	19.6	22.0	1.9	nd	20.2	20.2	2.6	1528
11-Jun	36.3	nd	36.3	2.6	19.3	nd	19.3	2.9	1557
12-Jun	nd	18.0	18.0	2.7	19.6	18.9	19.3	2.4	1593
13-Jun	22.3	21.7	22.0	2.8	18.4	18.3	18.3	3.1	1564
14-Jun	24.0	23.3	23.7	2.6	19.6	18.2	18.9	2.8	1565
15-Jun	nd	22.6	22.6	2.3	nd	18.7	18.7	2.6	1621
16-Jun	25.1	nd	25.1	2.6	20.0	nd	20.0	2.6	1697
17-Jun	25.0	21.7	23.3	2.6	22.0	17.9	20.0	2.6	1947
18-Jun	24.7	nd	24.7	2.6	18.3	nd	18.3	3	2082
19-Jun	20.0	nd	20.0	2.5	20.2	nd	20.2	3	2146
20-Jun	ns	ns	ns	ns	ns	ns	ns	ns	2154
21-Jun	ns	ns	ns	ns	ns	ns	ns	ns	2132
22-Jun	20.0	19.9	20.0	2.2	18.8	18.1	18.4	2.3	2127
23-Jun	20.1	20.1	20.1	2.3	17.7	17.7	17.7	2.8	2119
24-Jun	20.1	20.0	20.1	nd	13.9	12.6	13.3	nd	2130
25-Jun	23.0	20.9	22.0	nd	17.7	17.0	17.3	nd	2155
26-Jun	nd	nd	nd	nd	nd	nd	nd	nd	2105
27-Jun	ns	ns	ns	ns	ns	ns	ns	ns	2094
28-Jun	ns	ns	ns	ns	ns	ns	ns	ns	2110
29-Jun	nd	nd	nd	nd	nd	nd	nd	nd	2120
30-Jun	nd	20.0	20.0	nd	17.3	17.3	17.3	nd	2120
01-Jul	22.2	20.6	21.4	nd	17.5	17.6	17.6	nd	2112
02-Jul	16.6	16.5	16.6	nd	nd	16.2	16.2	nd	2112
03-Jul	nd	20.6	20.6	nd	16.8	nd	16.8	nd	2116
04-Jul	ns	ns	ns	ns	ns	ns	ns	ns	2115
05-Jul	ns	ns	ns	ns	ns	ns	ns	ns	2125
06-Jul	ns	ns	ns	ns	ns	ns	ns	ns	2097
07-Jul	19.6	18.8	19.2	nd	16.5	15.3	15.9	nd	2077
08-Jul	19.5	19.0	19.3	nd	16.5	15.8	16.1	nd	2110
09-Jul	19.2	19.0	19.1	nd	16.3	15.6	15.9	nd	2009
10-Jul	20.6	19.6	20.1	nd	19.5	19.3	19.4	nd	1861
11-Jul	ns	ns	ns	ns	ns	ns	ns	ns	1830
12-Jul	ns	ns	ns	ns	ns	ns	ns	ns	1828
13-Jul	19.1	19.2	19.1	2.8	16.5	16.2	16.4	2.9	1810
14-Jul	18.7	18.4	18.6	2.6	17.3	16.1	16.7	2.8	1799
15-Jul	19.5	19.3	19.4	2.8	17.2	16.2	16.7	3.1	1808
16-Jul	19.5	19.3	19.4	nd	17.9	16.5	17.2	nd	1805





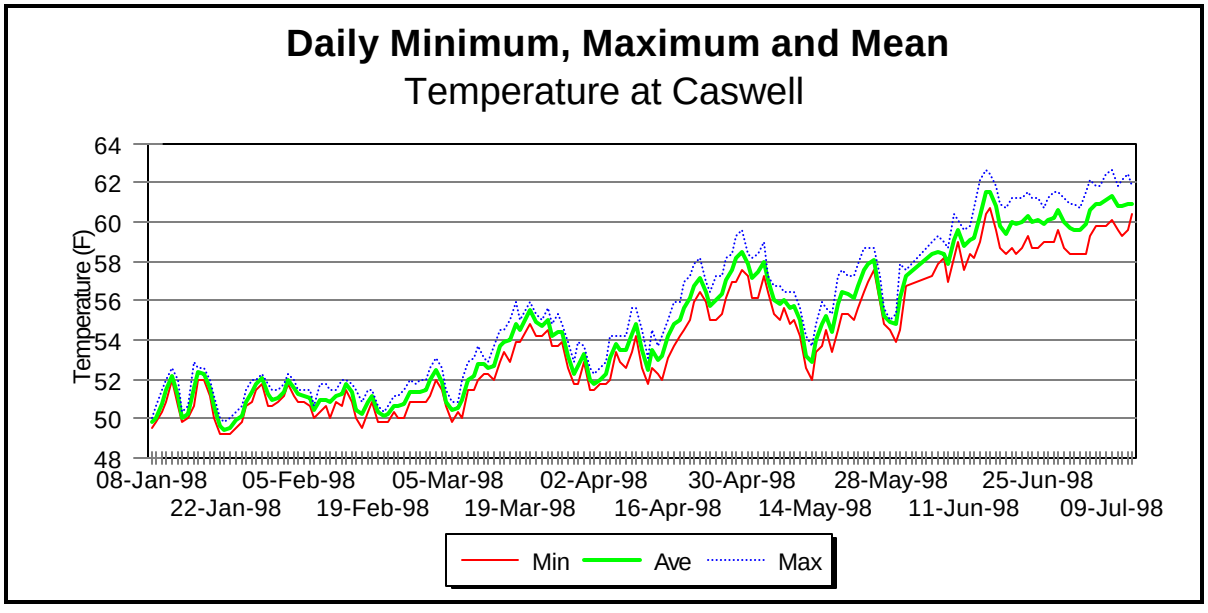
15. Daily minimum, maximum and mean river temperature at Caswell, 1998.

	Celsius			Fahrenheit		
Date	Min	Ave	Max	Min	Ave	Max
08-Jan-98	9.72	9.93	10.03	49.50	49.87	50.05
09-Jan-98	9.88	10.02	10.34	49.78	50.04	50.61
10-Jan-98	10.19	10.41	10.81	50.34	50.74	51.46
11-Jan-98	10.50	10.79	11.12	50.90	51.42	52.02
12-Jan-98	11.12	11.21	11.42	52.02	52.18	52.56
13-Jan-98	10.34	10.65	11.12	50.61	51.17	52.02
14-Jan-98	9.88	10.03	10.19	49.78	50.05	50.34
15-Jan-98	10.03	10.15	10.34	50.05	50.27	50.61
16-Jan-98	10.34	10.85	11.58	50.61	51.53	52.84
17-Jan-98	11.12	11.35	11.42	52.02	52.43	52.56
18-Jan-98	11.12	11.29	11.42	52.02	52.32	52.56
19-Jan-98	10.66	10.87	11.12	51.19	51.57	52.02
20-Jan-98	10.03	10.36	10.66	50.05	50.65	51.19
21-Jan-98	9.57	9.81	10.03	49.23	49.66	50.05
22-Jan-98	9.57	9.68	9.88	49.23	49.42	49.78
23-Jan-98	9.57	9.76	10.03	49.23	49.57	50.05
24-Jan-98	9.72	9.99	10.19	49.50	49.98	50.34
25-Jan-98	9.88	10.10	10.34	49.78	50.18	50.61
26-Jan-98	10.34	10.49	10.81	50.61	50.88	51.46
27-Jan-98	10.50	10.78	11.12	50.90	51.40	52.02
28-Jan-98	10.81	10.98	11.12	51.46	51.76	52.02
29-Jan-98	10.96	11.13	11.27	51.73	52.03	52.29
30-Jan-98	10.34	10.68	10.96	50.61	51.22	51.73
31-Jan-98	10.34	10.51	10.81	50.61	50.92	51.46
01-Feb-98	10.50	10.61	10.81	50.90	51.10	51.46
02-Feb-98	10.66	10.75	10.96	51.19	51.35	51.73
03-Feb-98	10.96	11.12	11.27	51.73	52.02	52.29
04-Feb-98	10.66	10.89	11.12	51.19	51.60	52.02
05-Feb-98	10.50	10.70	10.81	50.90	51.26	51.46
06-Feb-98	10.50	10.67	10.81	50.90	51.21	51.46
07-Feb-98	10.34	10.61	10.81	50.61	51.10	51.46
08-Feb-98	10.03	10.25	10.34	50.05	50.45	50.61
09-Feb-98	10.19	10.54	10.96	50.34	50.97	51.73
10-Feb-98	10.34	10.55	10.96	50.61	50.99	51.73
11-Feb-98	10.03	10.47	10.81	50.05	50.85	51.46
12-Feb-98	10.50	10.66	10.81	50.90	51.19	51.46
13-Feb-98	10.34	10.69	11.12	50.61	51.24	52.02
14-Feb-98	10.81	10.99	11.12	51.46	51.78	52.02
15-Feb-98	10.50	10.76	10.96	50.90	51.37	51.73
16-Feb-98	10.03	10.27	10.81	50.05	50.49	51.46
17-Feb-98	9.72	10.12	10.50	49.50	50.22	50.90
18-Feb-98	10.19	10.49	10.81	50.34	50.88	51.46
19-Feb-98	10.50	10.62	10.81	50.90	51.12	51.46
20-Feb-98	9.88	10.17	10.34	49.78	50.31	50.61
21-Feb-98	9.88	10.06	10.19	49.78	50.11	50.34
22-Feb-98	9.88	10.14	10.34	49.78	50.25	50.61
23-Feb-98	10.19	10.37	10.66	50.34	50.67	51.19
24-Feb-98	10.03	10.38	10.66	50.05	50.68	51.19
25-Feb-98	10.03	10.42	10.81	50.05	50.76	51.46
26-Feb-98	10.50	10.76	11.12	50.90	51.37	52.02
27-Feb-98	10.50	10.74	10.96	50.90	51.33	51.73
28-Feb-98	10.50	10.77	11.12	50.90	51.39	52.02

	Celsius			Fahrenheit		
Date	Min	Ave	Max	Min	Ave	Max
01-Mar-98	10.50	10.84	11.12	50.90	51.51	52.02
02-Mar-98	10.66	11.07	11.42	51.19	51.93	52.56
03-Mar-98	11.12	11.37	11.73	52.02	52.47	53.11
04-Mar-98	10.81	11.03	11.42	51.46	51.85	52.56
05-Mar-98	10.34	10.49	10.81	50.61	50.88	51.46
06-Mar-98	9.88	10.23	10.50	49.78	50.41	50.90
07-Mar-98	10.19	10.32	10.50	50.34	50.58	50.90
08-Mar-98	10.03	10.54	11.12	50.05	50.97	52.02
09-Mar-98	10.81	11.11	11.58	51.46	52.00	52.84
10-Mar-98	10.81	11.21	11.73	51.46	52.18	53.11
11-Mar-98	11.12	11.53	12.04	52.02	52.75	53.67
12-Mar-98	11.27	11.53	11.73	52.29	52.75	53.11
13-Mar-98	11.27	11.46	11.58	52.29	52.63	52.84
14-Mar-98	11.12	11.52	12.04	52.02	52.74	53.67
15-Mar-98	11.58	12.06	12.51	52.84	53.71	54.52
16-Mar-98	11.89	12.17	12.51	53.40	53.91	54.52
17-Mar-98	11.58	12.23	12.82	52.84	54.01	55.08
18-Mar-98	12.20	12.67	13.28	53.96	54.81	55.90
19-Mar-98	12.20	12.49	12.82	53.96	54.48	55.08
20-Mar-98	--	--	--	--	--	--
21-Mar-98	12.67	13.06	13.28	54.81	55.51	55.90
22-Mar-98	12.36	12.72	12.98	54.25	54.90	55.36
23-Mar-98	12.36	12.62	12.82	54.25	54.72	55.08
24-Mar-98	12.51	12.80	13.13	54.52	55.04	55.63
25-Mar-98	12.04	12.36	12.67	53.67	54.25	54.81
26-Mar-98	12.04	12.43	12.98	53.67	54.37	55.36
27-Mar-98	12.20	12.43	12.67	53.96	54.37	54.81
28-Mar-98	11.42	11.77	12.20	52.56	53.19	53.96
29-Mar-98	10.96	11.24	11.58	51.73	52.23	52.84
30-Mar-98	10.96	11.49	12.20	51.73	52.68	53.96
31-Mar-98	11.58	11.80	12.04	52.84	53.24	53.67
01-Apr-98	10.81	11.07	11.42	51.46	51.93	52.56
02-Apr-98	10.81	11.00	11.27	51.46	51.80	52.29
03-Apr-98	10.96	11.10	11.42	51.73	51.98	52.56
04-Apr-98	10.96	11.24	11.58	51.73	52.23	52.84
05-Apr-98	11.12	11.70	12.36	52.02	53.06	54.25
06-Apr-98	11.89	12.10	12.36	53.40	53.78	54.25
07-Apr-98	11.58	11.97	12.36	52.84	53.55	54.25
08-Apr-98	11.42	11.93	12.36	52.56	53.47	54.25
09-Apr-98	11.89	12.41	13.13	53.40	54.34	55.63
10-Apr-98	12.36	12.69	13.13	54.25	54.84	55.63
11-Apr-98	11.42	11.97	12.51	52.56	53.55	54.52
12-Apr-98	10.96	11.37	11.73	51.73	52.47	53.11
13-Apr-98	11.42	11.95	12.51	52.56	53.51	54.52
14-Apr-98	11.27	11.64	12.04	52.29	52.95	53.67
15-Apr-98	11.12	11.75	12.36	52.02	53.15	54.25
16-Apr-98	11.73	12.31	12.82	53.11	54.16	55.08
17-Apr-98	12.04	12.66	13.28	53.67	54.79	55.90
18-Apr-98	12.36	12.82	13.28	54.25	55.08	55.90
19-Apr-98	12.51	13.15	13.89	54.52	55.67	57.00
20-Apr-98	12.82	13.40	14.05	55.08	56.12	57.29
21-Apr-98	13.28	13.76	14.36	55.90	56.77	57.85

	Celsius			Fahrenheit		
Date	Min	Ave	Max	Min	Ave	Max
22-Apr-98	13.59	14.00	14.52	56.46	57.20	58.14
23-Apr-98	13.28	13.57	13.89	55.90	56.43	57.00
24-Apr-98	12.82	13.21	13.59	55.08	55.78	56.46
25-Apr-98	12.82	13.36	14.05	55.08	56.05	57.29
26-Apr-98	12.98	13.51	14.05	55.36	56.32	57.29
27-Apr-98	13.44	13.94	14.52	56.19	57.09	58.14
28-Apr-98	13.89	14.22	14.67	57.00	57.60	58.41
29-Apr-98	13.89	14.54	15.15	57.00	58.17	59.27
30-Apr-98	14.21	14.71	15.31	57.58	58.48	59.56
01-May-98	14.05	14.38	14.67	57.29	57.88	58.41
02-May-98	13.44	13.96	14.52	56.19	57.13	58.14
03-May-98	13.44	14.17	14.67	56.19	57.51	58.41
04-May-98	14.05	14.42	14.99	57.29	57.96	58.98
05-May-98	13.59	13.93	14.05	56.46	57.07	57.29
06-May-98	12.98	13.38	13.74	55.36	56.08	56.73
07-May-98	12.82	13.27	13.74	55.08	55.89	56.73
08-May-98	13.13	13.37	13.59	55.63	56.07	56.46
09-May-98	12.67	13.14	13.59	54.81	55.65	56.46
10-May-98	12.82	13.19	13.59	55.08	55.74	56.46
11-May-98	12.36	12.80	13.13	54.25	55.04	55.63
12-May-98	11.42	11.79	12.36	52.56	53.22	54.25
13-May-98	11.12	11.60	12.04	52.02	52.88	53.67
14-May-98	11.89	12.25	12.67	53.40	54.05	54.81
15-May-98	12.04	12.68	13.28	53.67	54.82	55.90
16-May-98	12.51	12.92	13.13	54.52	55.26	55.63
17-May-98	11.89	12.43	12.98	53.40	54.37	55.36
18-May-98	12.51	13.24	14.05	54.52	55.83	57.29
19-May-98	12.98	13.57	14.21	55.36	56.43	57.58
20-May-98	12.98	13.52	14.05	55.36	56.34	57.29
21-May-98	12.82	13.44	14.05	55.08	56.19	57.29
22-May-98	13.13	13.74	14.36	55.63	56.73	57.85
23-May-98	13.59	14.19	14.83	56.46	57.54	58.69
24-May-98	13.89	14.39	14.83	57.00	57.90	58.69
25-May-98	14.21	14.49	14.83	57.58	58.08	58.69
26-May-98	13.28	13.48	14.05	55.90	56.26	57.29
27-May-98	12.67	12.88	13.13	54.81	55.18	55.63
28-May-98	12.51	12.71	12.82	54.52	54.88	55.08
29-May-98	12.20	12.66	12.98	53.96	54.79	55.36
30-May-98	12.51	13.42	14.36	54.52	56.16	57.85
31-May-98	13.74	14.02	14.21	56.73	57.24	57.58
01-Jun-98	--	--	--	--	--	--
02-Jun-98	--	--	--	--	--	--
03-Jun-98	--	--	--	--	--	--
04-Jun-98	--	--	--	--	--	--
05-Jun-98	14.05	14.63	14.99	57.29	58.33	58.98
06-Jun-98	14.36	14.73	15.15	57.85	58.51	59.27
07-Jun-98	14.52	14.66	14.99	58.14	58.39	58.98
08-Jun-98	13.89	14.36	14.83	57.00	57.85	58.69
09-Jun-98	14.52	15.07	15.78	58.14	59.13	60.40
10-Jun-98	14.99	15.31	15.62	58.98	59.56	60.12
11-Jun-98	14.21	14.87	15.31	57.58	58.77	59.56
12-Jun-98	14.67	15.06	15.47	58.41	59.11	59.85

Date	Celsius			Fahrenheit		
	Min	Ave	Max	Min	Ave	Max
13-Jun-98	14.52	15.12	15.94	58.14	59.22	60.69
14-Jun-98	14.99	15.74	16.73	58.98	60.33	62.11
15-Jun-98	15.78	16.43	17.04	60.40	61.57	62.67
16-Jun-98	15.94	16.41	16.89	60.69	61.54	62.40
17-Jun-98	15.31	16.00	16.57	59.56	60.80	61.83
18-Jun-98	14.83	15.43	16.09	58.69	59.77	60.96
19-Jun-98	14.67	15.23	15.94	58.41	59.41	60.69
20-Jun-98	14.83	15.54	16.26	58.69	59.97	61.27
21-Jun-98	14.67	15.48	16.26	58.41	59.86	61.27
22-Jun-98	14.83	15.57	16.26	58.69	60.03	61.27
23-Jun-98	15.15	15.74	16.41	59.27	60.33	61.54
24-Jun-98	14.83	15.58	16.26	58.69	60.04	61.27
25-Jun-98	14.83	15.64	16.26	58.69	60.15	61.27
26-Jun-98	14.99	15.48	15.94	58.98	59.86	60.69
27-Jun-98	14.99	15.61	16.26	58.98	60.10	61.27
28-Jun-98	14.99	15.67	16.41	58.98	60.21	61.54
29-Jun-98	15.31	15.88	16.41	59.56	60.58	61.54
30-Jun-98	14.83	15.56	16.26	58.69	60.01	61.27
01-Jul-98	14.67	15.41	16.09	58.41	59.74	60.96
02-Jul-98	14.67	15.33	16.09	58.41	59.59	60.96
03-Jul-98	14.67	15.36	15.94	58.41	59.65	60.69
04-Jul-98	14.67	15.50	16.41	58.41	59.90	61.54
05-Jul-98	15.15	15.91	16.73	59.27	60.64	62.11
06-Jul-98	15.47	16.05	16.57	59.85	60.89	61.83
07-Jul-98	15.47	16.04	16.57	59.85	60.87	61.83
08-Jul-98	15.47	16.17	16.89	59.85	61.11	62.40
09-Jul-98	15.62	16.30	17.04	60.12	61.34	62.67
10-Jul-98	15.31	16.00	16.57	59.56	60.80	61.83
11-Jul-98	15.15	16.00	16.73	59.27	60.80	62.11
12-Jul-98	15.31	16.09	16.89	59.56	60.96	62.40
13-Jul-98	15.78	16.08	16.57	60.40	60.94	61.83



16. Stanislaus River 1998 average daily temperature.

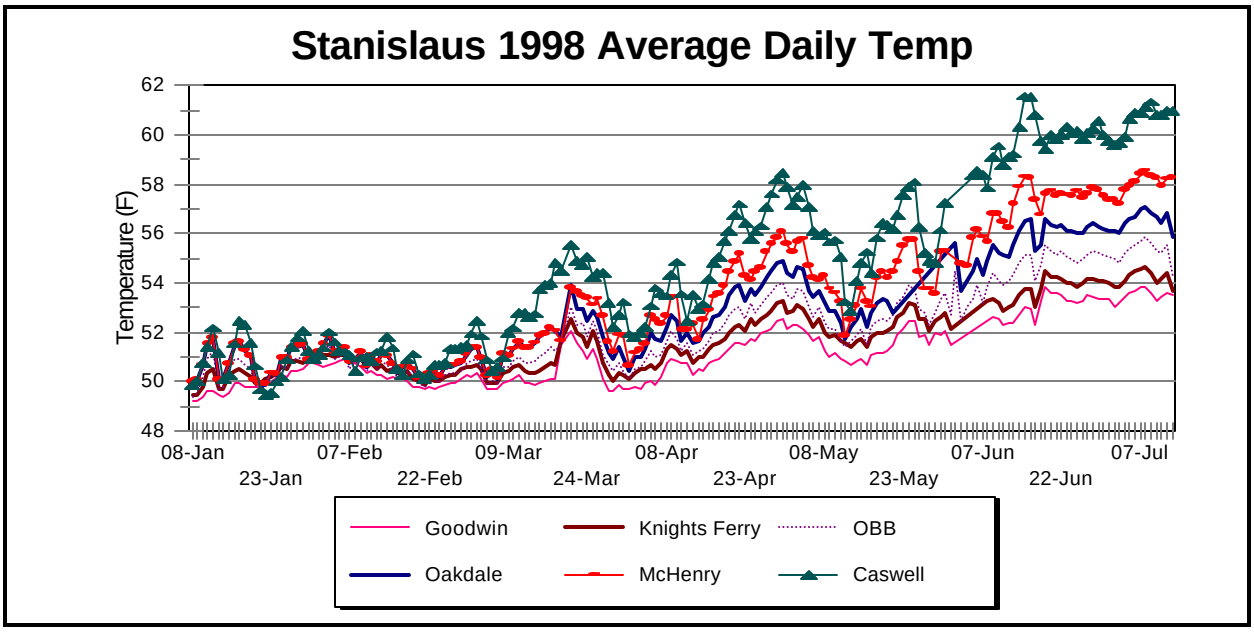
Date	Goodwin	Knights Ferry	Temp at OBB	Oakdale	McHenry	Temp at Caswell
08-Jan	49.24	49.46	49.41	49.82	50.00	49.87
09-Jan	49.19	49.48	49.55	50.04	50.04	50.04
10-Jan	49.39	49.80	50.16	50.68	50.68	50.74
11-Jan	49.64	50.34	50.94	51.49	51.49	51.42
12-Jan	49.60	50.49	51.22	51.75	51.75	52.18
13-Jan	49.48	49.69	49.68	50.09	50.09	51.17
14-Jan	49.35	49.68	49.77	50.09	50.09	50.05
15-Jan	49.55	50.29	50.63	50.74	50.74	50.27
16-Jan	49.93	50.47	50.94	51.49	51.49	51.53
17-Jan	49.98	50.54	50.95	51.60	51.60	52.43
18-Jan	49.82	50.34	50.68	51.26	51.26	52.32
19-Jan	49.75	50.18	50.54	51.03	51.03	51.57
20-Jan	49.78	49.96	49.86	50.05	50.05	50.65
21-Jan	49.80	49.93	49.68	49.87	49.87	49.66
22-Jan	49.91	50.07	49.77	49.87	49.87	49.42
23-Jan	49.98	50.20	50.04	50.36	50.36	49.57
24-Jan	50.16	50.34	50.09	50.29	50.29	49.98
25-Jan	50.29	50.58	50.58	50.95	50.95	50.18
26-Jan	50.16	50.50	50.54	50.94	50.94	50.88
27-Jan	50.47	50.85	50.95	51.39	51.39	51.40
28-Jan	50.43	50.83	50.94	51.42	51.42	51.76
29-Jan	50.49	50.79	50.99	51.51	51.51	52.03
30-Jan	50.77	50.97	50.76	50.90	50.90	51.22
31-Jan	50.72	50.97	50.86	51.08	51.08	50.92
01-Feb	50.70	50.92	50.94	51.17	51.17	51.10
02-Feb	50.61	51.08	51.26	51.51	51.51	51.35
03-Feb	50.65	51.12	51.44	51.87	51.87	52.02
04-Feb	50.72	51.01	50.92	51.17	51.17	51.60
05-Feb	50.81	51.10	51.03	51.24	51.24	51.26
06-Feb	50.90	51.12	51.13	51.37	51.37	51.21
07-Feb	50.72	50.81	50.54	50.79	50.79	51.10
08-Feb	50.72	50.95	50.76	50.92	50.92	50.45
09-Feb	50.56	50.88	50.86	51.17	51.17	50.97
10-Feb	50.38	50.58	50.41	50.59	50.59	50.99
11-Feb	50.47	50.76	50.72	51.04	51.04	50.85
12-Feb	50.27	50.52	50.54	50.79	50.79	51.19
13-Feb	50.31	50.68	50.83	51.12	51.12	51.24
14-Feb	50.07	50.47	50.65	51.04	51.04	51.78
15-Feb	50.22	50.52	50.45	50.72	50.72	51.37
16-Feb	50.11	50.36	50.16	50.38	50.38	50.49
17-Feb	50.07	50.38	50.29	50.59	50.59	50.22
18-Feb	50.05	50.45	50.40	50.72	50.72	50.88
19-Feb	49.80	50.13	50.16	50.50	50.50	51.12
20-Feb	49.82	50.05	49.91	50.11	50.11	50.31
21-Feb	49.68	49.86	49.82	50.11	50.11	50.11

Date	Goodwin	Knights Ferry	Temp at OBB	Oakdale	McHenry	Temp at Caswell
22-Feb	49.78	50.13	50.13	50.32	50.32	50.25
23-Feb	49.71	50.00	50.09	50.43	50.43	50.67
24-Feb	49.77	50.04	49.96	50.20	50.20	50.68
25-Feb	49.86	50.18	50.25	50.56	50.56	50.76
26-Feb	49.93	50.23	50.32	50.63	50.63	51.37
27-Feb	49.96	50.27	50.36	50.68	50.68	51.33
28-Feb	50.11	50.49	50.43	50.79	50.79	51.39
01-Mar	50.23	50.63	50.74	51.10	51.10	51.51
02-Mar	50.20	50.63	50.86	51.35	51.35	51.93
03-Mar	50.32	50.70	50.90	51.39	51.39	52.47
04-Mar	50.14	50.49	50.52	50.94	50.94	51.85
05-Mar	49.71	49.95	49.86	50.22	50.22	50.88
06-Mar	49.69	49.96	50.05	50.45	50.45	50.41
07-Mar	49.73	49.96	49.89	50.14	50.14	50.58
08-Mar	49.95	50.34	50.58	51.10	51.10	50.97
09-Mar	50.02	50.41	50.59	51.06	51.06	52.00
10-Mar	50.14	50.58	50.83	51.31	51.31	52.18
11-Mar	50.25	50.67	50.97	51.58	51.58	52.75
12-Mar	49.98	50.41	50.77	51.39	51.39	52.75
13-Mar	49.91	50.34	50.79	51.37	51.37	52.63
14-Mar	49.89	50.34	50.86	51.57	51.57	52.74
15-Mar	49.98	50.45	50.99	51.82	51.82	53.71
16-Mar	50.04	50.58	51.17	51.94	51.94	53.91
17-Mar	50.13	50.72	51.37	52.20	52.20	54.01
18-Mar	50.14	50.65	51.22	52.05	52.05	54.81
19-Mar	51.48	51.66	51.46	51.76	51.64	54.48
20-Mar	--	--	--	--	--	--
21-Mar	52.02	52.57	53.01	53.91	53.78	55.51
22-Mar	51.53	51.96	52.30	52.97	53.64	54.90
23-Mar	51.21	51.80	52.34	52.97	53.49	54.72
24-Mar	50.95	51.37	51.78	52.47	53.38	55.04
25-Mar	51.30	52.02	52.45	52.88	53.10	54.25
26-Mar	50.94	51.60	52.09	52.65	53.35	54.37
27-Mar	50.07	50.72	51.08	51.82	52.66	54.37
28-Mar	49.62	50.27	50.70	51.19	51.60	53.19
29-Mar	49.64	50.05	50.41	50.88	51.21	52.23
30-Mar	49.89	50.38	50.76	51.39	51.89	52.68
31-Mar	49.68	50.31	50.43	50.97	51.87	53.24
01-Apr	49.69	50.11	50.11	50.47	50.65	51.93
02-Apr	49.82	50.32	50.54	50.97	51.15	51.80
03-Apr	49.71	50.52	50.61	50.99	51.30	51.98
04-Apr	49.95	50.50	50.83	51.35	51.49	52.23
05-Apr	50.04	50.67	51.26	51.98	52.65	53.06
06-Apr	49.86	50.49	50.99	51.71	52.50	53.78
07-Apr	50.18	50.72	51.04	51.60	52.36	53.55
08-Apr	50.74	51.28	51.64	52.18	52.65	53.47
09-Apr	50.94	51.51	52.03	52.72	53.40	54.34

Date	Goodwin	Knights Ferry	Temp at OBB	Oakdale	McHenry	Temp at Caswell
10-Apr	50.81	51.30	51.73	52.43	53.44	54.84
11-Apr	50.72	51.06	51.21	51.67	52.09	53.55
12-Apr	50.79	51.26	51.53	51.94	52.07	52.47
13-Apr	50.25	50.79	51.10	51.58	52.32	53.51
14-Apr	50.50	50.99	51.22	51.60	51.69	52.95
15-Apr	50.47	50.97	51.35	51.98	52.47	53.15
16-Apr	50.77	51.28	51.66	52.25	52.88	54.16
17-Apr	50.86	51.46	51.98	52.66	53.44	54.79
18-Apr	50.94	51.55	52.02	52.74	53.56	55.08
19-Apr	51.13	51.75	52.34	53.06	53.87	55.67
20-Apr	51.30	52.00	52.68	53.53	54.46	56.12
21-Apr	51.53	52.20	52.95	53.82	54.88	56.77
22-Apr	51.58	52.29	53.04	53.89	55.17	57.20
23-Apr	51.51	52.07	52.56	53.29	54.27	56.43
24-Apr	51.73	52.54	53.15	53.78	54.14	55.78
25-Apr	51.67	52.29	52.75	53.55	54.46	56.05
26-Apr	51.96	52.57	53.08	53.85	54.63	56.32
27-Apr	52.02	52.68	53.40	54.25	55.24	57.09
28-Apr	52.16	52.84	53.62	54.50	55.56	57.60
29-Apr	52.48	53.15	53.92	54.82	55.83	58.17
30-Apr	52.54	53.29	54.03	54.91	56.08	58.48
01-May	52.12	52.81	53.49	54.36	55.56	57.88
02-May	52.32	52.84	53.33	54.23	55.22	57.13
03-May	52.32	53.08	53.76	54.68	55.69	57.51
04-May	52.16	52.97	53.65	54.55	55.78	57.96
05-May	51.91	52.54	52.99	53.71	54.68	57.07
06-May	51.64	52.25	52.66	53.40	54.21	56.08
07-May	51.76	52.52	53.02	53.65	54.14	55.89
08-May	51.22	51.98	52.41	53.22	54.25	56.07
09-May	50.99	51.76	52.11	52.83	53.76	55.65
10-May	51.13	51.85	52.14	52.88	53.60	55.74
11-May	50.90	51.67	51.67	52.36	53.24	55.04
12-May	50.86	51.55	51.37	51.71	51.82	53.22
13-May	50.70	51.39	51.60	52.21	52.52	52.88
14-May	50.86	51.60	51.89	52.54	53.08	54.05
15-May	50.94	51.71	52.16	52.92	53.76	54.82
16-May	50.67	51.42	51.51	52.23	53.24	55.26
17-May	51.08	51.78	52.18	52.79	53.02	54.37
18-May	51.17	51.93	52.47	53.19	54.21	55.83
19-May	51.15	51.93	52.54	53.38	54.46	56.43
20-May	51.26	52.02	52.48	53.28	54.19	56.34
21-May	51.49	52.18	52.74	52.80	54.45	56.19
22-May	51.89	52.61	53.20	--	54.86	56.73
23-May	52.14	52.77	53.46	--	55.49	57.54
24-May	52.45	53.20	53.91	--	55.72	57.90
25-May	52.47	53.11	53.69	--	55.74	58.08
26-May	51.84	52.57	52.92	--	54.41	56.26

Date	Goodwin	Knights Ferry	Temp at OBB	Oakdale	McHenry	Temp at Caswell
27-May	51.91	52.50	52.79	--	53.74	55.18
28-May	51.44	52.02	52.27	--	53.76	54.88
29-May	51.96	52.47	52.81	--	53.56	54.79
30-May	51.87	52.61	53.35	--	55.26	56.16
31-May	52.07	52.81	53.58	--	55.29	57.24
01-Jun	51.51	52.14	52.68	--	--	--
02-Jun	--	--	54.50	55.58	--	--
03-Jun	--	--	52.47	53.65	54.79	--
04-Jun	--	--	53.01	54.05	54.68	--
05-Jun	--	--	53.33	54.50	55.81	58.33
06-Jun	--	--	53.92	55.00	56.16	58.51
07-Jun	--	--	53.22	54.34	55.85	58.39
08-Jun	52.45	53.26	53.83	54.90	55.69	57.85
09-Jun	52.65	53.38	54.41	55.53	56.77	59.13
10-Jun	52.56	53.15	54.05	55.20	56.77	59.56
11-Jun	52.27	52.84	53.89	55.13	56.44	58.77
12-Jun	52.34	53.04	54.05	55.08	56.21	59.11
13-Jun	52.38	53.11	54.32	55.53	57.16	59.22
14-Jun	52.74	53.51	54.79	56.14	57.88	60.33
15-Jun	52.99	53.74	55.17	56.52	58.30	61.57
16-Jun	52.92	53.74	55.17	56.57	58.24	61.54
17-Jun	52.32	53.01	54.07	55.27	57.38	60.80
18-Jun	53.26	53.78	54.70	55.58	56.75	59.77
19-Jun	53.85	54.46	55.53	56.61	57.60	59.41
20-Jun	53.58	54.25	55.31	56.35	57.72	59.97
21-Jun	53.62	54.21	55.13	56.23	57.49	59.86
22-Jun	53.47	54.18	55.27	56.34	57.63	60.03
23-Jun	53.28	54.01	55.04	56.12	57.56	60.33
24-Jun	53.26	54.01	55.00	56.10	57.54	60.04
25-Jun	53.17	53.82	54.82	56.05	57.72	60.15
26-Jun	53.28	54.00	55.00	56.01	57.47	59.86
27-Jun	53.49	54.18	55.17	56.30	57.63	60.10
28-Jun	53.42	54.14	55.27	56.44	57.83	60.21
29-Jun	53.37	54.07	55.18	56.28	57.74	60.58
30-Jun	53.35	54.09	55.11	56.21	57.52	60.01
01-Jul	53.33	54.03	55.06	56.10	57.38	59.74
02-Jul	52.99	53.82	54.93	56.10	57.36	59.59
03-Jul	53.17	53.87	54.84	55.99	57.20	59.65
04-Jul	53.44	54.10	55.20	56.44	57.74	59.90
05-Jul	53.60	54.34	55.40	56.57	57.92	60.64
06-Jul	53.67	54.46	55.53	56.70	58.12	60.89
07-Jul	53.87	54.59	55.72	56.97	58.39	60.87
08-Jul	53.82	54.63	55.83	57.11	58.53	61.11
09-Jul	53.58	54.41	55.62	56.82	58.35	61.34
10-Jul	53.28	54.03	55.29	56.64	58.26	60.80
11-Jul	53.46	54.18	55.22	56.44	57.96	60.80
12-Jul	53.56	54.37	55.53	56.80	58.21	60.96

Date	Goodwin	Knights Ferry	Temp at OBB	Oakdale	McHenry	Temp at Caswell
13-Jul	53.49	53.71	54.21	55.85	58.28	60.94



17. Stanislaus River flow at OBB, 1998.

Stanislaus River Flow at Orange Blossom Bridge

1998	Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug
	1	266	2526	3713	1645	2019	1929	2112	1797
	2	273	2524	3508	1580	1972	1671	2112	1803
	3	271	3854	2967	1758	2008	1551	2116	1826
	4	371	3767	2450	1649	2049	1527	2115	1856
	5	302	5497	2048	1580	2063	1537	2125	1872
	6	273	4915	2106	1561	2011	1531	2097	1860
	7	274	4333	2071	1822	--	1536	2077	1825
	8	273	5434	2059	2080	--	1539	2110	1824
	9	273	5460	2089	2065	2025	1515	2009	1810
	10	365	5095	1974	2062	2005	1528	1861	1821
	11	450	5004	1721	2066	2004	1557	1830	1835
	12	1619	4850	1620	2069	2033	1593	1828	1814
	13	2419	4772	1577	2206	2088	1564	1810	1827
	14	1532	4508	1577	2182	2027	1565	1799	1868
	15	2038	4358	1574	2066	2017	1621	1808	1821
	16	2612	5003	1570	2051	2019	1697	1805	1825
	17	1618	4468	1569	2035	2028	1947	1784	1838
	18	1313	5064	1768	1996	2023	2082	1799	1825
	19	1521	4481	2798	1996	2016	2146	1825	1829
	20	1274	4530	3413	2008	2027	2154	1787	1847
	21	1160	4566	3365	1979	2010	2132	1794	1858
	22	996	4571	2744	1982	2036	2127	1833	1824
	23	843	4201	2499	2009	2033	2119	1820	1868
	24	833	3746	2491	2057	2061	2130	1863	1862
	25	825	3746	2657	2016	2077	2155	1861	1851
	26	1036	3751	2351	1992	2067	2105	1850	
	27	1366	3700	1883	2005	2060	2094	1782	
	28	1365	3709	1728	1998	2086	2110	1818	
	29	1806	--	1593	2004	2035	2120	1816	
	30	2623	--	1561	2014	2034	2120	1846	
	31	2629	--	1582	--	2053		1821	
	count	**31**	**28**	**30**	**30**	**29**	**30**	**30**	**31**
	Mean Flow	**1123**	**4373**	**2288**	**1951**	**2034**	**1833**	**1964**	**1480**

Source: Daily mean flow data from the California Data Exchange Center

Mean Monthly Stanislaus River Flow

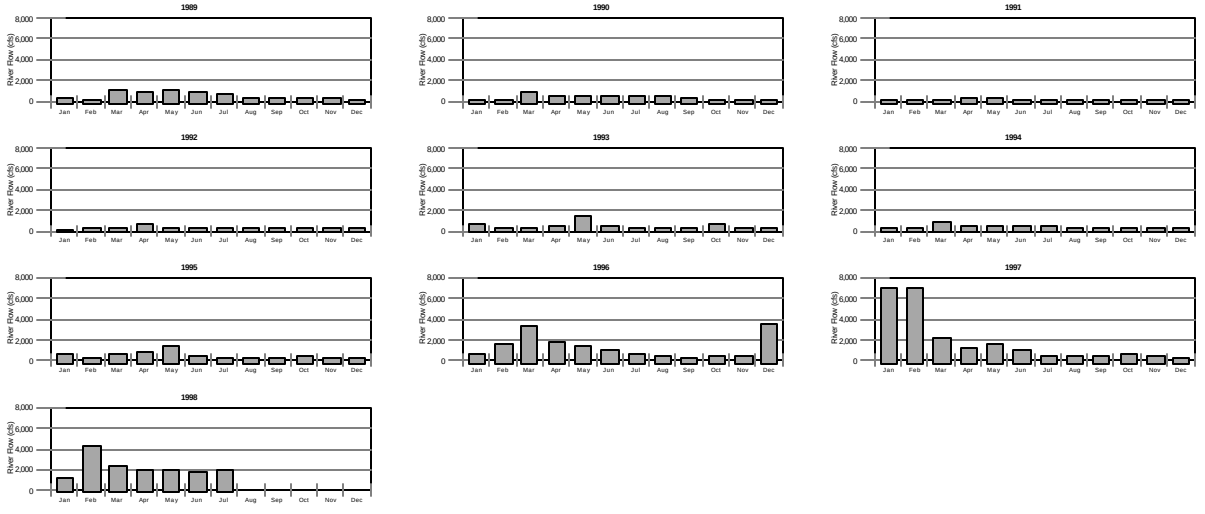
Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1989	289	195	1022	834	1047	835	610	339	303	263	224	199
1990	147	155	876	480	414	596	579	494	278	204	176	169
1991	155	159	201	231	296	211	200	125	116	170	167	122
1992	122	218	222	754	288	233	259	271	293	298	214	213
1993	580	258	269	470	1444	472	399	286	240	588	355	322
1994	334	300	927	473	441	450	446	378	266	381	254	258
1995	590	251	623	911	1377	488	275	286	251	421	366	288
1996	620	1671	3259	1712	1426	969	705	497	358	511	534	3521
1997	7121	6949	2270	1238	1547	1034	388	428	478	740	389	331
1998	1123	4373	2288	1951	2034	1833	1964					
Ave.	**317**	**219**	**591**	**593**	**758**	**469**	**416**	**316**	**249**	**317**	**232**	**214**

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec

Source: Daily data from CDEC. Monthly averages calculated from daily flow values.

Mean Monthly Stanislaus River Flow

1989 - 1998 at Orange Blossom Bridge



18. Cross-sectional profiles of the Stanislaus River at the Caswell trapping site, 1998.

Date: 3/11/98
Time: 1600
Flow: 1,974

Distance	Depth	Flow at 1ft	Flow at 4ft
3	2	1	0.4
6	4	0.5	0.5
9	7	0	0.2
12	8.5	0.2	0.4
15	9.5	2.2	2.4
18	11	2.3	2.5
21	12	2.5	2.8
24	13	2.8	2.8
27	13	2.8	2.8
30	13	3	3
33	13	2.9	2.8
36	13	2.9	2.9
39	13	2.5	2.9
42	13	3.1	3.1
45	13	3.3	3.2
48	13	3.3	3.3
51	12.5	3.3	3.4
54	12	2.8	2.8
57	12	2.5	2.5
60	12	2.8	2.7
63	11.5	3	3.1
66	11	3.2	3.3
69	11	3.2	3.3
72	11	3.3	3.3
75	11	3.1	3.1
78	11	3.2	3.2
81	11.5	2.4	2.7
84	11.5	2.2	2.3
87	0.6	1.5	1.7

Approx. 9 ft to bank - trees.

Date: 3/14/98
Time: 1800
Flow: 1,577

Distance	Depth	Flow at 1ft	Flow at 4ft
3	2	0	0
6	2	0	0.1
9	5	0.1	0
12	8	0.1	0.1
15	8.5	0.8	1
18	9.5	1.3	1.2
21	11.5	2.3	2.5
24	12	2.1	2.3
27	12	2.2	2.4
30	12	2.5	2.5
33	12	2.2	2.3
36	11.5	2.5	2.5
39	11.5	2.8	2.8
42	12	2.6	2.7
45	11	2.8	2.8
48	11.5	2.6	2.7
51	11.5	2.7	2.8
54	11	2.3	2.3
57	11	2.1	2
60	10.5	2	2
63	10.5	2	2
66	10	2.1	2.1
69	10	2.7	2.8
72	10	2.8	2.8
75	10	2.7	2.8
78	10	2.7	2.8
81	10	2.7	2.8
84	10	2.5	2.5
87	10	2.2	2.4
90	9	1.5	1.6

Approx. 9 ft to bank - trees.

Date: 3/21/98
Time:
Flow: 3,365

Distance	Depth	Flow at 1ft	Flow at 4ft
3	3	1.2	--
6	6	0.9	--
9	9	0.5	0.5
12	12	1.1	1.3
15	14	1.3	1.1
18	14	1.7	1.3
21	14	3	3.6
24	13	3.3	3.1

Date: 3/24/98
Time: 1600
Flow: 2,491

Distance	Depth	Flow at 1ft	Flow at 4ft
3	3	0.9	--
6	7	0.4	0.3
9	7	0.3	0.2
12	10	2.2	0.7
15	11	2.7	1
18	11	2.4	1
21	12	3.1	3.9
24	14	2.7	3.2

27	14	3.1	3.4
30	15	3.3	2.8
33	15	3.2	3.2
36	15	2.8	2.6
39	15	4	3.3
42	15	3.6	3.5
45	15	3.2	2.9
48	15	3.1	2.9
51	14	3.6	3.3
54	15	3.5	3.2
57	15	2.8	2.8
60	15	2.7	2.7
63	14	3.2	2.4
66	14	3	2.9
69	14	3.2	3.2
72	14	3.3	3.3
75	13	3.2	3.2
78	13	3.4	3.4
81	14	2.9	2.6
84	14	2.7	2.7
87	12	2.9	2.8
90	7	2	0.8
93	6	1.7	1.6

Approximately 9 ft to bank - trees.

27	14	2.8	3.1
30	14	3	3.3
33	14	3.2	3.6
36	14	3.1	3.7
39	14	3.2	3.2
42	14	3.1	3.4
45	14	2.7	2.9
48	14	3.2	3.2
51	14	3.2	3.1
54	14	2.6	3.4
57	14	2.5	2.7
60	14	2.5	2.3
63	14	2.8	2.8
66	13	2.6	2.7
69	13	3.2	2.6
72	13	3	2.8
75	13	3.1	2.8
78	13	3.4	2.8
81	13	3.2	3.1
84	13	3.2	2.7
87	10	1.9	1.2

Approximately 9 ft to bank - trees.

Date: 3/26/98
Time: 900
Flow: 2,351

Distance	Depth	Flow at 1ft	Flow at 4ft
3	4	0.6	0.7
6	8	0.3	0.8
9	7	0.4	0.2
12	10	0.8	0.3
15	11	2.6	0.7
18	12	0.5	1.3
21	13	1.6	3.2
24	15	2.4	3.3
27	14	0.7	2.8
30	14	3.2	3.4
33	14	2.6	3.1
36	14	3.2	3.4
39	14	3.5	2.8
42	14	3.4	3.1
45	14	3.1	3.2
48	14	3.1	3.2
51	14	2.4	3.2
54	14	2.6	2.5
57	14	2.6	2.4
60	13	2.8	2.5
63	13	3.6	2.3
66	13	3	3.2
69	13	3.6	2.8
72	13	2.8	3.1

Date: 3/28/98
Time: 830
Flow: 1,728

Distance	Depth	Flow at 1ft	Flow at 4ft
3	2	0.3	0.3
6	4	0.4	0
9	5	0.2	0.37
12	8	0.2	1
15	10	1.1	0.4
18	12	1.7	2.6
21	13	2.2	3
24	13	2.6	2.6
27	13	1.9	2.5
30	13	1.9	2.5
33	13	2.3	2.4
36	13	0.7	0.8
39	13	2.3	2.8
42	13	0.3	2.1
45	13	0.9	1.8
48	13	2.1	2.3
51	12	2	2.2
54	12	2.5	1.9
57	12	2.9	3
60	12	3	3
63	11	2.6	2.9
66	11	3.6	2.7
69	11	2.1	2.8
72	9	1.3	1.9

75	12	3.2	2.9
78	12	3.3	3.2
81	12	3	3
84	11	2.7	2.8
87	10	1.1	0.8

Approximately 9 ft to bank - trees.

Date: 4/3/98
Time: 1000
Flow: 1,758

Distance	Depth	Flow at 1ft	Flow at 4ft
3	2.5	0	0.1
6	4.5	0	0
9	9	0.4	0.3
12	9	0.6	0.7
15	10	1.2	1
18	10	1.8	2.2
21	12	2.6	2.8
24	12	2.8	2.4
27	12	2.7	2.7
30	12	2.9	2.7
33	12	2.7	2.7
36	12	2.8	2.9
39	12	2.8	2.8
42	12	2.7	2.7
45	12	2.4	2.5
48	11.5	2.3	2
51	11.5	1.9	1.9
54	11	1.8	2
57	11	1.8	2
60	11	1.9	1.9
63	11	2.4	2.3
66	10.5	2.4	2.5
69	10.5	2.6	2.6
72	10	2.6	2.6
75	10	2.4	2.4
78	11	2.5	2.6
81	11	2.3	2.4
84	9	1.2	1.6
87	7	1.5	1.6
90	4	trees	trees

Approximately 6 ft to bank - trees.

Date: 4/13/98
Time: 1030
Flow: 2,206

Distance	Depth	Flow at 1ft	Flow at 4ft
3	3	0.3	--
6	4	0.2	--
9	6	0.2	0.2
12	9	0.4	0.6
15	9	1.1	0.6
18	11	1.8	1.5
21	11	3.3	2.7
24	13	2.6	2.6
27	13	2.4	3
30	13	2.2	2.8
33	13	2.7	2.7
36	13	2.8	2.9
39	13	2.7	2.6
42	13	2.7	2.7
45	13	2.7	3.1
48	13	2.5	2.5
51	13	2	2.1
54	12	2.1	1.9
57	13	2.1	1.9
60	13	2.1	2.2
63	12	2.8	2.5
66	12	2.7	2.6
69	11	3	3
72	11	3	2.9
75	11	2.8	2.7
78	11	2.5	2.7
81	11	2.7	2.8
84	11	2	2.2
87	4	1.8	--

Approximately 9 ft to bank - trees.

Date: 4/23/98
Time: 1015
Flow: 2,009

Distance	Depth	Flow at 1ft	Flow at 4ft
3	--	--	--
6	--	--	--
9	8	0.5	0.4
12	9	1.3	1.6
15	10	1.3	1.2

Date: 6/1/98
Time: 1030
Flow: 1,929

Distance	Depth	Flow at 1ft	Flow at 4ft
3	--	--	--
6	--	--	--
9	--	--	--
12	10	0.4	0.3
15	10	0.9	1.1

18	11	1.9	1.3
21	13	2.5	2.7
24	13	2.9	2.7
27	13	2.4	2.4
30	13	2.4	2.8
33	13	2.6	2.9
36	13	2.9	3.2
39	13	2.7	2.6
42	13	2.4	2.8
45	13	2.1	2.8
48	13	2.5	2.3
51	12	2.6	2.3
54	12	2.3	2.3
57	12	2.7	2.4
60	12	2.3	2.5
63	12	3.1	2.9
66	11	3.2	3
69	11	3.1	2.8
72	11	2.6	3
75	11	3.1	2.8
78	12	2.4	2.3
81	10	2	2.2

1st 9 ft and last 9 ft heavy brush.

18	11	1.8	1.5
21	11	2.4	2.9
24	13	2.8	3.2
27	13	2.4	2.6
30	13	2.6	3.2
33	13	2.8	3
36	13	2.7	2.9
39	13	2.6	2.8
42	13	2.9	3.1
45	13	3.1	3.2
48	13	3.1	2.4
51	13	2.9	2.6
54	13	2.1	2.3
57	12	2.3	2.4
60	12	2.2	2.4
63	12	2.5	2.6
66	12	2.8	2.8
69	12	3	3.2
72	12	3	3.1
75	11	3.2	3
78	11	3	2.9
81	11	3.1	3.1
84	12	3.1	3.1
87	10	2.1	2.1

1st 9 ft from bank - heavy brush, no flow.
Last 12 ft - heavy brush, little flow.

Date: 6/12/98
Time: 815
Flow: 1,593

Distance	Depth	Flow at 1ft	Flow at 4ft
3	2	0	0
6	7	1.2	0
9	8	1	0.9
12	9.5	1.9	1.9
15	11	2.8	2.7
18	11	2.6	2.6
21	11	3.2	2.3
24	11	2.4	2.6
27	11.5	2.4	2.8
30	11.5	2.6	2.7
33	11	2.6	2.8
36	12	2.3	2.5
39	12	1.4	2
42	12	1.6	1.9
45	11	1.3	1.8
48	11	1.3	1.7
51	10	1.7	2
54	10	2.1	2.1
57	11	2.2	2.3
60	10	2.1	2.4
63	10	2	2.4
66	10	2.3	2.6

Date: 7/11/98
Time: 930
Flow: 1,830

Distance	Depth	Flow at 1ft	Flow at 4ft
3	nd	nd	nd
6	nd	nd	nd
9	nd	nd	nd
12	11.0	2.0	0.3
15	9.0	1.2	0.5
18	10.0	2.0	0.6
21	12.0	3.1	0.8
24	12.0	2.8	2.9
27	12.0	2.9	3.2
30	12.0	3.6	3.3
33	12.0	3.1	3.2
36	12.0	3.3	3.0
39	12.0	2.6	3.1
42	12.0	2.6	3.3
45	12.0	2.8	3.0
48	12.0	2.5	3.0
51	12.0	2.0	2.3
54	12.0	1.7	2.0
57	11.0	2.1	2.1
60	11.0	2.0	2.2
63	11.0	2.2	2.2
66	11.0	2.5	2.4

69	11	1.7	2.1
72	11	2.1	2.2
75	10	1.6	2
78	9	0.5	0.6

Last 9 ft covered in brush.

69	11.0	2.7	3.9
72	11.0	3.2	3.1
75	11.0	3.8	3.1
78	10.0	2.9	2.7
81	11.0	3.0	2.9
84	11.0	3.1	3.1
87	11.0	3.0	3.9

First & last 12ft was heavy brush with no flow.

Date: 7/12/98
Time: 845
Flow: 1,828

Distance	Depth	Flow at 1ft	Flow at 4ft
3	nd	nd	nd
6	nd	nd	nd
9	nd	nd	nd
12	7.0	no flow	no flow
15	8.0	0.9	1.0
18	9.0	1.5	0.7
21	10.0	2.1	0.6
24	12.0	2.9	2.1
27	12.0	2.6	2.3
30	12.0	3.6	2.9
33	12.0	2.5	3.0
36	12.0	2.6	2.8
39	12.0	3.2	3.1
42	12.0	3.0	3.1
45	12.0	3.2	2.8
48	12.0	3.2	2.8
51	12.0	3.3	2.8
54	13.0	3.3	3.0
57	12.0	3.0	2.8
60	12.0	2.2	2.5
63	12.0	2.1	2.3
66	11.0	2.0	1.9
69	11.0	2.4	2.4
72	11.0	2.1	1.9
75	12.0	3.3	2.6
78	11.0	2.8	2.7
81	11.0	2.8	3.0
84	10.0	3.0	2.9
87	11.0	3.0	2.7
90	11.0	2.8	2.9
93	11.0	2.4	3.1
96	11.0	2.9	2.6
99	10.0	2.5	2.2

First & last 12ft was heavy brush with no flow.

Date: 7/13/98
Time: 1000
Flow: 1,810

Distance	Depth	Flow at 1ft	Flow at 4ft
3	nd	nd	nd
6	nd	nd	nd
9	nd	nd	nd
12	8.0	no flow	no flow
15	9.0	1.5	0.8
18	10.0	1.2	0.9
21	11.0	2.5	1.4
24	11.0	2.0	2.8
27	12.0	2.1	2.7
30	12.0	2.8	2.5
33	12.0	2.6	2.8
36	12.0	3.1	2.7
39	12.0	3.0	3.0
42	12.0	2.9	2.7
45	12.0	2.6	3.1
48	13.0	3.1	2.7
51	13.0	3.4	3.0
54	12.0	2.5	2.3
57	12.0	2.4	2.3
60	11.0	2.2	2.2
63	11.0	2.4	2.2
66	11.0	2.2	2.2
69	11.0	2.0	2.7
72	11.0	3.9	2.5
75	11.0	3.0	3.0
78	11.0	3.1	1.0
81	10.0	2.8	3.8
84	11.0	3.2	3.0
87	11.0	3.9	3.2
90	11.0	0.7	0.7

First & last 12ft was heavy brush with no flow.

Date: 7/14/98
Time: 1200
Flow: 1,799

Distance	Depth	Flow at 1ft	Flow at 4ft

3	nd	nd	nd
6	nd	nd	nd
9	nd	nd	nd
12	5.0	0.2	no flow
15	6.0	0.4	no flow
18	8.0	1.4	0.7
21	9.0	0.9	1.5
24	10.0	2.4	2.3
27	11.0	2.8	3.1
30	12.0	2.8	2.9
33	12.0	2.5	3.2
36	12.0	2.8	2.7
39	12.0	2.9	3.6
42	12.0	3.0	3.0
45	12.0	2.6	3.1
48	12.0	2.8	2.9
51	nd	2.9	2.8
54	nd	2.6	2.9
57	nd	1.7	2.4
60	nd	2.2	2.2
63	nd	2.1	2.3
66	nd	2.0	2.3
69	nd	2.6	2.1
72	nd	2.7	2.3
75	nd	3.0	3.0
78	nd	2.9	2.7
81	nd	2.9	2.9
84	nd	3.2	3.1
87	nd	2.9	3.0
90	nd	2.8	3.8

First & last 12ft was heavy brush with no flow. Depth gun stopped working.