FINAL PERFORMANCE REPORT

FEDERAL AID IN SPORT FISH RESTORATION ACT

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Project No. 17: Klamath River Basin Juvenile Salmonid Investigations

Job No. 1 & 2: Natural vs Hatchery Proportions of Juvenile Salmonids Migrating through the Klamath River Estuary *and* Monitor Natural and Hatchery Juvenile Salmonid Emigration From the Klamath River Basin

Period Covered: July 1, 1998, through June 30, 2003

I. Summary: During the past five years the Natural Stocks Assessment Project (NSA) continued to monitor juvenile salmonid emigration through the Klamath River estuary to assess their relative abundance, emigration patterns and natural versus hatchery proportions. During the study, natural origin Chinook salmon (Chinook) annually accounted for 34 to 87% of the subyearling Chinook captured in the lower Klamath River estuary and 48 to 92% captured in the upper estuary. Annual median travel times of captured coded-wire tagged Chinook from hatchery to estuary ranged from 30-34 days for Iron Gate Hatchery (IGH) fall Chinook, 10-32 days for Trinity River Hatchery (TRH) spring Chinook, and 23-75 days for TRH fall Chinook. NSA noted that smaller fish took longer to emigrate from the basin than larger ones. June and July was the time when the greatest proportion of hatchery Chinook was present in the estuary. Annual natural Chinook relative abundance ranged from 0.59 to 2.88 fish/1000ft^2 in the lower estuary and 3.16 to 8.80 fish/minute in the upper estuary. August mean fork-length of Chinook salmon ranged from 87.2 $\pm$ 5.3 mm to 97.9 $\pm$ 7.5 mm in the lower estuary and 87.7$\pm$7.1 mm to 98.8$\pm$8.6 mm in the upper estuary. There was a positive and usually significant correlation between the volume of summer river flow entering the estuary and the relative abundance of subyearling Chinook in the upper Klamath River estuary. Annual relative abundance of yearling coho salmon (coho) ranged from 0.01 to 0.31 fish/1000ft^2 in the lower estuary and 0.24 to 0.43 fish/minute in the upper estuary. During the study, 28.4 % of the coho catch were natural fish, 65.0% were from TRH, and 6.6% were from IGH. Annual relative abundance of steelhead trout (steelhead) ranged from 0.06 to 0.28 fish/1000ft^2 in the lower estuary and 0.36 to 1.34 fish/minute in the upper estuary. During the study 90.8% of the steelhead catch was natural origin and the remaining fish were from TRH. All juvenile coastal cutthroat trout (cutthroat) in the catches were natural origin fish. Annual relative abundance of cutthroat ranged from 0.07 to 0.48 fish/1000ft^2 in the lower estuary and 0.09 to 0.28 fish/minute in the upper estuary. NSA captured many more juvenile salmonids

within or adjacent to the cool water plume at the mouth of Hunter Creek than at the other lower estuary sampling sites. This indicates that the mouth of Hunter Creek is an important rearing area for salmonids.

II. **Background**:

Salmonid resources in the Klamath River have declined from historical levels (Klamath River Task Force 1991). Many factors such as dams, water diversion, logging, mining, over fishing, agriculture, grazing and hatcheries have been identified as contributing to this decline (Klamath River Task Force 1991; Nehlsen et al. 1991). In response to the State's shrinking salmonid population California enacted Senate Bill 221 to mandate that the California Department of Fish and Game (CDFG) maintain and enhance natural habitats to double the natural production of salmon and steelhead stocks by the year 2010. Also, coho salmon (coho) are presently listed as threatened under the Federal Endangered Species Act and numerous other salmonid stocks in the Klamath-Trinity basin have been considered for threatened or endangered species status by NOAA Fisheries (NOAA). Also, the State of California has found coho salmon warranted for listing under its' Endangered Species Act.

Information is needed to develop strategies to stop the declines in salmonid populations and gage the success of recovery plans implemented by the CDFG, NOAA, and others. Presently, salmonid management in the Klamath-Trinity basin is largely based on adult escapement to the basin and its' hatcheries. The juvenile life history of anadromous salmonids in the basin has not been adequately described, especially for naturally produced fish. A thorough understanding of their juvenile life history is necessary for proper management to protect, restore, and enhance these stocks in order to meet SB 221's mandate and to avoid further Federal listings. Information on the relative abundance and survival of the juvenile stages of natural salmonid stocks would help improve management strategies by isolating the effects of in-river conditions from ocean conditions on salmonid survival. This would allow managers to identify in-river factors that reduce juvenile survival and take steps to remedy them thereby increasing natural salmonid production.

A basic need for the investigation of natural stocks is the ability to distinguish them from hatchery stocks. Hatchery production has been cited as contributing to the decline of natural salmonid production (Klamath River Task Force 1991; Nehlsen et al. 1991). In the mid 1990's CDFG altered some of their hatchery practices in the Klamath basin to attempt to minimize competition between natural and hatchery salmonids. Some of these changes include universal marking of hatchery coho and steelhead trout (steelhead), setting and enforcing constraints on the number of eggs collected and juveniles released by hatcheries, and discontinuing the practice of releasing pre-smolt Chinook salmon (Chinook). Also, CDFG and the Hoopa Valley Tribe have recently begun a constant fractional mark program for Chinook at Trinity River Hatchery. Continued monitoring of juvenile salmonids is needed to assess their response to these recent changes.

One way to gage the success of these new management strategies is to see if the trend of relative abundance and/or proportion of natural juvenile salmonids increase after these strategies are implemented. However, little of this type of information exists for Klamath basin salmonids. Wallace (1993) reported that hatchery marked Chinook were captured in the Klamath River estuary throughout much of the year and that peak catches of juvenile salmonids corresponded to peak catches of hatchery marked fish. The U.S. Fish and Wildlife Service (USFWS) reported that between 1992 and 1996, Iron Gate Hatchery (IGH) fingerlings comprised between 19 and 62% of subyearling Chinook migrating past their trap in the Klamath River at Big Bar and that Trinity River Hatchery (TRH) fingerlings comprised between 11 and 42% of the subyearling Chinook migrating past their trap in the Trinity River at Willow Creek (USFWS 1998; USFWS 1999). USFWS also reported that TRH steelhead comprised between 15 and 76% of their steelhead catches and TRH coho comprised between 26 and 90% of their coho catches at their Trinity River trap (USFWS 1998; USFWS 1999). However, their Big Bar and Willow Creek trapping sites are located roughly 80 and 95 kilometers (km), respectively, above the estuary and therefore miss the contribution of natural fish produced downstream of their sites. Beginning in 1993, (excluding 1995) the CDFG's Natural Stocks Assessment Project (NSA) established standard sampling sites and methodologies in the Klamath River estuary to monitor natural and hatchery juvenile Chinook emigration and to compare annual changes in the proportion, relative abundance and size of juvenile salmonids emigrating from the Klamath-Trinity basin. From 1993 to 1997, NSA estimated that natural origin Chinook comprised 49 to 84% of their annual catches of subyearling Chinook in the Klamath estuary (CDFG 2002). NSA also found that in 1997 roughly 66% of their coho catches were comprised of natural origin fish (CDFG 1997).

The purpose of this study was to continue monitoring the proportion of natural versus hatchery salmonids emigrating from the basin to ascertain if rehabilitation efforts or new management strategies result in increased contributions of natural origin salmonids. Also, CDFG wanted to make NSA's past data available to other researchers. NSA also continued to monitor juvenile salmonid relative abundance, emigration timing, and average size to gage their response to changing management strategies. Though this report covers 1998-2002, I also include data prior to 1998 in some analyses to illustrate long term trends. Gathering this baseline data will allow fishery managers to evaluate fish recovery plans by 1) gauging the relative change in proportion of at risk natural stocks; 2) evaluating possible impacts of hatchery fish on natural stocks; and 3) identifying the effects of adaptive management strategies (i.e. different flow schedules from basin dams and modifications in basin hatchery practices) on natural stocks.

III. Objectives:

1) To determine the annual proportion of natural versus hatchery juvenile salmonids captured in the Klamath River estuary.
2) Compare trends in natural proportions over time.
3) Monitor annual emigration timing and patterns of juvenile salmonids leaving the Klamath River basin.
4) Determine sizes of juvenile salmonids annually leaving the Klamath River basin.
5) Try to determine if changes in juvenile salmonid emigration is due to specific natural or man-made events.

IV. Procedures:

Study Area- The Klamath River enters the Pacific Ocean about 51 km south of the California Oregon border (Figure 1). The estuary is relatively short and small when compared to the size of the watershed. Physical conditions in the Klamath River estuary such as saltwater intrusion show a high degree of annual, seasonal and daily variation due to changes in river flow, tidal action and the location of the river mouth (Wallace

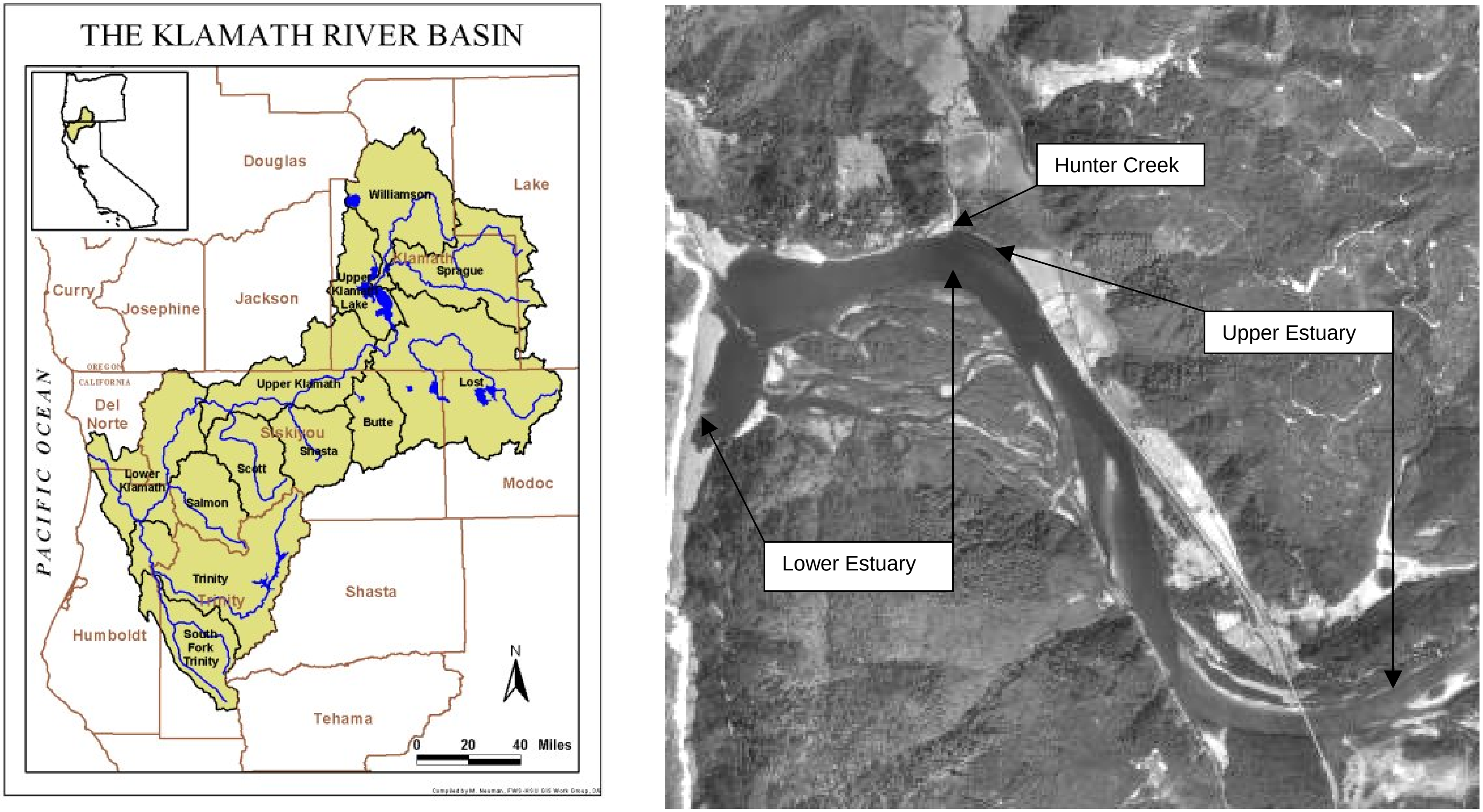

Figure 1. Location of the Klamath River basin and aerial photograph of the Klamath River estuary showing sampling areas. Photo by USGS.

1998). The lower estuary experiences tidal fluctuation up to 2 m and brackish water (15-30 ppt) is usually present along the bottom from May through October (Wallace 1998). Brackish water usually extends upstream to about river km (rkm) 4.8 at high tide, but reaches as far as rkm 6.4 when high tides coincide with low river discharge. However, a layer of fresh water 1-2 m deep is found along the surface throughout most of the estuary, making littoral areas primarily freshwater habitat.

Sampling and Data Analysis- NSA defined the estuary as the lower 6.4 km of the river normally subjected to tidal influence. The estuary is divided into an upper and lower section demarcated by Hunter Creek near rkm 2.4 (Figure 1). Also, beginning in 1993, (excluding 1995) NSA established standard sampling sites and methodologies in the estuary to monitor natural and hatchery juvenile Chinook emigration and to compare annual changes in relative abundance and size of juvenile salmonids occurring there. NSA attempted to capture juvenile salmonids one day/week in each section from March through September to determine the relative abundance and average size of juvenile salmonids. NSA also performed a mark recapture study to determine the length of estuarine residence of juvenile sea-run coastal cutthroat trout (cutthroat).

NSA sampled the upper estuary at night with a Smith-Root SR-18 electrofishing boat. In the upper estuary I established four standard transects and NSA attempted to shock them each year once a week for up to 10 minutes each. I calculated catch-per-unit-effort (CPUE) as the number of fish captured per minute shocked. In the lower estuary NSA sampled five standard sites once a week with a 45.7 m X 3.1 m X 6.4 mm mesh beach seine deployed from the bow of a 4.9 m boat. I calculated CPUE as the number of fish captured per 1000 ft^2 seined. These standard sampling sites allowed NSA to compare trends of natural Chinook proportions and juvenile salmonid abundance across years (CDFG 1994; CDFG 1996; CDFG 1997; CDFG 1998; CDFG 1999, CDFG 2000; CDFG 2001; CDFG 2002). The location of some lower estuary sampling sites varied during the study due to changes in location of the river mouth and annual physical changes at some seining locations. During 2000 and 2001 I added three sites to the quantitative samples in the lower estuary, in part, to investigate the importance of the cool water plume at the mouth of Hunter Creek to rearing juvenile salmonids. Unless otherwise stated I excluded catches from these new sites when I compared 2000 and 2001 salmonid abundance to the other years. However, I did not exclude these sites when calculating and comparing the natural to hatchery fish ratio or average fish size. In 2002 NSA stopped sampling two of these new sites adjacent to the mouth of Hunter Creek. I excluded the one remaining new site from our abundance estimate in 2002 but did include it when describing natural to hatchery fish ratio and average fish size.

NSA narcotized captured juvenile salmonids with alka-seltzer prior to measurements. Field crews recorded fork lengths (FL) each week to the nearest millimeter (mm) for up to 30 fish per salmonid species per sampling location. All fish were identified, counted and examined for fin clips and marks. NSA retained all adipose fin clipped Chinook to recover coded-wire tag information to evaluate the emigration patterns of known origin hatchery fish.

In 2000, field crews applied a unique mark each week to captured juvenile cutthroat to determine their length of estuarine residence. Field crews applied the marks by using a MadaJet needleless dental innoculator to inject alcian blue stain (65mg/ml aqueous solution) into the fin rays of the fish. In 2001, field crews inserted visual implant (VI) tags into the anal fins of juvenile cutthroat to determine their length of estuarine residence. Field crews also applied a secondary mark to assess VI tag retention by using a MadaJet needleless dental inoculator to inject alcian blue stain (65mg/mL) aqueous solution) into the caudal fin of the fish. During both years NSA counted, measured, and released all recaptured project marked fish. In 2001 field crews recorded their VI tag codes.

I made weekly estimates of the number of hatchery Chinook captured by NSA by multiplying the number of fish captured in each tag code by its ratio of untagged to tagged fish reported by basin hatcheries (Appendix 13). However, to increase the sample size of CWT Chinook I pooled all tag codes into one of three groups, IGH, TRH fall-run and TRH spring-run to estimate their contribution. Any Chinook not accounted for by hatchery expansion were assumed to be of natural origin. In weeks when the estimated number of hatchery Chinook exceeded the actual number of fish captured, I used the actual number of fish captured as the number of hatchery fish present. Also, if there was more than one tag group represented during those weeks I “pro-rated” the number of each group by their percentage of expected occurrence. For example, the untagged to tagged ratio of each group in 2001 was roughly 25:1 for IGH fall-run, 3:1 for TRH fall-run and 3:1 for TRH spring-run (Appendix 13). Therefore, if NSA captured one CWT fish from each group I assumed a total of 31 hatchery fish were present in our catch. However, if NSA captured one fish from each tag group but only had 20 fish in our catch, I assumed all were hatchery fish but attributed 25/31 (80.6%) of the catch to IGH (.806*20=16.1) or 16 out of 20 fish to IGH. I then followed the same steps to allocate the number captured to the other groups of fish. I then summed the weekly estimates to determine the total portion of captured Chinook which were of hatchery origin by month and season. Estimates of natural origin coho and steelhead in the catch were much easier since all hatchery origin fish were marked.

I also calculated the median days at liberty (DAL) for each tag code and fish group by determining the number of days between their hatchery release date and their capture date in the estuary (Table 1; Appendices 8-13). For hatchery marked fish released over multiple days I used the mid-point of release dates as the release date. I feel the mid-point release date must be within seven days of the entire range of release dates in order for a meaningful travel time to be calculated. Additionally, I examined the effects of size at release of subyearling Chinook from IGH and TRH on their travel time from

Table 1. Median and range of travel time (in days) of subyearling Chinook salmon from hatchery release to capture in Klamath River estuary, 1998-2002.

Year	**IGH**			**TRH fall-run**			**TRH spring-run**		
	n	travel time	range	n	travel time	range	n	travel time	range
1998	70	34	15- 94	150	59	35-100	53	30	15- 80
1999	42	30	17- 91	49	75	34-124	35	32	25-102
2000	69	30	20-109	35	52	31-112	17	17	9- 78
2001	59	30	16- 61	131	23	9- 90	20	10	9- 19
2002	8	34	13- 39	77	24	11- 82	22	19	11- 55

hatchery to estuary using simple regressions. I only included Chinook CWT groups with at least five recaptures in the estuary in my analysis. I obtained the size information from hatchery planting receipts and used the DAL calculations for each CWT fish to estimate travel time.

I investigated potential effects of river flow on subyearling Chinook abundance in the upper estuary. I did not compare flows to catches from the lower estuary due to the confounding effects of extended estuarine rearing on CPUE estimates (Wallace 2000). I ran simple regressions to calculate correlations between subyearling Chinook CPUE and river discharge. The river flow values I used were cumulative flows from June 1 through August 31 or August 1 through 31 as reported by the USGS gauging station at Turwar, approximately 3.2 km upstream of the estuary. I calculated subyearling Chinook CPUE estimates from 1988 to 2001 from weekly samples at NSA's standard upper estuary sampling sites. Prior to 1993 there were no standard sampling sites established, so I calculated annual CPUE from all similar sampling effort (electrofishing in the upper estuary). I did not include data from the upper estuary in 1986, 1987 and 1992 where it was obvious that sampling was not done in a similar manner to other years. I calculated correlations between June through Aug/Sept Chinook CPUE against total river discharge at Turwar for June-Aug/Sept and correlations between August subyearling Chinook CPUE against August river discharge. I separately compared natural, hatchery, and total Chinook CPUE to river discharge. I excluded 1991 and 1994 TRH fall Chinook and 1993 TRH spring Chinook from analysis due to the low number of subyearling Chinook released from TRH in those years. I excluded 1993 from IGH fall Chinook analysis due to low hatchery release numbers. I also excluded June-August CPUE analysis in 1999 and 1998 because NSA didn't begin electrofishing until late June or early July in those years. I picked June through Aug/Sept CPUE because the great majority of subyearling Chinook emigrate through the Klamath estuary during this time (Wallace 1995; CDFG 2002). I picked August CPUE versus river flows to test whether high late summer river flows lead to increased abundance of subyearling Chinook emigrating through the estuary in the late summer. These late emigrating fish have been shown to survive to adults at a much higher rate than the more numerous but smaller emigrants earlier in the summer (Nicholas and Hankin 1989; Reimers 1971).

V. Findings:

River flows in the Klamath-Trinity basin appear to affect emigration timing of all juvenile Chinook stocks and the relative abundance of some stocks of juvenile Chinook.

Chinook Emigration

Migration Rate- From 1998-2002 annual median travel times of captured coded-wire tagged Chinook from hatchery to estuary ranged from 30-34 days for Iron Gate Hatchery (IGH) fall Chinook, 10-32 days for Trinity River Hatchery (TRH) spring Chinook, and 23-75 days for TRH fall Chinook (Table 1). CWT groups containing smaller fish took longer to emigrate from the basin than larger ones (Appendices 8-12). Median travel time from hatchery release to estuary was significantly and positively correlated ($r=0.72$, $P<0.001$) to the average size of fish in CWT groups (Figure 2), so that CWT groups containing larger fish had faster travel times. Individual hatchery stock travel times were positively and significantly (or nearly so) correlated to their size at release. TRH fall Chinook had the highest correlation ($r=0.84$, $P<0.001$) followed by TRH spring Chinook ($r=0.57$, $P=0.08$) and IGH Chinook ($r=0.43$, $P=0.09$).

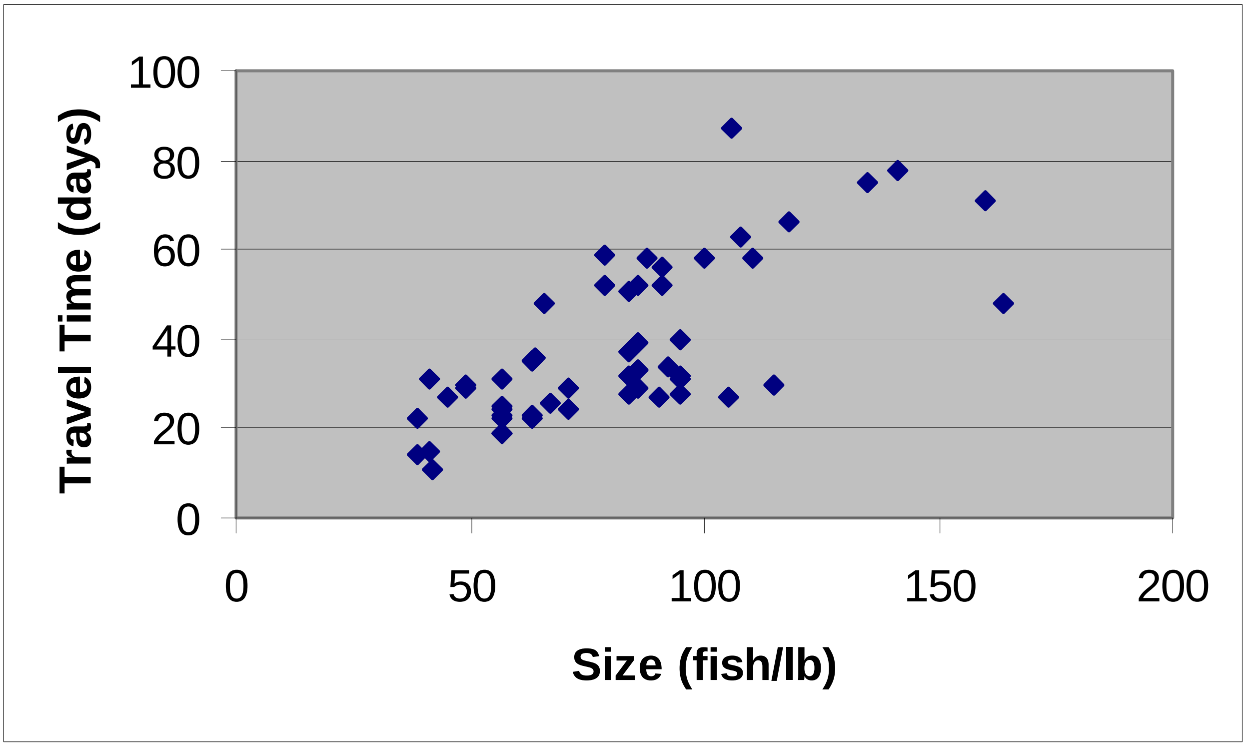

Figure 2. Median travel time of CWT groups of subyearling Chinook salmon with at least five recaptures in the Klamath River estuary versus size at hatchery release, 1993-2001 (r=0.72, P<0.001).

River flows did not appear to effect travel time of CWT subyearling Chinook. I compared the median travel time from hatchery to estuary of subyearling Chinook CWT groups with June-August Klamath River volume at Turwar from 1993-2001. The correlation was positive but not significant for IGH (r=0.41, P=0.31) and TRH fall (r=0.21' P=0.61) Chinook and negative but not significant for TRH spring Chinook (-0.17, P=0.67). Therefore, it appears that releasing pulse flows to speed the emigration of subyearling Chinook out of the basin is not supported by our data, and in fact, based on the positive correlations of increased travel time to increased water volume for IGH and TRH fall Chinook, may actually slow their migration rate. Wallace and Collins (1997) had higher late summer catches of subyearling Chinook in a high flow year than in a low flow year. They speculated that high river flows increased rearing times of subyearling Chinook upstream of the estuary and that low river flows likely reduced mainstem rearing habitat for subyearling Chinook. The low flows may have contributed to their faster emigration rate compared to the high river flow year (Wallace and Collins 1997).

Natural to Hatchery Ratio- In most years the natural to hatchery Chinook ratio in NSA's catch varied between the lower and upper estuary (Table 2). During quantitative sampling from June through September 1993-2002, natural origin subyearling Chinook annually accounted for 49.0 to 89.7 % of the total Chinook catch in the Klamath River estuary (Table 2). In the upper estuary natural Chinook accounted for 47.5 to 91.9% of

Table 2. Proportions of natural and hatchery origin subyearling Chinook salmon migrating through the Klamath River estuary, 1993-2002.

	Lower Estuary		Upper Estuary		Total	
Year	% Natural	% Hatchery	% Natural	% Hatchery	% Natural	%Hatchery
1993	83.5	16.5	85.7	14.3	85.5	14.5
1994	78.0	22.0	73.4	26.6	76.3	23.7
1996	76.3	23.7	66.0	34.0	69.8	30.2
1997	58.1	41.9	47.5	52.5	49.0	51.0
1998	34.2	65.8	68.3	31.7	55.6	44.4
1999	58.6	41.4	81.3	18.7	79.6	20.4
2000	58.2	41.8	60.9	39.1	59.5	40.5
2001	87.1	12.9	91.9	8.1	89.7	10.3
2002	68.4	31.6	90.0	10.0	80.6	19.4

the total Chinook catch and in the lower estuary it ranged from 34.2 to 87.1% (Table 2). The samples showed that hatchery origin Chinook usually comprised the greatest proportion of our catch during late June and early July in the upper and lower estuary (Appendices 14-23).

In some years the changing portion of natural versus hatchery origin Chinook were due to changes in relative abundance of one or both stocks of fish (see Relative Abundance section below). These natural to hatchery fish ratio estimates are tenuous because I based the expansions on a small number of CWT's each year (Appendices 14-23).

In 2001 NSA captured enough yearling Chinook to estimate a natural to hatchery ratio. The composition of natural yearling Chinook in the catches were higher in the lower estuary than the upper estuary, however, NSA captured most of the yearling Chinook in the upper estuary (Appendix 24 & 25). Natural origin yearling Chinook accounted for 62.7% of the catch in the lower estuary and 45.6% in the upper estuary (Appendix 24 & 25). Overall estimates (upper and lower estuary catches combined) suggest that about 48% of the yearling Chinook captured by NSA project during 2001 were of natural origin (Appendix 25). NSA probably only sampled the latter portion of the yearling Chinook emigration since they were present in large numbers in March when sampling first began. Most of the hatchery yearling Chinook were from IGH (Appendix 24 & 25). The higher catch of yearling Chinook is probably due, in part, to NSA starting field sampling earlier in the year. However, NSA never encountered this many CWT yearling Chinook the few years it successfully sampled in February and March. Also, 2001 was the first time NSA captured CWT yearling Chinook from TRH. The higher abundance of yearling Chinook salmon in 2001 may have been due to the very low winter river flows in the Klamath and Trinity Rivers. The low flows might have prompted the yearling Chinook to linger in the mainstem rivers rather than migrate to the ocean. These natural to hatchery composition estimates for yearling Chinook are tenuous because I based the expansions on a small number of CWT's (43 total; Appendix 25).

Relative Abundance- The relative abundance of naturally produced subyearling Chinook ranged from 0.59 to 6.17 fish/1000ft^2 in the lower estuary and 3.16 to 8.80 fish/minute in the upper estuary (Table 3). There was no apparent trend in the abundance of subyearling Chinook during the study. Natural Chinook usually arrived in the estuary in low numbers beginning in late March and early April (Appendices 1-7 & 14-23). The emigration timing is similar to those reported in earlier studies of the Klamath River estuary (Wallace 1993; Wallace 1995; CDFG 2002).

River Flow Effects on Relative Abundance- It appears that the relative abundance of subyearling Chinook captured by electrofishing in the upper estuary is positively and usually significantly correlated with the amount of summer river flow near the mouth of the Klamath River (Table 4). I compared annual Klamath River volume in August at Turwar with the upper estuary CPUE of all subyearling Chinook in August from 1988-2001 and the correlation was positive (r=0.81; p=0.0024) and highly significant (Table 4). When I compared June-August flows at Turwar to August CPUE of all Chinook the correlation was also positive (r=0.71; p=0.013) and significant (Table 4). When I compared June-August flows at Turwar to June-August CPUE of all Chinook the correlation was positive (r=0.56; p=0.07) and nearly significant (Table 4). Studies from other river systems have found that higher juvenile Chinook abundance corresponded with higher summer flows (Satterthwaite 1987; Stevens and Miller 1983).

The relative abundance of some stocks of subyearling Chinook seemed to be more correlated to river flow than others. When I compared August flows at Turwar to August CPUE of natural Chinook the correlation was positive (r=0.69; p=0.02) and significant (Table 4). When I compared August flows at Turwar to August CPUE of hatchery Chinook the correlation was positive and significant (r=0.81; p=0.014). However, the strong correlation for hatchery fish seems to be driven primarily by TRH fall Chinook. When I compared August flows at Turwar to August subyearling TRH fall Chinook CPUE I found a positive and significant correlation (r=0.87; p=0.005), but when I compared the same flows to August CPUE of subyearling TRH spring (r=0.15, p=0.72), and IGH Chinook (r=0.40, p=0.33) I found positive but not significant correlations (Table 4).

Table 3. Overall CPUE of natural, IGH, and spring and fall-run TRH Chinook salmon captured in the lower and upper Klamath River estuary, 1993-2002.

	LOWER (Fish/1000ft^2)					UPPER (Fish/minute)				
Year	Nat	IGH	TRHf	TRHs	Total	Nat	IGH	TRHf	TRHs	Total
1993	3.26	0.27	0.49	0.06	4.08	6.77	0.18	0.93	0.19	8.07
1994	6.17	1.28	0.03	0.43	7.91	2.42	0.66	0.004	0.04	3.13
1996	2.57	0.12	0.28	0.42	3.39	3.87	0.56	0.83	0.50	5.76
1997	1.82	1.08	0.19	0.04	3.13	5.25	5.14	0.53	0.14	11.06
1998	2.67	2.95	1.03	0.53	7.18	4.17	0.58	1.28	0.08	6.11
1999	0.59	0.24	0.12	0.05	1.00	8.80	1.32	0.54	0.16	10.82
2000	2.01	1.26	0.14	0.08	3.49	3.16	1.61	0.38	0.11	5.26
2001	2.88	0.23	0.15	0.004	3.26	4.14	0.20	0.12	0.03	4.49
2002	1.71	0.29	0.40	0.06	2.46	3.83	0.24	0.10	0.11	4.28

Table 4. Summary of correlations between subyearling Chinook salmon catch-per-unit-effort in the upper Klamath River estuary and Klamath River volume at Turwar, 1988-2001.

Flow Period	CPUE Period	Fish Stock	Correlation Coefficient	Probability Level
August	August	All	0.81	0.0024*
June-August	August	All	0.71	0.0135*
June-August	June-August	All	0.56	0.0741
August	August	Natural	0.69	0.0200*
August	August	Hatchery	0.81	0.0144*
August	August	TRH Fall	0.87	0.0047*
August	August	TRH Spring	0.15	0.7225
August	August	IGH	0.40	0.3289

*significant correlation

When analyzing the CPUE versus flow data I faced the same dilemma as Stevens and Miller (1983). Though I hypothesized that river flow influenced juvenile salmonid abundance, I did not know in advance which stock would be most effected or what river flow period would be most important. Therefore, I tested various flow periods versus the different stocks of juvenile Chinook. By using so many combinations, and because the two flow periods are interrelated my chances of obtaining spurious statistically significant correlations were increased. Therefore, the correlations should be looked at as just a general guide to interpret what time periods are most important and which stocks are most affected by river flows (Stevens and Miller 1983).

However, many of these results make biological and intuitive sense. Relatively low correlation between IGH fall Chinook and river flows were at least partly due to the large range of size at release of CWT juvenile Chinook from IGH. IGH fall Chinook release sizes ranged from 63 to 269 fish/lb. during the years of estuary sampling. In contrast, TRH fall and spring Chinook release sizes ranged from 66 to 117 fish/lb. and 44 to 85 fish/lb., respectively. Survival and migration rates of subyearling Chinook are effected by their size at hatchery release. Smaller sized Chinook generally experience lower survival and take longer to emigrate from the Klamath-Trinity basin than larger sized Chinook (USFWS 1998 ; Wallace 1995; Memo dated 12/15/98 from Mike Wallace to Gary Stacy; Memo dated 3/12/98 from Mike Wallace to Bob McAllister; Memos dated 10/10/97 and 11/30/95 from Mike Wallace to Kim Rushton). Therefore, because IGH released their fish at widely different sizes each year during the study it likely masked the influences of river flow on NSA's estuary catches. TRH spring Chinook typically are the largest sized subyearling Chinook released from basin hatcheries and subsequently spend less time in the river before entering the estuary than other Klamath basin stocks (Table 1; USFWS 1998 ; Wallace 1995; Memo dated 12/15/98 from Mike Wallace to Gary Stacy; Memo dated 3/12/98 from Mike Wallace to Bob McAllister). Therefore, it is plausible that they would be least influenced by river flow and habitat conditions in the mainstem river and not surprising that I found low correlations between river flow and their CPUE in the estuary.

Generally, natural and TRH fall Chinook rear longer in the mainstem Klamath-Trinity rivers than the other groups of Chinook in this study (Table 1; Wallace 1995; Memo dated 12/15/98 from Mike Wallace to Gary Stacy; Memo dated 3/12/98 from Mike Wallace to Bob McAllister; CDFG unpublished data), therefore it makes sense that their abundance in the estuary was more highly correlated (and significantly so) to river flows than the other groups. Also, natural Chinook CPUE in the upper estuary was more related to August flows than June through August flows at Turwar. This suggests that more water late in the summer is important to subyearling Chinook survival. August CPUE of natural Chinook was significantly correlated to river flows at Turwar suggesting that more water throughout the summer increased production of late emigrating Chinook. Since other studies have shown that later emigrating fish have higher marine survival rates than earlier emigrating fish (Nicholas and Hankin 1989), it seems that increased summer flows would potentially increase the number of returning natural adult Chinook to the Klamath-Trinity basin. The higher river flows probably increase the quantity and quality of rearing habitat available to juvenile Chinook that lead to NSA's increased subyearling Chinook catch.

Chinook Size- The size of subyearling Chinook varied annually. Their mean FL in August ranged from 87 mm in 2002 to 99 mm in 1993 the lower estuary (Table 5) and 87 mm in 1994 to 99 mm in 1999 in the upper estuary (Table 6). The smaller mean FL's tended to occur in low river flow years and the large ones in high river flow years. When I compared June-August flows at Turwar to August mean FL of all subyearling Chinook the correlation was positive but not significant in both the lower ($r=0.40$; $p=0.33$) and the upper estuary ($r=0.42$; $p=0.30$). Therefore, higher flows not only seem to increase the relative abundance of subyearling Chinook in the Klamath River but may also help them to attain a larger size before migrating to the ocean. Nicholas and Hankin (1989) and Reimers (1971) found that subyearling Chinook salmon entering the ocean at a larger size have higher ocean survival rates than smaller fish.

Use of Cool Water Refugia at the Mouth of Hunter Creek- Most of the subyearling Chinook captured by NSA in the lower estuary were from the sites adjacent to the mouth of Hunter Creek (Figure 1). In 2001 their annual CPUE was 32.82 fish/1000ft^2 at Hunter Creek and 3.24fish/1000ft^2 at the standard lower estuary sites, and in 2000 it was 6.90 fish/1000ft^2 at Hunter Creek and 3.49 fish/1000ft^2 at the standard sampling sites (Table 7). In 2001, the their peak CPUE was in mid to late June at the standard sites but at Hunter Creek it occurred in mid June and mid July and was high from mid June to mid July (Table 7). The 2001 water year was very dry so higher numbers of subyearling Chinook may have moved into the estuary earlier than in high flow years (Wallace and Collins 1997) causing their abundance at Hunter Creek to be much higher than in 2000. In 2000 the peak CPUE of subyearling Chinook in the lower estuary was in late June and early July, but peak CPUE at Hunter Creek occurred in mid July and mid August (Table 7) when estuary water temperatures were warmest. Water temperatures in the main portion of the estuary were 20-22^{o}C during July and August. Water temperatures at the mouth of Hunter Creek were substantially colder (range 14-18 ^{o}C) than the main estuary during the late spring and summer (CDFG unpublished data). The high catch of subyearling Chinook adjacent to Hunter Creek was probably due to them seeking cold water supplied by Hunter Creek. NSA noted high catches of other species of juvenile salmonids at the mouth of Hunter Creek in 2001 and 2000 (Table 7) and during opportunistic sampling in 1999 and 1998 (CDFG unpublished data). Belchik (1997)

Table 5. Monthly number (n), mean fork length (FL), and standard deviation (SD) of subyearling Chinook salmon measured in the lower Klamath River estuary 1993-2002.

Year	May			June			July			August			September			Total		
	n	FL	SD	n	FL	SD	n	FL	SD	n	FL	SD	n	FL	SD	n	FL	SD
2002	8	64.8	8.0	47	89.9	6.1	248	85.4	6.9	149	87.2	5.3	-	-	-	461	85.3	8.9
2001	80	69.0	16.6	313	87.3	7.9	444	86.1	7.1	407	89.0	6.9	151	96.4	7.9	1395	87.4	9.8
2000	40	67.6	9.3	205	91.0	10.1	237	91.6	8.7	177	97.3	8.5	177	113.7	8.4	836	96.2	14.1
1999	-	-	-	15	94.3	2.6	184	92.2	7.2	115	97.9	7.5	48	113.8	10.9	362	96.9	10.5
1998	-	-	-	110	88.7	4.9	234	89.7	5.8	195	92.8	6.9	153	106.3	7.0	692	94.1	9.2
1997	50	55.1	13.1	278	94.3	7.1	184	92.4	5.5	74	97.9	7.3	-	-	-	586	90.8	13.3
1996	79	75.9	14.2	254	87.3	10.4	174	88.8	7.4	134	89.0	6.3	-	-	-	641	86.7	10.4
1994	42	51.4	11.3	195	88.6	9.4	304	84.1	5.8	526	89.1	6.5	5	99.8	7.5	1072	86.2	10.3
1993	56	49.5	11.5	137	83.7	15.7	344	86.3	7.3	45	98.9	11.3	12	111.5	6.7	594	83.7	16.1

Table 6. Monthly number (n), mean fork length (FL), and standard deviation (SD) of subyearling Chinook salmon measured in the upper Klamath River estuary 1993-2002.

Year	May			June			July			August			September			Total		
	n	FL	SD	n	FL	SD	n	FL	SD	n	FL	SD	n	FL	SD	n	FL	SD
2002	23	74.4	14.0	158	91.0	8.4	465	82.1	6.3	136	89.8	7.3	-	-	-	782	85.0	8.5
2001	83	86.9	10.5	322	88.7	9.2	387	84.6	6.4	206	87.7	7.1	-	-	-	998	86.8	8.1
2000	29	91.9	13.7	171	100.7	11.8	431	93.8	7.2	222	97.4	6.8	251	112.6	9.5	1104	99.8	11.4
1999	-	-	-	62	93.7	6.8	426	91.0	7.2	380	98.8	8.6	468	116.6	10.8	1336	102.3	14.1
1998	-	-	-	-	-	-	328	89.1	8.1	519	92.3	6.7	237	103.3	6.6	1084	93.7	8.8
1997	14	96.3	11.6	154	95.4	10.0	512	93.6	6.6	298	95.1	6.4	-	-	-	978	94.4	7.3
1996	-	-	-	359	89.4	9.6	304	87.5	7.8	200	88.5	6.2	-	-	-	863	88.5	8.3
1994	17	89.8	20.9	281	89.8	8.7	247	82.8	6.6	149	87.4	7.2	-	-	-	696	86.8	8.8
1993	6	67.3	11.8	280	89.0	13.5	297	86.8	7.3	422	96.2	7.5	490	112.0	9.0	1495	98.0	14.0

Table 7. Comparisons between catch-per-unit-effort of juvenile salmonids captured adjacent to the mouth of Hunter Creek and standard seining sites in the lower Klamath River estuary in 2000 and 2001.

2001

	Chinook		Coho		Steelhead		Cutthroat	
Date	Estuary	Hunter	Estuary	Hunter	Estuary	Hunter	Estuary	Hunter
3/15	0	0	0	0	0	0.30	0	0.10
3/27	0	0	0	0	0.24	0	0	0
4/09	0.25	0	0	0	0	0	0	0
4/23	0.12	2.53	0	0	0.36	0	0	0
5/07	2.92	0.48	0	0	0.04	0	0.08	0.10
5/23	0.33	1.61	0	11.96	0.08	0.54	0.17	0.18
5/30	2.59	22.67	0.05	15.85	0	2.22	0.05	0.15
6/04	0.47	9.88	0	0.95	0	0.36	0.12	0.24
6/11	4.83	128.17	0	5.87	0	4.92	0.04	0.32
6/18	8.72	23.62	0	0.38	0.07	1.81	0	0.38
6/25	8.09	66.73	0	1.51	0.07	4.12	0	1.61
7/02	6.53	25.23	0	0.20	0.25	0.78	0	0.39
7/09	3.17	34.75	0	0.20	0	4.65	0	2.63
7/16	5.72	103.53	0	0.12	0.04	2.94	0.04	0.59
Total	**3.24**	**32.82**	**<0.01**	**2.23**	**0.08**	**1.61**	**0.03**	**0.42**

2000

	Chinook		Coho		Steelhead		Cutthroat	
Date	Estuary	Hunter	Estuary	Hunter	Estuary	Hunter	Estuary	Hunter
5/12	0.18	0	0.26	0	0.26	0.24	0.04	0.47
5/17	2.61	0	0.16	0	0.65	0.82	0.16	0.14
5/26	0.35	0.24	0	0.24	0.06	2.93	0.18	1.46
6/02	0.45	0.63	0.06	12.81	0	0.78	0.23	0.94
6/09	0.37	0.72	0	0	0.05	0.10	0.32	0.20
6/15	1.59	0.10	0	0.10	0	0.10	0.57	0
6/21	5.69	2.03	0	0	0	0	0	0
6/29	15.65	7.39	0	0	0	0	0.14	0.36
7/07	17.58	7.14	0	0	0	0.12	0.17	0.95
7/12	9.62	1.09	0	0	0.05	0	0.16	0.54
7/19	1.72	61.06	0	0	0.64	0.24	0.52	2.47
7/25	4.89	6.46	0	0	0.32	0	0.19	0.37
8/02	2.90	6.77	0	0	0.06	16.45	0.39	2.02
8/10	0.56	15.00	0	0	0	0.36	0	0.89
8/17	1.26	0.11	0	0	0	4.09	0	0.23
8/23	2.45	24.89	0	0	0.05	2.90	0	1.45
8/30	1.61	5.83	0	0	0.04	6.44	0.08	1.14
9/08	2.48	2.22	0	0	0	0.37	0	0.65
9/14	2.72	1.46	0	0	0.09	2.50	0.09	0.52
9/21	1.09	0.47	0	0	0	0.35	0	0.70
9/28	1.07	0.15	0	0	0.04	2.54	0.18	1.15
Total	**3.49**	**6.90**	**0.02**	**0.44**	**0.11**	**2.42**	**0.15**	**0.85**

observed high concentrations of juvenile salmonids at the mouths of cooler tributaries entering the Klamath River.

Coho Emigration

During this study period the CPUE of yearling coho in the Klamath River estuary usually peaked during May and very few were captured after June (Tables 8 & 9). This is similar to the emigration timing reported in past years (Wallace 1995). Most of the coho in NSA's catches were hatchery origin fish, primarily from TRH (Table 10.) However, natural origin yearling coho were a significant part of NSA's catch comprising 27 to 66% of the catch (Table 10). The natural coho component of screw trap catches on the mainstem Klamath and Trinity Rivers was usually lower than the natural component in the estuary (Weskamp and Voight 2001; Weskamp et al. 1998; USFWS 1999; USFWS unpublished data). This suggests that most of the natural coho production in the Klamath-Trinity basin occurs in the lower Klamath River tributaries downstream of the screwtraps and Trinity River. NSA captured very few subyearling coho in the estuary, so it appears that very few use the estuary for rearing.

Hatchery yearling coho usually spent about 2 months in the mainstem Klamath and Trinity Rivers (Table 11). Coho emigration data collected from screwtraps on the mainstem Klamath and Trinity Rivers showed that peak catches of hatchery coho usually occurred in mid to late May (USFWS 1999; USFWS 1998; USFWS unpublished data; Weskamp and Voight 2001; Weskamp et al. 1998; YTFD unpublished data), similar to the time of peak catches in the estuary, suggesting that most of the hatchery coho smolts spent most of their time upstream of the traps.

Natural origin yearling coho probably spend a month or more in the mainstem Klamath and Trinity Rivers. Determining the emigration pattern of natural origin juvenile coho in the mainstem river is more difficult than hatchery origin coho due to their widespread distribution and extended period of mainstem river entry. Screwtraps sampling the mainstem Klamath and Trinity Rivers showed that natural coho smolt catches peaked about the same time as hatchery coho catches (USFWS 1999; USFWS 1998; USFWS unpublished data; Weskamp and Voight 2001; Weskamp et al. 1998; YTFD unpublished data). In the mainstem Trinity River near Big Bar, Healey (1973), stated that peak catches of "mostly wild" coho smolts peaked during May. Numerous Klamath and Trinity River tributaries have been sampled near their mouths by a variety of trapping methods and should provide a close approximation of when natural juvenile coho leave the tributaries and enter the mainstem rivers. On the Shasta River from 2000 to 2002 peak emigration of coho smolts usually occurred in mid to late April (Chesney and Yokel 2003; Chesney 2001; Chesney 2000). Very few coho smolts were captured from the Scott River but most of them were captured between late March and early May (Chesney and Yokel 2003; Chesney 2001; Chesney 2000). Coho smolt catches on Blue Creek (a lower Klamath River tributary) peaked in mid to late April and the researchers felt that trapping had started after the coho smolt emigration began (USFWS 1994a; USFWS 1994b). Peak emigration of coho smolts from Hunter Creek occurred in early to mid April with a smaller peak occurring again in mid to late May (Hayden and Gale 1999).

Voight and Gale (1998) speculated that they missed coho smolt emigrations from other lower Klamath River tributaries because peak emigration of coho smolts occurred February through May before the bulk of their surveys. So, it appears that the bulk of natural origin coho smolts enter the mainstem rivers in April and May while peak catches

Table 8. Monthly beach seine catch-per-unit-effort (fish/1000ft^2) of juvenile coho salmon, steelhead trout and coastal cutthroat trout captured in the lower Klamath River estuary 1993-2002. Three sites were excluded from the 2000 and 2001 catches so that they could compared to CPUE's from past years.

Year	May				June				July				August				September				Total			
	Effort	Coho	SH	CUT	Effort	Coho	SH	CUT	Effort	Coho	SH	CUT	Effort	Coho	SH	CUT	Effort	Coho	SH	CUT	Effort	Coho	SH	CUT
2002	101.6	0.74	0.06	0.15	107.8	0.00	0.14	0.54	98.3	0.00	0.03	0.04	102.0	0.00	0.04	0.22	-	-	-	-	409.7	0.18	0.07	0.24
2001	95.0	0.04	0.12	0.18	105.5	0.00	0.04	0.04	135.8	0.00	0.10	0.01	108.4	0.00	0.04	0.08	105.2	0.00	0.00	0.05	549.9	0.01	0.06	0.07
2000	58.1	0.15	0.33	0.12	94.4	0.01	0.01	0.24	76.1	0.00	0.28	0.28	107.8	0.00	0.03	0.07	99.1	0.00	0.03	0.07	435.5	0.02	0.11	0.15
1999	19.9	0.90	0.00	0.05	102.6	0.99	0.14	0.12	81.2	0.00	0.43	0.16	104.8	0.00	0.25	0.14	78.8	0.00	0.43	0.17	387.4	0.31	0.28	0.14
1998	-	-	-	-	29.9	0.00	0.30	1.04	56.3	0.02	0.28	0.57	67.3	0.00	0.15	0.18	45.4	0.00	0.04	0.46	198.8	0.01	0.19	0.48
1997	47.9	1.40	1.42	1.92	89.5	0.03	0.19	0.52	70.7	0.00	0.00	0.14	63.7	0.00	0.00	0.02	-	-	-	-	276.2	0.25	0.31	0.54
1996	27.2	0.07	0.47	0.33	62.8	0.02	1.21	0.80	84.8	0.00	0.00	0.01	96.7	0.00	0.02	0.01	-	-	-	-	271.4	0.01	0.34	0.22
1994	96.5	0.00	0.03	0.01	101.5	0.00	0.13	0.05	87.5	0.00	0.00	0.00	116.3	0.00	0.01	0.01	-	-	-	-	424.9	0.00	0.04	0.02
1993	27.8	0.18	0.07	0.54	51.4	0.00	0.08	0.12	97.2	0.00	0.11	0.12	118.2	0.00	0.00	0.02	83.6	0.00	0.00	0.00	378.3	0.01	0.04	0.09

Table 9. Monthly electrofishing catch-per-unit-effort (fish/minute) of juvenile coho salmon, steelhead trout and coastal cutthroat trout captured in the upper Klamath River estuary 1993-2002.

Year	May				June				July				August				September				Total			
	Effort	Coho	SH	CUT	Effort	Coho	SH	CUT	Effort	Coho	SH	CUT	Effort	Coho	SH	CUT	Effort	Coho	SH	CUT	Effort	Coho	SH	CUT
2002	100.3	1.00	1.65	0.21	109.1	0.01	0.58	0.21	156.2	0.00	0.23	0.14	60.5	0.00	0.28	0.26	-	-	-	-	426.0	0.24	0.66	0.19
2001	125.4	1.69	0.57	0.33	107.0	0.04	0.64	0.55	151.1	0.00	0.08	0.07	123.5	0.00	0.27	0.19	-	-	-	-	507.0	0.43	0.36	0.28
2000	57.8	2.23	3.20	0.45	91.6	0.07	1.88	0.34	130.3	0.01	0.97	0.17	97.8	0.00	0.86	0.08	109.8	0.00	0.77	0.11	487.3	0.28	1.34	0.20
1999	-	-	-	-	25.6	0.04	0.74	0.74	108.6	0.00	1.33	0.09	130.6	0.00	0.28	0.01	136.6	0.01	0.54	0.07	434.8	0.01	0.65	0.09
1998	-	-	-	-	-	-	-	-	128.4	0.01	0.97	0.33	180.0	0.00	0.40	0.02	84.7	0.01	0.20	0.00	393.0	<0.01	0.54	0.11
1997	24.8	0.57	1.62	0.36	99.2	0.01	1.36	0.29	154.0	0.00	0.84	0.12	128.6	0.00	0.31	0.02	-	-	-	-	406.6	0.04	0.85	0.15
1996	-	-	-	-	84.7	0.04	2.01	0.58	99.2	0.00	1.02	0.26	93.6	0.00	0.88	0.17	-	-	-	-	277.4	0.01	1.27	0.33
1994	109.4	2.39	0.52	0.48	154.2	0.01	0.10	0.16	158.5	0.01	0.01	0.01	200.8	0.00	0.00	0.03	-	-	-	-	623.0	0.43	0.12	0.14
1993	10.1	0.50	0.60	0.60	77.1	0.00	0.51	0.36	77.8	0.00	0.06	0.04	152.3	0.00	0.07	0.03	199.0	0.00	0.18	0.06	516.2	0.01	0.19	0.10

Table 10. Natural versus hatchery origin composition of yearling coho salmon in Klamath River estuary catches, 1998-2002. Lower and upper estuary catches are combined.

	TRH		IGH		Natural		
Year	**No.**	**Percent**	**No.**	**Percent**	**No.**	**Percent**	**Total**
2002	126	62.1	7	3.4	70	34.5	203
2001	321	61.5	61	11.7	140	26.8	522
2000	131	57.0	9	3.9	90	39.1	230
1999	Started sampling after coho emigration						
1998	Started sampling after coho emigration						
1997*	63	29.0	10	4.6	144	66.4	217

* sampling didn't begin until mid May

Table 11. Estimated travel time of yearling coho salmon smolts from Iron Gate and Trinity River Hatcheries to Klamath River estuary.

Year	Date of IGH Release	Date of TRH Release	Peak Catch Upper Estuary	Peak Catch Lower Estuary	Mean Time (months)
2002	3/27	3/15-22	5/14	5/29	1.5-2.5
2001	3/29	3/15-20	5/21	5/30	2
2000	3/30	3/15-20	5/14	6/4	1.5-2.5
1999	3/30	3/15-22	-	6/4	2-2.5
1997	4/14	3/17-21	5/28	5/28	1.5-2
1994	3/16	3/15-28	5/9&17	4/4	0.5-2

in the estuary occurred in May, meaning they likely spend a month or more in the mainstem river.

Based on the large size of yearling coho and their relatively brief occurrence in the estuary catches it appears that they move quickly through the estuary without much rearing. Other researchers have noted that most yearling coho move through estuarine habitat fairly quickly (Miller and Sadro 2003; Myers and Horton 1982).

The mean FL of hatchery origin coho was much larger than natural coho ranging from 24 to 81 mm longer than natural origin coho (Table 12). NSA has no information regarding competition between hatchery and natural coho yearlings. However, other studies have shown that hatchery salmonids may out-compete natural salmonids especially if they are much larger than natural fish (Rhodes and Quinn 1998).

It appears that TRH coho do not grow much after hatchery release. In 2002, 5,425 TRH coho were measured just prior to release. Their mean FL was 183 mm and ranged from 90-332 mm FL (memo from W. Sinnen CDFG to G. Ramsden CDFG dated 4/3/02). The mean fork length of TRH coho captured by NSA was 200$\pm$32 mm (range 139-275 mm) in

Table 12. Number measured, mean fork length, and standard deviation of Trinity River Hatchery, Iron Gate Hatchery, and natural origin juvenile coho salmon captured in the upper and lower Klamath River estuary, 1998-2002.

		TRH		IGH		Natural	
Year	**Area**	**No.**	**FL**	**No.**	**FL**	**No.**	**FL**
2002	Upper	89	200±32	2	216±19	12	135±30
2002	Lower	23	186±23	1	156	34	132±13
2001	Upper	105	181±22	7	174±25	39	146±24
2001	Lower	57	185±23	26	167±17	46	141±14
2000	Upper	72	163±13	6	167±14	44	130±14
2000	Lower	17	170±12	1	171	25	134±13
1999	Both	Sampling started after coho emigration					
1998	Both	Sampling started after coho emigration					

the upper estuary and 186±23 mm (range 155-239 mm) in the lower estuary (Table 12). There was very little difference in mean FL between the hatchery and lower estuary. The difference between mean FL from hatchery release to upper estuary was 17 mm but that was still within a single standard deviation (Table 7) and electrofishing is biased towards capturing larger fish (Reynolds 1996). Even if the size bias from electrofishing was ignored, the apparent growth of TRH coho would still have only been about 1.5-2.5 mm/week based on the 1.5 to 2.5 months (Table 11) the fish were at liberty.

Use of Cool Water Refugia at the Mouth of Hunter Creek- Most of the coho captured by NSA in the lower estuary were from the sites adjacent to the mouth of Hunter Creek. In 2001 the annual CPUE was 2.23 fish/1000ft^2 at Hunter Creek and <0.01 fish/1000ft^2 at the other lower estuary standard sampling sites (Table 7). In 2000 the annual coho CPUE was 0.44 fish/1000ft^2 at Hunter Creek and 0.02 fish/1000ft^2 at the standard sampling sites (Table 7). In 2001 NSA captured most of the coho at Hunter Creek between May 30 and June 11 after estuary water temperatures reached greater than 18^o C. In 2000, NSA captured high numbers of coho in early June at Hunter Creek and very few coho at other estuary sites throughout the year. Water temperatures in the main portion of the estuary were usually greater than 18^{o}C by late May. Water temperatures at the mouth of Hunter Creek were substantially colder (range 14-18^{o}C) than the main estuary during the late spring and summer (CDFG unpublished data). The high catch of coho smolts adjacent to Hunter Creek was probably due to them seeking cold water supplied by Hunter Creek. NSA noted high catches of other species of juvenile salmonids at the mouth of Hunter Creek in 2000 and 2001 (Table 7) and during opportunistic sampling in 1999 and 1998 (CDFG unpublished data).

Steelhead Emigration

Juvenile steelhead CPUE usually peaked during May and June in the lower estuary and May in the upper estuary (Tables 8 & 9). Steelhead catches were also very high and occasionally peaked in April during the few years NSA began sampling this early (CDFG unpublished data), so the actual peak of emigration may occur prior to the normal start of NSA's sampling in May. This is about the time of peak catches in past years (Wallace

1995). However, juvenile steelhead were usually present throughout the entire sampling period each year.

NSA normally captured more steelhead electrofishing in the upper estuary than seining in the lower estuary. This is probably due to the larger steelhead smolts avoiding our seine net and being more susceptible to capture by electrofishing (Reynolds 1996). The highest CPUE of steelhead occurred in 2000 and 1996 subsequent to high water years in 1999 and 1995 (Tables 8 & 9). Juvenile steelhead CPUE in the upper and lower estuary from 1996-2002 was higher than NSA observed in 1993 and 1994 (Tables 8 & 9) and in the late 1980's (CDFG unpublished data) during the prolonged drought of the late 1980's and early 1990's. The increased steelhead CPUE observed by NSA suggests that juvenile steelhead production in the Klamath-Trinity basin has increased during the last seven to eight years of relatively good water years.

Almost all hatchery steelhead captured by NSA were from TRH. The highest hatchery juvenile steelhead contribution occurred in 2002 and 2001 (Table 13). I think this is due to NSA initiating sampling at an earlier date than past years resulting in intercepting hatchery marked steelhead at a greater rate. Releases of steelhead from IGH and TRH usually occurred in late April from IGH and mid to late March from TRH. Most of the emigrating hatchery origin steelhead passed through the estuary in April prior to the start of sampling in past years. It appears that hatchery origin steelhead leave the Klamath basin rather quickly, about 1 month after their release from basin hatcheries.

Use of Cool Water Refugia at the Mouth of Hunter Creek- Most of the juvenile steelhead captured by NSA in the lower estuary were from the sites adjacent to the mouth of Hunter Creek. In 2001 the annual CPUE was 1.61 fish/1000ft^2 at Hunter Creek and 0.08 fish/1000ft^2 at the other lower estuary standard sampling sites (Table 7). In 2000 the annual steelhead CPUE was 2.42 fish/1000ft^2 at Hunter Creek and 0.11 fish/1000ft^2 at the standard sampling sites (Table 7). In 2001 NSA captured very few juvenile steelhead in the lower estuary except at Hunter Creek where catches were high from late May until NSA discontinued sampling at Hunter Creek in mid July. In 2000 peak steelhead catches at Hunter Creek occurred in August when water temperatures in the main part of the estuary was 20-22^{o}C. Water temperatures at the mouth of Hunter Creek were substantially colder (range 14-18 ^{o}C) than the main estuary during the late spring and summer (CDFG unpublished data). The high catch of juvenile steelhead adjacent to Hunter Creek was probably due to them seeking cold water supplied by Hunter Creek. NSA noted high catches of other species of juvenile salmonids at the mouth of Hunter Creek in 2000 and 2001 (Table 7) and during opportunistic sampling in 1999 and 1998 (CDFG unpublished data).

Sea-run Coastal Cutthroat Trout Emigration and Estuary Rearing

From 1993 to 2002 the CPUE of sea-run cutthroat trout usually peaked in May or June in both the lower and upper estuary (Tables 8 & 9). However, NSA usually captured cutthroat trout throughout the entire sampling season. This is similar to findings from an earlier study (Wallace 1995).

Estuary Residence- During 2001 and 2000 NSA conducted a length of estuarine residence study on cutthroat in the Klamath River estuary. In 2001 NSA marked and released 132 cutthroat with visual implant (VI) tags and a secondary mark of alcian blue

Table 13. Natural versus hatchery origin composition of juvenile steelhead trout captured in the Klamath River estuary, 1998-2002. Upper and lower estuary catches are combined.

	Start Sample Date		Hatchery		Natural		
Year	**Up Est**	**Low Est**	**No.**	**Percent**	**No.**	**Percent**	**Total**
2002	4/03	3/05	48	12.8	326	87.2	374
2001	3/13	3/05	97	17.4	460	82.6	557
2000	5/15	5/12	5	0.7	693	99.3	698
1999	6/30	5/19	Started sampling after hatchery steelhead emigration				
1998	7/05	6/21	Started sampling after hatchery steelhead emigration				

dye. NSA recaptured only three marked fish and two additional fish which had lost their VI tag (one fish was captured twice). Their average length of residence was 14 days (range 7-28 days). The recaptured cutthroat had high growth rates. The one fish at large for 28 days grew more than 30 mm while the two fish at large for seven days grew 4 and 5 mm respectively. NSA marked 89 fish and recaptured two marked fish that had lost their VI tags while electrofishing in the upper estuary. NSA marked 24 fish and recaptured one fish that had been marked at the same site where it was captured while seining in the lower estuary (exclusive of the Hunter Creek sites). NSA marked 19 fish and recaptured two fish that had been marked previously at Hunter Creek and one fish that had lost its tag while seining the Hunter Creek sites.

In 2000 NSA marked 245 cutthroat with only dye marks so fish growth and movement could not be tracked. NSA recaptured 34 fish (which likely included individual fish captured multiple times). Their mean length of estuary residence was 27 days and ranged from 5-89 days. NSA marked 89 fish and recaptured four marked fish while electrofishing in the upper estuary, and marked 58 fish and recaptured three while seining in the lower estuary (exclusive of the Hunter Creek sites). NSA marked 98 fish and recaptured 27 while seining the Hunter Creek sites.

The Hunter Creek sites had much higher recapture rates than either the upper estuary or other portions of the lower estuary. This suggests that cutthroat trout are more likely to rear adjacent to Hunter Creek than other estuary locations and/or that NSA's capture efficiency is higher at the Hunter Creek sites. The Klamath River estuary, especially near the mouth of Hunter Creek, appears to be extremely important rearing habitat for Klamath River sea-run coastal cutthroat trout.

Use of Cool Water Refugia at the Mouth of Hunter Creek- Most of the juvenile cutthroat captured by NSA in the lower estuary were from the sites adjacent to the mouth of Hunter Creek. In 2001 the annual CPUE was 0.42 fish/1000ft^2 at Hunter Creek and 0.03 fish/1000ft^2 at the other lower estuary standard sampling sites (Table 7). In 2000 the annual cutthroat trout CPUE was 0.85 fish/1000ft^2 at Hunter Creek and 0.15 fish/1000ft^2 at the standard sampling sites (Table 7). In 2001 NSA captured very few juvenile cutthroat in the lower estuary except at Hunter Creek where catches were high from late June until NSA discontinued sampling at Hunter Creek in mid July. In 2000 peak cutthroat CPUE in the main estuary occurred in mid June and mid July while peak catches at Hunter Creek occurred in late May, and then again in mid July to early August. Water temperatures in the main portion of the estuary were 20-22^{o}C during July and August. Water temperatures at the mouth of Hunter Creek were substantially colder (range 14-18 ^{o}C) than the main estuary during the late spring and summer (CDFG unpublished data). The high catch of juvenile cutthroat adjacent to Hunter Creek was probably due to them seeking cold water supplied by Hunter Creek. NSA noted high catches of other species of juvenile salmonids at the mouth of Hunter Creek in 2001 and 2000 (Table 7) and during opportunistic sampling in 1999 and 1998 (CDFG unpublished data).

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Appendix 1. Weekly and total seining catch-per-unit-effort (fish/1000ft^2) of subyearling Chinook salmon at all sites in the lower Klamath River estuary, 2002.

JW	Date	Effort (ft)^2	Total # Chin	Total CPUE	No. IGH	CPUE IGH	No. TRH f	CPUE TRH f	No. TRH s	CPUE TRH s	No. Hatch	CPUE Hatch	No. Nat	CPUE Nat
10	3/05	23250	0	0	0	0	0	0	0	0	0	0	0	0
11	3/18	29900	1	0.03	0	0	0	0	0	0	0	0	1	0.03
12	3/25	27350	0	0	0	0	0	0	0	0	0	0	0	0
14	4/02	28600	2	0.07	0	0	0	0	0	0	0	0	2	0.07
15	4/08	24200	6	0.25	0	0	0	0	0	0	0	0	6	0.25
16	4/17	29275	4	0.14	0	0	0	0	0	0	0	0	4	0.14
17	4/22	31800	1	0.03	0	0	0	0	0	0	0	0	1	0.03
18	4/29	28025	0	0	0	0	0	0	0	0	0	0	0	0
19	5/08	28200	0	0	0	0	0	0	0	0	0	0	0	0
20	5/13	30050	5	0.17	0	0	0	0	0	0	0	0	5	0.17
21	5/20	32500	10	0.31	0	0	0	0	0	0	0	0	10	0.31
22	5/29	30600	0	0	0	0	0	0	0	0	0	0	0	0
23	6/03	36900	7	0.19	0	0	0	0	0	0	0	0	7	0.19
24	6/12	31450	5	0.16	5	0.16	0	0	0	0	5	0.16	0	0
25	6/17	30000	6	0.20	0	0	0	0	0	0	0	0	6	0.20
26	6/26	30700	213	6.94	0	0	72	2.35	21	0.68	93	3.03	120	3.91
27	7/01	33500	125	3.73	30	0.90	59	1.76	3	0.09	92	2.75	33	0.99
28	7/10	30700	185	6.03	89	2.90	29	0.94	0	0	118	3.84	67	2.18
29	7/19	27000	134	4.96	0	0	24	0.89	6	0.22	30	1.11	104	3.85
30	7/22	27900	44	1.58	0	0	3	0.11	0	0	3	0.11	41	1.47
31	8/01	24600	158	6.42	0	0	12	0.49	3	0.12	15	0.61	143	5.81
32	8/08	26100	91	3.49	0	0	0	0	0	0	0	0	91	3.49
33	8/12	26175	88	3.36	0	0	3	0.11	0	0	3	0.11	85	3.25
34	8/19	28000	13	0.46	0	0	0	0	0	0	0	0	13	0.46
35	8/28	22575	11	0.49	0	0	3	0.13	0	0	3	0.13	8	0.35
Total		**719,350**	**1,109**	**1.54**	**124**	**0.17**	**205**	**0.28**	**33**	**0.05**	**361**	**0.50**	**747**	**1.04**
Jun-Aug Total		**375,600**	**1,080**	**2.88**	**124**	**0.33**	**205**	**0.55**	**33**	**0.09**	**361**	**0.96**	**718**	**1.91**

Appendix 2. Weekly and total electrofishing catch-per-unit-effort (fish/minute) of subyearling Chinook salmon in the upper Klamath River estuary, 2002.

JW	Date	Effort (sec)	Total # Chin	Total CPUE	No. IGH	CPUE IGH	No. TRH f	CPUE TRH f	No. TRH s	CPUE TRH s	No. Hatch	CPUE Hatch	No. Nat	CPUE Nat
14	4/03	870	0	0	0	0	0	0	0	0	0	0	0	0
17	4/23	1669	0	0	0	0	0	0	0	0	0	0	0	0
18	5/01	1473	0	0	0	0	0	0	0	0	0	0	0	0
19	5/14	1410	1	0.04	0	0	0	0	0	0	0	0	1	0.04
21	5/21	1447	10	0.41	0	0	0	0	0	0	0	0	10	0.41
22	5/30	1686	12	0.43	0	0	0	0	0	0	0	0	12	0.43
23	6/04	1755	12	0.41	0	0	0	0	0	0	0	0	12	0.41
24	6/10	1139	25	1.32	0	0	0	0	0	0	0	0	25	1.32
25	6/18	1833	168	5.50	47	1.54	6	0.20	32	1.05	85	2.78	83	2.72
26	6/24	1819	45	1.48	30	0.99	6	0.20	0	0	36	1.19	9	0.30
27	7/02	1986	99	2.99	0	0	9	0.27	0	0	9	0.27	90	2.72
28	7/08	1858	170	5.49	0	0	3	0.10	3	0.10	6	0.19	164	5.30
29	7/17	1889	296	9.40	0	0	0	0	0	0	0	0	296	9.40
30	7/24	1886	221	7.03	0	0	3	0.10	0	0	3	0.10	218	6.94
31	7/30	1751	165	5.65	0	0	0	0	0	0	0	0	165	5.65
32	8/15	1780	109	3.67	0	0	0	0	0	0	0	0	109	3.67
33	8/20	1850	84	2.72	0	0	6	0.19	0	0	6	0.19	78	2.53
Total		**28101**	**1417**	**3.03**	**77**	**0.16**	**33**	**0.07**	**35**	**0.07**	**145**	**0.31**	**1272**	**2.72**
Jun-Aug Total		**19546**	**1394**	**4.28**	**77**	**0.24**	**33**	**0.10**	**35**	**0.11**	**145**	**0.45**	**1249**	**3.83**

Appendix 3. Weekly and total catch-per-unit-effort (fish/1000ft^2) of subyearling Chinook salmon at sites 1-8 in the lower Klamath River estuary, 2001.

JW	Date	Effort (ft^2)	Total # Chin	Total CPUE	No. IGH	CPUE IGH	# TRH fall	CPUE TRH f	# TRH spring	CPUE TRH s	No. Hatch	CPUE Hatch	No. Nat	CPUE Nat
10	3/05	27275	0	0	0	0	0	0	0	0	0	0	0	0
11	3/15	40175	0	0	0	0	0	0	0	0	0	0	0	0
12	3/19	35600	0	0	0	0	0	0	0	0	0	0	0	0
13	3/27	32725	0	0	0	0	0	0	0	0	0	0	0	0
14	4/04	28775	2	0.07	0	0	0	0	0	0	0	0	2	0.07
15	4/09	39300	6	0.15	0	0	0	0	0	0	0	0	6	0.15
16	4/16	34100	24	0.70	0	0	0	0	0	0	0	0	24	0.70
17	4/23	38275	27	0.71	0	0	0	0	0	0	0	0	27	0.71
18	4/30	24525	48	1.96	0	0	0	0	0	0	0	0	48	1.96
19	5/07	42100	81	1.92	0	0	0	0	0	0	0	0	81	1.92
20	5/17	28750	8	0.28	0	0	0	0	0	0	0	0	8	0.28
21	5/23	33050	17	0.51	0	0	0	0	0	0	0	0	17	0.51
22	5/30	31950	210	6.57	0	0	0	0	0	0	0	0	210	6.57
23	6/04	38150	97	2.54	0	0	0	0	0	0	0	0	97	2.54
24	6/11	44450	1,845	41.51	456	10.26	0	0	0	0	456	10.26	1,389	31.25
25	6/18	41025	668	16.28	152	3.71	16	0.39	26	0.63	194	4.73	474	11.55
26	6/25	42150	1,048	24.86	355	8.42	106	2.51	16	0.38	477	11.32	571	13.55
27	7/02	36825	738	20.04	178	4.83	50	1.36	0	0	228	6.19	510	13.85
28	7/09	36700	265	7.22	51	1.39	3	0.08	0	0	54	1.47	211	5.75
29	7/16	38300	1,205	31.46	101	2.64	81	2.11	0	0	182	4.75	1,023	26.71
30	7/23	40625	336	8.27	76	1.87	25	0.61	0	0	101	2.49	235	5.78
31	7/30	32225	166	5.15	0	0	12	0.37	0	0	12	0.37	154	4.78
32	8/06	33525	141	4.21	0	0	0	0	0	0	0	0	141	4.21
33	8/13	29800	207	6.95	0	0	19	0.64	0	0	19	0.64	188	6.31
34	8/20	34800	276	7.93	0	0	12	0.34	0	0	12	0.34	264	7.59
35	8/27	29750	251	8.44	0	0	6	0.20	0	0	6	0.20	245	8.24
36	9/07	32200	61	1.89	0	0	3	0.09	0	0	3	0.09	58	1.80
37	9/10	33925	27	0.80	0	0	0	0	0	0	0	0	27	0.80
38	9/17	32150	51	1.59	0	0	0	0	0	0	0	0	51	1.59
39	9/24	30175	54	1.79	0	0	0	0	0	0	0	0	54	1.79
Total		**1,043,375**	**7,859**	**7.53**	**1,369**	**1.31**	**333**	**0.32**	**42**	**0.04**	**1,744**	**1.67**	**6,115**	**5.86**

Appendix 4. Weekly and total catch-per-unit-effort (fish/1000ft^2) of subyearling Chinook salmon at sites 1-5in the lower Klamath River estuary, 2001
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JW	Date	Effort (ft^2)	Total # Chin	Total CPUE	No. IGH	CPUE IGH	# TRH fall	CPUE TRH f	# TRH spring	CPUE TRH s	No. Hatch	CPUE Hatch	No. Nat	CPUE Nat
10	3/05	23275	0	0	0	0	0	0	0	0	0	0	0	0
11	3/15	25775	0	0	0	0	0	0	0	0	0	0	0	0
12	3/19	28800	0	0	0	0	0	0	0	0	0	0	0	0
13	3/27	20625	0	0	0	0	0	0	0	0	0	0	0	0
14	4/04	23175	2	0.09	0	0	0	0	0	0	0	0	2	0.09
15	4/09	24300	6	0.25	0	0	0	0	0	0	0	0	6	0.25
16	4/16	28400	24	0.85	0	0	0	0	0	0	0	0	24	0.85
17	4/23	25275	3	0.12	0	0	0	0	0	0	0	0	3	0.12
18	4/30	20525	48	2.34	0	0	0	0	0	0	0	0	48	2.34
19	5/07	26000	76	2.92	0	0	0	0	0	0	0	0	76	2.92
20	5/17	23850	8	0.34	0	0	0	0	0	0	0	0	8	0.34
21	5/23	23950	8	0.33	0	0	0	0	0	0	0	0	8	0.33
22	5/30	21200	55	2.59	0	0	0	0	0	0	0	0	55	2.59
23	6/04	25550	12	0.47	0	0	0	0	0	0	0	0	12	0.47
24	6/11	24650	119	4.83	25	1.01	0	0	0	0	25	1.01	94	3.81
25	6/18	27525	240	8.72	51	1.85	0	0	0	0	51	1.85	189	6.87
26	6/25	27800	225	8.09	25	0.90	34	1.22	3	0.11	62	2.23	163	5.86
27	7/02	24200	158	6.53	0	0	28	1.16	0	0	28	1.16	130	5.37
28	7/09	26150	83	3.17	0	0	16	0.61	0	0	16	0.61	67	2.56
29	7/16	25000	143	5.72	76	3.04	19	0.76	0	0	95	3.80	48	1.92
30	7/23	35225	306	8.69	0	0	12	0.34	0	0	12	0.34	294	0.68
31	7/30	25225	121	4.80	0	0	0	0	0	0	0	0	121	4.80
32	8/06	28425	126	4.43	0	0	0	0	0	0	0	0	126	4.43
33	8/13	24700	184	7.45	0	0	6	0.24	0	0	6	0.24	178	7.21
34	8/20	30000	229	7.63	0	0	0	0	0	0	0	0	229	7.63
35	8/27	25250	186	7.37	0	0	0	0	0	0	0	0	186	7.37
36	9/07	26200	48	1.83	0	0	0	0	0	0	0	0	48	1.83
37	9/10	27925	18	0.64	0	0	0	0	0	0	0	0	18	0.64
38	9/17	27250	44	1.61	0	0	0	0	0	0	0	0	44	1.61
39	9/24	23775	41	1.72	0	0	0	0	0	0	0	0	41	1.72
Total		**770,000**	**2,513**	**3.26**	**177**	**0.23**	**115**	**0.15**	**3**	**0.004**	**295**	**0.38**	**2,218**	**2.88**

Appendix 5. Weekly and total catch-per-unit-effort (fish/minute) of subyearling Chinook salmon in the upper Klamath River estuary, 2001.

JW	Date	Effort (sec)	Total # Chin	Total CPUE	No. IGH	CPUE IGH	# TRH fall	CPUE TRH f	# TRH spring	CPUE TRH s	No. Hatch	CPUE Hatch	No. Nat	CPUE Nat
11	3/13	1822	0	0	0	0	0	0	0	0	0	0	0	0
12	3/20-21	1828	1	0.03	0	0	0	0	0	0	0	0	1	0.03
15	4/12	1626	0	0	0	0	0	0	0	0	0	0	0	0
16	4/17	1602	7	0.26	0	0	0	0	0	0	0	0	7	0.26
17	4/24&27	1174	4	0.20	0	0	0	0	0	0	0	0	4	0.20
18	5/02	1826	0	0	0	0	0	0	0	0	0	0	0	0
19	5/08	2192	1	0.03	0	0	0	0	0	0	0	0	1	0.03
21	5/21	1681	3	0.11	0	0	0	0	0	0	0	0	3	0.11
22	5/28	1827	102	3.35	0	0	0	0	0	0	0	0	102	3.35
23	6/05	1041	20	1.15	0	0	0	0	0	0	0	0	20	1.15
24	6/12	1728	266	9.24	51	1.77	0	0	0	0	51	1.77	215	7.47
25	6/19	1876	327	10.46	0	0	31	0.99	19	0.61	50	1.60	277	8.86
26	6/28	1773	449	15.16	51	1.73	28	0.95	3	0.10	82	2.77	367	12.42
27	7/05	1741	159	5.48	0	0	0	0	0	0	0	0	159	5.48
28	7/10	1788	398	13.36	0	0	9	0.30	0	0	9	0.30	389	13.05
29	7/18	1742	328	11.30	0	0	3	0.10	0	0	3	0.10	325	11.19
30	7/26	1632	108	3.97	25	0.92	0	0	0	0	25	0.92	83	3.05
31	7/31	2165	345	9.56	0	0	3	0.08	0	0	3	0.08	342	9.48
32	8/07	1833	130	4.26	0	0	0	0	0	0	0	0	130	4.26
33	8/14	1796	165	5.51	0	0	0	0	0	0	0	0	165	5.51
34	8/23	1810	10	0.33	0	0	0	0	0	0	0	0	10	0.33
35	8/28	1971	54	1.64	0	0	0	0	0	0	0	0	54	1.64
Total		**38474**	**2877**	**4.49**	**127**	**0.20**	**74**	**0.12**	**22**	**0.03**	**223**	**0.35**	**2654**	**4.14**

Appendix 6. Weekly and total catch-per-unit-effort (fish/1000ft^2) of subyearling Chinook salmon in the lower Klamath River estuary, 2000.

JW	Date	Effort (ft^2)	Total # Chin	Total CPUE	No. IGH	CPUE IGH	No. TRH f	CPUE TRH f	No. TRH s	CPUE TRH s	No. Hatch	CPUE Hatch	No. Nat	CPUE Nat
19	5/12	31725	4	0.13	0	0	0	0	0	0	0	0	4	0.13
20	5/17	28350	48	1.69	0	0	0	0	0		0	0	48	1.69
21	5/26	28350	8	0.28	0	0	0	0	0	0	0	0	8	0.28
										0				
22	6/02	27250	12	0.44	0	0	0	0	0		0	0	12	0.44
23	6/09	31725	15	0.47	0	0	0	0	0	0	0	0	15	0.47
24	6/15	31025	29	0.93	0	0	0	0	0	0	0	0	29	0.93
25	6/21	26725	112	4.19	0	0	0	0	27	0	27	1.01	85	3.18
26	6/29	32825	408	12.43	403	12.28	0	0	5	1.01	408	12.43	0	0
										0.15				
27	7/07	29350	373	12.71	192	6.54	10	0.34	0		202	6.88	171	5.83
28	7/12	31625	195	6.17	82	2.59	0	0	0	0	82	2.59	113	3.57
29	7/19	36300	559	15.40	165	4.55	30	0.83	0	0	195	5.37	364	10.03
30	7/25	28450	132	4.64	27	0.95	10	0.35	5	0	42	1.48	90	3.16
										0.18				
31	8/02	34300	129	3.76	0	0	0	0	22		22	0.64	107	3.12
32	8/10	35375	180	5.09	55	1.55	10	0.28	0	0.64	65	1.84	115	3.25
33	8/17	40600	50	1.23	0	0	10	0.25	0	0	10	0.25	40	0.99
34	8/23	33550	265	7.90	0	0	39	1.16	0	0	39	1.16	226	6.74
35	8/30	40450	116	2.87	27	0.67	0	0	0	0	27	0.67	89	2.20
										0				
36	9/08	38300	105	2.74	27	0.70	0	0	0		27	0.70	78	2.04
37	9/14	37900	79	2.08	0	0	0	0	0	0	0	0	79	2.08
38	9/21	38200	40	1.05	27	0.71	0	0	0	0	27	0.71	13	0.34
39	9/27& 28	45150	65	1.44	55	1.22	0	0	0	0	55	1.22	10	0.22
										0				
Total		**387350**	**2924**	**4.13**	**1061**	**1.50**	**108**	**0.15**	**59**	**0.08**	**1228**	**1.74**	**1696**	**2.40**

Appendix 7. Weekly and total catch-per-unit-effort (fish/minute) of subyearling Chinook salmon in the upper Klamath River estuary, 2000.

JW	Date	Effort (ft^2)	Total # Chin	Total CPUE	No. IGH	CPUE IGH	No. TRH f	CPUE TRH f	No. TRH s	CPUE TRH s	No. Hatch	CPUE Hatch	No. Nat	CPUE Nat
20	5/15	1408	3	0.13	0	0	0	0	0	0	0	0	3	0.13
21	5/24	1005	6	0.36	0	0	0	0	0	0	0	0	6	0.36
22	5/31	1057	21	1.19	0	0	0	0	0	0	0	0	21	1.19
23	6/06	1176	48	2.45	0	0	0	0	0	0	0	0	48	2.45
24	6/13	1461	44	1.71	0	0	0	0	5	0.19	5	0.19	39	1.51
25	6/19	1446	57	2.37	0	0	0	0	27	1.12	27	1.12	30	1.24
26	6/27	1414	22	0.93	0	0	0	0	0	0	0	0	22	0.93
27	7/05	1738	390	13.46	220	7.59	49	1.69	16	0.55	285	9.84	105	3.62
28	7/10	1608	173	6.46	156	5.82	17	0.63	0	0	173	6.46	0	0
29	7/17	1549	219	8.48	110	4.26	10	0.39	0	0	120	4.65	99	3.83
30	7/26	1464	162	6.64	55	2.25	39	1.60	0	0	94	3.85	68	2.79
31	7/31	1457	73	3.01	0	0	0	0	0	0	0	0	73	3.01
32	8/08	1437	70	2.92	55	2.30	0	0	0	0	55	2.30	15	0.63
33	8/14	1278	100	4.69	27	1.27	0	0	0	0	27	1.27	73	3.43
34	8/21	1558	218	8.40	27	1.04	0	0	5	0.19	32	1.23	186	7.16
35	8/28	1597	192	7.21	27	1.01	0	0	0	0	27	1.01	165	6.20
36	9/5-6	1728	312	10.83	55	1.91	20	0.69	0	0	75	2.60	237	8.23
37	9/12	1875	212	6.78	55	1.76	39	1.25	0	0	94	3.01	118	3.78
38	9/19	1523	119	4.69	0	0	0	0	0	0	0	0	119	4.69
39	9/25	1462	128	5.25	0	0	10	0.41	0	0	10	0.41	118	4.84
Total		**29329**	**2569**	**5.26**	**787**	**1.61**	**184**	**0.38**	**53**	**0.11**	**1024**	**2.09**	**1545**	**3.16**

Appendix 8. Summary of young-of-the-year CWT juvenile Chinook salmon captured in the Klamath River estuary March-August 2002.

Release Site	**CWT**	**Size at Release**	**Release Dates**	**No. Tagged**	**No. Released**	**No. Cap**	**Median DAL***	**Range DAL***	**AVG FL**
	0601020400	91/lb	May 10	49,315	815,593	2	36	33-39	101.5
	0601020401	90/lb	May 21	47,538	806,918	0	-	-	-
IGH	0601020402	85/lb	May 28	51,363	1,648,495	0	-	-	-
	0601020403	105/lb	June 5	50,545	1,495,322	6	27	13-35	94.8
IGH TOTAL				198,761	4,766,328	8	34	13-39	96.5
	065281	39/lb	June 3-10	89,482	276,612	9	14	11-24	104.1
TRH(s)	065282	39/lb	June 3-10	85,978	273,636	8	22	11-55	99.8
	065283	45/lb	June 3-10	73,788	227,742	5	27	11-42	98.2
TRH SPRING TOTAL				249,248	777,990	22	19	11-55	101.8
	065284	71/lb	June 3-10	119,555	368,099	14	29	11-66	91.5
	065285	71/lb	June 3-10	114,119	379,607	14	24	19-55	88.6
TRH(f)	065286	86/lb	June 3-10	126,135	384,128	22	29	17-74	87.0
	065287	86/lb	June 3-10	121,607	377,601	25	33	17-82	88.0
	065290	126/lb	June 3-10	10,234	30,805	2	40	24-55	80.0
	065291	126/lb	June 3-10	8,269	24,890	0	-	-	- .
TRH FALL TOTAL				499,919	1,565,130	77	24	11-82	88.3

* DAL= Days at Liberty

Appendix 9. Summary of young-of-the-year CWT juvenile Chinook salmon captured in the Klamath River estuary March-September 2001.

Release Site	CWT	Size at Release	No. Tagged	No. Released	No. Cap	Median DAL*	Range DAL*	AVG FL
	0601020305	90/lb	49,087	868,663	31	27	21-49	91.9
	0601020306	92/lb	48,954	869,863	15	34	16-58	92.6
IGH	0601020307	115/lb	44,238	1,742,500	5	30	23-37	90.6
	0601020308	164/lb	45,138	1,468,638	8	48	33-61	95.6
IGH TOTAL			187,417	4,949,664	59	30	16-61	92.5
	065260	33.3/lb	33,049	139,006	2	9	9- 9	106.1
	065262	33.3/lb	24,480	103,002	2	13	9-16	109.0
	065263	33.3/lb	34,385	139,236	2	13	9-16	101.0
TRH(s)	065264	42.0/lb	31,857	143,765	3	13	10-19	99.7
	065269	33.3/lb	52,491	212,540	4	11	9-16	104.8
	065270	42.0/lb	52,580	237,227	7	11	9-16	106.3
TRH SPRING TOTAL			228,842	974,776	20	10	9-19	104.7
	065265	56.5/lb	32,795	136,615	6	23	10-37	93.7
	065266	56.5/lb	33,806	137,340	6	19	9-37	95.5
	065267	56.5/lb	34,852	141,040	4	20	10-37	95.0
	065268	86.0/lb	33,240	136,834	10	33	16-79	89.3
	065271	56.5/lb	54,867	228,510	13	19	10-37	94.6
	065272	56.5/lb	36,035	150,105	10	24	9-44	95.3
TRH(f)	065273	56.5/lb	57,444	232,417	10	22	10-37	97.1
	065274	56.5/lb	32,096	129,893	8	31	9-44	97.9
	065275	56.5/lb	64,250	260,944	16	19	9-37	96.3
	065276	56.5/lb	27,159	110,356	9	25	16-39	96.4
	065277	86.0/lb	56,582	232,832	19	39	16-72	89.0
	065278	86.0/lb	34,183	140,711	14	52	16-79	91.9
	065643	65.6/lb	25,007	112,293	6	48	16-90	98.3
TRH FALL TOTAL			522,316	2,149,890	131	23	9-90	94.1
IGH	066351	10.0/lb	43,332	478,265	18	161	128-184	180.7
Yearling	066352	10.0/lb	47,888	478,265	22	156	128-184	181.6
IGH YEARLING TOTAL			91,220	956,530	40	158	128-184	181.2
TRH(f) Yearling	065259	11.5-12.7/lb	66,469	192,280	6	179	161-217	176.0

* DAL= Days at Liberty

Appendix 10. Summary of young-of-the-year CWT juvenile Chinook salmon captured in the Klamath River estuary May-September, 2000.

Release Site	**CWT**	**Size at Release**	**No. Tagged**	**No. Released**	**No. Cap**	**Median DAL***	**Range DAL***	**AVG FL**
	0601020309	95/lb	51,641	1,419,782	17	28	20-103	96.8
	0601020310	95/lb	52,964	1,456,164	20	40	33-109	98.4
IGH	0601020311	95/lb	53,203	1,462,755	22	31	20-109	96.9
	0601020312	95/lb	24,323	668,730	10	32	26- 90	97.8
	IGH TOTAL	95/lb	182,131	5,007,431	69	30	20-109	97.4
TRH(s)	065251	40.8/lb	49,421	326,943	7	15	9- 17	106.1
	065252	40.8/lb	51,993	330,602	6	31	17- 51	102.8
	065253	50.6/lb	46,966	290,210	4	23	15- 78	100.1
	TRH SPRING TOTAL		148,380	947,755	17	17	9- 78	103.7
	065254	79.4/lb	44,654	482,866	9	52	45-112	101.1
	065255	79.4/lb	42,549	459,385	7	59	31- 99	94.9
TRH(f)	065256	90.5/lb	43,565	470,891	10	56	31- 99	98.1
	065257	90.5/lb	50,533	553,426	9	52	31- 99	92.0
TRH FALL TOTAL			181,301	1,966,568	35	52	31-112	96.7

* DAL= Days at Liberty

Appendix 11. Summary of young-of-the-year CWT juvenile Chinook salmon captured in the Klamath River estuary May-September, 1999. Data includes both standard and qualitative samples.

Release Site	CWT	Size at Release	No. Tagged	No. Released	No. Cap	Median DAL	Range DAL	AVG FL
	0601020301	84/lb	51,641	1,366,673	10	51	23- 91	108.1
IGH	0601020302	84/lb	54,373	1,438,918	12	37	22- 84	103.4
	0601020303	84/lb	48,919	1,294,650	8	32	23- 85	102.0
	0601020304	84/lb	32,670	864,611	12	28	17- 79	93.7
	IGH TOTAL	84/lb	187,603	4,964,852	42	30	17- 91	101.5
	065247	55/lb	54,378	384,725	4	30	25- 32	95.3
TRH(s)	065248	64/lb	61,516	389,049	12	36	25- 53	92.0
	065249	67/lb	61,074	387,665	19	26	25-102	95.8
	TRH SPRING TOTAL		176,968	1,161,439	35	32	25-102	94.5
	065242	106/lb	46,399	521,081	14	87	40-124	106.1
TRH(f)	065243	118/lb	42,659	479,507	11	66	34-116	92.4
	065244	135/lb	49,332	528,476	10	75	45-124	102.2
	065245	141/lb	46,391	524,972	14	78	37-104	98.3
	TRH FALL TOTAL		184,781	2,054,036	49	75	34-124	100.0

* DAL= Days at Liberty

Appendix 12. Summary of young-of-the-year CWT juvenile Chinook salmon captured in the Klamath River estuary June-September, 1998. Data includes both standard and qualitative samples.

Release Site	CWT	Size at Release	No. Tagged	No. Released	No. Cap	Median DAL*	Range DAL*	AVG FL
	0601020212	63/lb	57,375	1,456,645	16	22	15- 43	93.3
	0601020213	63/lb	56,339	1,430,343	18	23	16- 56	90.6
IGH	0601020214	63/lb	49,400	1,254,174	23	35	17- 87	95.8
	0601020215	63/lb	30,047	762,838	13	35	22- 94	95.7
	IGH TOTAL	63/lb	193,161	4,904,000	70	34	15- 94	93.9
TRH(s)	065237	49/lb	104,577	541,895	22	29	21- 56	96.1
	065238	49/lb	104,578	541,894	31	30	15- 80	98.2
	TRH SPRING TOTAL	49/lb	209,155	1,083,789	53	30	15- 80	97.3
	065233	110/lb	50,947	493,455	35	58	36-100	92.6
	065234	108/lb	49,353	502,248	39	63	35- 98	93.2
TRH(f)	065235	100/lb	49,786	493,401	28	58	35-100	93.5
	065236	88/lb	48,382	508,360	34	58	35- 87	92.8
	065239	160/lb	18,304	183,421	14	71	51-100	93.4
	TRH FALL TOTAL		216,772	2,180,885	150	59	35-100	93.1

* DAL= Days at Liberty

Appendix 13. Total number of unmarked and coded-wire tagged Chinook salmon released from Klamath basin hatcheries and expansion factors used to determine the hatchery component of emigrating Chinook salmon in the Klamath River estuary, 1998-2002.

HATCHERY	UNMARKED FISH	TAGGED FISH	EXPANSION FACTOR
2002			
Trinity River (spring run)	777,990	249,248	3.12:1
Trinity River (fall run)	1,565,130	499,919	3.13:1
Iron Gate	4,768,328	198,761	23.99:1
2001			
Trinity River (spring-run)	872,106	261,463	3.34:1
Trinity River (fall-run)	1,622,641	522,316	3.11:1
Iron Gate	4,752,580	187,417	25.36:1
Trinity River Yearlings	655,495	216,593	3.03:1
Iron Gate Yearlings	810,445	100,702	8.05:1
2000			
Trinity River (spring-run)	799,375	148,380	5.39:1
Trinity River (fall-run)	1,785,267	181,301	9.85:1
Iron Gate	4,825,300	182,131	26.49:1
1999			
Trinity River (spring-run)	970,972	176,968	5.49:1
Trinity River (fall-run)	1,860,416	184,781	10.07:1
Iron Gate (fall-run)	4,761,481	187,603	25.38:1
1998			
Trinity River (spring-run)	1,083,789	209,155	5.18:1
Trinity River (fall-run)	2,180,885	216,772	10.06:1
Iron Gate	4,910,315	193,161	25.42:1

Appendix 14. Origin and portion of subyearling Chinook salmon emigrating through the lower Klamath River estuary based on expansions of CWT's recovered at standard sampling sites, March-August 2002. Numbers in parenthesis are actual numbers of captured salmon containing CWT's.

WEEK OF	TOTAL CHINOOK	IGH	TRH fall	TRH spring	NUMBER NATURAL	NUMBER HATCHERY	PERCENT NATURAL
3/03	0	0	0	0	0	0	-
3/17	1	0	0	0	1	0	100.0
3/24	0	0	0	0	0	0	-
Total	**1**	**0**	**0**	**0**	**1**	**0**	**100.0**
3/31	2	0	0	0	2	0	100.0
4/07	6	0	0	0	6	0	100.0
4/14	4	0	0	0	4	0	100.0
4/21	1	0	0	0	1	0	100.0
Total	**13**	**0**	**0**	**0**	**13**	**0**	**100.0**
4/28	0	0	0	0	0	0	-
5/05	0	0	0	0	0	0	-
5/12	5	0	0	0	5	0	100.0
5/19	10	0	0	0	10	0	100.0
5/26	0	0	0	0	0	0	-
Total	**15**	**0**	**0**	**0**	**15**	**0**	**100.0**
6/02	7	0	0	0	7	0	100.0
6/09*	5	5(1)	0	0	0	5	0
6/16	6	0	0	0	6	0	0
6/23	213	0	72(23)	22(7)	119	94	55.9
Total	**231**	**5(1)**	**72(23)**	**22(7)**	**132**	**99**	**57.1**
6/30	125	24(1)	59(19)	3(1)	39	86	31.2
7/07	185	72(3)	28(9)	0	85	100	45.9
7/14	134	0	25(8)	6(2)	103	31	76.9
7/21	44	0	3(1)	0	41	3	93.2
Total	**488**	**96(4)**	**115(37)**	**9(3)**	**268**	**220**	**54.9**
7/28	158	0	13(4)	3(1)	142	16	89.9
8/04	91	0	0	0	91	0	100.0
8/11	88	0	3(1)	0	85	3	96.6
8/18	13	0	0	0	13	0	100.0
8/25	11	0	3(1)	0	8	3	72.7
Total	**361**	**0**	**19(6)**	**3(1)**	**339**	**22**	**93.9**
TOTAL	**1109**	**101(5)**	**206(66)**	**34(11)**	**768**	**341**	**69.3**
JUNE-AUG TOTAL	**1080**	**101(5)**	**206(66)**	**34(11)**	**739**	**341**	**68.4**

			Untagged:Tagged
IGH	=	Iron Gate Hatchery	23.99:1
TRH	=	Trinity River Hatchery	
		Spring Run	3.12:1
		Fall Run	3.13:1

* Coded-wire expansions exceeded total Chinook catch.

Appendix 15. Origin and portion of subyearling Chinook salmon emigrating through the upper Klamath River estuary based on expansions of CWT's recovered at standard sampling sites, March-August 2002. Numbers in parenthesis are actual numbers of captured salmon containing CWT's.

WEEK OF	TOTAL CHINOOK	IGH	TRH fall	TRH spring	NUMBER NATURAL	NUMBER HATCHERY	PERCENT NATURAL
3/31	0	0	0	0	0	0	-
4/21	0	0	0	0	0	0	-
Total	**0**	**0**	**0**	**0**	**0**	**0**	**-**
4/28	0	0	0	0	0	0	-
5/12	1	0	0	0	1	0	100.0
5/19	10	0	0	0	10	0	100.0
5/26	12	0	0	0	12	0	100.0
Total	**23**	**0**	**0**	**0**	**23**	**0**	**100.0**
6/02	12	0	0	0	12	0	100.0
6/09	25	0	0	0	25	0	100.0
6/16	168	48(2)	6(2)	31(10)	83	85	49.4
6/23	45	24(1)	6(2)	0	15	30	33.3
Total	**250**	**72(3)**	**12(4)**	**31(10)**	**135**	**115**	**54.0**
6/30	99	0	9(3)	0	90	9	90.9
7/07	170	0	3(1)	3(1)	164	6	96.5
7/14	296	0	0	0	296	0	100.0
7/21	221	0	3(1)	0	218	3	98.6
7/28	165	0	0	0	165	0	100.0
Total	**951**	**0**	**15(5)**	**3(1)**	**933**	**18**	**98.1**
8/11	109	0	0	0	109	0	100.0
8/18	84	0	6(2)	0	78	6	92.9
Total	**193**	**0**	**6(2)**	**0**	**187**	**6**	**96.9**
TOTAL	**1417**	**72(3)**	**33(11)**	**34(11)**	**1278**	**139**	**90.2**
JUNE-AUG TOTAL	**1394**	**72(3)**	**33(11)**	**34(11)**	**1255**	**139**	**90.0**
LOWER ESTUARY TOTAL	**1080**	**101(5)**	**206(66)**	**34(11)**	**739**	**341**	**68.4**
ANNUAL TOTAL	**2474**	**173(8)**	**239(77)**	**68(22)**	**1994**	**480**	**80.6**

		Untagged:Tagged
IGH	= Iron Gate Hatchery	23.99:1
TRH	= Trinity River Hatchery	
	Spring Run	3.12:1
	Fall Run	3.13:1

Appendix 16. Origin and portion of subyearling Chinook salmon emigrating through the lower Klamath River estuary based on expansions of CWT's recovered at standard sampling sites, March-September 2001. Numbers in parenthesis are actual numbers of captured salmon containing CWT's.

WEEK OF	TOTAL CHINOOK	IGH	TRH fall	TRH spring	NUMBER NATURAL	NUMBER HATCHERY	PERCENT NATURAL
3/04	0	0	0	0	0	0	0
3/11	0	0	0	0	0	0	0
3/18	0	0	0	0	0	0	0
3/25	0	0	0	0	0	0	0
Total	**0**	**0**	**0**	**0**	**0**	**0**	**0**
4/01	2	0	0	0	2	0	100.0
4/08	6	0	0	0	6	0	100.0
4/15	24	0	0	0	24	0	100.0
4/22	3	0	0	0	3	0	100.0
4/29	48	0	0	0	48	0	100.0
Total	**83**	**0**	**0**	**0**	**83**	**0**	**100.0**
5/06	76	0	0	0	76	0	100.0
5/13	8	0	0	0	8	0	100.0
5/20	8	0	0	0	8	0	100.0
5/27	55	0	0	0	55	0	100.0
Total	**147**	**0**	**0**	**0**	**147**	**0**	**100.0**
6/03	12	0	0	0	12	0	100.0
6/10	119	25(1)	0	0	94	25	79.0
6/17	240	51(2)	0	0	189	51	78.8
6/24	225	25(1)	34(11)	3(1)	163	62	72.4
Total	**596**	**101(4)**	**34(11)**	**3(1)**	**458**	**138**	**76.8**
7/01	158	0	28(9)	0	130	28	82.3
7/08	83	0	16(5)	0	67	16	80.7
7/15	143	76(3)	19(6)	0	48	95	33.6
7/22	306	0	12(4)	0	294	12	96.1
7/29	121	0	0	0	121	0	100.0
Total	**811**	**76(3)**	**75(24)**	**0**	**660**	**151**	**81.4**
8/05	126	0	0	0	126	0	100.0
8/12	184	0	6(2)	0	178	6	96.7
8/19	229	0	0	0	229	0	100.0
8/26	186	0	0	0	186	0	100.0
Total	**725**	**0**	**6(2)**	**0**	**719**	**6**	**99.2**
9/02	48	0	0	0	48	0	100.0
9/09	18	0	0	0	18	0	100.0
9/16	44	0	0	0	44	0	100.0
9/23	41	0	0	0	41	0	100.0
Total	**151**	**0**	**0**	**0**	**151**	**0**	**100.0**
TOTAL	**2,513**	**177(7)**	**115(37)**	**3(1)**	**2,218**	**295**	**88.3**
JUNE-SEPT TOTAL	**2,283**	**177(7)**	**116(37)**	**3(1)**	**1,988**	**295**	**87.1**

			Untagged:Tagged
IGH	=	Iron Gate Hatchery	25.36:1
TRH	=	Trinity River Hatchery	
		Spring Run	3.34:1
		Fall Run	3.11:1

Appendix 17. Origin and portion of subyearling Chinook salmon emigrating through the upper Klamath River estuary based on expansions of CWT's recovered during standard sampling, March-September 2001. Numbers in parenthesis are actual numbers of captured salmon containing CWT's.

WEEK OF	TOTAL CHINOOK	IGH	TRH fall	TRH spring	NUMBER NATURAL	NUMBER HATCHERY	PERCENT NATURAL
3/11	0	0	0	0	0	0	0
3/18	1	0	0	0	1	0	100.0
Total	**1**	**0**	**0**	**0**	**1**	**0**	**100.0**
4/08	0	0	0	0	0	0	0
4/15	7	0	0	0	7	0	100.0
4/22	4	0	0	0	4	0	100.0
4/29	0	0	0	0	0	0	0
Total	**11**	**0**	**0**	**0**	**11**	**0**	**100.0**
5/06	1	0	0	0	1	0	100.0
5/20	3	0	0	0	3	0	100.0
5/27	102	0	0	0	102	0	100.0
Total	**106**	**0**	**0**	**0**	**106**	**0**	**100.0**
6/03	20	0	0	0	20	0	100.0
6/10	266	51(2)	0	0	215	51	82.0
6/17	327	0	31(10)	20(6)	276	51	84.7
6/24	449	51(2)	28(9)	3(1)	367	82	82.4
Total	**1,062**	**102(4)**	**59(19)**	**23(7)**	**878**	**184**	**82.7**
7/01	159	0	0	0	159	0	100.0
7/08	398	0	9(3)	0	389	9	97.7
7/15	328	0	3(1)	0	325	3	99.1
7/22	108	25(1)	0	0	83	25	76.9
7/29	345	0	3(1)	0	342	3	99.1
Total	**1,338**	**25(1)**	**15(5)**	**0**	**1,298**	**40**	**97.0**
8/05	130	0	0	0	130	0	100.0
8/12	165	0	0	0	165	0	100.0
8/19	10	0	0	0	10	0	100.0
8/26	54	0	0	0	54	0	100.0
Total	**359**	**0**	**0**	**0**	**359**	**0**	**100.0**
TOTAL	**2,877**	**127(5)**	**74(24)**	**23(7)**	**2,653**	**224**	**92.2**
JUNE-SEPT TOTAL	**2,759**	**127(5)**	**74(24)**	**23(7)**	**2,535**	**224**	**91.9**
LOWER ESTUARY TOTAL	**2,283**	**177(7)**	**116(37)**	**3(1)**	**1,988**	**295**	**87.1**
ANNUAL TOTAL	**5,042**	**304(12)**	**190(61)**	**26(8)**	**4,523**	**519**	**89.7**

		Untagged:Tagged
IGH	= Iron Gate Hatchery	25.36:1
TRH	= Trinity River Hatchery	
	Spring Run	3.34:1
	Fall Run	3.11:1

Appendix 18. Origin and portion of subyearling Chinook salmon emigrating through the lower Klamath River estuary based on expansions of CWT's recovered during standard sampling, May-September 2000. Numbers in parenthesis are actual numbers of captured salmon containing CWT's.

WEEK OF	TOTAL CHINOOK	IGH	TRH fall	TRH spring	NUMBER NATURAL	NUMBER HATCHERY	PERCENT NATURAL
5/07	4	0	0	0	4	0	100.0
5/14	48	0	0	0	48	0	100.0
5/21	8	0	0	0	8	0	100.0
Total	**60**	**0**	**0**	**0**	**60**	**0**	**100.0**
5/28	12	0	0	0	12	0	100.0
6/04	15	0	0	0	15	0	100.0
6/11	29	0	0	0	29	0	100.0
6/18	112	0	0	27(5)	85	27	75.9
6/25	408	397(15)	0	5(1)	6	402	1.5
Total	**576**	**397(15)**	**0**	**32(6)**	**147**	**429**	**25.5**
7/02	373	185(7)	10(1)	0	178	195	47.7
7/09	195	79(3)	0	0	116	79	59.5
7/16	559	159(6)	30(3)	0	370	189	66.2
7/23	132	26(1)	10(1)	5(1)	91	41	68.9
Total	**1259**	**449(17)**	**50(5)**	**5(1)**	**755**	**504**	**60.0**
7/30	129	0	0	22(4)	107	22	82.9
8/06	180	53(2)	10(1)	0	117	63	65.0
8/13	50	0	10(1)	0	40	10	80.0
8/20	265	0	39(4)	0	226	39	85.2
8/27	116	26(1)	0	0	90	26	77.6
Total	**740**	**79(3)**	**59(6)**	**22(4)**	**580**	**160**	**78.4**
9/03	105	26(1)	0	0	79	26	75.2
9/10	79	0	0	0	79	0	100.0
9/17	40	26(1)	0	0	14	26	35.0
9/24	65	53(2)	0	0	12	53	18.5
Total	**289**	**105(4)**	**0**	**0**	**184**	**105**	**63.7**
TOTAL	**2924**	**1030(39)**	**109(11)**	**59(11)**	**1726**	**1198**	**59.0**
JUNE-SEPT TOTAL	**2864**	**1030(39)**	**109(11)**	**59(11)**	**1666**	**1198**	**58.2**

			Untagged:Tagged
IGH	=	Iron Gate Hatchery	26.49:1
TRH	=	Trinity River Hatchery	
		Spring Run	5.39:1
		Fall Run	9.85:1

Appendix 19. Origin and portion of subyearling Chinook salmon emigrating through the upper Klamath River estuary based on expansions of CWT recovered during standard sampling, May-October 2000. Numbers in parenthesis are actual numbers of captured salmon containing CWT's.

WEEK OF	TOTAL CHINOOK	IGH	TRH fall	TRH spring	NUMBER NATURAL	NUMBER HATCHERY	PERCENT NATURAL
5/14	3	0	0	0	3	0	100.0
5/21	6	0	0	0	6	0	100.0
Total	**9**	**0**	**0**	**0**	**9**	**0**	**100.0**
5/28	21	0	0	0	21	0	100.0
6/04	48	0	0	0	48	0	100.0
6/11	44	0	0	5(1)	39	5	88.6
6/18	57	0	0	27(5)	30	27	52.6
6/25	22	0	0	0	22	0	100.0
Total	**192**	**0**	**0**	**32(6)**	**160**	**32**	**83.3**
7/02	390	212(8)	49(5)	16(3)	113	277	30.0
7/09*	173	149(7)	24(3)	0	0	173	0
7/16	219	106(4)	10(1)	0	103	116	47.0
7/23	162	53(2)	39(4)	0	70	92	43.2
Total	**944**	**520(21)**	**122(13)**	**16(3)**	**286**	**658**	**30.3**
7/30	73	0	0	0	73	0	100.0
8/06	70	53(2)	0	0	17	53	24.3
8/13	100	26(1)	0	0	74	26	74.0
8/20	218	26(1)	0	5(1)	187	31	85.8
8/27	192	26(1)	0	0	166	26	86.5
Total	**653**	**131(5)**	**0**	**5(1)**	**517**	**136**	**79.2**
9/03	312	53(2)	20(2)	0	239	73	76.6
9/10	212	53(2)	39(4)	0	120	92	56.6
9/17	119	0	0	0	119	0	100.0
9/24	128	0	10(1)	0	118	10	92.1
Total	**771**	**106(4)**	**69(7)**	**0**	**596**	**175**	**77.3**
TOTAL	**2569**	**757(30)**	**191(20)**	**53(10)**	**1568**	**1001**	**61.0**
JUN-SEPT TOTAL	**2560**	**757(30)**	**191(20)**	**53(10)**	**1559**	**1001**	**60.9**
LOWER ESTUARY TOTAL	**2864**	**1030(39)**	**109(11)**	**59(11)**	**1666**	**1198**	**58.2**
GRAND TOTAL	**5424**	**1787(69)**	**300(31)**	**112(21)**	**3225**	**2199**	**59.5**

		Untagged:Tagged
IGH	= Iron Gate Hatchery	26.49:1
TRH	= Trinity River Hatchery	
	Spring Run	5.39:1
	Fall Run	9.85:1

* Coded-wire expansions exceeded total Chinook catch.

Appendix 20. Origin and portion of subyearling Chinook salmon emigrating through the lower Klamath River estuary based on expansions of CWT=s recovered during standard sampling, June-September 1999. Numbers in parenthesis are actual numbers of captured salmon containing CWT=s.

WEEK OF	TOTAL CHINOOK	IGH	TRH fall	TRH spring	NUMBER NATURAL	NUMBER HATCHERY	PERCENT NATURAL
5/30	0	0	0	0	0	0	0
6/06	0	0	0	0	0	0	0
6/13	0	0	0	0	0	0	0
6/20	0	0	0	0	0	0	0
6/27	15	0	0	0	0	0	0
Total	**15**	**0**	**0**	**0**	**15**	**0**	**0**
7/04	11	0	0	0	11	0	100.0
7/11	47	0	0	17(3)	30	17	63.8
7/18*	33	28(2)	5(1)	0	0	33	0
7/25	117	25(1)	10(1)	5(1)	77	40	67.5
Total	**208**	**53(3)**	**15(2)**	**22(4)**	**118**	**90**	**56.7**
8/01	5	0	0	0	5	0	100.0
8/08	16	0	0	0	16	0	100.0
8/15	41	0	20(2)	0	21	20	51.2
8/22	37	0	10(1)	0	27	10	73.0
Total	**99**	**0**	**30(3)**	**0**	**69**	**30**	**69.7**
8/29*	19	19(1)	0	0	0	19	0
9/05*	22	22(1)	0	0	0	22	0
9/12	10	0	0	0	10	0	100.0
9/19	14	0	0	0	14	0	100.0
9/26	2	0	0	0	2	0	100.0
Total	**67**	**41(2)**	**0**	**0**	**26**	**41**	**38.8**
TOTAL	**389**	**94(5)**	**45(5)**	**22(4)**	**228**	**161**	**58.6**

			Untagged:Tagged
IGH	=	Iron Gate Hatchery	25.38:1
TRH	=	Trinity River Hatchery	
		Spring Run	5.49:1
		Fall Run	10.07:1

* Coded-wire expansions exceeded total Chinook catch.

Appendix 21. Origin and portion of subyearling Chinook salmon emigrating through the upper Klamath River estuary based on expansions of CWT recovered during standard sampling, June-September 1999. Numbers in parenthesis are actual numbers of captured salmon containing CWT=s.

WEEK OF	TOTAL CHINOOK	IGH	TRH fall	TRH spring	NUMBER NATURAL	NUMBER HATCHERY	PERCENT NATURAL
6/27	98	0	0	22(4)	76	22	77.6
7/04	247	0	0	33(6)	214	33	86.6
7/11	334	152(6)	10(1)	5(1)	167	167	50.0
7/18	314	102(4)	0	0	212	102	67.5
7/25	340	0	0	0	340	0	100.0
Total	**1235**	**254(10)**	**10(1)**	**38(7)**	**933**	**302**	**75.5**
8/01	594	127(5)	10(1)	5(1)	452	142	76.1
8/08	379	25(1)	10(1)	0	344	35	90.8
8/15	472	0	91(9)	0	381	91	80.7
8/22	299	25(1)	0	0	274	25	91.6
Total	**1744**	**177(7)**	**111(11)**	**5(1)**	**1451**	**293**	**83.2**
8/29	250	25(1)	40(4)	0	185	65	74.0
9/05	317	51(2)	20(2)	0	246	71	77.6
9/12	306	51(2)	20(2)	5(1)	230	76	75.2
9/19	386	25(1)	0	0	361	25	93.5
9/26	207	0	0	0	207	0	100.0
Total	**1466**	**152(6)**	**80(8)**	**5(1)**	**1229**	**237**	**83.8**
10/3	229	0	40(4)	0	189	40	82.5
TOTAL	**4772**	**583(23)**	**241(24)**	**70(13)**	**3878**	**894**	**81.3**
LOWER ESTUARY TOTAL	**389**	**94(5)**	**45(5)**	**22(4)**	**228**	**161**	**58.6**
GRAND TOTAL	**5161**	**677(28)**	**286(29)**	**92(13)**	**4106**	**1055**	**79.6**

			Untagged:Tagged
IGH	=	Iron Gate Hatchery	25.38:1
TRH	=	Trinity River Hatchery	
		Spring Run	5.49:1
		Fall Run	10.07:1

Appendix 22. Origin and portion of subyearling Chinook salmon emigrating through the lower Klamath River estuary based on expansions of CWT=s recovered during standard sampling, June-September 1998. Numbers in parenthesis are actual numbers of captured salmon containing CWT=s.

WEEK OF	TOTAL CHINOOK	IGH	TRH fall	TRH spring	NUMBER NATURAL	NUMBER HATCHERY	PERCENT NATURAL
6/21*	51	51(3)	0	0	0	51	0
6/28	59	25(1)	0	0	34	25	57.6
Total	**110**	**76(4)**	**0**	**0**	**34**	**76**	**30.9**
7/05	39	0	0	5(1)	34	5	87.2
7/12	636	458(18)	0	88(17)	90	546	14.2
7/19	79	25(1)	10(1)	5(1)	39	40	49.4
7/26	78	0	10(1)	0	68	10	87.2
Total	**832**	**483(19)**	**20(2)**	**98(19)**	**231**	**601**	**27.8**
8/02*	28	11(1)	17(4)	0	0	28	0
8/09	200	0	101(10)	0	99	101	49.5
8/16	27	0	20(2)	0	7	20	25.9
8/23	77	0	40(4)	5(1)	32	45	41.6
Total	**332**	**11(1)**	**178(20)**	**5(1)**	**138**	**194**	**41.6**
8/30*	28	18(1)	7(1)	3(1)	0	28	0
9/06	52	0	10(1)	0	42	10	80.8
9/13	52	0	20(2)	0	32	20	61.5
9/20	22	0	10(1)	0	12	10	54.5
Total	**154**	**18(1)**	**47(5)**	**3(1)**	**86**	**68**	**55.8**
TOTAL	**1428**	**588(25)**	**245(27)**	**106(21)**	**489**	**939**	**34.2**

		Untagged:Tagged
IGH	= Iron Gate Hatchery	25.42:1
TRH	= Trinity River Hatchery	
	Spring Run	5.18:1
	Fall Run	10.06:1

* Coded-wire expansions exceeded total Chinook catch

Appendix 23. Origin and portion of subyearling Chinook salmon emigrating through the upper Klamath River estuary based on expansions of CWT recovered during standard sampling, June-September 1998. Numbers in parenthesis are actual numbers of captured salmon containing CWT's.

WEEK OF	TOTAL CHINOOK	IGH	TRH fall	TRH spring	NUMBER NATURAL	NUMBER HATCHERY	PERCENT NATURAL
7/05	103	51(2)	0	0	52	51	50.5
7/12	82	51(2)	0	16(3)	15	67	18.3
7/19	155	25(1)	20(2)	0	110	45	71.0
7/26	160	0	20(2)	5(1)	135	25	84.4
Total	**500**	**127(5)**	**40(4)**	**21(4)**	**312**	**188**	**62.4**
8/02	218	25(1)	30(3)	0	163	55	74.5
8/09	367	25(1)	70(7)	5(1)	267	100	72.8
8/16	356	0	111(11)	0	245	111	68.8
8/23	271	0	101(10)	0	170	101	62.7
Total	**1212**	**50(2)**	**312(31)**	**5(1)**	**845**	**367**	**69.7**
8/30	355	51(2)	91(9)	5(1)	208	147	58.6
9/06	95	0	20(2)	0	75	20	78.9
9/13	112	0	10(1)	0	102	10	91.1
9/20	128	0	30(3)	0	98	30	76.6
Total	**690**	**51(2)**	**151(15)**	**5(1)**	**483**	**207**	**70.0**
TOTAL	**2402**	**228(9)**	**503(50)**	**31(6)**	**1640**	**762**	**68.3**
LOWER ESTUARY TOTAL	**1428**	**588(25)**	**245(27)**	**106(21)**	**489**	**939**	**34.2**
GRAND TOTAL	**3830**	**816(34)**	**748(77)**	**137(27)**	**2129**	**1701**	**55.6**

		Untagged:Tagged
IGH	= Iron Gate Hatchery	25.42:1
TRH	= Trinity River Hatchery	
	Spring Run	5.18:1
	Fall Run	10.06:1

Appendix 24. Origin and portion of yearling Chinook salmon emigrating through the lower Klamath River estuary based on expansions of CWT recovered during standard sampling, March-September 2001. Numbers in parenthesis are actual numbers of captured salmon containing CWT's.

WEEK OF	TOTAL CHINOOK	IGH	TRH fall	TRH spring	NUMBER NATURAL	NUMBER HATCHERY	PERCENT NATURAL
3/04	4	0	0	0	4	0	100.0
3/11	3	0	0	0	3	0	100.0
3/18	1	0	0	0	1	0	100.0
3/25*	4	4(1)	0	0	0	4	0
Total	**12**	**4(1)**	**0**	**0**	**8**	**4**	**66.7**
4/01	0	0	0	0	0	0	0
4/08	0	0	0	0	0	0	0
4/15	0	0	0	0	0	0	0
4/22	1	0	0	0	1	0	100.0
4/29	0	0	0	0	0	0	0
Total	**1**	**0**	**0**	**0**	**1**	**0**	**100.0**
5/06	39	24(3)	0	0	15	24	38.5
5/13	0	0	0	0	0	0	0
5/20	16	0	0	0	16	0	100.0
5/27	7	0	0	0	7	0	100.0
Total	**62**	**24(3)**	**0**	**0**	**38**	**24**	**61.3**
6/03	0	0	0	0	0	0	0
6/10	0	0	0	0	0	0	0
6/17	0	0	0	0	0	0	0
6/24	0	0	0	0	0	0	0
Total	**0**	**0**	**0**	**0**	**0**	**0**	**0**
7/01	0	0	0	0	0	0	0
7/08	0	0	0	0	0	0	0
7/15	0	0	0	0	0	0	0
7/22	0	0	0	0	0	0	0
7/29	0	0	0	0	0	0	0
Total	**0**	**0**	**0**	**0**	**0**	**0**	**0**
8/05	0	0	0	0	0	0	0
8/12	0	0	0	0	0	0	0
8/19	0	0	0	0	0	0	0
8/26	0	0	0	0	0	0	0
Total	**0**	**0**	**0**	**0**	**0**	**0**	**0**
9/02	0	0	0	0	0	0	0
9/09	0	0	0	0	0	0	0
9/16	0	0	0	0	0	0	0
9/23	0	0	0	0	0	0	0
Total	**0**	**0**	**0**	**0**	**0**	**0**	**0**
TOTAL	**75**	**28(4)**	**0**	**0**	**47**	**28**	**62.7**

		Untagged:Tagged
IGH	= Iron Gate Hatchery	8.05:1
TRH	= Trinity River Hatchery Fall Run	3.03:1

* Coded-wire expansions exceeded total Chinook catch

Appendix 25. Origin and portion of yearling Chinook salmon emigrating through the upper Klamath River estuary based on expansions of CWT's recovered during standard sampling, March-September 2001. Numbers in parenthesis are actual numbers of captured salmon containing CWT's.

WEEK OF	TOTAL CHINOOK	IGH	TRH fall	TRH spring	NUMBER NATURAL	NUMBER HATCHERY	PERCENT NATURAL
3/11	81	64(8)	3(1)	0	14	67	17.3
3/18	77	8(1)	6(2)	0	63	14	81.8
Total	**158**	**72(9)**	**9(3)**	**0**	**77**	**81**	**48.7**
4/08	79	40(5)	3(1)	0	36	43	45.6
4/15	94	72(9)	0	0	22	72	23.4
4/22	30	24(3)	0	0	6	24	20.0
4/29	128	32(4)	0	0	96	32	75.0
Total	**331**	**168(21)**	**3(1)**	**0**	**160**	**171**	**48.3**
5/06	37	32(4)	3(1)	0	2	35	5.4
5/20	2	0	0	0	2	0	100.0
5/27	0	0	0	0	0	0	0
Total	**39**	**32(4)**	**3(1)**	**0**	**4**	**35**	**10.3**
6/03	0	0	0	0	0	0	0
6/10	0	0	0	0	0	0	0
6/17	0	0	0	0	0	0	0
6/24	0	0	0	0	0	0	0
Total	**0**	**0**	**0**	**0**	**0**	**0**	**0**
7/01	0	0	0	0	0	0	0
7/08	0	0	0	0	0	0	0
7/15	0	0	0	0	0	0	0
7/22	0	0	0	0	0	0	0
7/29	0	0	0	0	0	0	0
Total	**0**	**0**	**0**	**0**	**0**	**0**	**0**
8/05	0	0	0	0	0	0	0
8/12	0	0	0	0	0	0	0
8/19	0	0	0	0	0	0	0
8/26	0	0	0	0	0	0	0
Total	**0**	**0**	**0**	**0**	**0**	**0**	**0**
TOTAL	**528**	**272(34)**	**15(5)**	**0**	**241**	**287**	**45.6**
LOWER ESTUARY TOTAL	**75**	**28(4)**	**0**	**0**	**47**	**28**	**62.7**
GRAND TOTAL	**603**	**300(38)**	**15(5)**	**0**	**288**	**315**	**47.8**

		Untagged:Tagged
IGH	= Iron Gate Hatchery	8.05:1
TRH	= Trinity River Hatchery Fall Run	3.03:1