# SECTION 4: DISCUSSION

This study was designed to enhance and contribute to the limited information available on juvenile salmonid early marine residency in shoreline areas of central Puget Sound. The results of this study provide information on the general timing, distribution, species composition, and diet of juvenile salmon in the study area. These results have a variety of implications for salmon recovery planning and resource management actions that extend beyond salmon originating in local watersheds. For example, the mixing of multiple salmon stocks in the study area highlights the common and broad use of nearshore marine waters by salmonids originating from both local and distant watersheds. The apparent use of a complex of different habitats is illustrated by their spatial and temporal distribution, which suggests that preserving, or attempting to restore single or limited habitat attributes may be inadequate for supporting salmon in the nearshore and recovering listed species. In addition, the types of habitat responsible for prey production, the life history requirements of prey, and the seasonal and spatial patterns of prey abundance and distribution are important considerations in salmon conservation. Furthermore, considerations required to maintain or restore the larger scale ecosystem processes that form and maintain habitat for all species that are dependent upon the ecological integrity of the nearshore landscape, including adjacent riparian and upland landscapes, must also be addressed.

Distinguishing marked and unmarked salmonids in this study provided a much better understanding of relative abundance and distributions of hatchery and wild fish. In particular, the collection of CWT juvenile salmonids is valuable for enhancing the understanding of distribution, growth, rate of travel, catch composition, and origin, and is useful for understanding dynamics of multiple salmon stocks in Puget Sound.

Past attempts to fully characterizing "nearshore" use by juvenile salmonids have been difficult due to the limited sampling of segments of the nearshore (i.e., shallow, littoral/neritic waters) and sampling bias associated with each type of sampling gear (e.g., beach seine; surface tow net). All statements regarding timing and distribution, or use of the nearshore by salmonids need to be qualified to indicate the portion of the nearshore sampled, geographic area, time period, and biases associated with each sampling method. The nearshore is generally defined as that area between the lower limit of the photic zone (approximately –20 m MLLW) and the adjacent uplands (Williams et al. 2001; PSNERP 2003). Most floating beach seines used in Puget Sound only sample the upper 2 m of the water column, within approximately 30 m (offshore) of the beach. Therefore, fish that reside outside of the reach of this type of gear are not represented in the catch.

## *4.1. GENERAL PATTERNS OF TIMING, DISTRIBUTION, AND SIZE*

Some general patterns, irrespective of species and region sampled, emerged from the data. First, each different species of salmonid occurred in the nearshore during the same approximate time period in both years, but there were differences between peak abundance and persistence of individual species. Cutthroat trout, being a year-round resident of shallow nearshore areas (Johnston 1982), were found throughout the year. Pink and chum were present at the same time at the beginning of sampling in 2002, but pink salmon disappeared shortly thereafter. There was limited overlap in the peak timing of chum with coho and Chinook abundance. The peak of coho fell in between the peak catches of chum and Chinook. The north mainland sites appeared to have a higher degree of overlap than other regions, with the peak catch of coho overlapping with both chum and Chinook in 2002. In 2001, the peak catch of coho at north mainland sites occurred in between the primary and secondary peaks of Chinook abundance. As expected, very few juvenile steelhead, char, sockeye, and Atlantic salmon were caught in either year, and

pinks were only caught in 2002. Most Chinook, chum, and pink were subyearlings, while most coho and sockeye were yearlings. Cutthroat and steelhead were made up of multiple size classes.

The time/size-related patterns of persistence are illustrated in this study's catch records for all salmonids captured. Pink salmon are believed to move offshore at approximately 60-80 mm in the May-June time period (Emmett et al. 1991), which would explain why they were not prevalent in the catch. In general, Chinook tend to move offshore when they reach a size of approximately 130-150 mm, but reside for extended periods in shallow nearshore waters. Orsi and Jaenicke (1996) found Chinook larger than 130 mm when fishing in waters deeper than 30 m. Dawley et al. (1981) found mostly subyearling Chinook under 135 mm in water of 4 m depth. The findings of this study, while limited to shallow depths, appear to be in agreement with these previous findings.

### 4.1.1. Interannual Comparison

Far more chum and coho were caught (CPUE) in 2002 than 2001. This may be attributed to sampling bias or an increase in production of chum and coho smolts in 2002. Sampling occurred earlier in the year at the north mainland sites, which may account for more chum being caught in 2002. However, this does not explain the higher numbers of coho, since coho appear to migrate through the north mainland nearshore later than the other two regions. The north mainland was the only region where the peak abundance of coho was captured in both 2001 and 2002. This would indicate that the higher abundance seen in 2002 was not a sampling bias but was indicative of more coho present in the system. This is in agreement with Duffy (2003) who noted that higher spawning escapements and hatchery releases occurred in 2002 versus 2001.

Another notable difference between the two years was the difference in mean lengths of Chinook, coho, and chum. The lengths of these salmonids were significantly greater in 2001. Duffy (2003) also observed this pattern for Chinook and chum, but found the opposite for coho, with coho being larger in 2002. Possible reasons for differences between the two years include variability in environmental factors, negative competitive interaction between pink salmon (present during even years) and other salmonids, and/or size at release from hatcheries.

There was some seasonality to the percentages of hatchery Chinook caught in both years. Hatchery Chinook dominated the catch of Chinook in May, June, and July, while "wild" Chinook were more prevalent in the catches of August, September, and October. While the percentage of "wild" Chinook did increase over the summer, the actual numbers and CPUE of "wild" Chinook were decreasing during the same time period indicating a net movement out of the sampling area.

### 4.1.2. Regional Patterns

Several regional patterns were seen in the catch data. Cutthroat trout CPUE was significantly higher in both years at the northern sites than at the southern or island sites. This is likely due to a "hot spot" in that area for cutthroat trout. Even in 2002, when effort was lower at north mainland sites, and the "hot spot" was sampled only early in the season, enough fish were captured during those 5 days to influence the catch data for the 2002 north mainland region as a whole.

Though not statistically significant, more unclipped coho were caught at north mainland sites during both years than at the southern or island sites. This could be an artifact of different clipping rates and/or timing of different stocks. The greatest abundance of coho was recorded at north region sites. In the southern and island regions, the peak abundance may have been completely missed, or recorded while on the decline. This regional difference indicates either a strong variability in freshwater outmigration timing between stocks, or disparities in timing of peak usage of shallow nearshore areas between the different

regions. The timing of coho captured at the north mainland sites appears to be verified by the timing of PIT tagged "wild" coho out of the WRIA 8 system (DeVries 2002 and 2003). The WRIA 8 system is somewhat unusual because it is lake-dominated, which may delay migration timing, and explain the later peak abundance seen in the north mainland region. It is also possible that this observation is an artifact of different clipping rates between coho released from WRIAs 7, 8, 9, and 10. WRIA 10 clipped 80% and 96% of coho released in 2001 and 2002, respectively (rmis.org). Whereas, the other 3 WRIAs clipped approximately 40% and 55% of coho released in 2001 and 2002, respectively.

In 2001, more "wild" coho were caught at the northern index sites than at the southern or island index sites, yet more clipped coho were caught at the southern index sites. A similar north to south pattern was noted in 2002. As noted above, this observation is likely related to differences in clipping rates amongst the nearest hatcheries, with WRIA 10 reporting the highest clipping rate.

Interestingly, there was no significant difference in CPUE of juvenile Chinook between the island sites and the north and south mainland sites. This result is somewhat surprising considering that there are no Chinook-bearing streams on Vashon and Maury Islands. Given that juvenile Chinook are believed to be primarily shoreline oriented (Williams et al. 2001), this observation suggests that their distribution patterns, and the factors that influence their distribution, are more complex than previously thought. CPUE of hatchery and "wild" Chinook was highest in the south mainland region in 2001 as a result of the large catches of Chinook at Lincoln Beach.

Chum were caught in higher numbers in the northern region. This was likely due to the close proximity of the north mainland sites to the Snohomish River system. The Snohomish River system is known to have a large chum population relative to the other river systems within the study boundary (wdfw.wa.gov/fish/chum).

Pinks were caught almost entirely at the north mainland sites. As with chum, it is assumed that these pink salmon came from the Snohomish River system since WRIA 8 does not have a population of pinks (Kerwin 2001; Haring 2002). However, given that the Green River does have a population of pink salmon, it seems likely that they would have been caught in the southern region of study had they been present in the nearshore areas at the time of sampling. It is believed that sampling did not occur early enough in the year to catch the peak abundance of pinks at the southern and island sites.

### 4.1.3. Hatchery Influences

Several general patterns were seen when hatchery and "wild" data were compared. First, hatchery coho and Chinook were significantly larger in size than their "wild" counterparts for both years. This finding is in agreement with Duffy's (2003) observations. Next, the timing of hatchery and "wild" Chinook and coho appeared to vary more between years than within years. For example, smaller peaks in "wild" Chinook frequently accompanied large peaks in CPUE of hatchery Chinook. This pattern, although less uniform, is also present in coho. This pattern in timing can be interpreted in several ways: (1) Hatchery release timing mimics "wild" outmigration timing and there are simply fewer "wild" Chinook and coho; (2) The low clipping rate of hatchery fish results in misidentification of hatchery fish that are classified as "wild"; (3) The pied piper affect or "sweeping" is occurring (Flagg et al. 2000); and (4) The large influx of hatchery fish into the river mouth/estuary crops down the available food resulting in all fish searching for food in the nearshore system.

Finally, when examining the timing of hatchery and "wild" fish within each region and year separately, combined with the CWT data, peaks of CPUE in each region can clearly be connected with specific hatchery release dates. This effect of hatchery releases on peak timing has been documented in other studies (Dawley et al. 1981; Duffy 2003). Therefore, it is likely that the peaks for "wild" fish observed throughout this study have been influenced to some degree by hatchery releases.

## 4.2. ENVIRONMENTAL INFLUENCES

Relationships were observed between CPUE of chum and coho and substrate type. The CPUE of coho was significantly higher for gravel substrates than all other substrate categories. However, it is likely that the larger number of coho caught at north mainland sites early in 2002 may bias this result since this sampling generally occurred at sites with larger substrates. Chum salmon were caught in higher numbers at sites with sand substrate. This result does not fit with what Haggarty (1997) found in Burrard Inlet, B.C., with chum caught in significantly higher numbers over gravel/cobble substrates. Given these differences and potential biases associated with the sampling methods and data collection, it could be that the results are simply a reflection of site specificity. A relationship was also observed between coho CPUE and the presence of SAV. However, sampling was not always conducted "through" the SAV, when present, due to the inability of the seine to reach vegetation at depths greater than 2 meters. This limitation becomes especially significant at higher tides. Additional sampling and more refined analyses are needed to determine fish-substrate relationships. For juvenile salmonids, it is likely that the linkages are more related to prey production, support of SAV, and other functions.

Many of the distribution patterns observed from the CWT samples suggest that oceanographic (e.g., currents) and/or atmospheric (e.g., winds) forces may play a role in juvenile salmon distribution in Puget Sound. To what extent, however, remains unclear. Bax (1981) found a positive correlation between surface flows and outmigration rate of juvenile chum salmon in Hood Canal. He also reported recaptures of marked chum salmon on the opposite shore of Hood Canal within a day of release, indicating rapid movement across open water. Moser et al. (1991) found that juvenile coho migratory progress was influenced by surface currents. Furthermore, qualitative field observations of catch in areas such as points and embayments suggest that physical forces (e.g., winds, eddies) may play a role in juvenile salmon distribution and abundance (Stober and Chew, 1984). Additional research is needed to establish linkages between movement/migration patterns of salmon with Puget Sound and the oceanography of the region.

## 4.3. DISTRIBUTION PATTERNS OF CWT CHINOOK AND COHO

Based on the CWT data, it is apparent that after juvenile Chinook leave their natal estuaries, they appear to disperse broadly and mix with other Puget Sound stocks to a great degree. Although the dispersal was somewhat variable within and between stocks, some patterns did emerge.

As expected, south Sound CWT Chinook were recaptured north of their origin. However, they were not caught at sample sites in WRIA 8 (northern region). The fact that they were not recaptured as frequently at the WRIA 8 sampling sites may indicate that they moved offshore, were no longer susceptible to the sampling gear, or may move through Puget Sound via an alternate route. Alternate migration patterns may be volitional, or may be influenced by oceanographic forces.

In a similar pattern, but in the opposite and less expected direction, Chinook from north Sound stocks (north of WRIA 7) moved south (and southeast) and were recaptured almost entirely at WRIA 8 sample sites. Again, these fish were not captured in the nearshore waters of WRIA 9, possibly indicating that they had moved offshore out of reach of the gear or may move through Puget Sound via an alternate route.

Also notable, was the pattern of movement across the open waters of Puget Sound. Many Chinook and CWT fish were recaptured on Vashon and Maury Islands. Yet, there are no Chinook producing streams or hatchery releases of Chinook on the islands. The recaptures of Grovers Creek, Port Gamble, and Dungeness hatchery fish on the east side of Puget Sound frequently occurred after only a very short period of time-at-large.

Somewhat unexpectedly, Soos Creek Chinook were recaptured mostly to the south of their point of entry into Puget Sound in both years, though sampling effort to the north was not equal in 2002. This observation was surprising in that it demonstrated movement, for some individuals at least, deeper into Puget Sound instead of towards the entrance to the Pacific Ocean. The Wallace River Chinook were caught in almost equal numbers in WRIAs 8 and 9, but were caught almost entirely in WRIA 9 after August in both years. Unfortunately, few Chinook were coded wire tagged in WRIA 8 during the two years of the study, which limited the ability to identify any trends in their distribution.

The lower number of CWT coho samples provides a more limited picture of coho distribution in the study area. It is likely that earlier sampling, or use of a different sampling method would have resulted in the collection of more coho. Since most coho typically enter Puget Sound earlier than this study's sampling period, and they enter at a larger size, it is likely that they were not as susceptible as Chinook to the sampling gear. It is generally believed that coho are not as shoreline oriented (i.e., shallow water) as Chinook (Meyer et al. 1981) and that larger juvenile salmon tend to move farther offshore. Therefore, this study provides only a partial representation of coho distribution. However, there were representatives of north Sound and south Sound stocks recaptured in the study area, indicating northern, southern and cross-Sound distribution (e.g., Vashon/Maury Island samples) consistent with CWT Chinook movements. Earlier seasonal sampling and "offshore" sampling would greatly benefit the understanding of coho timing and distribution.

Clearly, some juvenile Chinook salmon do not simply leave their natal streams and make unidirectional migrations out of Puget Sound. Chinook have the most complex life-history patterns for emigration, with 36 distinct life history pathways (Wissmar and Simenstad 1998). The number of trajectories, or emigration patterns displayed by Chinook in the study area is unknown and, while heavily "masked" by dominant numbers of hatchery fish, are primarily composed of "ocean type" Chinook, which are more dependent upon estuarine and shoreline areas for rearing. The data collected as part of this study showed complex movement patterns, with many northern stocks of Chinook moving south or from the west to the east side of the Sound. Essentially, many stocks were moving deeper into Puget Sound, rather than moving directly out of the Sound. Other studies have found similar results, but did not necessarily have enough data to see general patterns. For example, Salo et al. (1967) recaptured pigment-marked fish originating from the Green River and the Snohomish River systems in South Puget Sound (Case Inlet, Carr Inlet, Point Defiance and Pickering Passage). The pattern of recoveries in Puget Sound seems to indicate migration by fingerling Chinook southward in the Sound from Everett Bay and Elliott Bay (Salo et al. 1967). Pearce et al. (1982) recaptured CWT Soos Creek hatchery fish in the Nisqually estuary. Similarly, Meyer et al. (1981) recaptured a number of marked fish from outside of the Hylebos waterway. More recently, several other studies have collected similar data on CWT Chinook providing more evidence that Chinook stocks mix in the nearshore. Duffy (2003) recaptured CWT fish in the south Sound from the Skagit River system and Hood Canal. Fresh et al. (in prep), conducting beach seine and surface tow net surveys in Sinclair Inlet, caught many CWT Chinook from outside their study area.

## *4.4. CWT GROWTH*

Growth rates (determined from changes in FL), calculated from the subsample of 2001 and 2002 CWT recaptures, ranged from 0.52 – 0.59 mm/d, which is similar to rates reported for Coos Bay fall Chinook by Fisher and Pearcy (1989). Fisher and Pearcy (1989) also provide a review of similar findings in other geographic areas (e.g., Dawley et al. 1986; Levings et al. 1986), but also note that these estimates are lower than those reported by Healey (1980a) and Argue et al. (1986). Although one would expect to find some variability in growth of juvenile Chinook from different geographic areas and of different genetic stocks, other variability could be due to differences in size classes sampled, time-at-large, density, or food supply. The greatest confounding factor in this study is the large number of Soos Creek hatchery fish that

exhibited negative growth. The cumulative growth rate would have been higher if these samples were eliminated from the calculations. It is possible that food supply limitations, or other environmental factors, could have resulted in a small amount of negative growth, but the most likely explanation is poor measurements or estimates of length and weight by the hatchery personnel at the time of release.

## 4.5. CWT TIME-AT-LARGE

Fish from specific hatcheries were recaptured after varying periods of time. For example, Grovers Creek hatchery Chinook were all caught within 30 days (many as early as 4 days). Similarly, most Soos Creek hatchery fish were caught within 2-4 weeks. The relatively large number of Soos Creek recaptures after a short period of time-at-large may be explained by the proximity of the natal river (Green River) to the sampling sites. However, approximately 30% of the Wallace River hatchery Chinook were recaptured 60 days after release. It is not clear if this is reflective of longer freshwater residency, or persistence in marine nearshore waters. Miller and Sadro (2003) determined that juvenile coho exhibited variable residence times in the lower estuary of Winchester Creek, Oregon, depending upon the time of year (spring vs. fall) they moved down river and into the estuary. The majority (75%) of fall/winter migrants resided from 12-40 days with the remainder residing 50-84 days, whereas 75% of the spring migrants resided 2-10 days with the remainder residing 26-28 days. Therefore, it is important to know migration rates within each segment of the migration route and to have a good understanding of residence times for fish with different trajectories within a particular system.

Similar problems arise when attempting to interpret distances and rates of travel for mark/recaptured fish. Estimates provide a minimum rate of travel for juvenile Chinook that ranged from approximately 3-4 km/day. Although these estimates of rate of travel fall within the ranges reported by some investigators (e.g., Bax 1983 and Orsi et al. 2000), they are significantly lower than those reported by others. For example, Dawley et al. (1981) and Pearcy and Fisher (1987) reported highly variable migration rates for juvenile coho that ranged from 14-23 km/day. These rates are for various stocks and systems (Pacific Ocean and Columbia River) and are not measured in an estuary similar to Puget Sound, making it difficult to compare results. Undoubtedly, the rates are somewhat variable between freshwater, estuarine, and marine systems, and vary by species, stock, and size of fish.

## 4.6. DIET

The diet analyses provide a comprehensive view of what juvenile Chinook are eating when utilizing shallow nearshore areas of the central Puget Sound shoreline. It is important to note, however, that juvenile salmonids are highly migratory, use a diverse array of habitats that change over time, and that digestion rates are variable due to temperature and digestibility of the prey. Therefore, it is difficult to identify exact sources of prey without conducting studies focused on identifying feeding location and prey productivity of particular habitat types. In addition, the variability in digestion rates may cause particular prey items to appear more important due to the slow digestion rates of particular insect body parts (Hyslop 1980). Size, weight, caloric value, and seasonal availability of individual taxa are also important considerations when evaluating fish diets (Duffy 2003). Although this study was not designed to address all of these important considerations, it does provide new information on juvenile salmonid diets, including the relative importance of specific prey taxa, seasonality and diversity of prey, and relationships between fish size, prey type, and ecological linkages (categories) to sources of prey.

### 4.6.1. Chinook

Most studies of juvenile Chinook salmon feeding habits have been conducted during their early out-migration through and residence in estuaries near river mouths. This is reflected in the results of these studies, which have shown diets dominated by typical tidal fresh water and euryhaline invertebrates (Healey 1991). A few studies of feeding in higher salinity habitats have found that juvenile Chinook diets contained a different prey spectrum that included more terrestrial insects and marine invertebrate plankton such as euphausiids, crab larvae, and pelagic amphipods (Fresh et al. 1981; Healey 1980b, 1982; Duffy 2003). This study expands on these earlier findings by analyzing stomach contents of fishes collected outside of river estuaries, at marine beaches of Puget Sound across multiple sites and times.

The overall results presented here point to three general habitat types—terrestrial/riparian, shallow benthic/epibenthic, and pelagic—as the most important prey production/foraging areas for juvenile Chinook salmon in shallow marine nearshore areas of Puget Sound. Prey taxa characteristic of emergent marshes (e.g., chironimid pupae and emergent adults) or marine supralittoral habitats (e.g., talitrid "beach-hopper" amphipods) were not important in the Chinook diets from this study. The lack of marsh-dwelling insects is not surprising considering that juvenile Chinook salmon in this study were caught along marine beaches. The reasons for low numbers of marine supralittoral organisms in the diets is unknown, but could include relatively short exposure time of the fish to the upper beach habitat, (i.e., only at high tides), behavior of potential invertebrate prey to avoid predation (e.g., talitrid amphipods staying above the high tide line), or habitat loss or degradation due to alteration of shorelines (Sobocinski 2003).

Insects characteristic of terrestrial vegetated habitats such as psocoptera, homoptera, and hymenoptera dominated the numerical composition of juvenile Chinook diets, especially those in the size range from 110-149 mm. These insects could have entered Puget Sound via either wash out from rivers or from terrestrial vegetation. However, the fact that most of the insects in the diets were fully developed winged adult forms, and that the sampling sites in the study were not located in close proximity to major rivers suggests that they were likely wind-blown or fell from overhanging vegetation rather than entering Puget Sound via river flow. Brodeur (1989) reached a similar conclusion for terrestrial insects that were important in juvenile Chinook and coho salmon 4-47 km off the Oregon and Washington coasts. In his study, an assemblage of terrestrial insects similar to those found in this study were numerically prominent in coho and Chinook salmon diets in July and September. In a study of juvenile salmon feeding in Hood Canal, Washington at a central, deep station and a shallow nearshore station, Bollens et al. (in preparation) found larger percentages of insects and spiders in fish captured at the nearshore station. Field observations of insects along the shoreline suggests that many of these insects are produced in areas close to the water.

Along with earlier, largely unpublished work, the results of this study point to vegetated shoreline habitats as an important source of juvenile Chinook salmon prey. Because much of the Puget Sound shoreline has been altered by armoring and backshore development, there may be a decreased input of terrestrial-derived salmon prey to Puget Sound. A recent study of insect fallout from vegetation on Puget Sound shorelines found that beaches altered by armoring and development resulted in consistently lower taxa richness than at more natural, non-armored, and adjacent beaches (Sobocinski 2003). Also, in that study, several prominent taxa of shore-dwelling insects and amphipod populations were significantly less dense at the human-altered sites than at the natural beaches. The magnitude of loss of terrestrial input of prey resources for juvenile Puget Sound salmon derived from shore vegetation is unknown, and some of this input could come from farther inland. Large mobile insects such as tent caterpillar moths (this study) and spruce budworms (Locke and Corey 1986; Brodeur 1989) that could have been produced inland, even occur in salmon diets many kilometers off shore. Long-distance overland dispersion of insects has been demonstrated by Caceres and Soluk (2002), but Russel and Wilson (2001), using doppler radar imaging of insect masses, concluded that their data supported the hypothesis that insects respond behaviorally near coastlines to avoid being blown out to sea. A number of studies of marine neuston and oceanic insect

trapping have established that many terrestrial insects are blown out to sea (up to 800 km away from land), and probably provide a considerable amount of organic matter to the surface water (Bowden and Johnson 1976; Cheng and Birch 1978; Yoshimoto and Gressitt 1960). Field observations made in conjunction with this study noted the presence (and seasonal abundance) of tent caterpillars and other insects associated with shoreline vegetation, which corresponded to when they were found in Chinook diets. Seasonal abundance and diversity of insect neuston has been observed in a number of studies (e.g., Lock and Corey 1986), which reflects their seasonal patterns of emergence and availability. Regardless of whether or not most of the insect prey in Puget Sound is produced along the shoreline, or further back from shore, salmonid prey production appears to be an important function of marine riparian areas and vegetated backshore. Therefore, preserving, enhancing, or restoring shoreline vegetation may play a role in salmon survival and recovery strategies.

A link between juvenile Chinook salmon diets and shallow vegetated habitats is evident through their concentrated feeding on the polychaete *Platynereis bicanaliculata* early in the season. For the smallest Chinook salmon studied (<90 mm), this species usually dominated diet contents weight. *Platynereis bicanaliculata* is an herbivorous polychaete that builds tubes on eelgrass and macroalgae and is common in Puget Sound in marine subtidal mixed-coarse, mixed fine, and cobble substrates and in estuarine subtidal sand and mixed fines, substrates (Dethier 1990). It enters the water column in synchronized reproductive swarms (Woodin 1977; Fong 1993; Minoru et al. 2003). Juvenile Chinook were feeding mainly on *Platynereis epitokes* (reproductive forms occurring in the water column). Although the life history stage of polychaetes in the diets was not explicitly recorded, it was noted that when intact, the Platynereis in the stomachs usually had characteristic body differentiation characteristic of the epitoke stage (see Appendix 1). Because invertebrates from the substrate or water column were not sampled, it is not possible to determine whether or not the dominance of *Platynereis* in Chinook diets earlier in the year was due to higher prey densities during those times, or to selectivity by the fish. Likewise, it is not known why the *Platynereis* diet dominance was approximately one month later in 2002 samples as compared to 2001. Ecological studies of *P. bicanaliculata* in an eelgrass bed in central Japan showed that epitokes occurred from late February to mid-November, with peak epitokal swarming activity in the warm season, and differences in peak abundance among years (Fukao 1996). Therefore, its seems likely that juvenile Chinook salmon in this study were taking advantage of *Platynereis* when it was swarming in the water column. Verification of this would require that plankton sampling be conducted along with the collection of diet samples.

Another planktonic organism found in the diet of Chinook and coho salmon was crab larvae (zoea and megalops phases). Crab larvae are most abundant in Puget Sound in the late spring-summer time period. During the earlier phases, zoea tend to be epibenthic, but may be found throughout the water column, whereas the megalops move inshore just prior to settling out in shallow nearshore areas (Don Velasquez, WDFW personal communication). The timing of this behavior corresponds with the seasonal abundance of crab larvae in fish diets. Other benthic/epibenthic taxa that occurred in the juvenile Chinook diets may have also been obtained during swimming stages of their life history. For example, several of the common prey gammarid amphipods that are commonly associated with algal habitats (e.g., *Calliopiidae*, *Allorchestes* spp, *Anisogammaridae*) were regularly observed in the plankton or swimming near shore (Bousfield and Hendrycks 1997; Hendrycks and Bousfield 2001).

Another common benthic prey item in the samples of juvenile Chinook diets was appendages and naupliar masses from barnacles. While barnacle exuviae are common in the diet, intact appendages and nauplii have not been previously reported as common prey items. Apparently, the salmon were feeding on naupliar masses as they were being released by the barnacles, before they had broken apart. In some cases the naupliar masses were still encased in membranes. In other cases, they appeared to be attached to exuviae. Most of the benthic/epibenthic prey that the juvenile Chinook consumed are associated with eelgrass, kelps, and other macroalgae. Whether these prey originated in kelps and algae that require hard

substrate, or in eelgrass that requires finer substrates, is not known. Substrate types and their relationship to prey production and other functions (i.e., primary and secondary productivity) deserve further study regarding their value as juvenile Chinook salmon habitat.

Because juvenile Chinook salmon are oriented to shallow water when they are small (Healey 1991), their predation on zooplankton from Puget Sound beaches may have represented opportunistic feeding, rather than an indication that the salmon were spending most of their time in that habitat. For example, switching feeding from aquatic insects to terrestrial insects and zooplankton (e.g., Daphnia) by sub-yearling Chinook salmon entering reservoirs in the Columbia River was attributed to opportunistic feeding on the high density of those prey in the reservoirs (Rondorf et al. 1990). Before the Chinook in this study began feeding on fish later in the year, they fed mainly on plankton taxa that are known to swarm or become entrained in fronts on the water surface.

From a graphical analysis of the juvenile Chinook diets in the three geographical regions of central Puget Sound (North, South, Vashon/Maury Islands), few differences were observed between the regions. Also, regional differences were dissimilar between 2001 and 2002. One exception was that the fish from the northern group of sites consumed fewer polychaete worms and more terrestrial insects than at the other two site groups. Duffy (2003) had similar findings with higher amounts of insects in the diet of Chinook found north of sites in this study compared with sites found south of this study's area. Because prey assemblages were not sampled, it is not known if these differences were due to differences in prey availability among the site groups. One way to partially answer this question would be to conduct a multivariate analysis of the diet data along with habitat data from beaches where fish were captured (e.g., beach slope, submerged/intertidal vegetation, supralittoral/backshore vegetation). This type of analysis could further elucidate site-related differences and provide explanations for them. In addition, sampling of the water column, quantifying caloric content of prey, and an integration of prey life history characteristics would greatly advance the understanding of Chinook diet, preferences, and habitat requirements.

Preliminary analysis of 2002 hatchery and wild Chinook salmon diets suggests that there was little difference in feeding between these two groups. There was one exception, for fish sampled in May, when hatchery Chinook had more euphausiids and barnacle exuviae in their diets and wild fish fed on more gammarid amphipods. This may be because the earlier out-migrants had not acclimated to natural feeding conditions (Myers 1980), but the results should be interpreted with care because the sample size for wild fish was small (n=6). For the remaining monthly comparisons, differences in diet between hatchery and wild fish were subtle, and consisted mostly of qualitative differences in ecological prey groupings (e.g., terrestrial insects made up of fewer psocoptera and more hymenoptera in hatchery Chinook captured in September). For the most part, the data from this study suggest that juvenile hatchery and wild Chinook utilize the same prey resources when they occupy nearshore habitats in Puget Sound. Given the temporal and spatial overlap of marine shoreline use by hatchery and wild Chinook, and the similarity in diets, it is likely that hatchery and wild fish compete for the same resources.

### 4.6.2. Coho

Findings that juvenile coho fed mainly on zooplankton before switching to fish at larger sizes is consistent with findings from previous studies in Puget Sound and elsewhere (Sandercock 1991, Fresh et al. 1981). In juvenile coho salmon captured at both north and south Puget Sound sites, Fresh et al. (1981) found that juvenile coho salmon fed mainly on crab larvae, euphausiids, and pelagic amphipods. Coho feeding on planktonic/nektonic invertebrate taxa appears to persist even after they switch to consuming mostly fish in the ocean off of Oregon and Washington (Brodeur and Pearcy 1990, Brodeur et al. 1992). Coho in this study fed on few terrestrial/riparian insects, but at least one other study found that insects were important prey for coho during early residence in Cook Inlet, Alaska (Moulton 1997).

However, in that study intensive feeding on surface insects was attributed to the high turbidity of the water.

Salmon ecology and the effects of habitat degradation on juvenile salmon in estuaries and nearshore marine habitats in Puget Sound and other waters in the Pacific Northwest are relatively well studied. In contrast, the ecology of juvenile salmon such as coho that feed in water column habitats of Puget Sound are poorly known. Brodeur et al. (1992) suggested that juvenile coho and Chinook salmon off of Oregon and Washington experienced planktonic food limitation during years of unusually low productivity (e.g., El Niño). Unfortunately the differences and similarities between Puget Sound and other coastal environments are poorly known, because quantitative studies of the zooplankton assemblage in the Puget Sound region are rare and quite limited in scope, consisting of several unpublished student theses (Dempster 1938; Hebard 1956; Damkaer 1964; Dumbauld 1985) and a few other studies (Bollens et al., in prep.; Giles and Cordell 1998). Understanding the ecology of planktivorous salmonids such as Puget Sound coho salmon will require considerable additional work on plankton biology, productivity, oceanography, and other environmental conditions that affect planktonic prey.

### 4.6.3. Cutthroat

Predation on other juvenile salmonids (especially pink and chum salmon) and their eggs has been recorded often for coastal cutthroat trout (Jauquet 2002). While fish dominated cutthroat diets in this study, juvenile salmon (chum) were found in only one fish (from Meadowdale beach in May, 2002), and most of the fish that were identifiable in the diets were Pacific herring. In 2001, most cutthroat samples were taken during times that did not coincide with juvenile chum salmon outmigration, which may explain the discrepancy between this study and Jauquet (2002). For cutthroat trout caught when adult or juvenile salmon were not present, Jauquet (2002) found that diets were more similar to those found in this study, having much higher proportions (by weight) of invertebrates and marine fish. Results for smaller size classes of cutthroat trout were also similar to those of Jauquet (2002), who found that cutthroat <300 mm had fewer fish and more invertebrates in their diets.

# SECTION 5: RECOMMENDATIONS

It is the opinion of the authors that, based on the results of this study, it is apparent that there are a number of management actions that should be taken to improve habitat conditions for juvenile salmonids, which would lead to increased survival and productivity. The advancements in our understanding of salmon ecology and use of marine nearshore areas in Central Puget Sound as a result of this study also helps to elucidate key questions to be answered, or hypotheses to be tested. This, in turn, could provide additional critical information for salmon recovery actions and shoreline management.

The following recommendations are divided into two nonprioritized lists: (1) Management actions; and, (2) Future studies/Additional analyses. Although recommendations are made for specific actions, there are a number of general actions that are needed to protect and restore marine nearshore ecosystems for the benefit of salmon and other living resources. Protection actions include regulatory, enforcement, acquisition, incentive programs, public education, and other actions that stop, or reduce further harm. Similarly, restoration actions, which include replacement, enhancement, mitigation, and other actions taken to replace, or improve ecological functions and processes, are not well developed and are generally lacking in most nearshore areas. Therefore, for each of these recommendations, there are a number of general actions that should be used to achieve management goals of protection and restoration.

## *5.1. MANAGEMENT ACTIONS*

**Protect and Restore Marine Riparian Vegetation**

Riparian areas provide multiple functions that may be important to salmonids, including prey production, water quality/pollution abatement, and habitat structure. Terrestrial insects are an important component of juvenile salmonid diets, especially for Chinook. This strongly suggests that riparian and/or upland vegetation may play an important role in the feeding ecology of juvenile Chinook salmon in Puget Sound.

**Protect and Restore Shallow Water Habitat**

Alteration and degradation of shallow marine nearshore areas has involved extensive armoring, filling, construction of overwater structures, and other modifications of natural hydrological and geological processes along the shores of Puget Sound. These shallow areas serve as important corridors for migration, refuge, prey production, and feeding by juvenile salmonids. Due to the extensive modification and degradation of river mouth estuaries, marine shoreline areas may have become increasingly important for young salmon as they make the transition from freshwater to a life at sea.

**Protect and Restore the Marine Nearshore Habitat Complex**

Juvenile and adult salmon use a diverse array of habitat types that serve different functions in space and time. Therefore, it is the complex of habitats, composed of varying substrate types, vegetation types, tidal stages, and other physical, chemical, and biological factors that support salmon in the nearshore. Ecologically, there are linkages between salmon and both terrestrial and aquatic environments, which suggests that a more holistic approach must be taken to protect and restore salmon and their habitats. Protecting and restoring the natural processes that form and maintain habitats is the key to success. The natural processes that form and maintain habitat in the nearshore serve as the foundation of the structure and functions that support salmon. Disruption of sediment and prey inputs, changes in hydrology and other processes results in a chain reaction, ultimately leading to lost or dysfunctional habitat for salmon. Impediments to natural processes need to be prevented or removed to allow for conditions conducive to salmon production.

**Require 100% Marking and Accurate Measurements of All Hatchery Fish**

The ability to distinguish hatchery and wild fish, determine relative proportions, or monitor individual stocks, depends upon accurate marking and measuring of hatchery releases. Research results are less accurate and fisheries management is much less precise or valuable given the inconsistent marking rates of hatchery fish throughout Puget Sound.

**Update the Washington Administrative Code's saltwater work closure periods to reflect the timing of ESA listed Chinook salmon.**

The saltwater closure period (construction work window) in the Washington Administrative Code (WAC) is currently out of date. The juvenile salmonid closure period corresponds with the timing of chum and pink salmon, and not ESA listed Chinook. While WDFW area habitat biologists have the ability to modify the work closure timing for any one project to reflect best available science, it would be prudent to correct the WAC with more accurate salmonid timing data.

**Support Collaborative/Cooperative Research and Management Efforts.**

Although this study has advanced our knowledge regarding juvenile salmonids in the central Puget Sound basin, numerous data gaps remain, many of which require large scale analyses. The fragmented manner in which some management actions, research, and planning occur has resulted in disconnected and often inadequate results for the level of information and actions necessary for larger-scale issues. It is abundantly clear that Chinook recovery is not the issue of a single watershed and that the common thread between all Puget Sound watersheds is found in the marine environment.

## *5.2. FUTURE STUDIES/ADDITIONAL ANALYSES*

Numerous data gaps in our understanding of salmon in the nearshore remain. While this research enhances our understanding of juvenile salmonids in central Puget Sound, additional studies are needed for scientifically-based management decisions about protection, restoration, and enhancement of nearshore habitats and salmon. Larger scale (both temporal and spatial) sampling is needed to understand onshore, offshore, and cross-Sound distribution patters. Multiple sampling methods will be required to capture patterns in horizontal, vertical, tidal, and temporal (day and night) distributions, as well as various habitat types. In addition, more information is needed about the physical forces (e.g. winds and currents) and shoreline geomorphology that may play a role in the timing, distribution, and abundance of salmon in the nearshore. Marking fish is critically important for tracking specific stocks and determining population dynamics. More information about marine nearshore carrying capacity, competitive interactions, and prey ecology is also necessary if the risk of extinction of salmonids within the Puget Sound ESU is to be eliminated. In light of these needs, the following recommendations for future study and additional analyses are made.

**Evaluate hatchery practices to reduce potential competitive interactions with wild fish.**

The carrying capacity of Puget Sound may or may not be able to support the number of smolts being produced by Puget Sound hatcheries along with wild production. The wild juvenile Chinook that enter the Puget Sound are vastly outnumbered by hatchery Chinook and other hatchery salmonids. Considering the similar timing, distribution, and feeding patterns, it is likely that negative competitive interactions might occur, especially in areas where food is limited.

**Conduct a combined prey availability/prey selectivity study for juvenile Chinook salmon in the shallow nearshore areas.**

While this study was able to quantify Chinook diets, no attempt was made to quantify prey availability and little is known about prey habitats. It is possible that Chinook are opportunistic feeders, eating whatever is the most abundant/available.

**Conduct a study to determine the source and the ecology of terrestrial insects and other prey found in the Chinook diets.**

The source of insects is likely from MRV, but production levels, role of proximity, and importance of vegetation composition/structure are all unknown at present. Large wood and beach wrack deposits on beaches may also play an important role in prey production. Currently little is known about the ecology of terrestrial prey items or marine prey organisms.

**Identify and quantify the factors that influence distribution patterns of juvenile salmon and their prey.**

Little is known about what drives juvenile salmon to be shoreline oriented, and/or distributed broadly across/throughout Puget Sound. Some indicators suggest physical forces (e.g., surface or tidal currents, wind) play a role, but these are poorly studied. Biological factors (e.g., volitional/innate migration, prey abundance/availability, predator avoidance) may also play a role, or it may be a combination of multiple factors. Additionally, offshore and day/night sampling are also needed to learn more about diel behaviors and use of various depths by different size classes of salmon.

**Conduct a study of subyearling Chinook smolts movement in the Duwamish estuary.**

As noted previously, it appears that Chinook migration appears to be both active and passive. A detailed migration study would allow a look at how long juvenile Chinook spend in different parts of the Duwamish estuary and open shorelines. It could also help elucidate how, when and where juvenile Chinook migrate across the open waters of Puget Sound in order to get to Vashon and Maury Islands, or move offshore at larger sizes. This would increase the understanding of what processes drive Chinook migration.

**Conduct studies on marine forage fishes to learn more about their biology and population dynamics.**

Although limited surveys of spawning areas have been conducted, little is known about the biology, population dynamics, and stock status of surf smelt and sand lance. These species are critical components of marine nearshore ecosystems and serve as important prey for salmonids (at all life stages) and other marine organisms.

**Undertake a multivariate analysis of the diet data along with environmental data to further elucidate site-related diet differences.**

Few consistent differences were seen in Chinook prey between the site groups. One exception was that the fish from a northern group of sites consumed fewer polychaete worms and more terrestrial insects than at the other two site groups. The reasons for this are unknown, but a multivariate analysis of the diet data along with a better understanding of the distribution of prey taxa could further elucidate these and other site-related differences.

**Run additional analyses on diet data.**

While data qualitatively suggests that the diets of hatchery and wild Chinook overlap, it would be more powerful to quantify the amount of overlap of specific prey groups.

**Explore the relationship between adipose fin clipping of juvenile salmonids and survival.**

Almost 60% of the CWT Chinook examined in this study were not adipose fin clipped, even though the percentage of nonclipped CWT Chinook released throughout Puget Sound is approximately 40% (RMIS database). (Note: This pattern may be influenced by bad clipping rates, which reinforces the management recommendation to make a greater effort to clip all hatchery Chinook and coho).

**Conduct long-term and larger scale ecological monitoring of juvenile salmon throughout Puget Sound.**

The types of studies being conducted in the Skagit system (Beamer *et al.* 2004) serve as an example of what is needed throughout Puget Sound. Using multiple gear types in various habitats and environmental conditions is critical for understanding the relationships between habitat use, marine growth, year class strength, and marine carrying capacity (Orsi et al. 2000).

**Conduct directed study of juvenile coho salmon.**

The ecology of planktivorous salmon such as coho in Puget Sound is poorly known. Plankton biology, productivity, oceanography, and other environmental conditions need to be better studied and integrated in order to understand these fish.

**Develop standard methods for recording and monitoring environmental data**

Environmental variables (e.g., substrate, vegetation, water chemistry/quality beach slope) likely play important roles in salmon distribution and survival. However, there are currently no standard protocols and procedures for collecting and analyzing these data relative to describing fish-habitat relationships in the nearshore.

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# APPENDIX 1

## *INSECTA AND SPIDERS FROM TERRESTRIAL HABITATS*

Hymenoptera, Formicidae (ants)

Coleoptera, Staphylinidae (rove beetle)

Diptera, Empididae (dance flies)

Diptera, Sciaridae (fungus gnat)

Diptera, Chironomidae (midges)

Arachnida, Araneae (spider)

### *INSECTA AND SPIDERS FROM TERRESTRIAL HABITATS, CONTINUED*

Homoptera, Cicadellidae (leafhopper)

Homoptera, Aphididae (aphids)

Psocoptera (bark lice)

Lepidoptera, *Malacosoma* sp. (tent caterpillar moth)

## *AMPHIPODA GAMMARIDEA FROM BENTHIC/EPIBENTHIC HABITATS*

*Allorchestes* sp.

*Anisogammarus pugettensis*

Calliopiidae

*Corophium* sp. *Corophium sp*.

*Gammaropsis* sp.

*Photis brevipes*

## *OTHER TAXA FROM BENTHIC/EPIBENTHIC HABITATS*

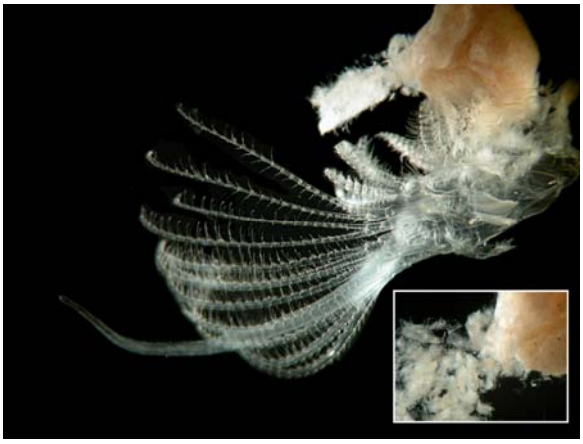
*Cumella vulgaris* (cumacean)

*Gnorimoshpaeroma insulare* (isopod)

*Idotea* sp. (juvenile isopod)

*Euphilomedes carcharodonta* (ostracods)

*Platynereis bicanaliculata* (polychaete worm)



Barnacle exuvia with attached naupliar mass (inset shows close-up of naupiar mass)

## *PELAGIC/PLANKTONIC PREY TAXA*

*Cancer* sp. megalopae (crab larvae)

*Cancer* sp. zoae (crab larvae)

Pinnotheridae zoea (crab larva)

*Fabia subquadrata* (commensal crab, swimming form)

*Hyperia* sp. (hyperiid amphipod)

*Ammodytes hexpaterus* (juvenile sand lance)

# APPENDIX 2

**Table A2-1. Summary of all fish caught by site in 2001 (Only reflects species catch; does not reflect effort (i.e. CPUE)**

| | | Burton | Carkeek Park | Golden Gardens | KVI | Lincoln Park | Marine View | Meadowdale | Maury I. Park | Ocean Avenue | Picnic Point | Richmond Beach | Seahurst | Tramp Harbor | Totals Per Species |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Salmon | Chum | 33 | 68 | 141 | 336 | 449 | 124 | 57 | 292 | 204 | 66 | 676 | 110 | 0 | 2556 |
| | Sockeye | 0 | 1 | 67 | 0 | 2 | 1 | 2 | 0 | 0 | 0 | 39 | 1 | 0 | 113 |
| | Cutthroat | 1 | 3 | 2 | 2 | 5 | 10 | 120 | 1 | 1 | 45 | 2 | 19 | 0 | 211 |
| | Steelhead | 0 | 0 | 0 | 1 | 2 | 0 | 1 | 0 | 0 | 1 | 1 | 1 | 0 | 7 |
| | Chinook | 41 | 55 | 29 | 80 | 368 | 115 | 63 | 97 | 32 | 19 | 57 | 109 | 1 | 1066 |
| | Coho | 0 | 12 | 12 | 6 | 10 | 78 | 16 | 12 | 4 | 30 | 23 | 31 | 0 | 234 |
| | Atlantic Salmon | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| | Total Salmonids | 75 | 139 | 252 | 425 | 836 | 328 | 259 | 402 | 241 | 161 | 798 | 271 | 1 | 4188 |
| Perch | Shiner perch | 9421 | 670 | 449 | 5124 | 573 | 2445 | 2749 | 1424 | 5239 | 2672 | 1439 | 1454 | 0 | 33659 |
| | Striped perch | 0 | 1 | 67 | 0 | 125 | 0 | 17 | 0 | 58 | 28 | 29 | 0 | 0 | 325 |
| | Pile perch | 7 | 0 | 0 | 2 | 8 | 6 | 3 | 5 | 10 | 17 | 4 | 6 | 0 | 68 |
| Flatfish | English sole | 0 | 65 | 93 | 93 | 0 | 253 | 192 | 30 | 479 | 244 | 94 | 26 | 0 | 1569 |
| | Rock sole | 1 | 34 | 5 | 16 | 13 | 3 | 262 | 30 | 32 | 164 | 19 | 53 | 0 | 632 |
| | Starry flounder | 17 | 35 | 33 | 109 | 1 | 35 | 25 | 20 | 9 | 22 | 2 | 26 | 0 | 334 |
| | Speckled sanddab | 31 | 5 | 31 | 13 | 0 | 0 | 1 | 2 | 2 | 2 | 1 | 0 | 0 | 88 |
| | C-O sole | 0 | 1 | 3 | 1 | 2 | 10 | 9 | 0 | 11 | 0 | 2 | 0 | 0 | 39 |
| | Sand sole | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 6 | 0 | 0 | 0 | 7 |
| | Flathead sole | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 |
| | Pacific sanddab | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| | Sanddab spp. | 0 | 1 | 0 | 1 | 0 | 1 | 5 | 0 | 5 | 0 | 1 | 0 | 0 | 14 |
| | Unid. Sanddab | 2 | 10 | 8 | 2 | 0 | 4 | 42 | 0 | 4 | 33 | 0 | 0 | 0 | 105 |
| | Unid. Flatfish | 0 | 0 | 0 | 18 | 0 | 2 | 44 | 0 | 0 | 0 | 55 | 0 | 0 | 119 |
| Sculpin | Staghorn sculpin | 118 | 68 | 56 | 788 | 17 | 71 | 54 | 39 | 156 | 50 | 49 | 34 | 0 | 1500 |
| | Great sculpin | 0 | 2 | 16 | 2 | 12 | 3 | 37 | 1 | 11 | 10 | 5 | 0 | 0 | 99 |
| | Northern sculpin | 0 | 2 | 14 | 4 | 0 | 5 | 3 | 10 | 1 | 2 | 1 | 0 | 0 | 42 |
| | Buffalo sculpin | 0 | 1 | 3 | 0 | 0 | 0 | 18 | 2 | 0 | 9 | 0 | 0 | 0 | 33 |
| | Silverspotted sculpin | 0 | 0 | 7 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 9 |
| | Cabezon | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 4 | 0 | 0 | 0 | 0 | 6 |
| | Tidepool sculpin | 0 | 1 | 1 | 2 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 5 |
| | Sailfin Sculpin | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| | Red Irish Lord | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 2 |
| | Unid. Sculpin | 0 | 0 | 1 | 0 | 4 | 0 | 1 | 1 | 0 | 8 | 0 | 2 | 0 | 17 |
| Forage Fish | Sand lance | 0 | 6 | 0 | 102 | 4 | 315 | 22 | 290 | 9 | 0 | 0 | 765 | 0 | 1513 |
| | Surf smelt | 20 | 20 | 0 | 7 | 0 | 0 | 6 | 12 | 28 | 0 | 2 | 165 | 0 | 260 |
| | Herring | 7 | 6 | 0 | 8 | 1 | 1 | 8 | 371 | 10 | 0 | 7 | 5 | 0 | 424 |
| Gunnels | Penpoint gunnel | 0 | 2 | 26 | 0 | 38 | 7 | 0 | 0 | 46 | 5 | 10 | 1 | 0 | 135 |
| | Crescent gunnel | 1 | 1 | 28 | 0 | 27 | 3 | 1 | 0 | 36 | 2 | 0 | 0 | 0 | 99 |
| | Saddleback gunnel | 0 | 0 | 1 | 2 | 13 | 2 | 0 | 5 | 3 | 0 | 1 | 0 | 0 | 27 |
| | Gunnels spp. | 0 | 1 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 6 | 0 | 0 | 9 |
| Tubefish | Tubesnout | 0 | 2 | 14 | 78 | 271 | 2 | 4 | 37 | 15 | 3 | 53 | 29 | 0 | 508 |
| | Threespine stickleback | 45 | 1 | 56 | 1 | 1 | 3 | 1 | 0 | 2 | 2 | 3 | 2 | 0 | 117 |
| | Bay pipefish | 5 | 0 | 1 | 0 | 5 | 9 | 0 | 1 | 0 | 0 | 1 | 2 | 0 | 24 |
| Others | Skate spp. | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 1 | 2 | 1 | 0 | 0 | 6 |
| | Big Skate | 0 | 0 | 2 | 0 | 0 | 1 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 5 |
| | Rockfish spp | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| | unid. snailfish | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| | Sturgeon Poacher | 0 | 0 | 0 | 1 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 |
| | Bay Goby | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| | Kelp Greenling | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| | Whitespotted Greenling | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 4 |
| | Unid. Greenling | 0 | 0 | 4 | 0 | 2 | 1 | 1 | 0 | 2 | 1 | 0 | 2 | 0 | 13 |
| | Pacific Cod | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 3 |
| | Pacific Tomcod | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 3 | 0 | 1 | 0 | 0 | 5 |
| | Pacific Midshipman | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 2 |
| | Ratfish | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| | Snake prickleback | 8 | 0 | 2 | 0 | 5 | 12 | 14 | 0 | 76 | 1 | 0 | 0 | 0 | 118 |
| | Walleye Pollock | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 |

**Table A2-2. Summary of all fish caught by site in 2002 (Only reflects species catch; does not reflect effort (i.e. CPUE) (continued on next page)**

| | | Burton | Carkeek Park | CMP | DNR83 | Deer Creek | Edmonds | EEG1 | EEG2 | Golden Gardens | KLP1 | KLP2 | KVI | Lincoln Park | MD1 | MD2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Salmon | Chum | 15 | 13 | 5 | 398 | 92 | 210 | 2347 | 19 | 175 | 6688 | 398 | 152 | 538 | 15 | 15 |
| | Sockeye | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Cutthroat | 2 | 6 | 14 | 2 | 0 | 0 | 0 | 2 | 8 | 5 | 1 | 1 | 9 | 4 | 1 |
| | Steelhead | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| | Chinook | 2 | 48 | 15 | 153 | 1 | 1 | 1 | 4 | 86 | 340 | 4 | 98 | 245 | 1 | 0 |
| | Coho | 1 | 23 | 2 | 0 | 22 | 0 | 0 | 167 | 30 | 228 | 2 | 2 | 61 | 0 | 1 |
| | Char | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Pink Salmon | 0 | 0 | 0 | 0 | 1 | 65 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Total Salmonids | 20 | 91 | 36 | 553 | 116 | 276 | 2348 | 192 | 300 | 7262 | 405 | 253 | 853 | 20 | 17 |
| Perch | Shiner perch | 848 | 1466 | 476 | 208 | 509 | 2 | 818 | 1726 | 1801 | 20 | 119 | 1600 | 1677 | 608 | 1448 |
| | Striped perch | 0 | 15 | 0 | 0 | 0 | 0 | 0 | 0 | 58 | 38 | 0 | 7 | 27 | 0 | 0 |
| | Pile perch | 8 | 28 | 0 | 0 | 2 | 0 | 0 | 0 | 12 | 0 | 1 | 1 | 17 | 0 | 0 |
| Flatfish | Butter Sole | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| | English sole | 0 | 259 | 37 | 0 | 1 | 19 | 0 | 1 | 125 | 0 | 0 | 69 | 0 | 0 | 0 |
| | Rock sole | 0 | 30 | 6 | 0 | 1 | 0 | 0 | 1 | 8 | 0 | 0 | 14 | 16 | 0 | 0 |
| | Starry flounder | 3 | 37 | 14 | 4 | 1 | 6 | 4 | 6 | 9 | 1 | 0 | 420 | 3 | 2 | 92 |
| | Speckled sanddab | 3 | 18 | 0 | 0 | 0 | 0 | 0 | 9 | 2 | 0 | 0 | 3 | 0 | 6 | 20 |
| | C-O sole | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Sand sole | 0 | 20 | 0 | 0 | 0 | 0 | 0 | 0 | 12 | 0 | 0 | 1 | 0 | 0 | 0 |
| | Pacific sanddab | 4 | 6 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Sanddab spp. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Unid. Flatfish | 0 | 2 | 0 | 16 | 0 | 0 | 8 | 2 | 4 | 36 | 0 | 0 | 0 | 5 | 2 |
| Sculpin | Staghorn sculpin | 10 | 193 | 14 | 291 | 0 | 0 | 1 | 31 | 41 | 1 | 0 | 391 | 17 | 316 | 35 |
| | Great sculpin | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 7 | 0 | 1 | 10 | 3 | 0 | 0 |
| | Northern sculpin | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 | 0 | 0 | 1 | 0 | 0 | 0 |
| | Buffalo sculpin | 0 | 1 | 1 | 0 | 0 | 1 | 1 | 3 | 10 | 6 | 0 | 29 | 2 | 0 | 0 |
| | Silverspotted sculpin | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Cabezon | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Tidepool sculpin | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 15 | 5 | 0 | 0 | 0 | 2 | 0 | 0 |
| | Padded Sculpin | 0 | 15 | 1 | 0 | 0 | 0 | 0 | 0 | 7 | 0 | 0 | 73 | 4 | 0 | 0 |
| | Sailfin Sculpin | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| | Unid. Sculpin | 0 | 20 | 2 | 0 | 0 | 1 | 8 | 11 | 6 | 3 | 0 | 25 | 7 | 0 | 0 |
| Forage Fish | Sand lance | 0 | 0 | 0 | 1 | 0 | 81 | 0 | 0 | 3 | 27 | 0 | 23 | 571 | 4 | 19 |
| | Surf smelt | 5 | 13 | 2 | 0 | 0 | 0 | 0 | 0 | 5 | 2 | 0 | 0 | 66 | 1 | 0 |
| | Herring | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 8 | 297 | 0 | 1 | 4 | 0 | 0 |
| Gunnels | Penpoint gunnel | 0 | 7 | 5 | 0 | 1 | 0 | 0 | 2 | 16 | 2 | 0 | 6 | 3 | 0 | 1 |
| | Crescent gunnel | 0 | 5 | 0 | 0 | 0 | 1 | 0 | 4 | 14 | 1 | 5 | 14 | 3 | 0 | 0 |
| | Saddleback gunnel | 0 | 3 | 8 | 0 | 2 | 0 | 0 | 2 | 1 | 2 | 7 | 29 | 33 | 0 | 0 |
| Tubefish | Tubesnout | 0 | 66 | 65 | 0 | 0 | 0 | 192 | 4 | 12 | 0 | 2 | 7 | 9 | 0 | 0 |
| | Threespine stickleback | 1 | 2 | 0 | 1 | 0 | 0 | 1 | 1 | 4 | 4 | 0 | 0 | 0 | 1 | 38 |
| | Bay pipefish | 0 | 0 | 2 | 1 | 0 | 0 | 8 | 25 | 1 | 0 | 0 | 2 | 3 | 0 | 1 |
| Other | Big Skate | 0 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| | Brown Rockfish | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 |
| | Rockfish spp | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| | Sturgeon Poacher | 0 | 0 | 3 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 17 | 0 | 0 | 0 |
| | Whitespotted Greenling | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 1 | 0 | 2 | 0 | 0 |
| | Unid. Greenling | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 1 | 0 | 0 | 0 |
| | Pacific Tomcod | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 2 | 0 | 0 |
| | Pacific Midshipman | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 16 | 0 | 0 | 0 | 0 | 0 | 0 | 7 |
| | Arrow Goby | 34 | 0 | 0 | 0 | 0 | 0 | 0 | 11 | 0 | 0 | 0 | 0 | 0 | 40 | 12 |
| | Ratfish | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 |
| | Northern Spearnose | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Spiney Lumpsucker | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Snake prickleback | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 7 | 1 | 0 | 0 | 3 | 0 | 0 | 0 |

Continued horizontally next page

**Table A2-2 continued. Summary of all fish caught by site in 2002 (Only reflects species catch; does not reflect effort (i.e. CPUE)**

| | | Maury I. Park | Picnic Point | PTR | Richmond Beach | Seahurst | SGB1 | SGB2 | SGF1 | SGF2 | Totals Per Species |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Salmon | Chum | 649 | 1917 | 0 | 2413 | 67 | 100 | 561 | 5940 | 404 | 24740 |
| | Sockeye | 0 | 0 | 0 | 4 | 0 | 0 | 0 | 0 | 0 | 4 |
| | Cutthroat | 1 | 9 | 4 | 6 | 13 | 1 | 0 | 0 | 0 | 133 |
| | Steelhead | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| | Chinook | 86 | 15 | 37 | 124 | 35 | 1 | 17 | 24 | 3 | 1354 |
| | Coho | 34 | 198 | 1 | 102 | 9 | 4 | 18 | 4 | 0 | 1053 |
| | Char | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| | Pink Salmon | 63 | 636 | 0 | 775 | 0 | 0 | 0 | 0 | 0 | 2518 |
| | Total Salmonids | 833 | 2775 | 42 | 3424 | 124 | 106 | 596 | 5968 | 407 | 29805 |
| Perch | Shiner perch | 1345 | 4161 | 1280 | 2073 | 4148 | 2739 | 363 | 225 | 9296 | 38965 |
| | Striped perch | 1 | 4 | 1 | 20 | 1 | 7 | 0 | 0 | 0 | 179 |
| | Pile perch | 4 | 1 | 3 | 19 | 0 | 92 | 0 | 0 | 0 | 188 |
| Flatfish | Butter Sole | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| | English sole | 175 | 25 | 11 | 214 | 176 | 0 | 0 | 5 | 5 | 1131 |
| | Rock sole | 11 | 13 | 10 | 19 | 75 | 0 | 0 | 0 | 0 | 213 |
| | Starry flounder | 55 | 8 | 25 | 28 | 39 | 11 | 0 | 20 | 0 | 794 |
| | Speckled sanddab | 0 | 3 | 0 | 52 | 2 | 35 | 0 | 0 | 5 | 161 |
| | C-O sole | 0 | 0 | 0 | 6 | 0 | 0 | 1 | 0 | 0 | 9 |
| | Sand sole | 11 | 0 | 0 | 4 | 2 | 0 | 0 | 0 | 0 | 50 |
| | Pacific sanddab | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 | 15 |
| | Sanddab spp. | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| | Unid. Flatfish | 4 | 0 | 0 | 2 | 8 | 1 | 1 | 14 | 4 | 109 |
| Sculpin | Staghorn sculpin | 46 | 8 | 19 | 38 | 152 | 9 | 5 | 4 | 5 | 1633 |
| | Great sculpin | 1 | 0 | 3 | 14 | 0 | 0 | 0 | 0 | 0 | 43 |
| | Northern sculpin | 1 | 0 | 0 | 0 | 4 | 0 | 0 | 0 | 0 | 10 |
| | Buffalo sculpin | 28 | 6 | 5 | 4 | 2 | 0 | 3 | 0 | 0 | 109 |
| | Silverspotted sculpin | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 6 |
| | Cabezon | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 |
| | Tidepool sculpin | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 22 |
| | Padded Sculpin | 28 | 0 | 6 | 1 | 11 | 0 | 0 | 0 | 0 | 146 |
| | Sailfin Sculpin | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| | Unid. Sculpin | 5 | 0 | 10 | 26 | 31 | 1 | 3 | 5 | 0 | 166 |
| Forage Fish | Sand lance | 357 | 21 | 0 | 36 | 9 | 0 | 0 | 0 | 4 | 1176 |
| | Surf smelt | 1 | 10 | 0 | 1 | 3 | 0 | 1 | 0 | 0 | 110 |
| | Herring | 1 | 0 | 0 | 13 | 11 | 5 | 1 | 0 | 0 | 343 |
| Gunnels | Penpoint gunnel | 0 | 0 | 0 | 42 | 1 | 0 | 2 | 0 | 2 | 90 |
| | Crescent gunnel | 3 | 0 | 0 | 8 | 0 | 0 | 10 | 1 | 10 | 80 |
| | Saddleback gunnel | 19 | 0 | 6 | 3 | 6 | 0 | 46 | 1 | 10 | 178 |
| Tubefish | Tubesnout | 5 | 8 | 5 | 135 | 16 | 0 | 0 | 14 | 12 | 553 |
| | Threespine stickleback | 0 | 3 | 0 | 3 | 4 | 3 | 0 | 0 | 1 | 67 |
| | Bay pipefish | 0 | 2 | 0 | 0 | 5 | 1 | 0 | 0 | 5 | 56 |
| Other | Big Skate | 0 | 0 | 0 | 3 | 1 | 0 | 0 | 0 | 0 | 9 |
| | Brown Rockfish | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| | Rockfish spp | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| | Sturgeon Poacher | 1 | 0 | 0 | 0 | 2 | 0 | 3 | 0 | 6 | 33 |
| | Whitespotted Greenling | 0 | 1 | 1 | 4 | 0 | 0 | 0 | 0 | 0 | 14 |
| | Unid. Greenling | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 5 |
| | Pacific Tomcod | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 7 |
| | Pacific Midshipman | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 26 |
| | Arrow Goby | 0 | 0 | 0 | 0 | 0 | 10 | 0 | 0 | 0 | 107 |
| | Ratfish | 10 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 13 |
| | Northern Spearnose | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| | Spiney Lumpsucker | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| | Snake prickleback | 1 | 0 | 0 | 0 | 4 | 6 | 0 | 0 | 0 | 24 |

# APPENDIX 3

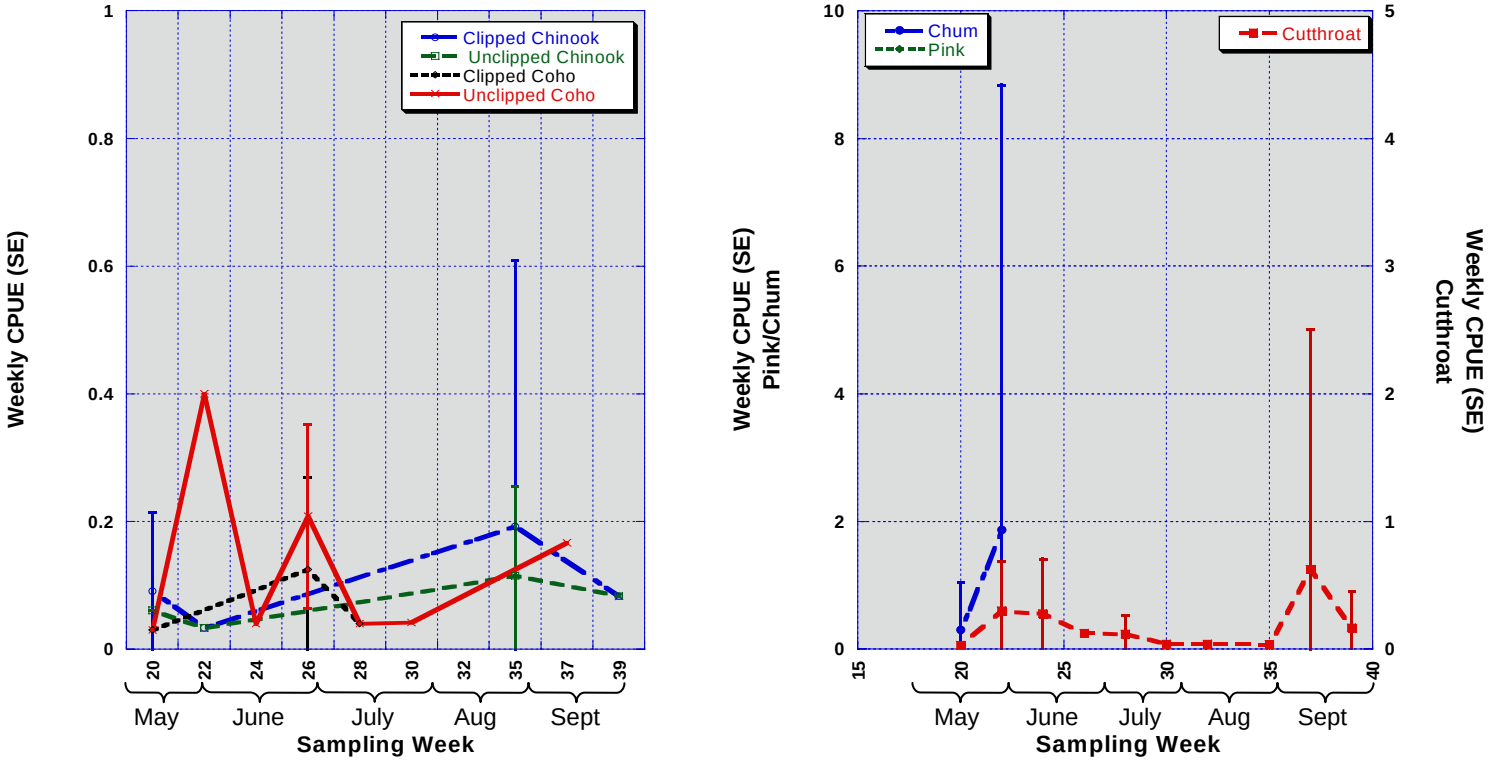



**Figure A3-1. CPUE of salmonids over time at Picnic Point from May 15th (week 20) to September 24th (week 39) in 2001.**

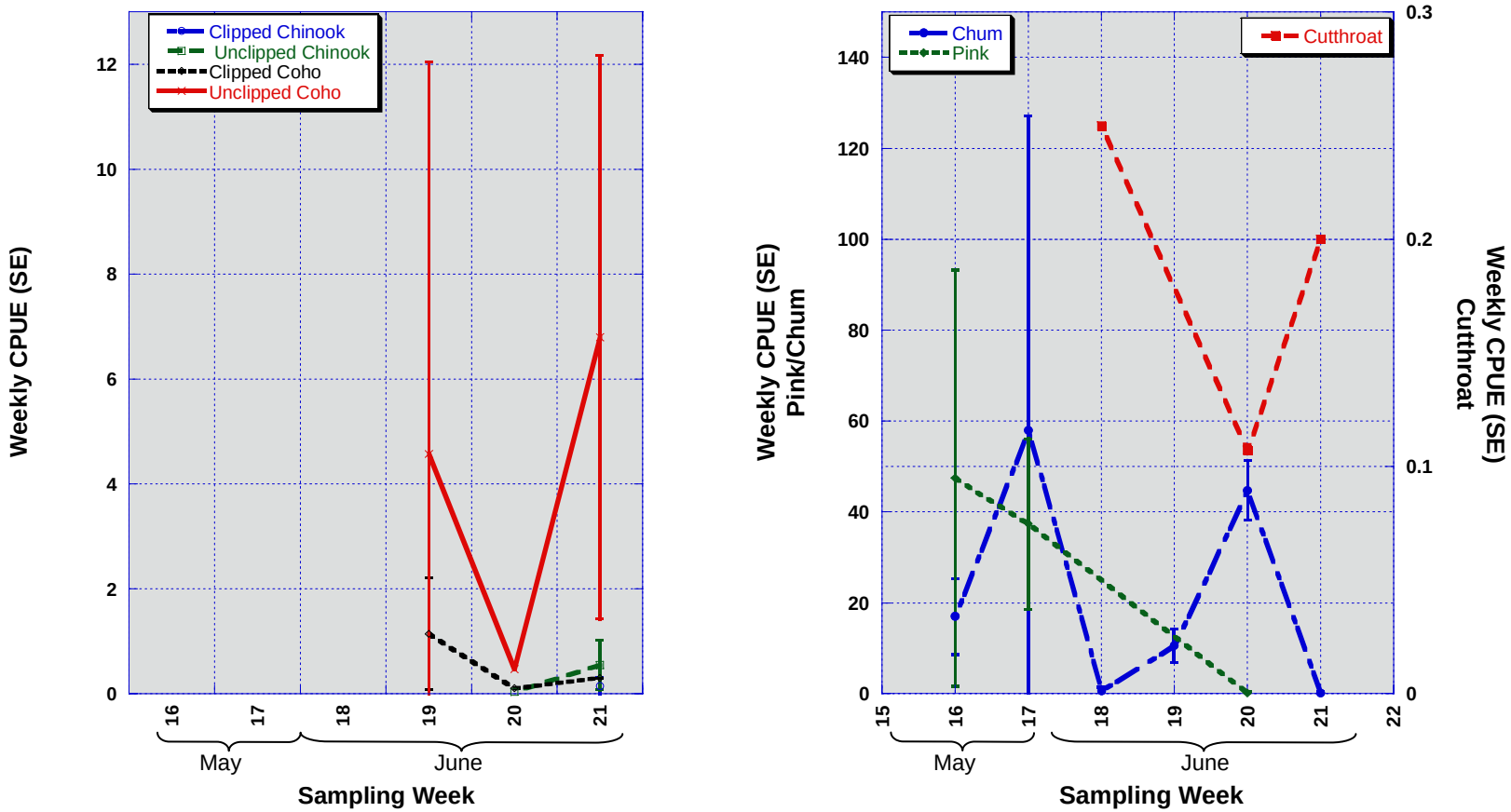



**Figure A3-2. CPUE of salmonids over time at Picnic Point from April 17th (week 16) to May 20th (week 21) in 2002.**

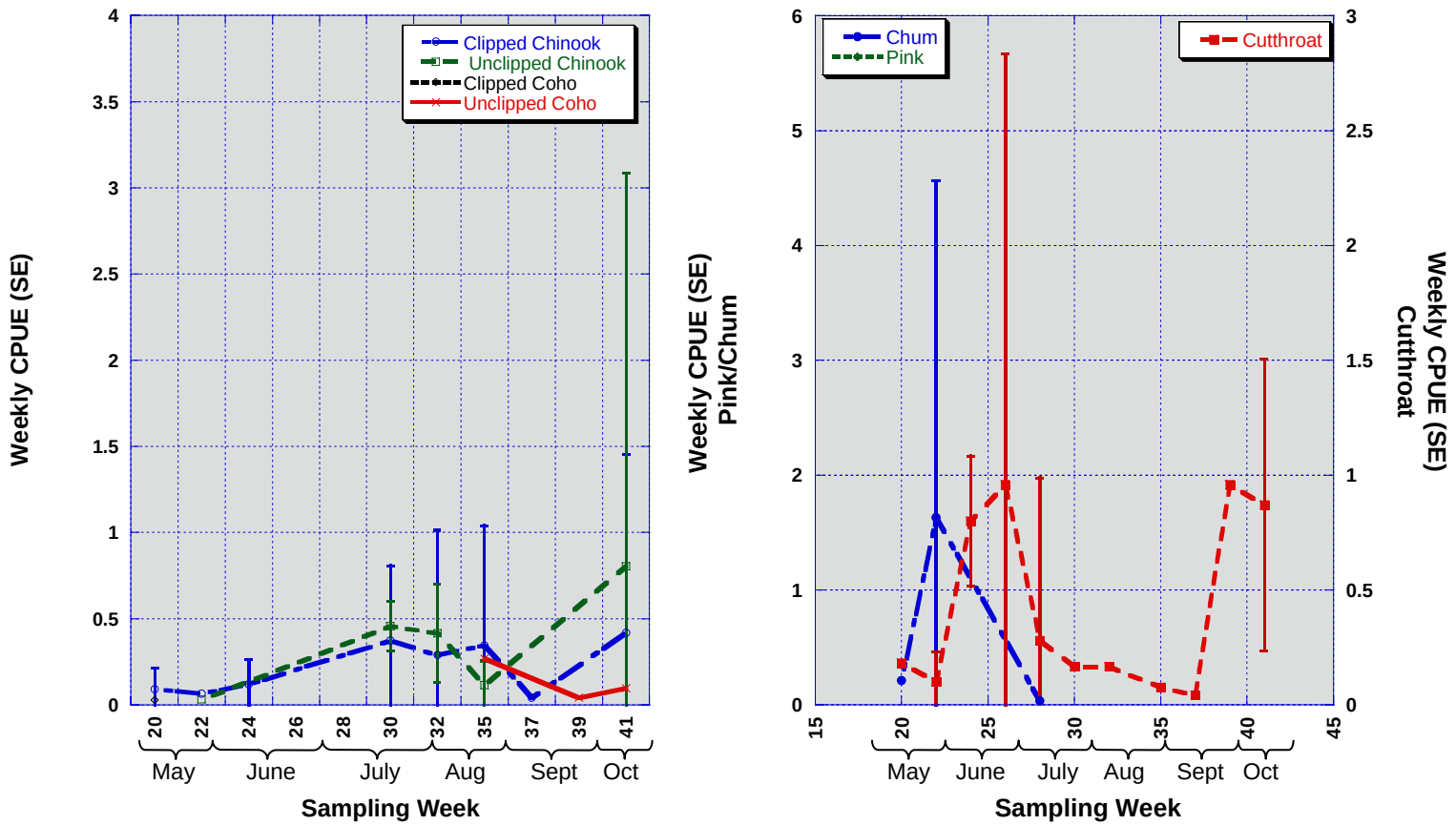



**Figure A3-3. CPUE of salmonids over time at Meadowdale from May 15th (week 20) to October 8th (week 41) in 2001.**

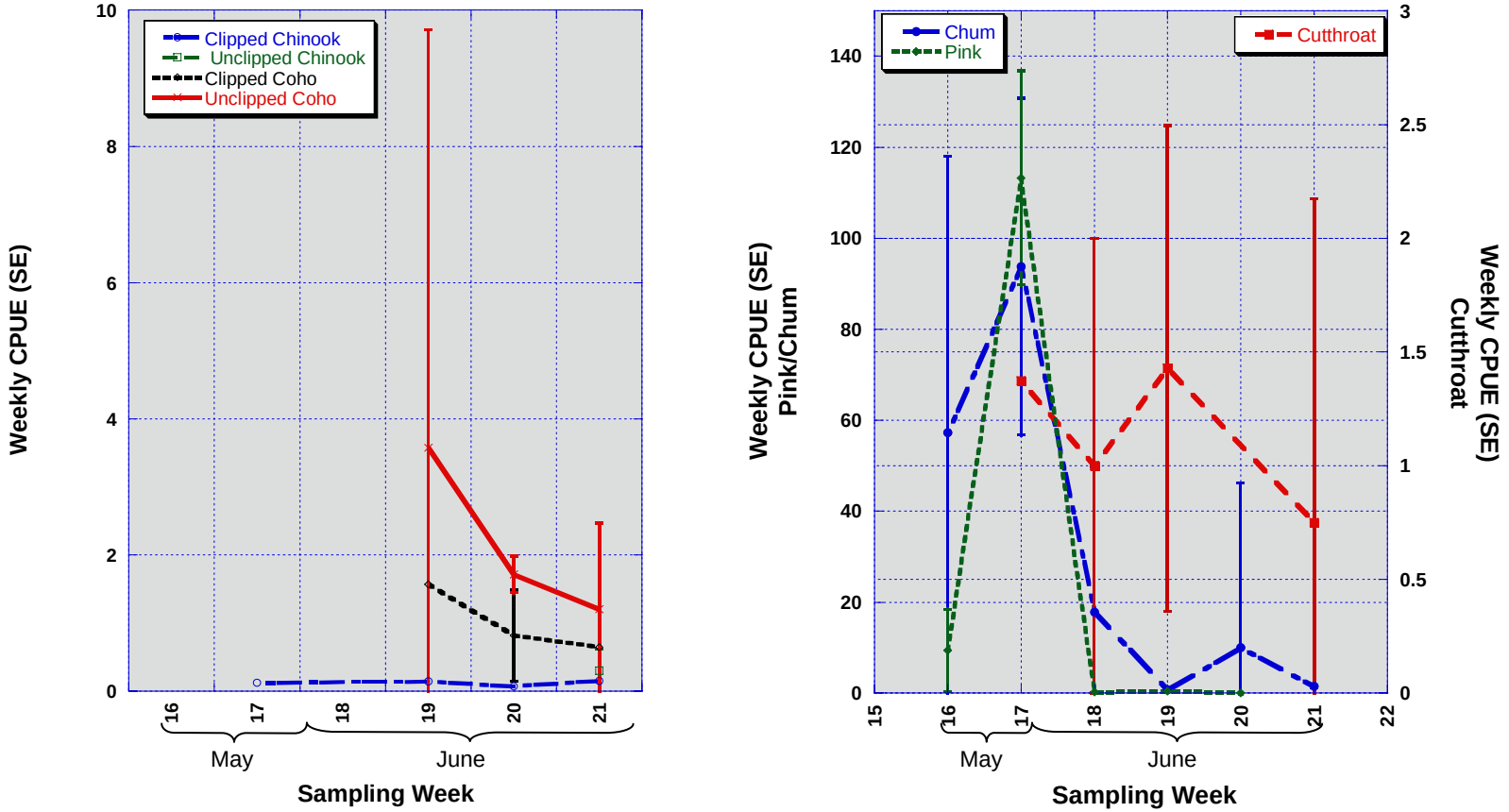



**Figure A3-4. CPUE of salmonids over time at Meadowdale from April 17th (week16) to May 20th (week 21) in 2002.**

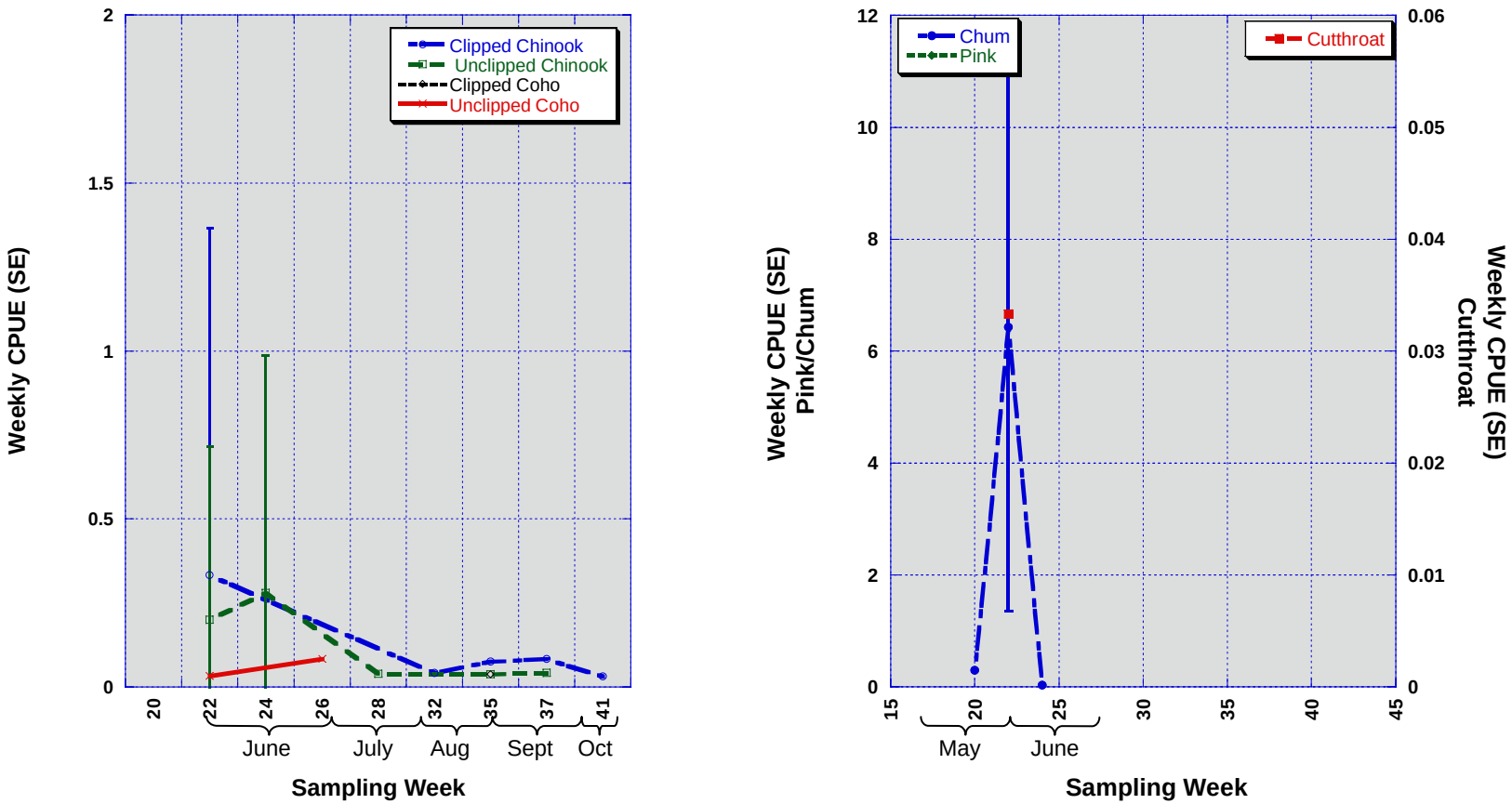



**Figure A3-5. CPUE of salmonids over time at Ocean Avenue from May 29th (week 22) to October 8th (week 41) in 2001.**

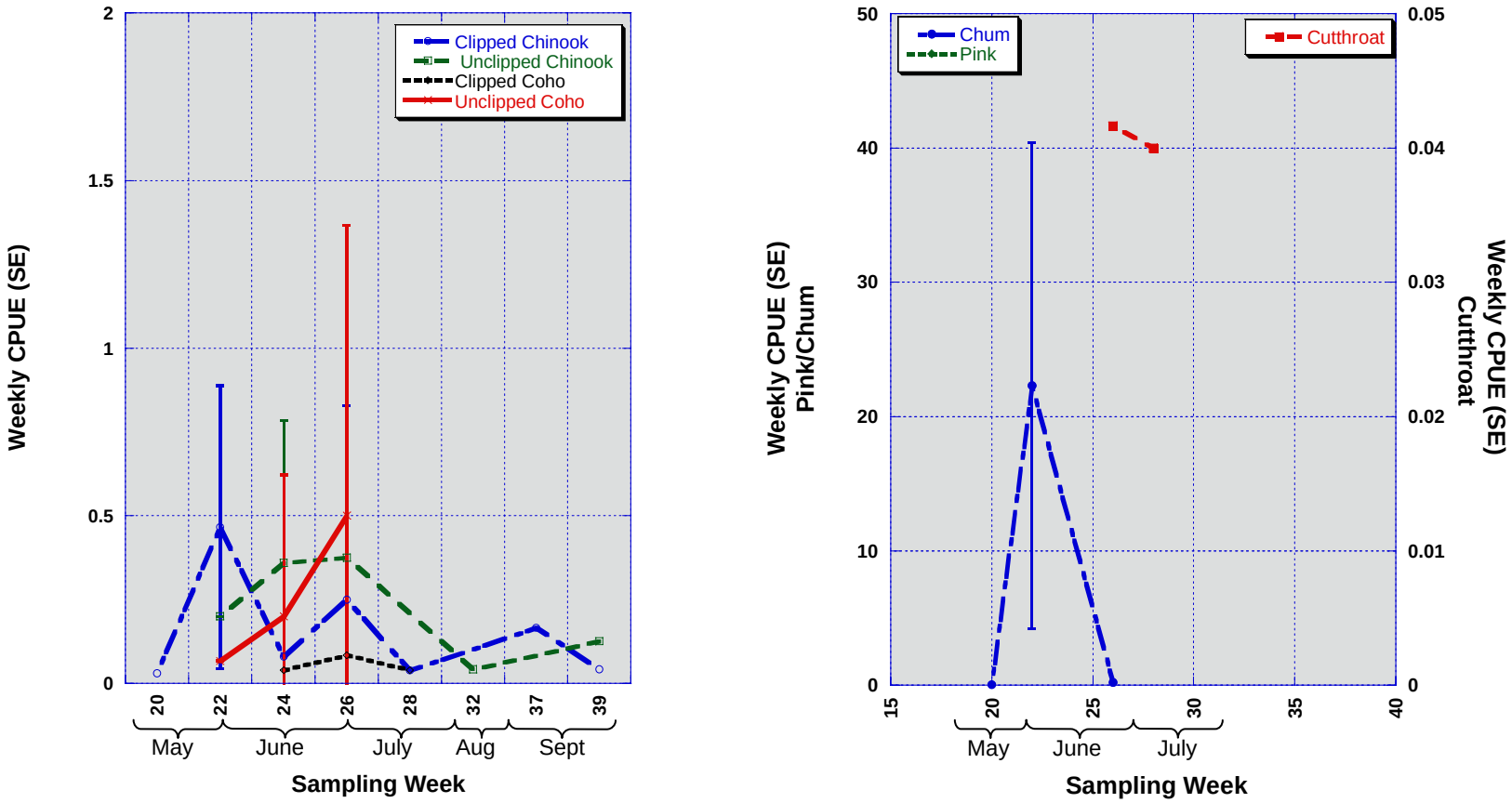



**Figure A3-6. CPUE of salmonids over time at Richmond Beach from May 15 (week 20) to September 24 (week 39) in 2001.**

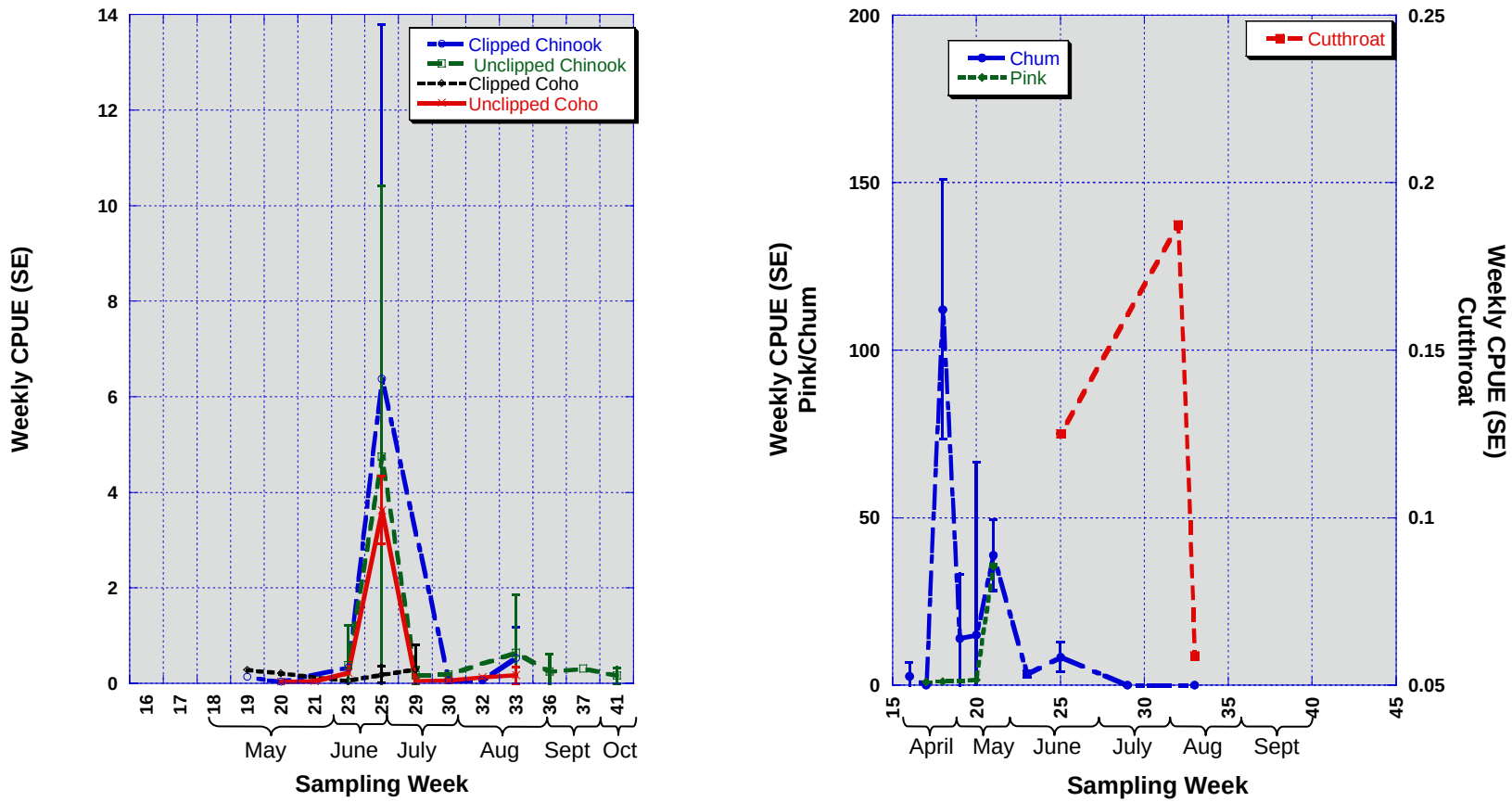



**Figure A3-7. CPUE of salmonids over time at Richmond Beach from April 7 (week16) to October 7 (week 41) in 2002.**

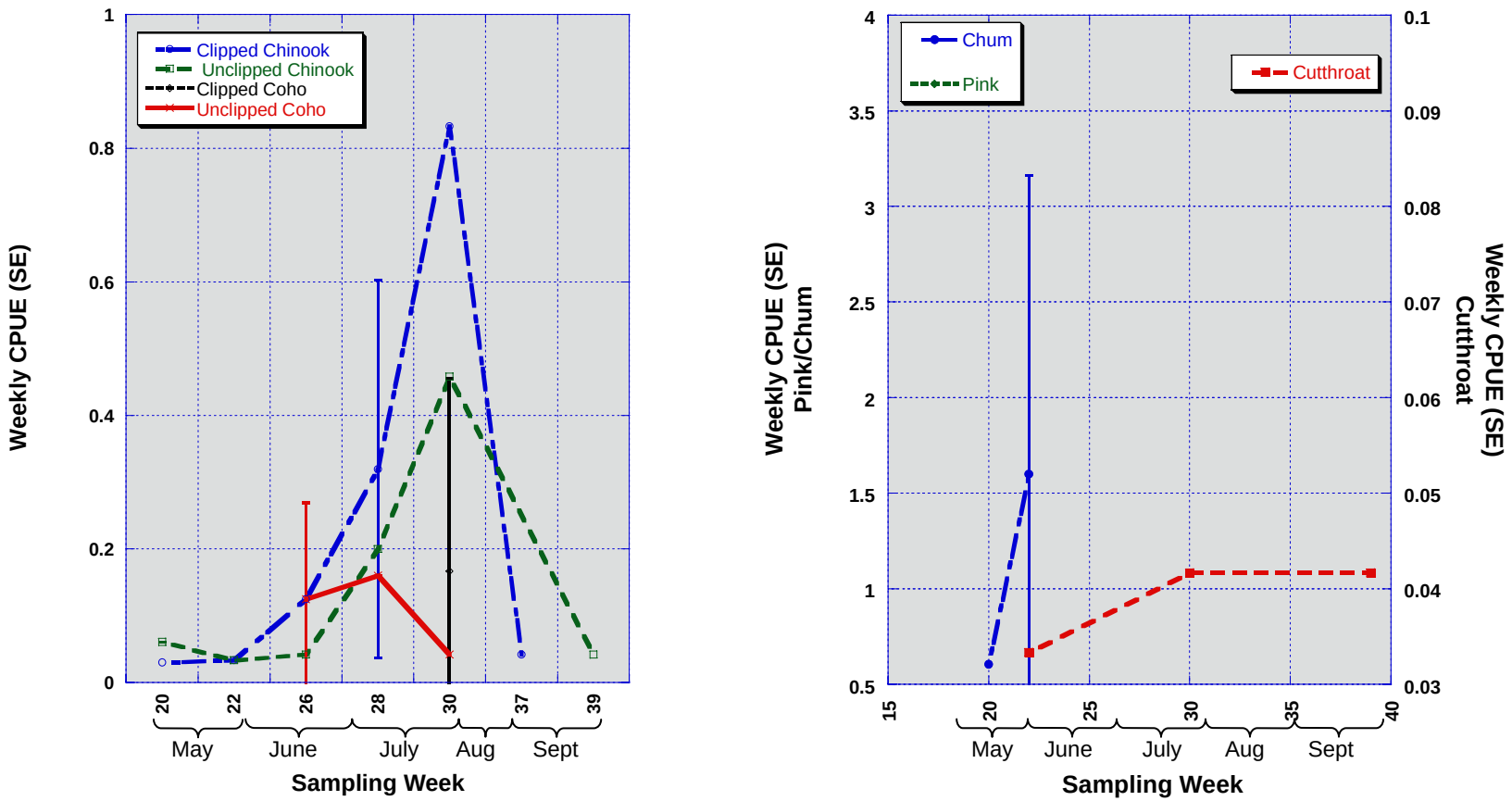



**Figure A3-8. CPUE of salmonids over time at Carkeek Park from May 15 (week 20) to September 24 (week 39) in 2001.**

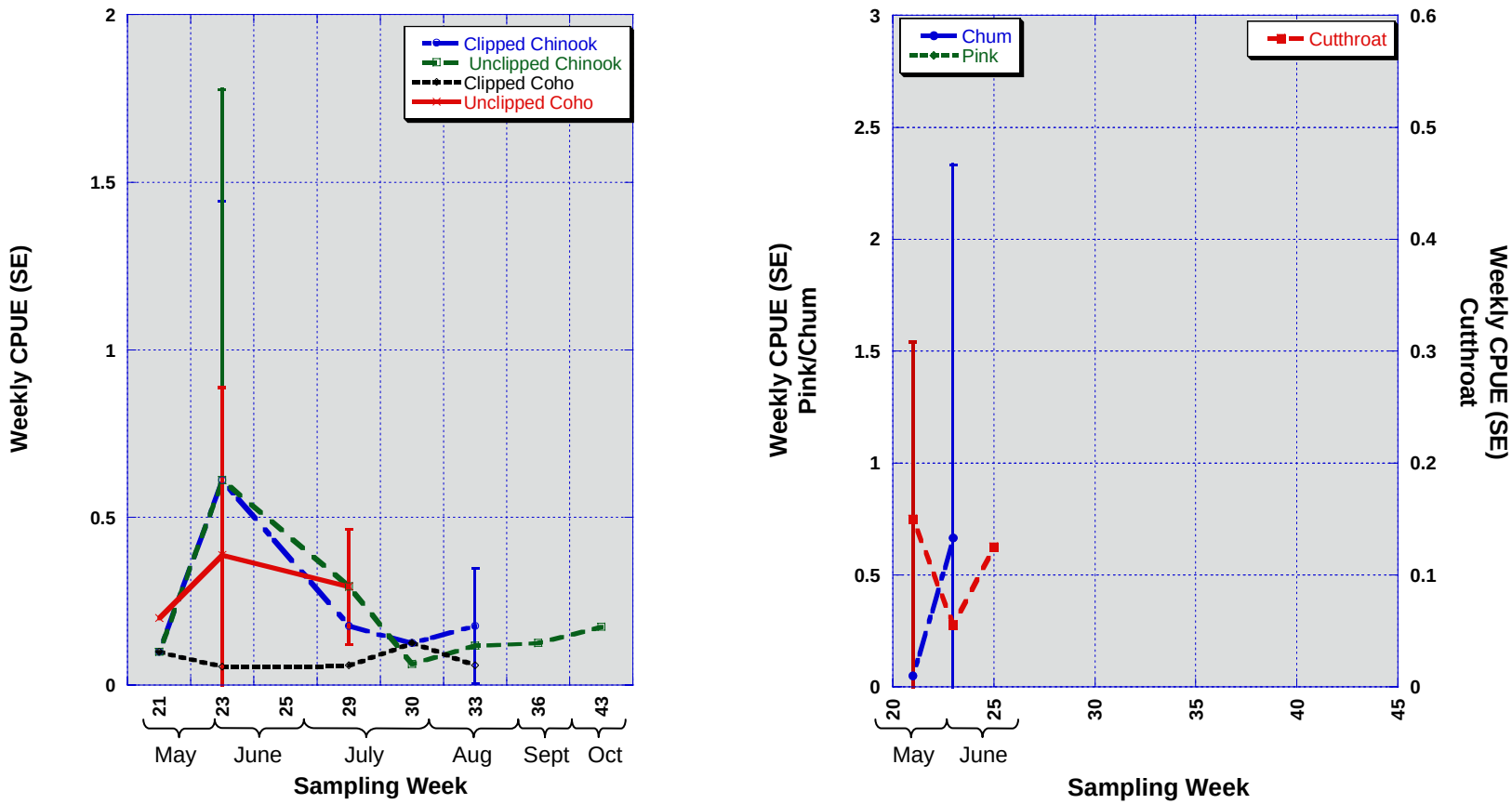



**Figure A3-9. CPUE of salmonids over time at Carkeek Park from May 20 (week 21) to October 21 (week 43) in 2002.**

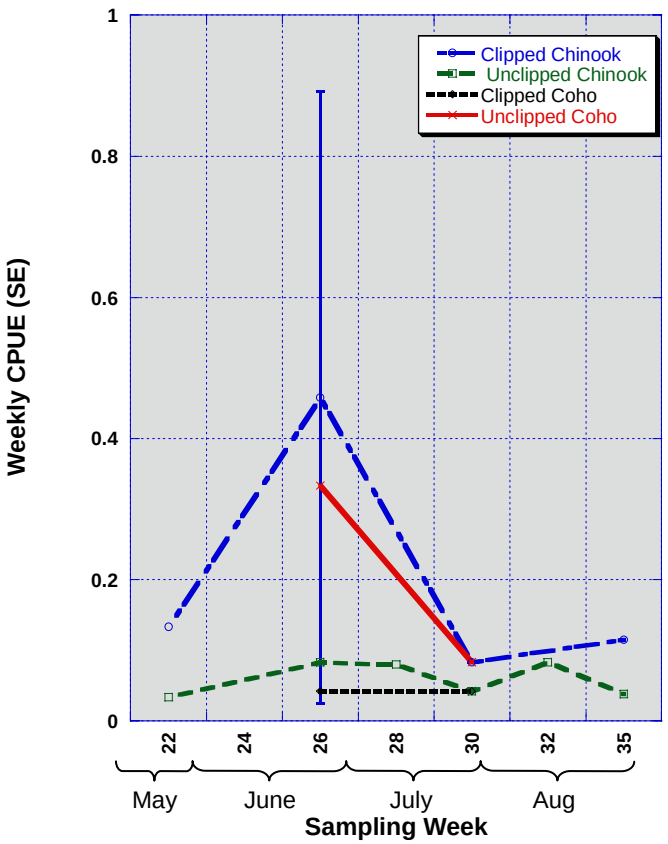



**Figure A3-10. CPUE of salmonids over time at Golden Gardens Park from May 15 (week 20) to September 24 (week 39) in 2001. Chum and cutthroat were caught in very small numbers in 2001 and not graphed.**

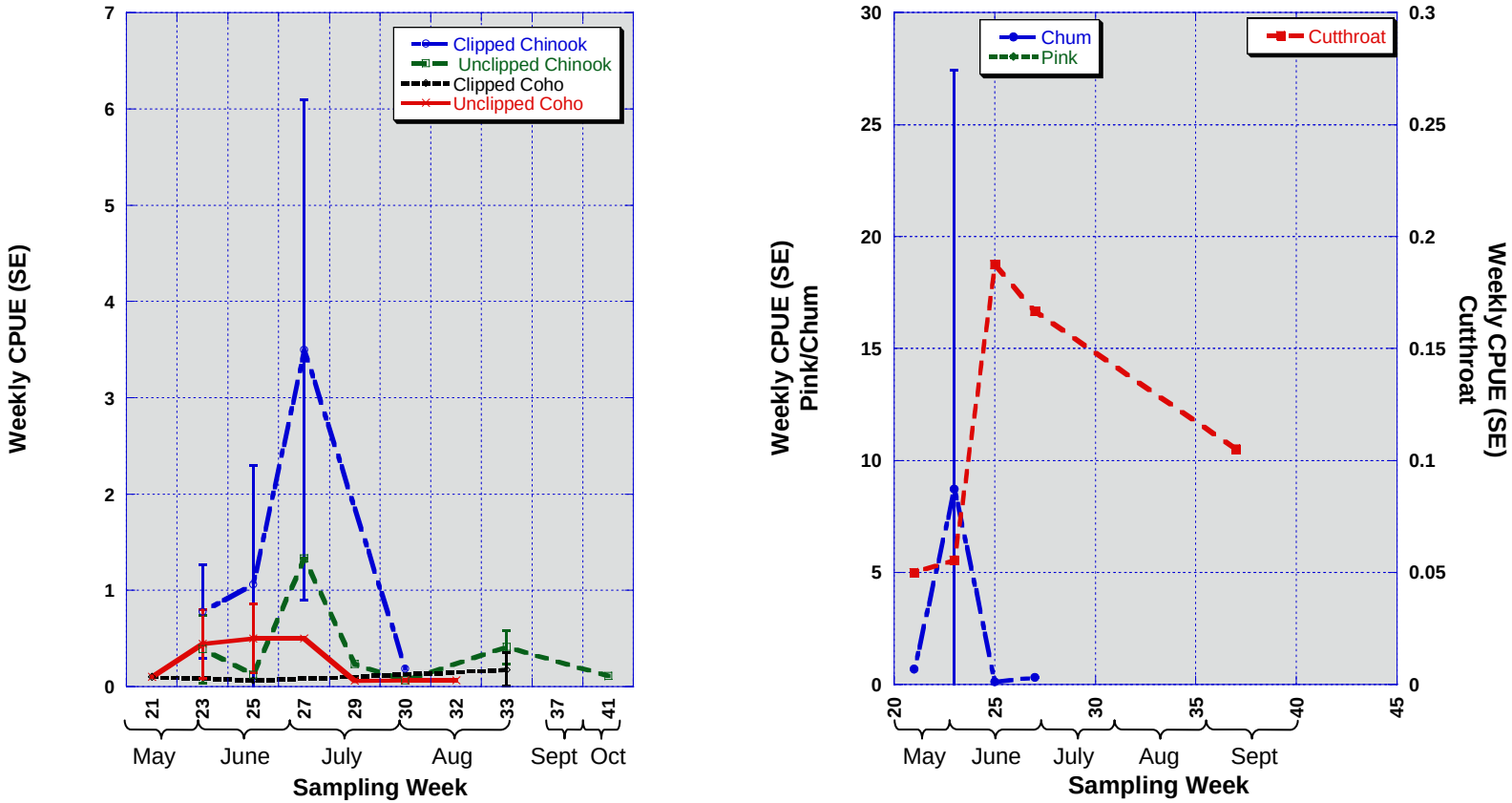



**Figure A3-11. CPUE of salmonids over time at Golden Gardens Park from May 20 (week 21) to October 7 (week 41) in 2002.**

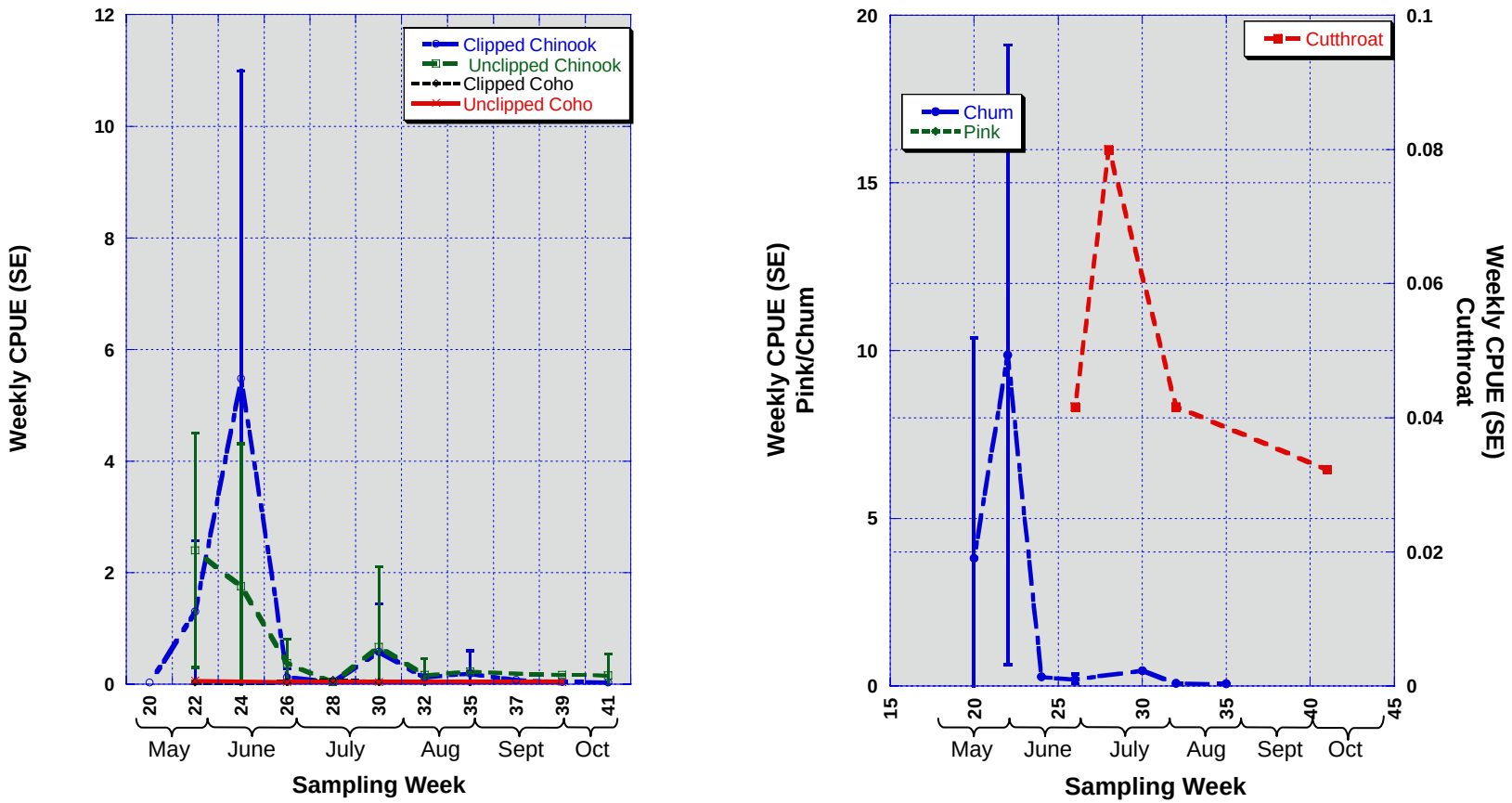



**Figure A3-12. CPUE of salmonids over time at Lincoln Park from May 15 (week 20) to October 8 (week 41) in 2001.**

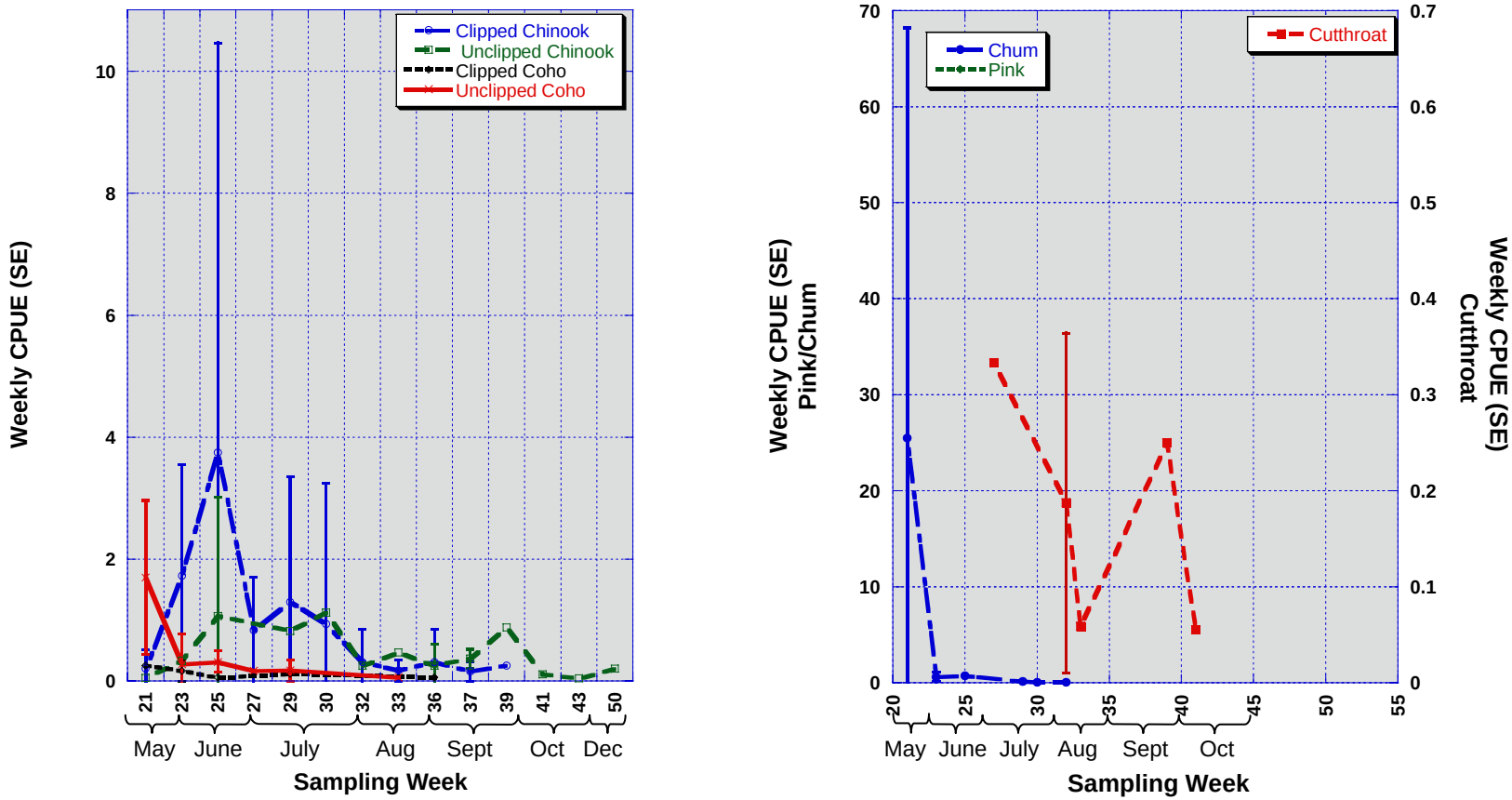



**Figure A3-13. CPUE of salmonids over time at Lincoln Park from May 20 (week 21) to December 9 (week 50) in 2002.**

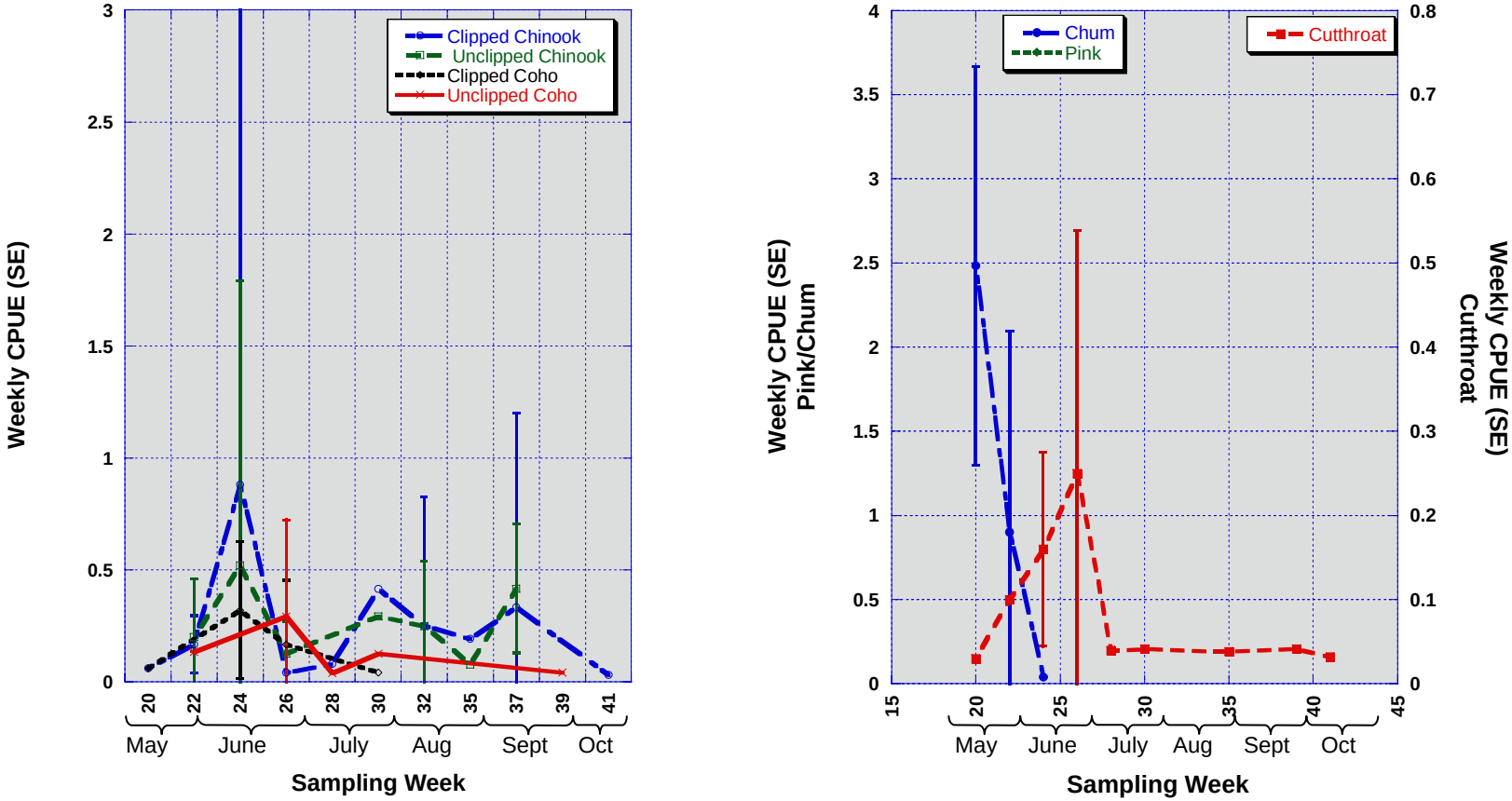



**Figure A3-14. CPUE of salmonids over time at Seahurst Park from May 15 (week 20) to October 8 (week 41) in 2001.**

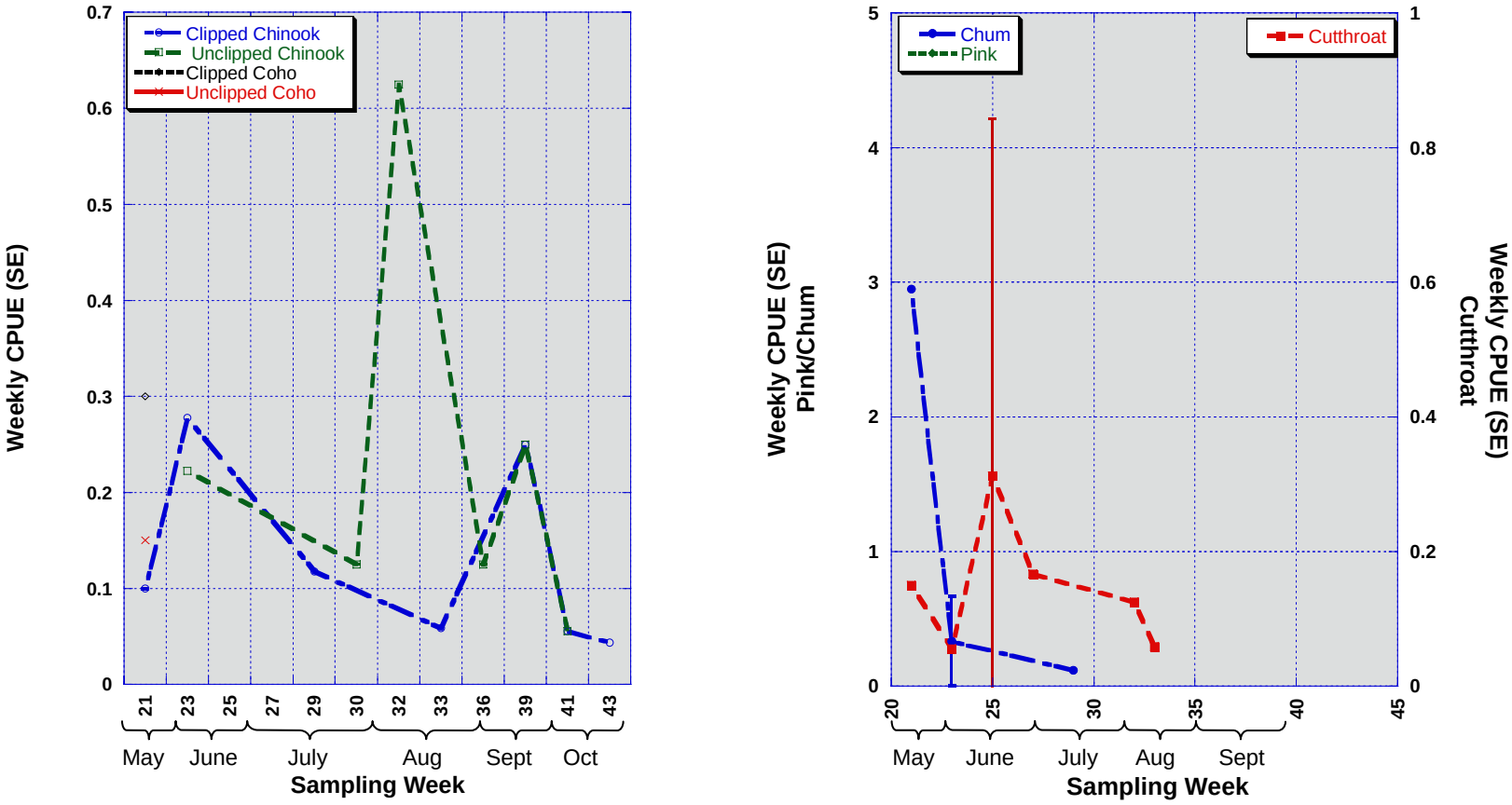



**Figure A3-15. CPUE of salmonids over time at Seahurst Park from May 20 (week 21) to October 21 (week 43) in 2002.**

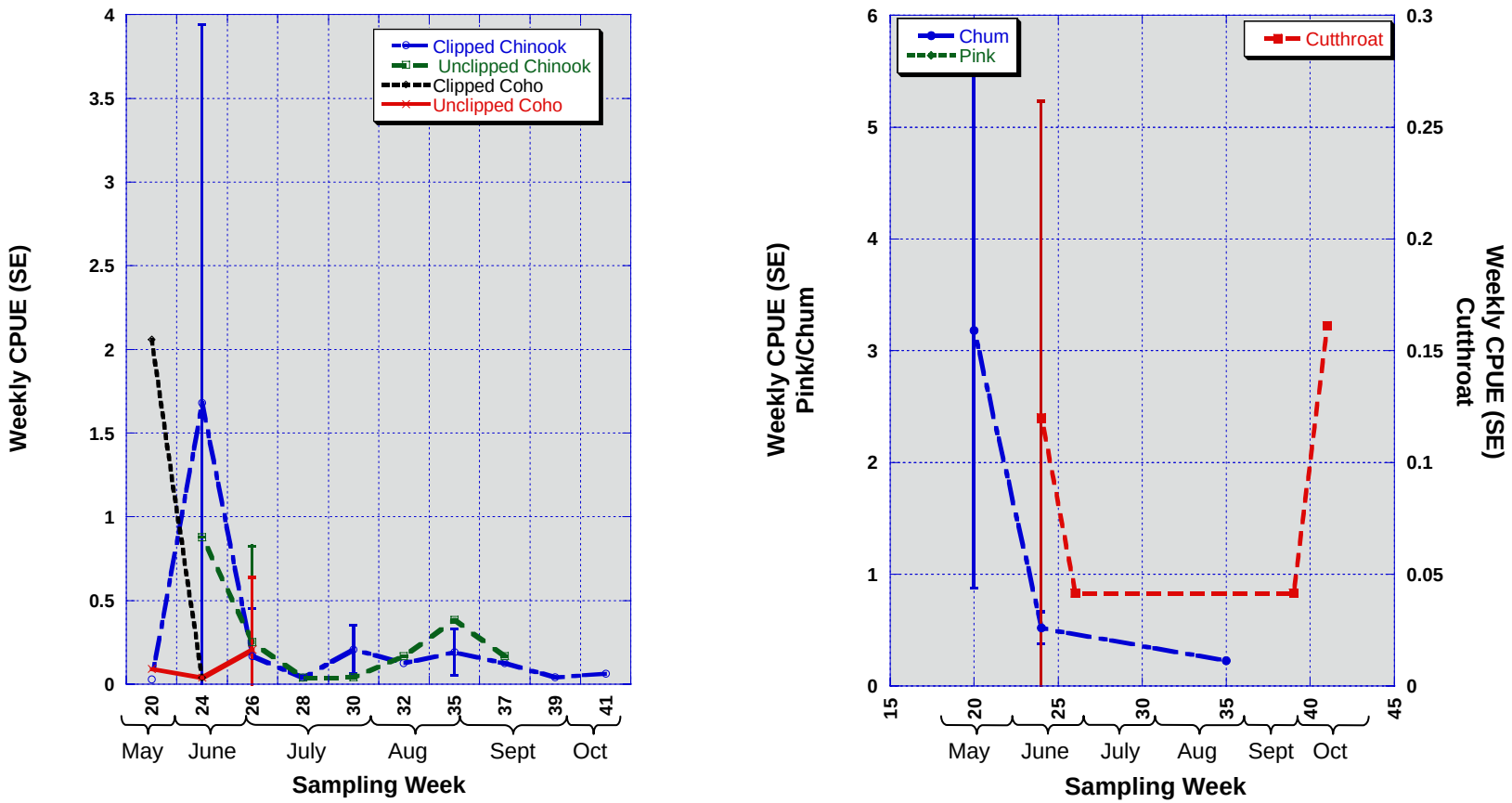



**Figure A3-16. CPUE of salmonids over time at Marine View Park from May 15 (week 20) to October 8 (week 41) in 2001.**

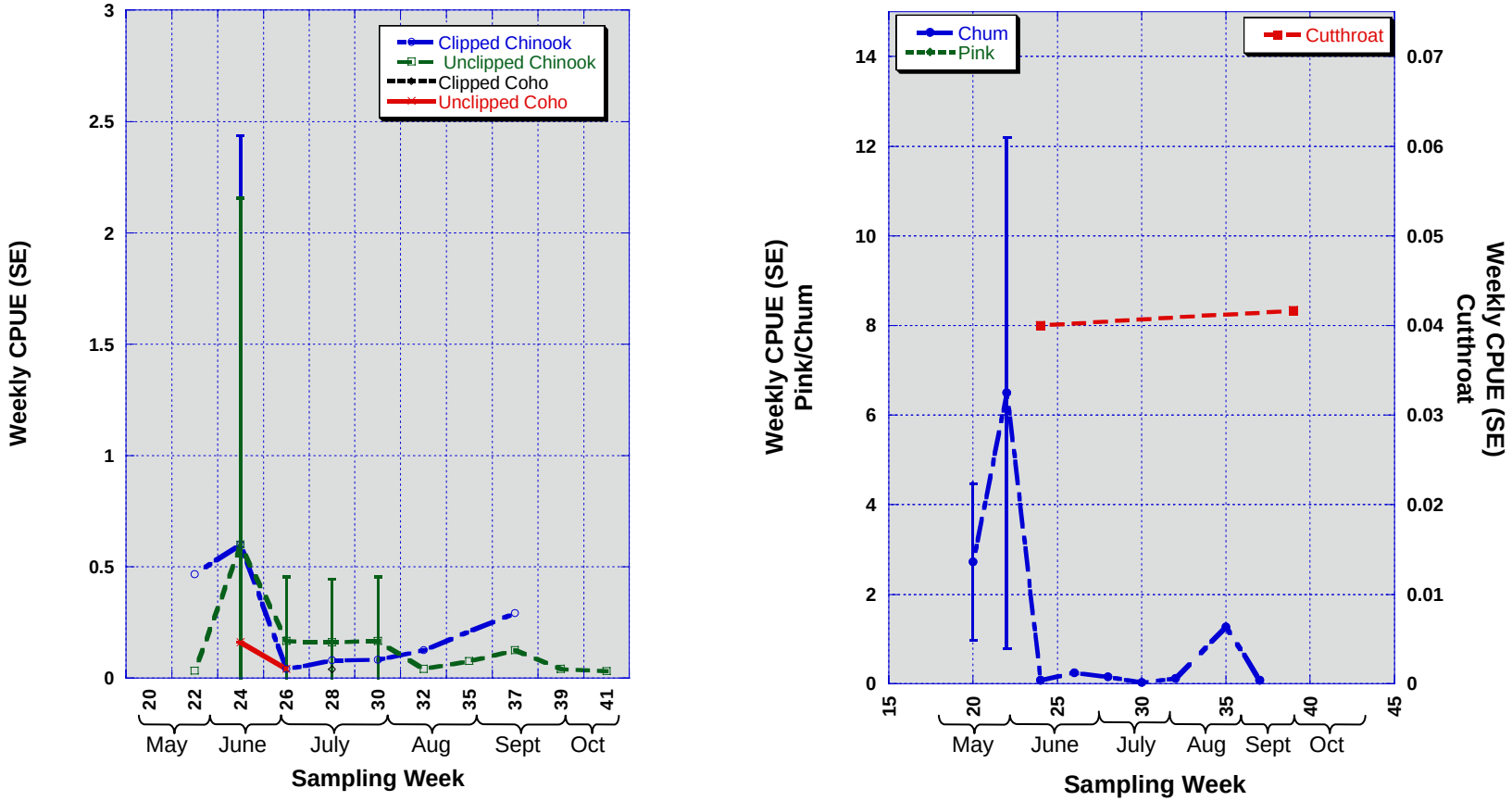



**Figure A3-17. CPUE of salmonids over time at KVI Beach from May 29 (week 22) to October 8 (week 41) in 2001.**

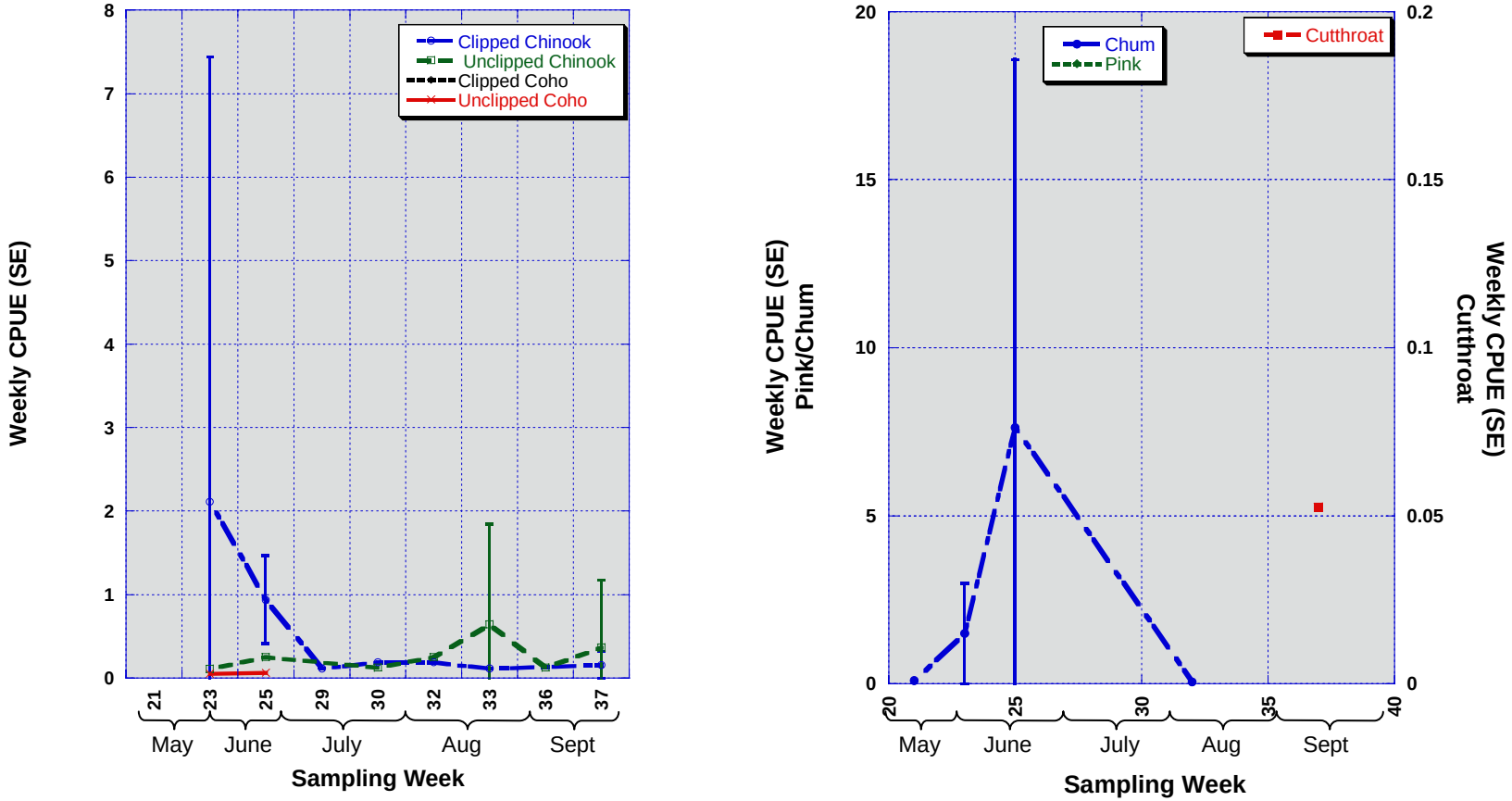



**Figure A3-18. CPUE of salmonids over time at KVI Beach from May 20 (week 21) to September 9 (week 37) in 2002.**

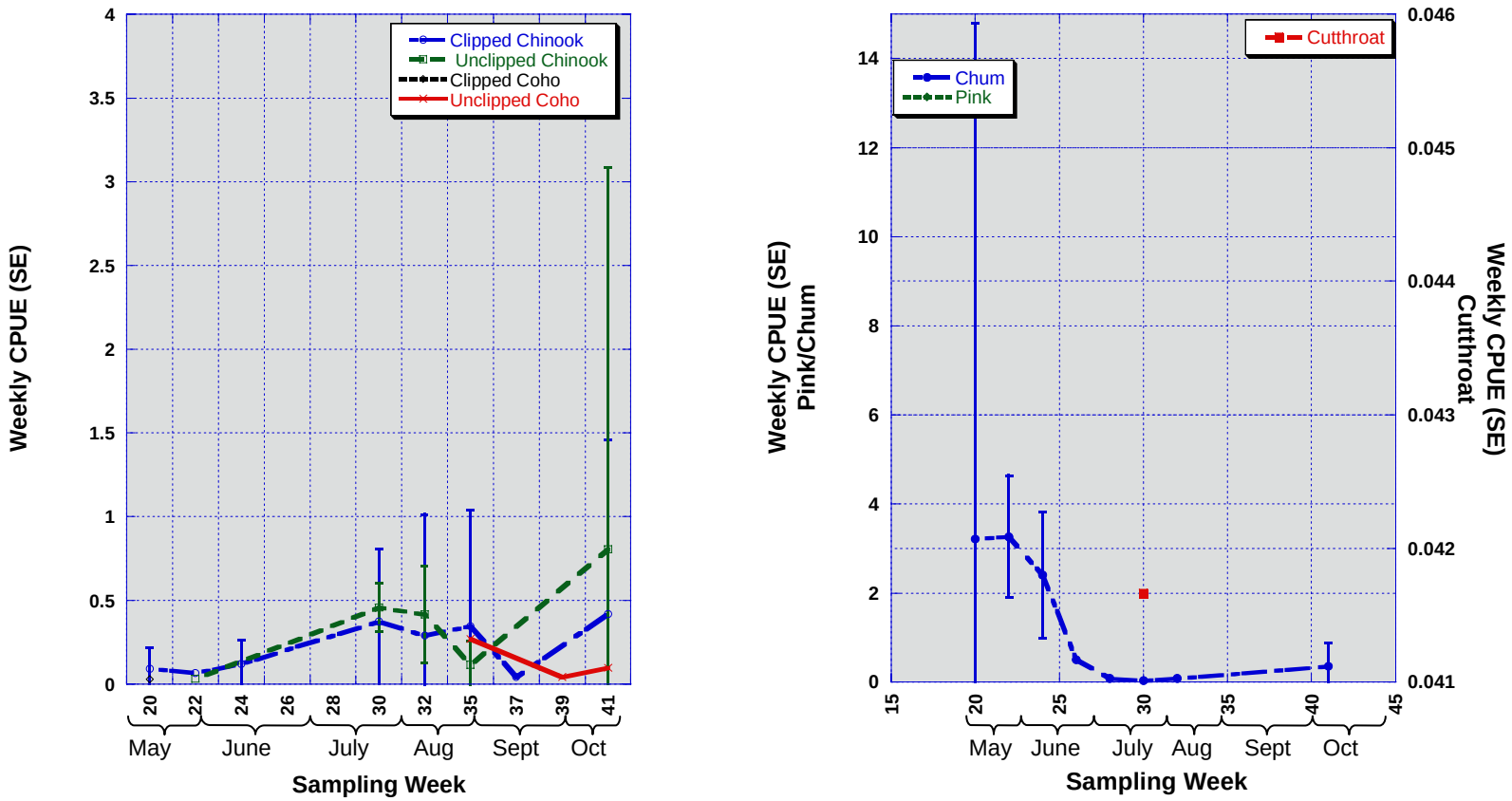



**Figure A3-19. CPUE of salmonids over time at Maury Island Marine Park from May 15 (week 20) to October 8 (week 41) in 2001.**

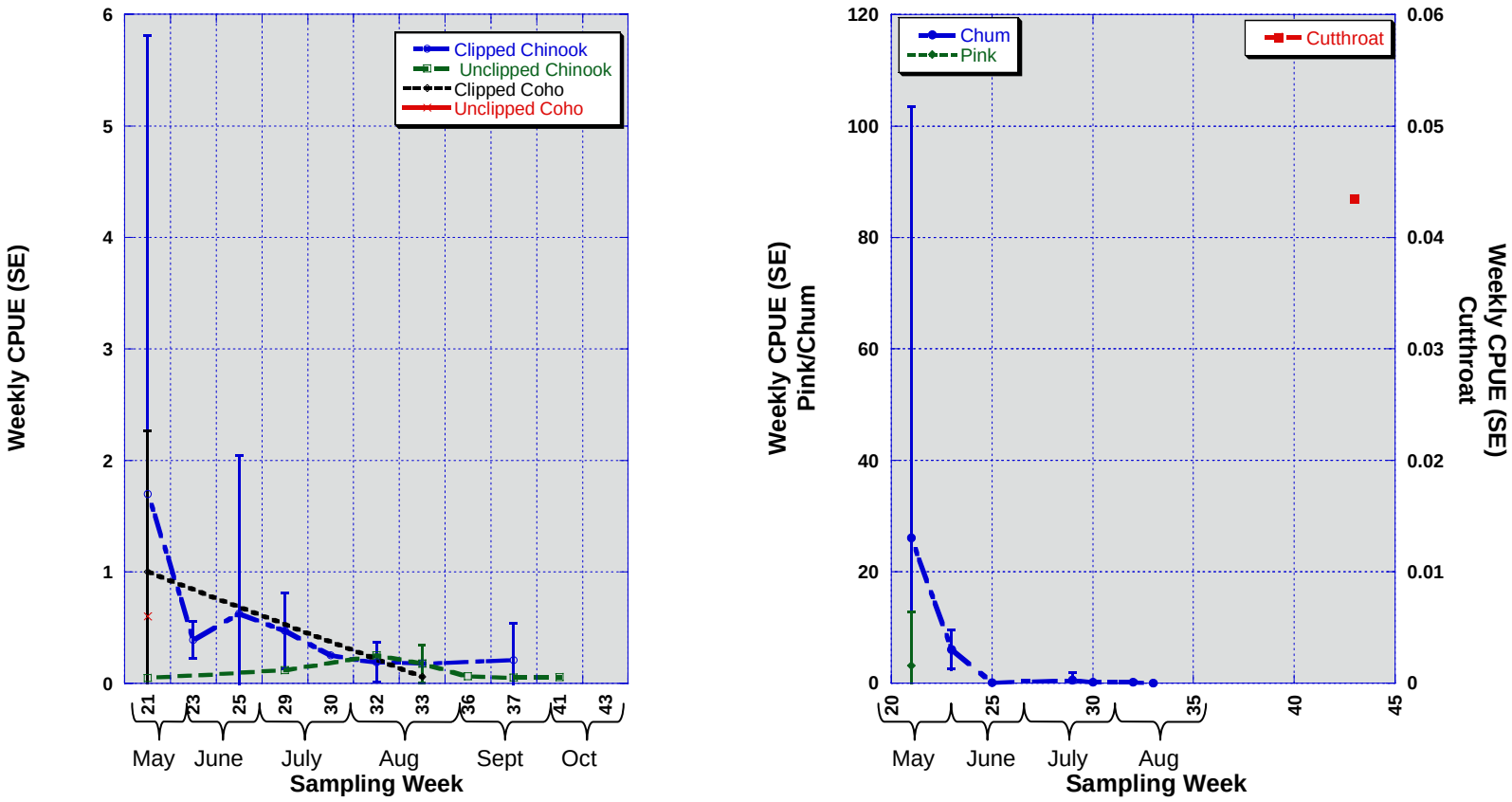



**Figure A3-20. CPUE of salmonids over time at Maury Island Marine Park from May 20 (week 21) to October 7 (week 41) in 2002.**

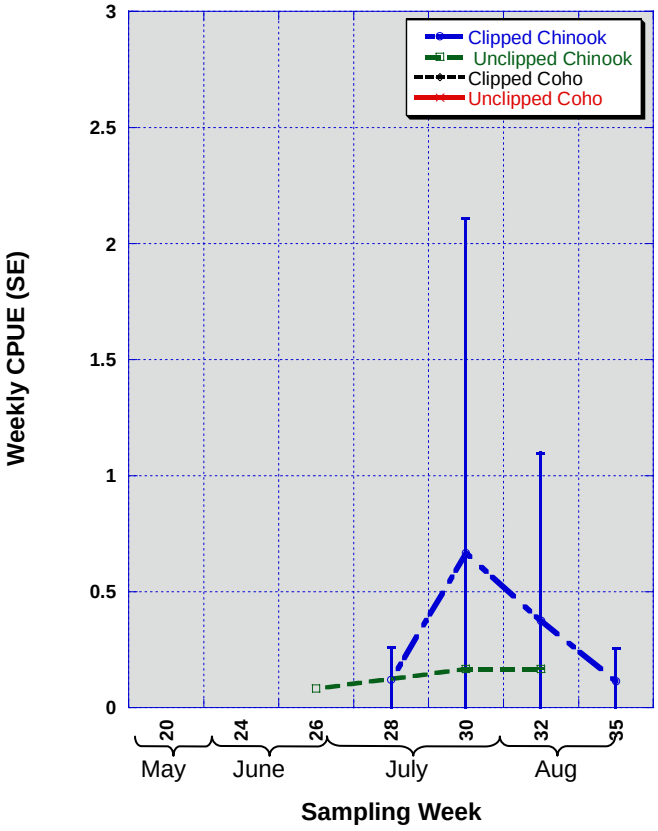



**Figure A3-21. CPUE of salmonids over time at Burton Park from May 15 (week 20) to October 9 (week 41) in 2001. There were not enough other salmonids caught in either year to graph.**

**Table A3-1. Weekly catch per unit effort values and standard effort for north mainland (WRIA 8) {see figure 3-5}. Note, shaded areas represent no sampling and NA means not applicable.**

| | 2001 | | | | 2002 | | | | 2001 | | 2002 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Week | CPUE Clipped Chinook | SE CPUE Clipped Chinook | CPUE Unclipped Chinook | SE CPUE Unclipped Chinook | CPUE Clipped Chinook | SE CPUE Clipped Chinook | CPUE Unclipped Chinook | SE CPUE Unclipped Chinook | CPUE Chum | SE CPUE Chum | CPUE Chum | SE CPUE Chum |
| 16 | | | | | 0.0000 | NA | 0.0000 | NA | | | 77.0000 | 41.0134 |
| 17 | | | | | 0.1250 | NA | 0.0000 | NA | | | 175.7500 | 61.6652 |
| 18 | | | | | 0.0000 | NA | 0.1250 | NA | | | 132.8750 | 72.1564 |
| 19 | | | | | 0.2857 | 0.0000 | 0.0000 | NA | | | 25.2857 | 11.9361 |
| 20 | 1.4000 | 0.7303 | 1.4000 | 0.6831 | 0.5714 | 0.2182 | 0.1429 | NA | 3.2667 | 1.7512 | 292.2857 | 101.6401 |
| 21 | | | | | 0.8000 | 0.2582 | 1.9000 | 0.6481 | | | 82.6000 | 55.9953 |
| 22 | 1.7222 | 0.6983 | 0.9444 | 0.3436 | | | | | 64.2222 | 20.9540 | | |
| 23 | | | | | 3.8750 | 0.7555 | 3.1250 | 1.0596 | | | 28.6250 | 17.8381 |
| 24 | 0.1667 | NA | 1.5000 | 0.7071 | | | | | 0.0833 | NA | | |
| 25 | | | | | 19.8333 | 12.2763 | 13.0000 | 10.7083 | | | 22.8333 | 16.2600 |
| 26 | 1.6667 | 0.6455 | 1.0000 | 1.1547 | | | | | 0.4167 | NA | | |
| 27 | | | | | 10.5000 | 4.5000 | 4.0000 | 0.0000 | | | 1.0000 | 0.0000 |
| 28 | 1.6667 | 0.5774 | 1.0833 | 0.5244 | | | | | 0.0833 | NA | | |
| 29 | | | | | 0.3750 | NA | 1.5000 | 0.6455 | | | 0.2500 | 0.0000 |
| 30 | 2.2500 | 2.3857 | 1.0833 | 1.6667 | 1.0000 | 0.4082 | 0.8333 | 0.4714 | 0.0000 | NA | 0.0000 | NA |
| 32 | 0.0833 | NA | 0.2500 | 0.2041 | 0.1667 | NA | 0.0000 | NA | 0.0000 | NA | 0.0000 | NA |
| 33 | | | | | 1.7143 | 0.7838 | 2.8571 | 1.1019 | | | 0.2857 | NA |
| 35 | 0.9167 | 0.3764 | 0.5000 | 0.1291 | | | | | 0.0000 | NA | | |
| 36 | | | | | 0.0000 | NA | 1.0000 | 0.4082 | | | 0.0000 | NA |
| 37 | 0.5833 | 0.4330 | 0.0833 | NA | 0.0000 | NA | 0.7500 | NA | 0.0000 | NA | 0.0000 | NA |
| 39 | 0.3333 | 0.1667 | 0.5000 | 0.2887 | | | | | 0.0000 | NA | | |
| 41 | 0.0909 | NA | 0.0000 | NA | 0.0000 | NA | 0.7143 | 0.2182 | 0.0000 | NA | 0.0000 | NA |
| 43 | | | | | 0.0000 | NA | 0.5714 | NA | | | 0.0000 | NA |

Table A3-1 concluded.

| | 2001 | | | | 2002 | | | | 2001 | | 2002 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Week | CPUE Clipped Coho | SE CPUE Clipped Coho | CPUE Unclipped Coho | SE CPUE Unclipped Coho | CPUE Clipped Coho | SE CPUE Clipped Coho | CPUE Unclipped Coho | SE CPUE Unclipped Coho | CPUE Cutthroat | SE CPUE Cutthroat | CPUE Cutthroat | SE CPUE Cutthroat |
| 16 | | | | | 0.0000 | NA | 0.0000 | NA | | | 0.0000 | NA |
| 17 | | | | | 0.0000 | NA | 0.0000 | NA | | | 1.3750 | NA |
| 18 | | | | | 0.0000 | NA | 0.0000 | NA | | | 1.2500 | 0.8165 |
| 19 | | | | | 3.0000 | 1.6147 | 8.1429 | 5.6432 | | | 1.4286 | 1.0690 |
| 20 | 0.0667 | NA | 0.4000 | 0.7303 | 6.0000 | 1.5721 | 10.5714 | 3.6489 | 0.4667 | 0.2981 | 0.4286 | NA |
| 21 | | | | | 2.3000 | 1.4480 | 16.7000 | 10.1512 | | | 2.3000 | 1.2344 |
| 22 | 0.0000 | NA | 1.0556 | 1.1230 | | | | | 0.7778 | 0.4635 | | |
| 23 | | | | | 0.2500 | 0.0000 | 2.3750 | 0.5204 | 0.0000 | NA | 0.2500 | 0.0000 |
| 24 | 0.0833 | NA | 0.7500 | 0.3764 | | | | | 2.2500 | 1.1637 | | |
| 25 | | | | | 0.6667 | 0.2357 | 11.0000 | 5.9395 | | | 1.1667 | 0.3909 |
| 26 | 0.5000 | 0.1667 | 2.5000 | 0.8695 | | | | | 2.2500 | 2.2158 | | |
| 27 | | | | | 0.0000 | NA | 1.5000 | NA | | | 0.5000 | NA |
| 28 | 0.1667 | 0.0000 | 0.4167 | 0.1667 | | | | | 0.9167 | 0.6258 | | |
| 29 | | | | | 0.7500 | 0.6124 | 0.8750 | 0.3385 | | | 0.0000 | NA |
| 30 | 0.4167 | 0.3333 | 0.5833 | 0.1581 | 0.3333 | NA | 0.3333 | 0.0000 | 0.6667 | 0.4082 | 0.0000 | NA |
| 32 | 0.0000 | NA | 0.0000 | NA | 0.0000 | NA | 0.5000 | 0.2887 | 0.4167 | 0.6124 | 0.5000 | NA |
| 33 | | | | | 0.5714 | 0.2182 | 0.4286 | 0.2673 | 0.0000 | NA | 0.1429 | NA |
| 35 | 0.0833 | NA | 0.0000 | NA | | | | | 0.2500 | 0.2041 | | |
| 36 | | | | | 0.0000 | NA | 0.0000 | NA | | | 0.0000 | NA |
| 37 | 0.0000 | NA | 0.3333 | NA | 0.0000 | NA | 0.0000 | NA | 1.3333 | 2.1667 | 0.2500 | NA |
| 39 | 0.0000 | NA | 0.0833 | NA | | | | | 2.3333 | 3.0912 | | |
| 41 | 0.0000 | NA | 0 | NA | 0.0000 | NA | 0.0000 | NA | 2.4545 | 1.0660 | 0.0000 | NA |
| 43 | | | | | 0.0000 | NA | 0.0000 | NA | | | 0.0000 | NA |

| | 2002 | |
|---|---|---|
| Week | CPUE Pink | SE CPUE Pink |
| 16 | 56.8571 | 36.4776 |
| 17 | 156.7500 | 68.8266 |
| 18 | 4.3750 | 3.9739 |
| 19 | 0.4286 | NA |
| 20 | 7.4286 | 7.3271 |
| 21 | 71.3000 | 0.6708 |

**Table A3-2. Weekly catch per unit effort values and standard error for south mainland (WRIA 9) {see figures 3-6}. Note, shaded areas represent no sampling and NA means not applicable.**

| | 2001 | | | | 2002 | | | | 2001 | | 2002 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Week | CPUE Clipped Chinook | SE CPUE Clipped Chinook | CPUE Unclipped Chinook | SE CPUE Unclipped Chinook | CPUE Clipped Chinook | SE CPUE Clipped Chinook | CPUE Unclipped Chinook | SE CPUE Unclipped Chinook | CPUE Chum | SE CPUE Chum | CPUE Chum | SE CPUE Chum |
| 20 | 0.4444 | 0.0000 | 0.0000 | NA | | | | | 34.7778 | 7.0706 | | |
| 21 | | | | | 1.5000 | 0.5000 | 0.2500 | NA | | | 142.2500 | 88.0771 |
| 22 | 7.3333 | 3.1011 | 13.0000 | 5.7634 | | | | | 53.8333 | 23.9881 | | |
| 23 | | | | | 9.0000 | 4.0927 | 2.5000 | 0.7071 | | | 4.2500 | 1.0308 |
| 24 | 28.7143 | 11.7880 | 11.2857 | 3.6128 | | | | | 3.0000 | 1.0856 | | |
| 25 | | | | | 15.0000 | 13.4350 | 4.2500 | 3.8891 | | | 3.0000 | NA |
| 26 | 1.3333 | 0.3651 | 3.0000 | 0.8563 | | | | | 0.8333 | 0.2887 | | |
| 27 | | | | | 1.2500 | 1.0607 | 0.0000 | NA | | | 0.0000 | NA |
| 28 | 0.6667 | 0.2357 | 0.3333 | 0.0000 | | | | | 0.0000 | NA | | |
| 29 | | | | | 6.0000 | 3.9686 | 3.5000 | NA | | | 1.2500 | 0.3536 |
| 30 | 4.8333 | 1.5916 | 4.0000 | 2.1602 | 3.7500 | 4.5962 | 5.0000 | 4.9075 | 1.8333 | NA | 0.2500 | NA |
| 32 | 2.0000 | 0.6667 | 2.3333 | 0.4216 | 1.2500 | 1.0607 | 3.5000 | 2.1213 | 0.3333 | NA | 0.2500 | NA |
| 33 | | | | | 1.0000 | 0.2887 | 2.0000 | NA | | | 0.0000 | NA |
| 35 | 2.1429 | 0.5976 | 2.5714 | 0.5071 | | | | | 1.1429 | 1.0911 | | |
| 36 | | | | | 1.2500 | 1.0607 | 1.5000 | 0.5000 | | | 0.0000 | NA |
| 37 | 2.1667 | 1.0646 | 2.3333 | 0.7817 | 0.7500 | 0.3536 | 1.7500 | 0.3536 | 0.0000 | NA | 0.0000 | NA |
| 39 | 0.3333 | 0.0000 | 0.6667 | NA | 1.0000 | 0.0000 | 2.2500 | 1.7678 | 0.0000 | NA | 0.0000 | NA |
| 41 | 0.8000 | 0.2582 | 1.0000 | 0.9487 | 0.2500 | NA | 0.7500 | 0.3536 | 0.0000 | NA | 0.0000 | NA |
| 43 | 0.0000 | NA | 0.2000 | NA | 0.0000 | NA | 0.2000 | NA | 0.0000 | NA | 0.0000 | NA |
| 50 | | | | | 0.0000 | NA | 0.2500 | NA | | | 0.0000 | NA |

Table A3-2 concluded.

| | 2001 | | | | 2002 | | | | 2001 | | 2002 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Week | CPUE Clipped Coho | SE CPUE Clipped Coho | CPUE Unclipped Coho | SE CPUE Unclipped Coho | CPUE Clipped Coho | SE CPUE Clipped Coho | CPUE Unclipped Coho | SE CPUE Unclipped Coho | CPUE Cutthroat | SE CPUE Cutthroat | CPUE Cutthroat | SE CPUE Cutthroat |
| 20 | 7.7778 | 15.5563 | 0.3333 | NA | | | | | 0.1111 | NA | | |
| 21 | | | | | 2.7500 | 0.3536 | 9.2500 | 4.5092 | | | 0.7500 | NA |
| 22 | 0.1667 | NA | 1.0000 | 0.2357 | | | | | 0.5000 | NA | | |
| 23 | | | | | 0.7500 | 0.3536 | 1.2500 | 1.0607 | | | 0.2500 | NA |
| 24 | 1.2857 | 0.5669 | 0.1429 | | | | | | 1.0000 | 0.2070 | | |
| 25 | | | | | 0.2500 | NA | 1.2500 | 0.3536 | | | 1.2500 | 1.0607 |
| 26 | 0.8333 | 0.4714 | 2.1667 | 0.7416 | | | | | 1.3333 | 0.5774 | | |
| 27 | | | | | 0.0000 | NA | 0.2500 | NA | | | 0.7500 | 0.0000 |
| 28 | 0.3333 | NA | 0.1667 | NA | | | | | 0.5000 | 0.0000 | | |
| 29 | | | | | 0.5000 | 0.0000 | 0.7500 | 0.3536 | | | 0.0000 | NA |
| 30 | 0.3333 | 0.0000 | 0.6667 | 0.5774 | 0.0000 | NA | 0.0000 | NA | 0.1667 | NA | 0.0000 | NA |
| 32 | 0.0000 | NA | 0.0000 | NA | 0.0000 | NA | 0.0000 | NA | 0.1667 | NA | 1.2500 | 0.2500 |
| 33 | | | | | 0.0000 | NA | 0.2500 | NA | | | 0.5000 | 0.0000 |
| 35 | 0.0000 | NA | 0.0000 | NA | | | | | 0.1429 | NA | | |
| 36 | | | | | 0.2500 | NA | 0.0000 | NA | | | 0.0000 | NA |
| 37 | 0.0000 | NA | 0.0000 | NA | 0.0000 | NA | 0.0000 | NA | 0.0000 | NA | 0.0000 | NA |
| 39 | 0.0000 | NA | 0.3333 | 0.0000 | 0.0000 | NA | 0.0000 | NA | 0.3333 | 0.0000 | 0.5000 | NA |
| 41 | 0.0000 | NA | 0.0000 | NA | 0.0000 | NA | 0.0000 | NA | 1.4000 | 1.0328 | 0.2500 | NA |
| 43 | 0.0000 | NA | 0.0000 | NA | 0.0000 | NA | 0.0000 | NA | 0.0000 | NA | 0.0000 | NA |
| 50 | | | | | 0.0000 | NA | 0.0000 | NA | | | 0.0000 | NA |

**Table A3-3. Weekly catch per unit effort values and standard error for island sites (WRIA 9) {see figures 3-7}. Note, shaded areas represent no sampling and NA means not applicable.**

| | 2001 | | | | 2002 | | | | 2001 | | 2002 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Week | CPUE Clipped Chinook | SE CPUE Clipped Chinook | CPUE Unclipped Chinook | SE CPUE Unclipped Chinook | CPUE Clipped Chinook | SE CPUE Clipped Chinook | CPUE Unclipped Chinook | SE CPUE Unclipped Chinook | CPUE Chum | SE CPUE Chum | CPUE Chum | SE CPUE Chum |
| 20 | 0.3333 | 0.2357 | 0.0000 | NA | 5.8095 | 7.8478 | 0.4286 | 0.7715 | 25.4444 | 10.4425 | 290.0000 | 138.3097 |
| 21 | | | | | 5.8333 | 6.5107 | 0.1667 | NA | | | 89.6667 | 100.8709 |
| 22 | 2.6667 | 3.4641 | 0.3333 | 0.0000 | 4.3929 | 4.1405 | 0.3571 | 0.5669 | 48.8333 | 11.0013 | 371.3214 | 207.5832 |
| 23 | | | | | 7.6667 | 5.9048 | 0.3333 | NA | | | 22.6667 | 10.3870 |
| 24 | 3.0000 | 2.5927 | 2.5000 | 3.1754 | | | | | 10.3333 | 6.9081 | | |
| 25 | | | | | 26.6667 | 14.3170 | 2.8333 | 1.0737 | | | 85.3333 | 38.9681 |
| 26 | 0.1667 | | 1.0000 | 0.4082 | | | | | 3.0000 | 1.7321 | | |
| 28 | 0.8571 | 0.2182 | 0.5714 | 0.5345 | | | | | 0.8571 | 0.5345 | | |
| 29 | | | | | 2.6000 | 0.7483 | 0.8000 | 0.0000 | | | 4.0000 | 2.2061 |
| 30 | 4.5000 | 1.8394 | 3.1667 | 0.7923 | 2.6667 | 1.2019 | 0.8333 | 0.2357 | 0.3333 | 0.0000 | 1.3333 | 0.5774 |
| 32 | 3.1667 | 1.0567 | 2.5000 | 0.8165 | 1.0000 | 0.4082 | 1.5000 | 0.7071 | 0.8333 | 0.2887 | 0.6667 | 0.2357 |
| 33 | | | | | 2.0000 | 0.8165 | 3.5000 | 1.4549 | | | 0.1667 | NA |
| 35 | 1.7143 | 1.0235 | 0.7143 | 0.2182 | | | | | 4.7143 | NA | | |
| 36 | | | | | 0.3333 | NA | 0.8333 | 0.2357 | | | 0.0000 | NA |
| 37 | 1.3333 | 1.7321 | 0.5000 | NA | 1.7143 | 0.3381 | 2.2857 | 0.8194 | 0.3333 | NA | 0.0000 | NA |
| 39 | 0.0000 | NA | 0.1667 | NA | | | | | 0.0000 | NA | | |
| 41 | 0.8667 | 1.4907 | 1.7333 | 2.8402 | 0.2857 | NA | 0.7143 | 0.4364 | 0.7333 | 0.7454 | 0.0000 | NA |
| 43 | | | | | 0.0000 | NA | 0.2727 | 0.2132 | | | 0.0000 | NA |

Table A3-3 concluded.

| | 2001 | | | | 2002 | | | | 2001 | | 2002 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Week | CPUE Clipped Coho | SE CPUE Clipped Coho | CPUE Unclipped Coho | SE CPUE Unclipped Coho | CPUE Clipped Coho | SE CPUE Clipped Coho | CPUE Unclipped Coho | SE CPUE Unclipped Coho | CPUE Cutthroat | SE CPUE Cutthroat | CPUE Cutthroat | SE CPUE Cutthroat |
| 20 | 0.1111 | NA | 0.0000 | NA | 15.1429 | 13.7548 | 2.0476 | 2.0410 | 0.0000 | NA | 0.0000 | NA |
| 21 | | | | | 3.5000 | 2.6771 | 2.0000 | NA | | | 0.3333 | 0.0000 |
| 22 | 0.0000 | NA | 0.0000 | NA | 1.0714 | 2.0845 | 0.6429 | 0.5225 | 0.0000 | NA | 0.4643 | 0.2245 |
| 23 | | | | | 0.0000 | NA | 0.1667 | NA | | | 0.0000 | NA |
| 24 | 0.0000 | NA | 0.6667 | 0.0000 | | | | | 0.3333 | 0.0000 | | |
| 25 | | | | | 0.0000 | NA | 0.1667 | NA | | | 0.3333 | 0.0000 |
| 26 | 0.0000 | NA | 0.1667 | NA | | | | | 0.0000 | NA | | |
| 28 | 0.1429 | NA | 0.0000 | NA | | | | | 0.0000 | NA | | |
| 29 | | | | | 0.0000 | NA | 0.0000 | NA | | | 0.0000 | NA |
| 30 | 0.0000 | NA | 0.0000 | NA | 0.1667 | NA | 0.1667 | NA | 0.1667 | NA | 1.3333 | 1.7321 |
| 32 | 0.0000 | NA | 0.0000 | NA | 0.0000 | NA | 0.0000 | NA | 0.0000 | NA | 0.1667 | NA |
| 33 | | | | | 0.1667 | NA | 0.0000 | NA | | | 0.1667 | NA |
| 35 | 0.0000 | NA | 1.0000 | NA | | | | | 0.0000 | NA | | |
| 36 | | | | | 0.1667 | NA | 0.0000 | NA | | | 0.6667 | NA |
| 37 | 0.0000 | NA | 0.0000 | NA | 0.0000 | NA | 0.0000 | NA | 0.0000 | NA | 0.2857 | 0.0000 |
| 39 | 0.0000 | NA | 0.1667 | NA | | | | | 0.1667 | NA | | |
| 41 | 0.0000 | NA | 0.2000 | NA | 0.0000 | NA | 0.0000 | NA | 0.0000 | NA | 0.4286 | 0.2673 |
| 43 | | | | | 0.0000 | NA | 0.0000 | NA | | | 0.1818 | 0.0000 |

**Table A3-4. Catch per unit effort values and standard error for annual CPUE by region (see figure 3-8)**

| | 2001 | | | | 2002 | | | |
|---|---|---|---|---|---|---|---|---|
| Region | Clipped Chinook | SE Clipped Chinook | Unclipped Chinook | SE Unclipped Chinook | Clipped Chinook | SE Clipped Chinook | Unclipped Chinook | SE Unclipped Chinook |
| North Mainland | 1.0357 | 0.2839 | 0.7857 | 0.2026 | 1.7190 | 1.1898 | 1.5702 | 0.7989 |
| South Mainland | 4.8000 | 1.7829 | 3.6571 | 0.9300 | 2.9649 | 1.3012 | 1.9474 | 0.6439 |
| Vashon/Maury | 1.5375 | 0.4500 | 1.2000 | 0.5054 | 4.4634 | 1.8654 | 0.8699 | 0.2020 |
| | 2001 | | | | 2002 | | | |
| | Clipped Coho | SE Clipped Coho | Unclipped Coho | SE Unclipped Coho | Clipped Coho | SE Clipped Coho | Unclipped Coho | SE Unclipped Coho |
| North Mainland | 0.1143 | 0.0550 | 0.5786 | 0.2254 | 0.8595 | 0.3634 | 3.3140 | 1.5600 |
| South Mainland | 1.2714 | 2.1995 | 0.4286 | 0.1504 | 0.3158 | 0.2719 | 0.9123 | 0.8483 |
| Vashon/Maury | 0.0250 | 0.0000 | 0.2000 | 0.2517 | 3.0244 | 4.0080 | 0.6179 | 0.5726 |
| | 2001 | | 2002 | | 2001 | | 2002 | |
| | Chum | SE Chum | Chum | SE Chum | Pink | SE Pink | Pink | SE Pink |
| North Mainland | 8.6571 | 6.4472 | 53.1322 | 15.5678 | 0.0000 | 0.0000 | 20.2893 | 13.9202 |
| South Mainland | 9.7571 | 4.2430 | 10.6140 | 14.9279 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Vashon/Maury | 8.2625 | 2.9375 | 143.9512 | 69.0087 | 0.0000 | 0.0000 | 0.5122 | 3.8892 |
| | 2001 | | 2002 | | | | | |
| | Cutthroat | SE Cutthroat | Cutthroat 2002 | SE Cutthroat 2002 | | | | |
| North Mainland | 1.2357 | 0.4538 | 0.6033 | 0.2740 | | | | |
| South Mainland | 0.4857 | 0.1316 | 0.3860 | 0.1213 | | | | |
| Vashon/Maury | 0.0500 | 0.0000 | 0.3089 | 0.1349 | | | | |

**Table A3-5. Catch per unit effort values and standard error for annual CPUE by site (see figures 3- 9).**

| | 2001 | | | | 2002 | | | | 2001 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Location | Clipped Chinook | SE Clipped Chinook | Unclipped Chinook | SE Unclipped Chinook | Clipped Chinook | SE Clipped Chinook | Unclipped Chinook | SE Unclipped Chinook | Clipped Coho | SE Clipped Coho | Unclipped Coho | SE Unclipped Coho |
| Richmond Beach | 1.2609 | 0.4445 | 1.2174 | 0.5517 | 3.1842 | 3.7075 | 2.9737 | 2.3270 | 0.1739 | 0.1204 | 0.8261 | 0.6516 |
| Carkeek | 1.4167 | 1.3966 | 0.8750 | 0.7817 | 0.9545 | 0.4959 | 1.2273 | 0.5576 | 0.1667 | 0.2887 | 0.3333 | 0.1118 |
| Golden Gardens | 0.9524 | 0.4912 | 0.4286 | 0.1065 | 1.8333 | 0.8014 | 1.0333 | 0.2518 | 0.0952 | 0.0000 | 0.4762 | 0.9258 |
| Lincoln Park | 8.6250 | 4.5704 | 6.7083 | 2.2151 | 5.5357 | 2.1150 | 3.2143 | 1.0068 | 0.2083 | 0.1021 | 0.2083 | 0.0000 |
| Seahurst Park | 2.4800 | 1.0793 | 1.8800 | 0.5750 | 0.4828 | 0.2579 | 0.7241 | 0.5867 | 0.6000 | 0.2430 | 0.6400 | 0.2760 |
| KVI | 1.5172 | 1.0363 | 1.2414 | 0.5814 | 2.7500 | 1.9608 | 1.3333 | 0.5074 | 0.0345 | 0.0000 | 0.1724 | 0.1072 |
| Maury Is. Park | 1.6207 | 0.5565 | 1.7241 | 1.2380 | 3.3182 | 1.5477 | 0.5909 | 0.2261 | 0.0345 | 0.0000 | 0.3793 | 0.5673 |

| | 2002 | | | | 2001 | | 2002 | | 2001 | | 2002 | | 2002 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Location | Clipped Coho | SE Clipped Coho | Unclipped Coho | SE Unclipped Coho | Chum 2001 | SE Chum | Chum | SE Chum | Cutthroat | SE Cutthroat | Cutthroat | SE Cutthroat | Pink | SE Pink |
| Richmond Beach | 0.4474 | 0.3086 | 1.8684 | 1.8848 | 29.3913 | 28.3928 | 63.5000 | 29.8973 | 0.0870 | 0.0000 | 0.1579 | 0.1622 | 20.3947 | 29.9379 |
| Carkeek | 0.3182 | 0.0870 | 0.7273 | 0.2780 | 2.8333 | 1.4814 | 0.5909 | 1.2309 | 0.1250 | 0.0000 | 0.2727 | 0.1231 | 0.0000 | 0.0000 |
| Golden Gardens | 0.2000 | 0.1054 | 0.8000 | 0.2611 | 6.7143 | 15.7162 | 5.8333 | 9.6183 | 0.0952 | 0.0000 | 0.2667 | 0.1633 | 0.0000 | 0.0000 |
| Lincoln Park | 0.4286 | 0.2827 | 1.7500 | 1.2707 | 18.7083 | 9.7056 | 19.2143 | 25.8073 | 0.2083 | 0.0000 | 0.3214 | 0.0922 | 0.0000 | 0.0000 |
| Seahurst Park | 0.2069 | 0.0000 | 0.1034 | 0.0000 | 4.4000 | 2.4972 | 2.3103 | 5.2333 | 0.7600 | 0.1992 | 0.4483 | 0.2206 | 0.0000 | 0.0000 |
| KVI | 0.0000 | 0.0000 | 0.0833 | 0.0000 | 11.5862 | 5.3605 | 6.3333 | 7.0257 | 0.0690 | 0.0000 | 0.0417 | 0.0000 | 0.0000 | 0.0000 |
| Maury Is. Park | 0.9545 | 1.3981 | 0.5455 | 0.0000 | 10.0690 | 4.9720 | 29.5000 | 30.5893 | 0.0345 | 0.0000 | 0.0455 | 0.0000 | 2.8636 | 9.1961 |

# APPENDIX 4

**Numbers, locations, and dates of all juvenile chinook salmon analyzed for diet contents.**

| Chinook 2001 | | | | | Chinook 2002 | | | |
|---|---|---|---|---|---|---|---|---|
| **Region** | **Site** | **Date** | **n** | | **Region** | **Site** | **Date** | **n** |
| Island | Burton | 6/28/01 | 2 | | Island | Burton | 5/22/02 | 1 |
| | | 7/12/01 | 2 | | | | 6/5/02 | 1 |
| | | 7/26/01 | 15 | | | Camp Sealth | 7/23/02 | 6 |
| | | 8/9/01 | 12 | | | | 8/6/02 | 1 |
| | | 8/30/01 | 1 | | | | 10/22/02 | 2 |
| | KVI | 5/31/01 | 5 | | | DNR | 6/18/02 | 15 |
| | | 6/13/01 | 6 | | | | 7/16/02 | 5 |
| | | 6/28/01 | 4 | | | KVI | 6/5/02 | 7 |
| | | 7/12/01 | 5 | | | | 6/18/02 | 9 |
| | | 7/26/01 | 4 | | | | 7/16/02 | 2 |
| | | 8/9/01 | 4 | | | | 7/23/02 | 5 |
| | | 8/30/01 | 2 | | | | 8/6/02 | 5 |
| | | 9/14/01 | 10 | | | | 8/13/02 | 5 |
| | | 9/27/01 | 1 | | | | 9/4/02 | 2 |
| | | 10/10/01 | 1 | | | | 9/10/02 | 6 |
| | Maury Is | 5/31/01 | 2 | | | Maury Is | 5/13/02 | 3 |
| | | 7/26/01 | 12 | | | | 5/14/02 | 5 |
| | | 8/9/01 | 12 | | | | 5/15/02 | 4 |
| | | 8/30/01 | 9 | | | | 5/22/02 | 10 |
| | | 9/14/01 | 1 | | | | 5/30/02 | 2 |
| | | 10/9/01 | 10 | | | | 6/5/02 | 5 |
| North | Carkeek | 5/16/01 | 1 | | | | 6/18/02 | 5 |
| | | 6/26/01 | 4 | | | | 7/16/02 | 7 |

**Chinook 2001**

| Region | Site | Date | n |
|---|---|---|---|
| | | 7/10/01 | 4 |
| | | 7/24/01 | 12 |
| | | 9/25/01 | 1 |
| | Golden Gardens | 5/29/01 | 3 |
| | | 6/26/01 | 2 |
| | | 7/10/01 | 1 |
| | | 7/24/01 | 2 |
| | | 8/7/01 | 1 |
| | | 8/28/01 | 4 |
| | Meadowdale | 5/15/01 | 7 |
| | | 5/30/01 | 2 |
| | | 6/11/01 | 2 |
| | | 7/9/01 | 11 |
| | | 7/23/01 | 6 |
| | | 8/27/01 | 2 |
| | | 9/24/01 | 1 |
| | Oceanview | 5/30/01 | 6 |
| | | 6/12/01 | 6 |
| | | 7/9/01 | 1 |
| | | 8/6/01 | 1 |
| | | 8/27/01 | 3 |
| | | 9/10/01 | 3 |
| | | 10/11/01 | 1 |
| | Picnic Pt | 5/15/01 | 2 |
| | | 5/30/01 | 1 |

**Chinook 2002**

| Region | Site | Date | n |
|---|---|---|---|
| | | 7/23/02 | 4 |
| | | 8/6/02 | 7 |
| | | 8/13/02 | 9 |
| | | 9/4/02 | 1 |
| | | 9/10/02 | 5 |
| | | 10/8/02 | 1 |
| | Pt Robinson | 8/13/02 | 6 |
| | | 9/4/02 | 4 |
| | | 9/10/02 | 5 |
| | | 10/8/02 | 6 |
| | | 10/22/02 | 1 |
| North | Carkeek | 5/20/02 | 4 |
| | | 6/6/02 | 8 |
| | | 7/17/02 | 7 |
| | | 7/24/02 | 3 |
| | | 8/14/02 | 5 |
| | | 9/5/02 | 2 |
| | | 10/23/02 | 1 |
| | Edmonds | 5/3/02 | 1 |
| | | 5/16/02 | 1 |
| | Golden Gardens | 6/4/02 | 5 |
| | | 6/6/02 | 2 |
| | | 6/17/02 | 5 |
| | | 7/1/02 | 13 |
| | | 7/15/02 | 4 |

**Chinook 2001**

| Region | Site | Date | n |
|---|---|---|---|
| | | 8/27/01 | 8 |
| | | 9/24/01 | 5 |
| | Richmond | 5/29/01 | 2 |
| | | 6/12/01 | 6 |
| | | 6/26/01 | 10 |
| | | 9/11/01 | 4 |
| | | 9/25/01 | 2 |
| South | Lincoln | 6/14/01 | 19 |
| | | 6/27/01 | 8 |
| | | 7/11/01 | 2 |
| | | 7/25/01 | 7 |
| | | 8/8/01 | 6 |
| | | 8/29/01 | 11 |
| | | 9/12/01 | 1 |
| | | 9/26/01 | 5 |
| | | 10/10/01 | 6 |
| | Marineview | 6/14/01 | 6 |
| | | 6/27/01 | 5 |
| | | 7/11/01 | 3 |
| | | 8/8/01 | 7 |
| | | 8/29/01 | 10 |
| | | 9/26/01 | 1 |
| | | 10/10/01 | 2 |
| | Seahurst | 6/1/01 | 3 |
| | | 6/14/01 | 10 |

**Chinook 2002**

| Region | Site | Date | n |
|---|---|---|---|
| | | 7/22/02 | 4 |
| | | 8/12/02 | 5 |
| | | 10/9/02 | 2 |
| | Meadowdale | 5/10/02 | 1 |
| | | 5/16/02 | 2 |
| | Picnic Pt | 5/16/02 | 1 |
| | Richmond | 5/10/02 | 2 |
| | | 6/6/02 | 6 |
| | | 6/19/02 | 18 |
| | | 7/17/02 | 3 |
| | | 7/24/02 | 4 |
| | | 8/7/02 | 1 |
| | | 8/14/02 | 10 |
| | | 9/5/02 | 4 |
| | | 9/11/02 | 5 |
| | | 10/7/02 | 3 |
| South | Lincoln | 5/21/02 | 5 |
| | | 6/4/02 | 11 |
| | | 6/17/02 | 14 |
| | | 7/1/02 | 5 |
| | | 7/15/02 | 11 |
| | | 7/22/02 | 12 |
| | | 8/5/02 | 5 |
| | | 8/12/02 | 7 |
| | | 9/3/02 | 6 |

**Chinook 2001**

| Region | Site | Date | n |
|---|---|---|---|
| | | 6/27/01 | 4 |
| | | 7/11/01 | 2 |
| | | 7/25/01 | 14 |
| | | 8/8/01 | 11 |
| | | 8/29/01 | 7 |
| | | 9/12/01 | 12 |
| | | 10/10/01 | 1 |
| Total | | | 410 |

**Chinook 2002**

| Region | Site | Date | n |
|---|---|---|---|
| | | 9/9/02 | 5 |
| | | 9/23/02 | 5 |
| | | 10/9/02 | 2 |
| | | 10/21/02 | 1 |
| | Seahurst | 5/21/02 | 2 |
| | | 6/4/02 | 5 |
| | | 7/15/02 | 2 |
| | | 7/24/02 | 2 |
| | | 8/5/02 | 5 |
| | | 8/12/02 | 1 |
| | | 9/3/02 | 2 |
| | | 9/23/02 | 4 |
| | | 10/9/02 | 2 |
| | | 10/21/02 | 1 |
| Total | | | 409 |