This edition does not include a full set of appendices.

BIOLOGICAL AND WATER QUALITY MONITORING IN THE RUSSIAN RIVER ESTUARY, 1999

FOURTH ANNUAL REPORT

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I. SUMMARY

This report summarizes the results for the fourth year of a five-year study to evaluate the impact of sandbar breaching at the mouth of the Russian River. The study included water quality sampling, fish and invertebrate sampling, and observations of pinniped numbers and behavior before, during, and after breaching. As in earlier studies in this series, fish and water quality surveys were made on three dates for each event: a pre-breaching survey made while the beach was closed and the water level high, a draining survey made the day following breaching, and a tidal survey made after the river mouth had been open for a few days.

In the summer of 1999 the Russian River estuary mouth closed twice in June, and then remained open for the next 78 days. The sandbar was breached five times in September, October, and November. This pattern of berm closures and breachings concentrated in fall was similar to most years studied except 1997 (when closures first occurred in late March). Five breaching events were studied in 1998.

STUDY RESULTS AND CONCLUSIONS

After four years of study, no major impacts of the breaching process on the biota of the estuary have been shown. The estuary has a biota that is adapted to survival in an environment that naturally alternates between being a tidal estuary and a coastal lagoon, and, in general, the bar-open state is more beneficial to the local biota. Additional conclusions derived from the study programs conducted over the last four years are as follows:

- The biota of the estuary exhibits high variability from one year to the next.

- The occurrence of low DO in the near-bottom layers of deep pools is often associated with bar-closed conditions, but anoxia can develop under tidal conditions during neap tides and/or low river flows.

- The renewal of DO in the saline near-bottom layers of deep pools is mediated by an interplay between river flow and tidal action (spring/neap cycle) in addition to post-breaching flushing.

- The appearance of sustained low DO in water draining from Willow Creek following breaching apparently can be avoided by breaching before the water level is 7 feet.

- Localized mortalities of marine species near the Willow Creek mouth under the current program of breaching before the water level reaches 7 feet were likely to have been caused by sudden immersion in freshwater. This effect is unlikely to impact mobile species such as salmonids which can actively avoid localized unsuitable conditions.

- Smolts of wild steelhead use the estuary during the summer and fall, and breaching provides an intermittent avenue to the sea. Steelhead evidently do not remain long enough in the estuary to show accelerated growth.

- Seals haul out near the mouth of the Russian River when the sand bar is open and are generally present in low numbers or absent from the site during bar closed conditions in late summer and fall, when closings are most common.

- When seals are present at the haulout during bar closed conditions, breaching activities usually result in evacuation of the haulout. Some disturbance is unavoidable since the haulout is located at the breaching site.

- Beach visitors approaching the breaching site/haulout often result in greater seal disturbances than the breaching process itself. This can be minimized by effective patrolling of the site before, during, and following breaching in conjunction with effective positioning of signs and cordons.

RECOMMENDATIONS

The four-year study has shown that the present program of artificial breaching of the estuary has no apparent negative impact on the aquatic habitat of fish and seals. Provided that breaching takes place before the water level reaches 7 feet on the gage at Jenner, the biological resources of the estuary appear to be protected. The present program of biological monitoring before, during, and after each breaching episode has been appropriate to reveal any potential negative impacts of breaching on biological resources in the estuary, but is not an efficient way of studying the general biological health of the estuary. In particular, the distribution of sampling effort so far has been largely concentrated in fall, when occupation of the estuary by many fish species is minimal…In the event that a biological monitoring program in the estuary is to be continued, it is recommended that sampling of breaching events be limited to maintenance of Datasondes to monitor temperature, salinity and DO at two locations in and near the mouth of Willow Creek. Continuation of level recording near Willow Creek bridge is not necessary provided that a continuous record is available from the Visitor's Center in Jenner (data collected in 1999 show that lag times in water level changes between Willow Creek and Jenner following breaching are negligible). A program of regular biological sampling cruises distributed throughout most of the year would expend no more effort (even with replicated sampling) than has been given to breaching studies, but would provide more basic and valuable information on seasonal use and general biological health of the estuary.

Monthly biological sampling (otter trawl and beach seine) conducted year-round during bar-open conditions is recommended, with the sampling performed at the same stations as used in the 1999 study. Where possible, samples should be replicated one or more times at each station. For example, beach seining could be replicated at Stations 3 and 4, but probably not at Station 1, whereas, paired otter trawls could be conducted at each station.

Based upon the pinniped monitoring results, it is recommended that the practice of posting signs 24 hours prior to breaching and leaving them in place for 24 hours following continue. Monitoring of breaching events shows that proper cordons and presence of the breaching crew helps to ensure public safety and contributes to less disturbance of the haul out. Placing signs and cordons on the jetty and across the entire width of the north side of the sand bar would likely be more effective in keeping visitors away from the haulout and breaching site. It is recommended that personnel be left on either side of the breach at least until the end of the breaching day to keep visitors away from the breach and to allow seals to haul out. In addition, Agency observers stationed at the overlook should radio the crew on the beach when visitors ignore the signs and approach the breaching activities.

The breaching process often results in the evacuation of the haulout. In some instances, disturbance of the haulout is unavoidable due to its proximity to the breaching site. However, the breaching crew may be unnecessarily close to the seals or shout loudly during the course of their work. It is recommended, that as much as possible, the crew keep a distance from the seals (perhaps by standing on the jetty to allow seals to cross the sand bar or to enter the breach cut) and keep noise to a minimum to limit disturbance of the haulout.

II. INTRODUCTION

BACKGROUND

The Russian River estuary in Sonoma County is subject to frequent closure by the formation of a barrier beach across its mouth. The barrier beach is artificially breached by personnel from the Sonoma County Water Agency (SCWA) when the water level behind the beach berm increases to levels which threaten to inundate shoreline properties. SCWA has responsibility for management of the breaching program and for biological monitoring of breaching events in the estuary.

A study of the hydrological, biological, and social impacts of artificially breaching the mouth of the Russian River was conducted in 1992-1993 for Sonoma County and the California State Coastal Conservancy under the direction of the Russian River Interagency Task Force. The final report of that study (Heckel, 1994) included selection of a preferred estuary management program which was used as the basis for the Russian River Estuary Management Plan subsequently adopted by the Board of Supervisors. The Management Plan includes biological and water quality monitoring to be conducted during artificial breaching events to support the adopted management approach or provide the basis for modification, as appropriate. The present report is the fourth of five annual biological monitoring studies required by the Management Plan.

The results of the 1996, 1997, and 1998 study programs were presented in previous reports (MSC 1997, 1998, 1999). This report presents the results of the 1999 field study and includes discussion of the data collected over the four-year period.

STUDY PROGRAM

The study program conducted during 1999 was similar to the approach used in the 1997 and 1998 studies, in that pre-breaching, draining, and tidal fish and water quality surveys were conducted; and pinniped monitoring was done on breaching and postbreaching days. In 1997 pre-breaching surveys were conducted after the river mouth had been closed at least seven days; however, due to higher summer river flows in 1998, the mouth never remained closed longer than 5 days. In 1999 the river remained closed for less than 7 days before most of the breachings. The following elements were included in the 1999 study:

- A “preclosure” tidal survey and Hydrolab Datasonde installation cruise was made on 8 June 1999, before the estuary closed for the first time. Datasondes are submerged continuous-recording meters that record temperature/salinity/ and dissolved oxygen and were deployed at three estuary locations throughout the study period.

- “Pre-breaching” surveys were conducted after the river mouth closed and the water was at an elevation of 5-7 feet on the Jenner gage.

- "Draining" surveys were conducted on the day following successful breaching, while the system was still in the process of being flushed.

- "Tidal" surveys were conducted two to four days after breaching, so that the data collected would be representative of typical bar-open, tidal circulation in the estuary.

- Access was obtained to hourly recorded estuary depth data records from the Jenner visitor center gage, and a second recording depth gage was installed on the Willow Creek bridge to record hourly.

- Pinniped monitoring was performed before, during, and after breaching events.

The locations of the primary sampling stations (Figure 2-1) are the same sites used in 1996-1998 studies. Stations 2, 3, and 4 are at the same locations as the corresponding stations used for biological and water quality sampling in the previous study (Heckel, 1994). The 1999 study included two additional sampling sites (3AA and 3AAA) in the vicinity of the Willow Creek mouth, where water quality problems were identified in 1998.

At Station 1, otter trawls and water quality measurements were taken near the jetty in water 8-11 meters (m) deep, but the beach seining for Station 1 was conducted at the western tip of Penny Island, about 300 m from the pier pilings. Beach seining was, by necessity, conducted at gently sloping beaches located as closely as possible to the designated station locations used for otter trawling and water quality sampling.

At Station 2, no beach seining was conducted in 1999 because the beach slope is too steep for seine deployment during pre-breaching (high water level) surveys, and post-breaching (low water level) surveys were not possible because of the numerous snags that accumulated there since the 1997 field season. No nearby site suitable for seining was identified. Otter trawls and water quality profiles were taken during each survey, in the 6-8 m deep channel adjacent to the south shore.

At Station 3, beach seining was conducted on the beach in front of the Ranger's residence just upstream of the mouth of Willow Creek, whereas, water quality sampling was conducted in the deep (4 m) channel adjacent to the east bank of the Russian River 200 m downstream from the Willow Creek mouth. Otter trawling was conducted in shallow (2 m) water near the deep channel (the deep channel was filled with submerged trees and large rock outcrops). On each pre-breaching survey, and on other surveys whenever the creek was navigable, water quality profiles were also taken inside Willow Creek at a location (Station 3A) about 0.5 km upstream from the bridge where the water was about 2 m deep at high water (Figure 2-1). Sampling in the vicinity of the Willow Creek mouth was also conducted at two additional locations. Profiles were made near the Willow Creek bridge, (Station 3AA), where a recording Datasonde was also located. Additional sampling was done in the last month of the 1999 study (mid-October through mid-November) at a location in the mouth of the creek downstream of the bridge (Station 3AAA), in the area where dead fish were observed on one occasion in 1998, and where dead crabs were seen in 1999 (see below). On survey days when Willow Creek was not

Figure 2-1

navigable, temperature, salinity, and dissolved oxygen were measured in shallow water located downstream of Willow Creek bridge, between Stations 3AA and 3AAA. This area is riffle-like when there is flow from the creek, and standing when there is no flow (as in the 1999 surveys).

At Station 4, water quality sampling was conducted in the deep (14 m) channel pool adjacent to the rocky cliff on the northwest bank of the Russian River just below the mouth of Sheephouse Creek. Otter trawling followed a route that included both the deep channel and shallower nearshore waters, and beach seining was done on the southeast bank opposite the mouth of Sheephouse Creek.

The potential effects of artificially breaching the sand bar at the Russian River estuary on pinnipeds were monitored by counting seal numbers and observing seal behavior before, during, and following breaching events.

METHODS

Water Quality Monitoring

Water quality vertical profiles (observations at 1 m vertical intervals) were conducted at each station each time biological sampling was conducted. Portable YSI salinity and dissolved oxygen (DO) meters were used to obtain *in situ* data on temperature, salinity, conductivity, and dissolved oxygen. The profiles were performed in the deepest part of the channel at each station, to determine whether or not salinity stratification was present. Near each water quality monitoring station a monument was established from which the water level at the time of sampling was measured. This enabled the water depths to be expressed relative to zero on the staff gage at the Jenner visitor's center. Water quality profiles for the 1999 data could therefore be plotted relative to this datum.

As in the 1997 and 1998 studies, Datasondes were installed in three locations in the estuary. These instruments were used to record hourly temperature, salinity, and DO a few centimeters above the river bottom. The Datasondes were typically retrieved on the day of the pre-breaching surveys and returned to the laboratory where data files were downloaded and the instruments were cleaned, serviced, and recalibrated. Datasondes were redeployed the following morning. Datasondes were deployed continuously throughout the study season. Their locations were modified somewhat based on results in previous studies. The Willow Creek Datasonde was moved from Station 3A to a location of similar depth near the creek bridge (Station 3AA), in order to insure that it occupied a site which would be exposed to all runoff which entered the estuary from Willow Creek and its marsh during draining episodes. The other two Datasondes were deployed at Stations 3 and 4. During the last month of the 1999 study, the Datasonde used at Station 4 was moved to a site in the mouth of Willow Creek downstream of the bridge (Station 3AAA). No Datasonde deployments were made at Station 1 in 1999.

A recording depth gage (Isco 3220) was installed under the Willow Creek Bridge (Station 3AA) on 3 June 1999. It provided an hourly record of estuary heights that supplemented recording gage data collected at the Jenner Visitor's Center, which was made available by SCWA.

Biological Monitoring: Fish and Macro-Invertebrates

Otter trawls are nets which are dragged along the bottom behind a boat. Otter trawl sampling was conducted in the deep channel at each station to collect slow-moving, benthic fishes and macro-invertebrates (e.g., crabs, shrimp, and mysids). The trawl used in this study is 8 feet wide at the mouth, with 1/8-inch. (square) mesh throughout. Single tows of four-minute duration were conducted at each station. The trawl was towed at 3-5 miles per hour behind a 16-foot. aluminum skiff powered by a 15 horsepower outboard motor. After each successful trawl was completed, the contents of the net were brought aboard and emptied into a large plastic tray filled with water for sorting, counting, and species identification. Nearly all specimens were released alive and unharmed. A small number of invertebrates and non-salmonid juvenile or larval fish were preserved for closer examination in the laboratory. Fish were identified to the species level, except for a few juvenile rockfish, which were identified only to the genus *Sebastes*. Most invertebrates were identified to species; in a few cases identifications were only to the genus or family level.

Beach seines collect fishes throughout the water column near shore. Beach seine sampling was used to capture more agile fishes (especially salmonids) which cannot be caught by otter trawl, as well as mid-water fishes. The beach seine used in this study is 100 ft. long, 8 ft. deep, with an 8 by 8 by 8 ft. bag in the center, and is composed of 3/8 in. mesh knotless nylon netting. The seine was deployed by using the boat to pull one end offshore, and then around in a half-circle while the other end was held onshore by another person. Both team members then pulled the net ashore by hand. Captured fish and invertebrates were placed in a water-filled tray for sorting, identifying, and counting prior to release. Captured salmonid smolts were also measured and examined closely for general condition and wild *versus* hatchery origin prior to release.

Biological Monitoring: Plankton

Plankton trawls were not included in the 1999 studies. The Russian River Estuary Management Task Force decided at its meeting on 20 May 1999 that the plankton sampling conducted in the earlier studies was not providing useful information about water quality in the vicinity of the Willow Creek mouth.

Biological Monitoring: Pinnipeds

Pinniped monitoring was performed during pre-breaching, breaching, and post-breaching events. Pre-breaching observations were made one to three days prior to breaching day and post-breaching occurred the day following breaching. Seals were counted on half-hour intervals throughout the day by an observer stationed on the bluffs adjacent to Highway One overlooking the seal haul out at the mouth of the Russian River. Disturbance of the seals was logged throughout the day (Appendix III in Appendix C of this report). These disturbances were analyzed using the method previously developed at

Jenner (Mortenson, 1996), which was derived from the standard interference measures used in studies at the Point Reyes National Seashore (Allen, 1984; Allen and King, 1992). The observer would note the source of the disturbance, the seal behavioral response, and the duration of disturbance (in minutes). This generates an hourly interference rate (the number of minutes per hour in which disturbance occurred).

Data showing seasonal trends in pinniped use of the haulout were obtained from separate, ongoing observations made by Elinor Twohy (Appendix I in Appendix C of this report). Ms. Twohy conducts a daily count of the seals from the same vantage point as used in this monitoring effort.

III. Results

Breaching Events and Monitoring Effort in 1999

The bar closed twice in June but then remained open for 78 days, not closing again until 17 September (Table 3-1, Figures 3-1 through 3-6). Five closures and breachings occurred between late September and mid-November, when the 1999 surveys ended. Hydrographic details including predicted tidal height, river flow, water level at Jenner Visitor Center, and water level at Willow Creek bridge, are given for each study month in Figures 3-1 through 3-6. Water levels recorded at Willow Creek bridge closely followed those at Jenner at high water, but since the mouth of the creek is approximately 2 feet above the zero point on the Jenner scale, levels measured in the creek never dropped below 2 feet. Level data collected at the creek mouth are useful to elucidate the time lag between changes in levels between the creek and the near the estuary mouth (Jenner). Also, the Jenner data were discontinuous due to occasional gage malfunction. Figure 3-4 shows that the berm closure of 17 September coincided with neap tides, while the river was flowing at 250 cfs. The role of river flow and the spring/neap tidal cycle on the distribution of water quality variables in the estuary is treated in the discussion.

In 1999, five breaching events were studied, one in June/July, one in September, two in October, and one in November (Table 3-2). A preliminary tidal cruise was made on 8 June when Datasondes were deployed and water quality profiles obtained. The first event (closed on 12 June, breached on 15 June) was not studied. A second tidal cruise was conducted on 24 August in order to download and recalibrate Datasondes. Fish collections and water quality profiles were included. No tidal survey was made in conjunction with the second studied breaching (berm was open less than 2 days, see Figure 3-4), and the pre-breaching survey in November was made early on the breaching day. The survey was completed before the estuary had significantly drained. The tidal survey following the breaching of 5 November could not be made until after the breaching of 10 November since the estuary closed again less than two days after it was first breached. As a result, the final tidal survey was made on 14 November. Survey dates are shown as small triangles on the bottom panels of Figures 3-1 through 3-6, using the event codes given (in parentheses) in Table 3-2.

Water Quality Monitoring

In situ *Profiles*

Profiles at deep-water stations

The water quality profile data collected before the first sandbar closure (Appendix A-1 and Appendix A-22) typify tidally-influenced conditions at relatively high river flows (averaging 400 cfs in first 8 days of June, Figure 3-1). All four stations had a stratified

Tables 3-1 and 3-2

Figure 3-1

Figure 3-2

Figure 3-3

Figure 3-4

Figure 3-5

Figure 3-6

water column with a fresh or brackish layer above a saline layer. The surface layer was fresh at Stations 2, 3, and 4, and thicker than at lower river flows (that the sandbar was partially closed for several high-flow days before complete closure—Figure 3-1—probably contributed to the thickening of the fresh layer). The fresh layer was 7 m thick at Station 4 and approximately 4 m thick at the other stations. Only Station 1 had measurable salinity (0.9 ppt) in the surface layer. Near-bottom salinity was about 25 ppt at all stations, and all except Station 1 had depleted dissolved oxygen in the near-bottom layers. The vertical distribution of dissolved oxygen under tidal conditions was similar to that observed in previous years, when observations were typically made at lower river flows. In general, near-bottom DO depletion in the deep parts of the estuary usually occurs during bar-closed conditions, but these sites were sometimes depleted of oxygen during bar-open conditions, particularly during low river outflows and/or neap tides. Under natural conditions (in the absence of summer flow augmentation from reservoir releases) the estuary would have very little outflow in summer, and would probably remain closed for several months, and would probably experience sustained anoxia in deep pools.

Profiles before the breaching of 1 July, the first event studied (Appendix A-2 and A-23 through A-20), show that at the time of the pre-breaching survey, the fresh water surface layer was thinner than in June and DO in the near-bottom layers had increased at all stations. Datasonde traces (discussed in the following section) show that the near bottom DO at Stations 3 and 4 increased following the unstudied breaching of 15 June, which occurred during spring tides at a river flow of around 300 cfs. Pre-breaching profiles thus did not differ markedly from draining and post-breaching tidal surveys during Event I. All stations had higher near-bottom salinities by the end of June than in the early June survey.

The second tidal survey (24 August), which was conducted after the estuary had been open for the previous 54 days, showed a very thin brackish layer and no depletion of DO at near-bottom levels at the deeper stations. Station 1 was virtually unstratified on this date (Appendix A-5, A-27).

When the pre-breaching survey was conducted for breaching Event II (see Appendix A-7 and A-28 through A-31), DO was reduced near the bottom at all stations, although not entirely depleted. No post-breaching tidal survey was made because the berm closed again after only 2 days, but at the time of the draining survey only Station 1 had higher near-bottom DO than before breaching.

One week later, near-bottom DO was depleted at Stations 2, 3, and 4 (pre-breaching survey, Event III, see Appendix A-10 and A-32 through A-35). At Stations 2 and 3 (but not Station 4), near-bottom DO had increased by the time of the tidal survey. Profiles made at Stations 1 through 4 before, during, and after breaching Event IV showed similar results (Appendix A-14 through A-16 and A-36 through A-39). Following Event V, near-bottom DO at Stations 2, 3 and 4 was *lower* during the tidal survey than in pre-breaching surveys (Appendix A-18 through A-20, and A-40 through A-43).

Profiles in and around Willow Creek near its confluence with the estuary

Water quality profiles in Willow Creek before Event I (Appendix A-6) showed close similarity between Stations 3A (location of Datasonde in 1998) and Station 3AA (near bridge—location of Datasonde in 1999). Minimum observed DO was 5.0 ppm. No salinities over 0.5 ppt were observed in the creek.

Before events II and III (Appendix A-9, A-13) near-bottom DO at Stations 3A and 3AA was 3-4 ppm. In the draining surveys near-bottom DO under the bridge was 0.2-0.3 ppm although there was no flow out of the creek at that time. DO values were higher at the time of the tidal survey. Creek stations had near-bottom salinities of 10 ppt at the time of the Event II pre-breaching survey, but only 4-5 ppt in Event III. During the Event III draining survey on 5 October a single dead Dungeness crab was noticed in the mouth of the creek downstream from the bridge. When the area was revisited on 7 October, twenty-seven (27) dead crabs were counted. All were juveniles about 2 inches in carapace width. This is the same area where dead sculpins were noticed on one occasion in 1998. This area is located on the downstream side of the lip at the stream mouth, and is nearly dry at low tides, except for a narrow channel along the bank. A Datasonde was placed in this area for the last month of the study in order to test whether the data recorded by the Datasonde under the bridge (upstream of the lip) was representative of conditions downstream of the lip.

No low DO—and little salinity incursion—was found at creek stations before, during, or after Event IV, except for a 0.3 m thick layer just above the bottom at Station 3AA on the pre-breaching survey, which had 9 ppt salinity and 1.2 ppm DO (Appendix A-17).

Higher salinities (up to 18.4 ppt) and low near-bottom DO (0.4-0.5 ppm) were observed at Stations 3A and 3AA in the pre-breaching survey for Event V (Appendix A-21). Near-bottom DO during the draining survey measured 2.1 and 0.3 ppm at these two stations, respectively. Profiles were also made during Event V at the station in the creek mouth downstream of the bridge (Station 3AAA). No low DO values were found (minimum was 5.5 ppm on draining survey—Appendix A-21).

Profiles, usually made during midafternoon, do not provide a good description of the dynamics of shallow stream environments such as these, which are characterized by high diurnal variability. A clearer picture is provided by the Datasonde records, which are presented in the following section.

Datasonde Records

Datasonde records at deep-water stations

Station 3

Datasonde records of water quality conditions near the bottom at estuary Stations 3 and 4 confirm and elucidate water quality changes discussed above in conjunction with profiles made with YSI meters. In combination with continuous records of river flow, estuary level, tide height (especially in a year such as 1999 when the system remained tidal for much of the study period), Datasonde records can reveal the interplay between these factors in determining the observed water quality conditions found in the estuary.

Near-bottom DO at Station 3, anoxic in early June, increased immediately following the otherwise unstudied breaching of 15 June, as was suspected from the pre-breaching profile made on 30 June (discussed above). Salinity increased by about 5 ppt, and temperature dropped by about $3^{o}C$ at the same time (Appendix A-47). These changes took place during spring tides, at a river flow of 315 cfs (refer to Figure 3-1).

At Station 3, near bottom DO decreased after the closure of 24 June, and was not replenished until 5 July, four days following the breaching of Event I. For the next 10 weeks—during the extended tidal period—DO at Station 3 fluctuated, generally increasing during spring tides and decreasing during neap tides (Appendix A-47, A-48), but became anoxic only after the estuary closed on 17 September. Near-bottom salinity during most of the extended tidal period fluctuated about 3 ppt on a daily basis with the maxima corresponding to the daily higher high tides. Anoxia, established during the closure of 17 September, was not relieved after the breaching of 23 September (the estuary was only tidal for two days). DO was reintroduced two days after the breaching of 4 October, just before the estuary closed again on 7 October (Appendix A-49). DO decreased steadily during the 14-day closure that followed, and anoxia was reestablished by 18 October. Two days following the 21 October breaching, DO was again introduced to the near-bottom layer at Station 3, and although DO declined during the two November closures, these were brief, so the near-bottom layer did not become completely anoxic during November. The estuary height at the time of the breaching of 10 November (8.9 ft) and the salinity drop of 7 ppt just following it are both probably related to rainfall in the watershed on 7 November, which exceeded one inch.

Station 4

Datasonde records from Station 4 show that near bottom anoxia was not relieved until five days after the breaching of 15 June, and was accompanied by a salinity decrease of 7 ppt. These changes took place during neap tides, at a river flow of 260 cfs (Appendix A-44). Near-bottom DO at Station 4 declined gradually during the closure beginning 24 June, and the decline continued for several days after the breaching of 1 July (Event I). DO gradually increased beginning on 7 July, and fluctuated during the extended tidal period, with highest values usually associated with spring tides (Appendix A-45).

When the Datasonde was retrieved for downloading and recalibration on 24 August, it was found to have been displaced to a shallower site (about 8 m deep) several meters from where it was deployed at the pool bottom (14-15 m). It evidently had been retrieved by someone who examined it briefly and returned it to the water intact. It is not known when during the deployment this occurred, but examination of Appendix A-45 suggests that it might have occurred between 1700 and 1800 hr on 17 August. At that time a pattern of large diel DO fluctuations began, with maxima corresponding to higher high tides. Such fluctuations have not previously been noted when the Datasonde has been deployed at the pool bottom. The circumstances surrounding the incident may never be known, but at least two plausible scenarios come to mind. One is that swimmers (a rope swing suggests that someone was using the pool as a swimming hole) noticed the cable attachment point on the shore (visible at low tides) and retrieved the Datasonde. A second possibility is that boaters may have inadvertently snagged the Datasonde or its cable with an anchor or with fishing tackle. In either case the unit was returned to the water undamaged. The Datasonde was returned to its original site at the pool bottom on 25 August.

The pool bottom at Station 4 became anoxic when the berm closed on 17 September, and it remained so through the next two closures and breachings (Appendix A-46). It was still anoxic when the Datasonde was removed on 13 October (during the Event IV closure) in order to relocate the unit to the mouth of Willow Creek for the last month of the study.

Datasonde records in and around Willow Creek near its confluence with the estuary

Station 3AA

Records from the Datasonde located near the Willow Creek bridge during the first two breachings (Appendix A-50) show that, as is the case with many shallow environments, water in the creek outflow showed a diurnal DO sag of 2-3 ppm. Maxima usually occurred between 1900 and 2100 hr, and minima between 0700 and 0900 hr. Such a diel pattern is caused by the alternation between the daylight period (when photosynthetic DO production exceeds DO losses due to respiration/decomposition) and the night (when respiration/decomposition DO losses dominate). Occasionally the DO sag is larger, even during tidal conditions (as was the case on 20 June, when the sag was 5.4 ppm—7.85 to 2.41 ppm). Such events are probably associated with cloudy weather during the daylight hours.

The daily DO minimum gradually decreased when the estuary was closed, with the lowest value recorded on the last night before the level dropped following breaching. During the first closure, (3 days, breached at 7.4 ft), the minimum decreased to 1.96 ppm. During the second closure (7 days, breached at 6.3 ft), the minimum decreased to 2.44 ppm. These data support the conclusion that the DO minima in Willow Creek are determined more by the height at breaching, rather than the duration of closure. In both of the first two events the lowest DO was recorded before draining was complete. Low DO, at least in the first two events, was caused by DO depletion in the deep channels *before* breaching, not in water draining from the marsh following breaching.

Near-bottom water in the creek mouth was fresh until after the breaching of 15 June, when salinity incursions of 4 ppt or less occurred. Salinity incursion was less following the breaching of 1 July.

Salinity incursions into the creek mouth were much larger during the extended tidal period (up to 28 ppt), and were associated with spring tides (Appendix A-51). During the closure of 17 September, the near-bottom zone became anoxic, and anoxia persisted during the brief draining period after the breaching of 23 September. This is a different result from the DO dynamics during the first two post-breaching periods. However, it does not necessarily indicate that this persistence represents anoxic water draining out of the creek. It may simply mean that a small anoxic zone persisted behind the lip at the creek mouth which was not entrained by the draining creek water because it has higher salinity than the draining creek water. Profile data collected on the draining survey of 24 September (Appendix A-9) support this view. Surface salinity and DO at Station 3AA were 2.2 ppt and 5.2 ppm, respectively, while the corresponding values just above the bottom were 13.3 ppt and 0.3 ppm.

The above interpretation is supported by the draining data following the next breaching (4 October, Appendix A-52), when lower salinity was insufficient to prevent entrainment of the deep water under the bridge. The near-bottom salinity was 3.2 ppt before breaching, and dropped to 1 ppt during draining, which indicates that the near-bottom water mass was entrained into the creek outflow. DO levels—low before the breaching—increased as soon as draining began.

Following the natural breaching of 4 November, anoxic water persisted at Station 3AA, but as in the case of 23 September discussed above, the profile data (Appendix A-21) support the conclusion that this represents a small pocket of anoxic and saline water not entrained by the fresher and well oxygenated creek outflow.

Station 3AAA

Datasonde records from the creek mouth during the last month of the study confirm the above conclusions based on the data from Station 3AA, i.e., DO in the creek outflow following the natural breaching of 4 November was not low (Appendix A-53). There were no periods of continued low DO associated with creek drainage after breaching. The salinity in this region was extremely dynamic, however, and it is likely that the observed dead Dungeness crabs found here in October were killed by outflowing fresh water, rather than by low DO. Direct evidence is lacking, however, since a Datasonde was not deployed at Station 3AAA until after the dead crab occurrence.

BIOLOGICAL MONITORING

Fish and Macro-Invertebrates

A total of 48 fish species representing 22 families have been captured in the estuary by otter trawl and seine (Table 3-3), combining all four years of the current study plus the earlier study (Heckel 1994), and not including a few unidentified larvae. Only three species (silver surfperch, tube-snout, and penpoint gunnel) caught in 1999 had not been captured in one or more of the earlier years studied. Eleven species were captured in every year of study. Longfin smelt, an estuarine species listed as a California Species of Special Concern, had never been confirmed as occurring in the Russian River prior to our collecting them in each of the past three years (P. Moyle, UC Davis, *pers. comm.*).

Otter trawls typically sample epibenthic and benthic species, and at Stations 1 and 4 trawls were deployed in deep channels with saline near-bottom layers. Trawl catches (Table 3-4)

Table 3-3

Tables 3-4 and 3-5

therefore included more marine benthic species than did the beach seine catches (Table 3-5). The beach seines used in this study sample the whole water column in shallow (up to about 6 ft. depth) near-shore areas. These areas are typically fresh or brackish, so marine species are less frequently caught than in trawls. Beach seines surround an area, isolating the fish within; they are more effective at catching fast-swimming species (including salmonids) than bottom trawls. Of the 48 species identified in Table 3-3, ten are considered to be freshwater species throughout their life cycles: hardhead, Navarro roach, Sacramento squawfish, Sacramento sucker, Russian River tuleperch, bluegill, carp, green sunfish, mosquitofish, and smallmouth bass (the latter five are introduced species). One species, threespine stickleback, is euryhaline (i.e., can liveand reproduce in a range of salinity from freshwater to saltier than seawater). Two species (steelhead and chinook) are anadromous, spawning and spending part of their juvenile lives in freshwater, but growing to adulthood at sea. The remaining 35 species are either typically estuarine throughout their lives (e.g., arrow goby, bay pipefish), live at sea as adults but spawn in estuaries (e.g, Pacific herring, topsmelt), or are primarily marine species that occasionally wander into the lower reaches of estuaries (e.g., bocaccio and other rockfishes, lingcod). Complete data for 1999 trawl and seine catches are provided in Appendices B-1 through B-40.

As occurred in 1998, the 1999 sampling effort was mostly limited to the fall months. Only one berm closure and breaching event suitable for study (within the study design parameters) occurred before mid-September (Table 3-1). Furthermore, although the diversity of fish species captured in 1999 was similar to other years of the study, the numbers of individuals captured in 1999 were relatively small, especially for otter trawls (Appendix B-16 through B-20). Similarly, few salmonids were captured in 1999: a single wild chinook smolt was caught in July, and nine wild steelhead smolts were captured on various dates, mostly at Station 3 (Appendix B-41). The size distribution of the steelhead is shown in Figure 3-7, along with that for previous years. An analysis of the combined four-year data set is provided in the Discussion.

Macro-invertebrates collected in otter trawls are included in Appendix B-1 to B-15. The most common invertebrates collected during the 1999 surveys were similar to those found in earlier studies. The bay shrimp *Crangon franciscorum* was less abundant in 1999 than in some of the previous years (Appendix B-45). Other commonly collected invertebrates were the mysid *Neomysis mercedis,* the Dungeness crab, *Cancer magister* (juveniles ca. 2-2.5 inches in carapace width), amphipods (*Eogammarus confervicolus*), and sphaeromatid isopods.

Pinnipeds and Other Aquatic Mammals

Seal numbers and disturbances were observed during five breaching events in 1999. The breaching events monitored occurred on July 1, September 23, October 4 and 14, and November 10, 1999. Monitoring occurred on pre-breaching, breaching, and post-breaching days, with the exception of the July 1 and November 10 events. No pre-breaching monitoring occurred during the July 1 and November 10 events.

Figure 3-7

The July 1 breaching event occurred during the molt, when maximum numbers of seals are recorded locally (Allen 1984; Allen and Huber 1984). On breaching day, the maximum number of seals counted was 117 in the morning prior to opening the sand bar. On the post-breaching day (July 2), the maximum count was 235. During the fall events (September 23, October 4 and 14, November 10), few or no seals were counted while the sand bar was closed, but the number of seals quickly recovered following breaching. This pattern of low numbers of seals during bar closed conditions (bar closed, pre-breaching and breaching day) followed by an increase in seals hauled out on the sand bar following the breaching event (bar open, post-breaching day) was observed in all five pinniped monitoring efforts in 1999 (Figure 3-7).

During the pre-breaching, breaching, and post-breaching monitoring, observations of seal disturbances were recorded. Generally, seals were hauled out during the morning hours. The number of seals usually decreased through the morning hours as a result of State Park visitors walking on the sand bar, kayakers floating too near the seal haulout, or unknown disturbances that resulted in the seals alerting and/or flushing into the ocean. On breaching days, the number of seals hauled out had usually decreased prior to equipment operators approaching the sand bar, but rebounded at some point following opening of the sand bar. Seals were more abundant on post-breaching days, but the number of individuals hauled out often fluctuated based on the amount of disturbance from the sources discussed above.

In 1999, as in the previous three years, observations made during pre- and post-breaching water quality and fish sampling cruises showed that a small group of seals (6-8 individuals) were typically seen hauled out on snags at low tide between Stations 3 and 4. During flooded conditions, the snags were submerged, and the seals dispersed; some were occasionally seen swimming throughout the study area during flooded conditions.

River otters (*Lutra canadensis*) have been observed occasionally during the last four years in the estuary. During 1998 and 1999, a group including two adults and several juveniles was often seen, usually near Stations 3 and 4 during draining and tidal surveys.

IV. DISCUSSION

WATER QUALITY

Analysis of water quality profiles and Datasonde records collected in the 1999 study have elucidated some relationships between stratification and other variables, including river flow, the spring/neap cycle (under bar-open conditions), duration of closure, and depth at breaching. In general, the conclusions made in earlier studies are confirmed, i.e., breaching before the berm exceeds 7 feet on the Jenner scale appears to preclude water quality problems in the mouth of Willow Creek during draining.

The 1999 study has focussed considerable attention on the monitoring of the outflow from Willow Creek for two reasons:

1. Willow Creek was the site of an anoxic episode that killed mysids and prickly sculpins in 1992 and was the site of dead prickly sculpins in 1998, and dead Dungeness crabs in 1999.

2. The mortality episodes of 1992, 1998 and 1999 are the only adverse impacts that have been identified in four years of study that could have even potentially been the result of sand bar breaching.

Continuous monitoring of channel-bottom sites in Willow Creek (such as Stations 3A and 3AA) during 1998 and 1999 have shown that during bar-closed conditions, near-bottom waters may become anoxic within a few days of closure. When closure follows an episode of salinity intrusion into the bottom of the creek channel (as following spring tides), this anoxic water becomes effectively isolated until draining occurs. However, the volume of low-DO water in the creek channel bottom is small relative to the volume of water which drains from the creek following breaching. In these cases, DO levels in the creek outflow are not low enough to cause problems.

The anoxic episode in 1992 (breaching took place on 16 November; Nielsen and Light 1993:122) occurred following a breaching at a water level of over 9 feet. At such levels, larger areas of the Willow Creek marsh are inundated, and these upper reaches presumably have a high organic content and a high biochemical oxygen demand. A larger water volume becomes anoxic:

> The upper reaches of Willow Creek marsh. . .became totally anoxic by mid-summer. Heavy sediment accumulation occurs in this area. Low fresh water inflows from Willow Creek are insufficient to provide mixing during summer runoff conditions. Stranded pools fed by limited subsurface flow from the creek, stratify and remain stagnant. The test breaching performed as part of this study, where the estuary water level was allowed to pass nine feet at the Jenner gage, caused inundation of these stagnant upper marsh areas. When the mouth was artificially breached, much of the anoxic waters from these pools also drained from the marsh. Turbulence during draining was not sufficient at Willow Creek mouth to break down the anoxic conditions of these waters. Numerous fish were recorded escaping the anoxic wedge as it passed through the marsh (from Nielsen and Light 1993, p. 105).

> One major impact from breaching recorded during this study was reflected in the drift and migrations out of Willow Creek marsh as the marsh drained. . .As this area drained, substantial quantities of mysid shrimp left or were drained from the marsh. During the 9'+ breach this species was so abundant they appeared like cream in the water. Fish in the marsh were also swept by the drainage velocity at the mouth of Willow Creek. Juvenile stickleback, Sacramento suckers and prickly sculpin appeared unable to swim against the outflow during the breach drainage. Larger sculpin were captured at the margins of the outflow channel, but it was not clear if they were following a food resource (i.e. small fish and shrimp) or if they too were forced out of the marsh by the flow. Only after the 9'+ breach, when anoxic waters surged from the marsh, were dead sculpin found along the bank of the outflow channel on Willow Creek (from Nielsen and Light 1993, p. 132).

The phase of creek drainage when mysids left the marsh must have been early in the process, when saline or brackish water left the system. It is assumed that the water leaving the creek was anoxic during this period, because living mysids do not have a creamy appearance, they are transparent. The anoxic waters which surged from the marsh carrying dead sculpins probably came later, when the draining water was fresh.

Whatever the mechanism for water quality problems in the creek mouth, breaching before the level reaches 7 feet at Jenner appears to avoid anoxia in the creek outflow. It is likely that the mortality observed in Dungeness crabs in 1999 was due to low salinity, not low DO. There is no way to avoid salinity changes in the creek mouth during draining, because the area is confined at low water. Any stenohaline marine organisms such as Dungeness crabs which happen to be in the creek mouth are vulnerable to sudden immersion in fresh water as draining occurs.

BIOLOGICAL MONITORING

An Analysis of the Four-Year Data Set

Four years of trawl and seine data are now available, and analysis of the combined data set for trends that can be related to pre- versus post-breaching, seasonality, and year-to-year patterns is appropriate. Examination of otter trawl catches for the four-year period (Figure 4-1) shows no clear tendency for either numbers or diversity to be related to pre- versus post-breaching surveys. Most species followed this pattern (Appendix B-42 through B-45). Some species (surf smelt, Sacramento sucker, threespine stickleback) in otter trawl catches, however, tended to be more abundant in pre-breaching trawls, while others (Pacific herring, shiner perch, bay pipefish) were more abundant in post-breaching/tidal trawls.

Total beach seine catches, as discussed in the previous report (MSC, 1999) generally were higher in the post-breaching/tidal surveys than in pre-breaching surveys (Figure 4-2, top panel). Fish diversity was also higher in the post-breaching surveys (Figure 4-2, bottom panel). However, as discussed in the previous report (MSC 1999), pre-breaching seine catches are problematic because of the difficulty of retrieving the seine at high water by

Figure 4-1

Figure 4-2

pulling it through flooded emergent and terrestrial vegetation and debris, and because such habitat is less likely to be used by fish for foraging or resting than would be habitat that is normally submerged. A similar analysis of individual species catches in beach seines (Appendix B-46 through B-49) shows that most fish species followed the general trend of lower catches during the pre-breaching survey. Only steelhead and Sacramento sucker were about equally likely to be caught at high as at low water.

Variability in the pattern of berm closure and of biological features in the estuary continue to be a striking feature of the data from the fourth year's study. Historically, berm closure has occurred in every season, but during the four years of this study, few events suitable for study have occurred prior to late summer, except in 1997. Examination of catches of individual species in 1997 (the triangles shown in Appendix figures B-42 through B-49) suggest a strong seasonal component to fish abundance in the estuary; some species (e.g., Pacific herring and three flatfish species) apparently being far more abundant in the early summer surveys than in late summer surveys, while others (shiner perch) became more abundant in late summer/fall. Seasonal as well as year-to-year variability in fish diversity and abundance is typical of California estuaries (Commins, et al, 1990, 1996). Typically, estuarine fish abundance and diversity is greatest in spring and early summer, and lowest in fall and winter (Kelley, 1966; Greenwald and Britton, 1987; Commins, et al, 1990, 1996; Smith, 1990). Many fish apparently move out of estuaries in fall, possibly because of unfavorable thermal conditions (J. Cech, U.C. Davis, *pers. comm.*). Such seasonal variability, particularly declining abundance in late summer and fall, limits the likelihood of our being able to detect any impacts, if they exist, of berm closure/breaching strategy on fish use of the estuary under the current study design.

Pinnipeds

Comparison to Twohy Data

A review of the seal count information collected by Elinor Twohy during closures and following breachings of the sand bar showed results similar to pinniped monitoring performed for this study. The January 12, 1999, breaching was of particular interest as it occurred during winter. During winter months greater numbers of seals are generally present and the effects of closure and breaching appear to be minimal (Mortenson, 1997). No large drop in seal numbers occurred during closure, nor was there a great increase following breaching.

The remaining closure and breaching events showed results similar to the monitoring study. Few or no seals were hauled out while the sand bar was closed, and the number of seals hauled out increased following breaching of the sand bar (refer to Appendix C).

Patterns in Seal Behavior During Closures and Breaching Over the Past Four Years

In all four years of this study, the number of seals fell when the river closed and rose once it opened. This effect was most exaggerated in fall, since on many days no seals were present when the river was barred (Twohy, unpublished data). Early morning observations in 1999 and previous monitoring years revealed that seals were hauled out at Jenner very early in the day, with one exception, but usually soon dispersed if the river was closed, either in response to natural or unknown causes or in reaction to people.

During each monitoring event in 1999, seals were observed going in and out of the breach once the sand bar was opened. Haul outs were observed forming soon after an early breach on two days, but most intensive observations were completed before the seals returned. Sometime before the post-breaching observations, which generally began about dawn, a haulout formed. At dawn, an increased number of seals was present without exception. The seals generally only dispersed due to human disturbances.

The interference rate (the number of minutes in which the seals were disturbed) in 1999 was 1.02 per hour. This was less than the 2.53 minutes per hour in 1998 and was below the 5.09 minutes per hour in a 1994-1995 interference study at Jenner (Mortenson, 1996). The 1999 flight rate (0.39 individuals per hour) was lower than the 1.06 individuals per hour observed in the 1994-1995 interference study.

Effects of Warning Signs on Human Behavior

The number of visitors, the location of the seal haulout and breaching events, increased in 1999 over the previous year, but few were observed reading the posted warning signs prior to and following breaching and many more passed the signs than were stopped by them (Table 4-1). Although some visitors may have simply followed others that had already ignored the signs into the haul out area, other visitors may not have seen the signs as they were placed farther from the breaching location than in previous years. In addition, the signage used in 1999 did not seem to affect boaters. In 1999, kayakers were twice observed being swept out of the mouth and losing control of their craft following breaching. In both cases, the kayakers approached the breach after the crew had left and when no State Parks lifeguards were present.

Table 4-1. Behavior of People at Signs

Behavior	Number
People Stopping at County Signs	9
People Reading County Signs and Passing	4
People Passing County Signs without Reading	210
People Stopping at State Signs	63
People Reading State Signs and Passing	20
People Passing State Signs without Reading	103
People stopped by Guard	10
People Passing Guard	2

V. CONCLUSIONS

After four years of study, no major impacts of the breaching process on the biota of the estuary have been shown. The estuary has a biota that is adapted to survival in an environment that naturally alternates between being a tidal estuary and a coastal lagoon, and, in general, the bar-open state is more beneficial to the local biota. Additional conclusions derived from the study programs conducted over the last four years are as follows:

- The biota of the estuary exhibits high variability from one year to the next.
- The occurrence of low DO in the near-bottom layers of deep pools is often associated with bar-closed conditions, but anoxia can develop under tidal conditions during neap tides and/or low river flows.
- The renewal of DO in the saline near-bottom layers of deep pools is mediated by an interplay between river flow and tidal action (spring/neap cycle) in addition to post-breaching flushing.
- The appearance of sustained low DO in water draining from Willow Creek following breaching apparently can be avoided by breaching before the water level is 7 feet.
- Localized mortalities of marine species near the Willow Creek mouth under the current program of breaching before the water level reaches 7 feet were likely to have been caused by sudden immersion in freshwater. This effect is unlikely to impact mobile species such as salmonids which can actively avoid localized unsuitable conditions.
- Smolts of wild steelhead use the estuary during the summer and fall, and breaching provides an intermittent avenue to the sea. Steelhead evidently do not remain long enough in the estuary to show accelerated growth.
- Seals haul out near the mouth of the Russian River when the sand bar is open and are generally present in low numbers or absent from the site during bar closed conditions in late summer and fall, when closings are most common.
- When seals are present at the haulout during bar closed conditions, breaching activities usually result in evacuation of the haulout. Some disturbance is unavoidable since the haulout is located at the breaching site.
- Beach visitors approaching the breaching site/haulout often result in greater seal disturbances than the breaching process itself. This can be minimized by effective patrolling of the site before, during, and following breaching in conjunction with effective positioning of signs and cordons.

VI. RECOMMENDATIONS

The four-year study has shown that the present program of artificial breaching of the estuary has no apparent negative impact on the aquatic habitat of fish and seals. Provided that breaching takes place before the water level reaches 7 feet on the gage at Jenner, the biological resources of the estuary appear to be protected. The present program of biological monitoring before, during, and after each breaching episode has been appropriate to reveal any potential negative impacts of breaching on biological resources in the estuary, but is not an efficient way of studying the general biological health of the estuary. In particular, the distribution of sampling effort so far has been largely concentrated in fall, when occupation of the estuary by many fish species is minimal. In the event that a biological monitoring program in the estuary is to be continued, it is recommended that sampling of breaching events be limited to maintenance of Datasondes to monitor temperature, salinity and DO at two locations in and near the mouth of Willow Creek. Continuation of level recording near Willow Creek bridge is not necessary provided that a continuous record is available from the Visitor's Center in Jenner (data collected in 1999 show that lag times in water level changes between Willow Creek and Jenner following breaching are negligible). A program of regular biological sampling cruises distributed throughout most of the year would expend no more effort (even with replicated sampling) than has been given to breaching studies, but would provide more basic and valuable information on seasonal use and general biological health of the estuary.

Monthly biological sampling (otter trawl and beach seine) conducted year-round during bar-open conditions is recommended, with the sampling performed at the same stations as used in the 1999 study. Where possible, samples should be replicated one or more times at each station. For example, beach seining could be replicated at Stations 3 and 4, but probably not at Station 1, whereas, paired otter trawls could be conducted at each station.

Based upon the pinniped monitoring results, it is recommended that the practice of posting signs 24 hours prior to breaching and leaving them in place for 24 hours following continue. Monitoring of breaching events shows that proper cordons and presence of the breaching crew helps to ensure public safety and contributes to less disturbance of the haul out. Placing signs and cordons on the jetty and across the entire width of the north side of the sand bar would likely be more effective in keeping visitors away from the haulout and breaching site. It is recommended that personnel be left on either side of the breach at least until the end of the breaching day to keep visitors away from the breach and to allow seals to haul out. In addition, Agency observers stationed at the overlook should radio the crew on the beach when visitors ignore the signs and approach the breaching activities.

The breaching process often results in the evacuation of the haulout. In some instances, disturbance of the haulout is unavoidable due to its proximity to the breaching site.

However, the breaching crew may be unnecessarily close to the seals or shout loudly during the course of their work. It is recommended, that as much as possible, the crew keep a distance from the seals (perhaps by standing on the jetty to allow seals to cross the sand bar or to enter the breach cut) and keep noise to a minimum to limit disturbance of the haulout.

VII. REFERENCES CITED

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VIII. APPENDIX

Appendix A-1. Preclosure Tidal Water Quality Profiles at Russian River Estuary Stations 1-4, Event I, 8 June 1999.

8-Jun-99																
	Station 1(1030 hr PDT)				Station 2 (1100 hr PDT)				Station 3 (1125 hr PDT)				Station 4 (1155 hr PDT)			
	water level, m		1.17	(3.8 ft)	water level, m		1.22	(4.0 ft)	water level, m		1.24	(4.1 ft)	water level, m		1.25	(4.1 ft)
Depth Meters	Temp °C	Sal °/oo	Cond µmho	D. O. ppm	Temp °C	Sal °/oo	Cond µmho	D. O. ppm	Temp °C	Sal °/oo	Cond µmho	D. O. ppm	Temp °C	Sal °/oo	Cond µmho	D. O. ppm
0	16.8	0.9	1150	8.5	18.0	0.0	380	9.4	18.5	0.0	285	8.6	19.5	0.0	260	9.0
1	16.9	0.9	1150	8.4	18.0	0.0	380	9.2	18.6	0.0	280	8.7	19.5	0.0	260	9.0
2	17.0	0.9	1150	8.4	18.1	0.0	390	8.9	18.6	0.0	281	8.5	19.5	0.0	260	8.8
3	16.9	0.9	1190	8.4	18.2	0.0	401	8.7	18.5	0.0	290	8.6	19.5	0.0	260	8.8
3.5	16.1	15.9	19000	5.3	18.0	10.1	19500	8.0	17.0	21.5	29000	3.5	19.5	0.0	260	8.8
4	15.3	19.3	25500	3.8	17.0	20.6	28000	2.7	16.0	22.1	29500	1.3	19.0	0.0	260	8.6
5	13.0	23.1	29900	6.9	14.0	24.8	31000	0.7	14.6	24.9	31100	0.1	19.0	0.0	260	8.5
6	12.6	25.0	30100	6.2	13.2	25.0	31200	0.1	14	25	31100	0.1	19.0	0.0	260	8.5
7	12.0	26.0	31000	6.5	12.5	25.2	31800	0.1					19.0	0.0	265	8.6
8													18.1	2.0	2100	6.0
9													17.0	8.2	12000	0.05
10													16.0	20.0	26000	0.1
11													-	-	-	-
12													-	-	-	-
13													15.2	26.5	34000	0.0
14																

Appendix A-2. Prebreaching Water Quality Profiles at Russian River Estuary Stations 1-4, Event I, 30 June 1999.

30-Jun-99																
	Station 1(1000 hr PDT)				Station 2 (1500 hr PDT)				Station 3 (1415 hr PDT)				Station 4 (1330 hr PDT)			
	water level, m		1.83	(6.0 ft)	water level, m		1.84	(6.0 ft)	water level, m		1.83	(6.0 ft)	water level, m		1.83	(6.0 ft)
Depth Meters	Temp °C	Sal °/oo	Cond µmho	D. O. ppm	Temp °C	Sal °/oo	Cond µmho	D. O. ppm	Temp °C	Sal °/oo	Cond µmho	D. O. ppm	Temp °C	Sal °/oo	Cond µmho	D. O. ppm
0	20.1	1.0	2850	8.8	23.5	0.9	1350	8.6	24.0	0.5	1010	8.7	24.0	0.7	640	8.4
1	21.5	2.9	3000	8.8	23.2	0.9	1350	8.7	23.9	0.5	1010	8.6	23.9	0.7	640	8.4
2	21.1	4.0	5100	10.1	21.9	4.5	7100	12.0	23.0	3.9	6100	12.2	23.0	4.5	7100	11.4
3	17.1	22.8	31000	14.1	19.0	23.8	34000	13.0	18.8	25.0	35000	9.4	19.0	24.5	34100	11.7
4	15.0	26.0	33900	13.2	15.0	26.1	36100	12.0	15.1	29.0	36100	11.0	17.0	26.1	35000	9.3
5	13.4	27.0	31000	12.1	13.2	30.0	36000	7.8	13.3	30.2	36000	5.7	16.0	26.9	35000	9.5
6	13.0	26.5	31000	9.0	12.7	30.0	36000	6.4	13.0	30.2	36000	2.2	15.8	27.2	35100	10.0
7	12.2	29.0	34000	5.8	12.0	30.5	36000	2.5					-	-	-	-
7.9	12.1	29.0	34000	5.9	-	-	-	-					-	-	-	-
8					12.0	30.5	36000	1.2					15.1	27.9	35100	9.8
8.5					-	-	-	1.2					-	-	-	-
9													-	-	-	-
10													15.0	28.0	35100	9.1
11													-	-	-	-
12													15.0	28.0	35100	9.0
13													-	-	-	-
14													15.0	28.0	35100	8.9

Appendix A-3. Draining Water Quality Profiles at Russian River Estuary Stations 1-4, Event I, 2 July 1999.

2-Jul-99																
	Station 1 (1000 hr PDT)				Station 2 (1510 hr PDT)				Station 3 (1440 hr PDT)				Station 4 (1400 hr PDT)			
	water level, m		0.34	(1.1 ft)	water level, m		0.55	(1.8 ft)	water level, m		0.47	(1.5 ft)	water level, m		0.37	(1.2 ft)
Depth Meters	Temp °C	Sal °/oo	92 µmho	D. O. ppm	Temp °C	Sal °/oo	Cond µmho	D. O. ppm	Temp °C	Sal °/oo	Cond µmho	D. O. ppm	Temp °C	Sal °/oo	Cond µmho	D. O. ppm
0	21.5	2.4	3560	7.2	22.0	2.4	3500	7.4	23.5	1.2	2350	7.0	24.5	0.6	1100	6.6
1	21.5	2.4	3600	7.1	22.5	2.2	3550	7.3	23.5	1.2	2350	6.8	24.0	1.0	1650	6.4
2	19.5	13.4	19700	7.9	19.0	22.0	29000	8.0	23.1	2.0	2820	6.7	23.9	2.0	3000	6.9
3	15.0	26.0	32800	8.0	15.9	26.1	34000	8.8	15.5	28.5	36200	7.2	17.0	27.0	35100	6.7
4	13.0	28.0	34000	7.6	14.0	29.0	36000	6.8	13.5	29.1	36000	2.8	16.1	27.0	35100	8.5
5	12.9	28.5	34200	7.9	13.0	30.0	36000	4.2	13.0	29.1	36000	2.3	15.5	27.6	35200	8.9
5.5	12.5	29.0	34200	7.8									-	-	-	-
6													15.0	28.0	35300	9.1
7													-	-	-	-
8													15.0	28.0	35200	7.8
9													-	-	-	-
10													15.0	28.0	35200	7.5
11													-	-	-	-
12													15.0	28.0	35200	7.5
13													-	-	-	-
14													15.0	28.0	35200	7.5

Appendix A-4. Tidal Water Quality Profiles at Russian River Estuary Stations 1-4, Event I, 6 July 1999.

6-Jul-99																
	Station 1 (0945 hr PDT)				Station 2 (1455 hr PDT)				Station 3 (1410 hr PDT)				Station 4 (1325 hr PDT)			
	water level, m 0.30 (1.0 ft)				water level, m 0.02 (0.1 ft)				water level, m 0.07 (0.2 ft)				water level, m 0.30 (1.0 ft)			
Depth Meters	Temp °C	Sal °/oo	Cond µmho	D. O. ppm	Temp °C	Sal °/oo	Cond µmho	D. O. ppm	Temp °C	Sal °/oo	Cond µmho	D. O. ppm	Temp °C	Sal °/oo	Cond µmho	D. O. ppm
0	19.0	4.2	6200	7.5	22.0	2.4	3100	7.6	23.0	1.0	1900	7.3	23.0	0.0	700	7.0
1	15.0	19.8	24900	7.3	22.0	2.4	3900	7.5	23.0	1.0	1900	7.2	23.0	0.2	1000	5.0
2	11.0	29.0	33500	7.7	16.0	27.5	35500	6.6	16.0	28.9	37200	5.9	17.9	26.0	35100	4.8
3	11.0	30.1	34800	7.2	13.0	29.0	34900	7.1	13.0	30.5	36000	6.1	16.5	27.1	35100	5.2
4	10.8	31.0	35200	7.0	12.0	29.8	34900	6.7					16.0	27.1	35100	5.3
5	10.5	31.8	35100	7.0	12.0	29.5	34900	6.5					16.0	27.1	35100	5.3
5.5	10.1	32.0	35100	7.0	-	-	-	-					-	-	-	-
6					12.0	29.9	34900	6.3					15.5	28.0	35000	5.5
7													-	-	-	-
8													15.1	28.0	35000	5.0
9													-	-	-	-
10													15.0	28.0	35000	4.5
11													-	-	-	-
12													15.0	28.0	35000	4.3
13													15.0	28.0	35000	4.2
14													15.0	28.0	35000	4.2

Appendix A-5. Second Tidal Water Quality Profiles at Russian River Estuary Stations 1-4, Event I, 24 August 1999.

24-Aug-99																
	Station 1 (1210 hr PDT)				Station 2 (1415 hr PDT)				Station 3 (1735 hr PDT)				Station 4 (1620 hr PDT)			
	water level, m		0.54	(1.8 ft)	water level, m		0.32	(1.1 ft)	water level, m		0.15	(0.5 ft)	water level, m		0.15	(0.5 ft)
Depth Meters	Temp °C	Sal °/oo	Cond µmho	D. O. ppm	Temp °C	Sal °/oo	Cond µmho	D. O. ppm	Temp °C	Sal °/oo	Cond µmho	D. O. ppm	Temp °C	Sal °/oo	Cond µmho	D. O. ppm
0	12.5	32.0	37200	8.6	20.1	9.0	13100	8.9	22.0	4.1	6500	8.8	23.0	1.9	3000	8.8
1	12.0	32.2	37300	8.8	17.0	24.0	32900	19.6	15.0	10.0	14100	16.0	23.0	2.0	3000	8.8
2	12.0	32.4	37300	8.8	13.2	29.6	36000	8.0	14.0	29.5	36000	8.1	17.0	23.5	31800	9.9
3	12.0	32.5	37400	8.8	13.0	30.0	36000	7.4	13.5	29.8	36000	7.8	15.0	28.4	35900	8.7
4	12.0	32.5	37400	8.8	13.0	30.0	36000	7.4	13.2	29.8	36000	7.6	14.6	28.9	35900	8.7
5	12.0	32.5	37500	8.8	13.0	30.0	36000	7.2	13.1	29.8	36000	7.2	-	-	-	-
5.7	12.0	32.5	37500	8.8	-	-	-	-					-	-	-	-
6					13.0	30.0	36000	7.2					14.0	28.9	35900	8.4
7					13.0	30.0	36000	7.2					-	-	-	-
8													14.0	28.9	35900	7.9
9													-	-	-	-
10													14.0	28.9	35900	7.6
11													-	-	-	-
12													14.0	28.9	35900	7.8
13													14.0	28.9	35900	7.7
14																

Appendix A-6. Water Quality Profiles in Willow Creek at Stations Near its Confluence with the Russian River, Before and During Event I, Breached 1 July 1999.

Station 3A (0.5 km upstream of bridge)

	Preclosure Tidal Survey 8 June (1345 hr PDT)				Prebreaching Survey 30 June (1355 hr PDT)				Draining Survey				Tidal Survey				Second Tidal Survey			
Depth Meters	Temp °C	Sal °/oo	Cond µmho	D. O. ppm	Temp °C	Sal °/oo	Cond µmho	D. O. ppm	Temp °C	Sal °/oo	Cond µmho	D. O. ppm	Temp °C	Sal °/oo	Cond µmho	D. O. ppm	Temp °C	Sal °/oo	Cond µmho	D. O. ppm
0	14.5	0.0	190	9.8	23.9	0.3	800	7.8												
1	14.0	0.0	190	9.7	22.9	0.3	800	6.8												
1.5	14.0	0.0	190	10.0	-	-	-	-												
2	-	-	-	-	17.5	0.3	410	7.1												

Station 3AA (near bridge)

	Prebreaching Survey 30 June (1415 hr PDT)				Prebreaching Survey 30 June (1405 hr PDT)				Draining Survey				Tidal Survey				Second Tidal Survey 24 August (1710 hr PDT)[3]			
Depth Meters	Temp °C	Sal °/oo	Cond µmho	D. O. ppm	Temp °C	Sal °/oo	Cond µmho	D. O. ppm	Temp °C	Sal °/oo	Cond µmho	D. O. ppm	Temp °C	Sal °/oo	Cond µmho	D. O. ppm	Temp °C	Sal °/oo	Cond µmho	D. O. ppm
0	15.0	0.0	192	9.5	24.0	0.5	850	8.2									20.5	6.0	11200	9.7
0.3	-	-	-	-	-	-	-	-									21.9	18.6	28100	12.3
0.6	-	-	-	-	-	-	-	-									19.9	23.0	32700	12.0
1	15.0	0.0	195	9.5	24.0	0.3	850	8.1												
1.5	15.0	0.0	195	9.5	19.0	0.1	500	5.7												
2	-	-	-	-	19.0	0.1	500	5.0												

Station 3AAA (100m downstream of bridge)

	Prebreaching Survey				Prebreaching Survey				Draining Survey 2 July (1425 hr PDT)[1]				Tidal Survey 6 July (1405 hr PDT)[2]				Second Tidal Survey			
Depth Meters	Temp °C	Sal °/oo	Cond µmho	D. O. ppm	Temp °C	Sal °/oo	Cond µmho	D. O. ppm	Temp °C	Sal °/oo	Cond µmho	D. O. ppm	Temp °C	Sal °/oo	Cond µmho	D. O. ppm	Temp °C	Sal °/oo	Cond µmho	D. O. ppm
0									21.1	0.0	600	7.2	20.0	0.0	550	-				
0.5													20.0	0.0	550	-				

[1]Measured in outflow at mouth of creek.
[2]Measured in shallow water at mouth of creek; no flow out of creek.
[3]No flow out of creek

Appendix A-7. Prebreaching Water Quality Profiles at Russian River Estuary Stations 1-4, Event II, 22 September 1999.

22-Sep-99																
	Station 1(1000 hr PDT)				Station 2 (1105 hr PDT)				Station 3 (1425 hr PDT)				Station 4 (1320 hr PDT)			
	water level, m	1.79	5.9		water level, m	1.79	(5.9 ft)		water level, m	1.79	(5.9 ft)		water level, m	1.79	(5.9 ft)	
Depth Meters	Temp °C	Sal °/oo	Cond µmho	D. O. ppm	Temp °C	Sal °/oo	Cond µmho	D. O. ppm	Temp °C	Sal °/oo	Cond µmho	D. O. ppm	Temp °C	Sal °/oo	Cond µmho	D. O. ppm
0	16.5	1.0	1600	9.9	17.8	0.1	520	9.3	19.0	0.0	460	9.3	19.0	0.0	349	9.1
1	16.5	1.0	1702	9.8	17.9	0.1	540	9.3	19.0	0.0	469	9.3	19.0	0.0	350	9.2
2	16.5	8.2	12500	9.6	17.5	7.0	10000	11.0	18.0	6.9	11000	10.4	18.0	7.0	10500	11.8
3	15.1	27.2	35900	6.7	17.0	27.1	36800	10.2	17.5	28.0	37500	7.0	18.0	28.1	38000	10.4
4	14.9	29.5	37000	3.3	15.0	29.6	37200	2.2	15.1	28.0	37500	1.6	17.7	28.1	38000	7.7
5	14.5	30.0	37000	3.4	14.5	29.9	37000	0.9	15.0	29.9	37500	0.9	17.0	28.1	37800	3.3
6	14.0	30.1	37000	2.1	14.1	29.9	37000	0.7	14.9	29.9	37000	0.7	16.0	28.5	37000	2.1
6.9	-	-	-	-	-	-	-	-	-	-	-	0.7	-	-	-	-
7	14.0	30.8	37200	2.5	14.1	29.9	37000	0.7					-	-	-	-
8	14.0	31.0	37800	2.6	14.0	29.9	37000	0.6					15.0	28.8	36000	0.8
9													-	-	-	-
10													14.9	29.9	36000	0.9
11													-	-	-	-
12													-	-	-	-
13													-	-	-	-
14													14.8	29.0	36100	0.7
17.5													-	-	-	0.5

Appendix A-8. Draining Water Quality Profiles at Russian River Estuary Stations 1-4, Event II, 24 September 1999.

24-Sep-99																
	Station 1 (0950 hr PDT)				Station 2 (1050 hr PDT)				Station 3 (1130 hr PDT)				Station 4 (1325 hr PDT)			
	water level, m		0.36	(1.2 ft)	water level, m		0.50	(1.6 ft)	water level, m		0.61	(2.0 ft)	water level, m		0.68	(2.2 ft)
Depth Meters	Temp °C	Sal °/oo	92 µmho	D. O. ppm	Temp °C	Sal °/oo	Cond µmho	D. O. ppm	Temp °C	Sal °/oo	Cond µmho	D. O. ppm	Temp °C	Sal °/oo	Cond µmho	D. O. ppm
0	18.0	3.0	4110	9.3	18.0	2.5	3700	8.6	18.0	2.0	2910	8.3	18.5	1.9	2270	8.2
1	15.1	20.1	25200	8.9	18.5	2.5	3700	8.8	18.2	2.0	2990	8.4	19.0	2.0	2850	8.2
2	14.0	24.5	30000	8.8	16.2	28.7	37000	1.6	16.1	29.0	37800	1.3	18.9	2.0	3200	8.0
3	13.9	28.5	35000	7.1	15.1	28.8	37000	1.3	15.1	29.2	37100	0.6	18.0	27.9	37900	5.3
4	13.8	28.9	35200	6.8	15.0	28.8	37000	0.8	15.0	29.1	37000	0.4	17.0	28.2	37000	2.3
5	13.1	29.0	35200	8.0	15.0	28.8	37000	0.6	15.0	29.1	37000	0.3	16.0	28.1	36500	1.0
6	12.9	29.2	35500	8.7	14.9	29.7	37000	0.5					15.0	28.5	36000	0.7
7					14.7	29.7	37000	0.5					-	-	-	-
8													15.0	28.5	36000	0.6
9													-	-	-	-
10													14.9	28.3	36000	0.6
11													-	-	-	-
12													14.9	28.3	36000	0.5
13													-	-	-	-
14													14.9	28.3	36000	0.4
15													-	-	-	0.3

Appendix A-9. Water Quality Profiles in Willow Creek at Stations Near its Confluence with the Russian River, Event II, Breached 23 September 1999.

Station 3A (0.5 km upstream of bridge)

	Prebreaching Survey 22 September (1400 hr PDT)				Draining Survey				Tidal Survey			
Depth Meters	Temp °C	Sal °/oo	Cond µmho	D. O. ppm	Temp °C	Sal °/oo	Cond µmho	D. O. ppm	Temp °C	Sal °/oo	Cond µmho	D. O. ppm
0	18.0	0.0	560	8.0								
1	18.0	0.1	580	7.3								
2	20.8	10.0	15000	3.2								

Station 3AA (near bridge)

	Prebreaching Survey 22 September (1410 hr PDT)				Draining Survey 24 September (1200 hr PDT)[1]				Tidal Survey			
Depth Meters	Temp °C	Sal °/oo	Cond µmho	D. O. ppm	Temp °C	Sal °/oo	Cond µmho	D. O. ppm	Temp °C	Sal °/oo	Cond µmho	D. O. ppm
0	18.1	0.0	481	8.8	18.0	2.2	3400	5.2				
0.9	-	-	-	-	20.5	13.2	19000	0.3				
1	18.0	0.0	480	8.5								
2	20.5	10.2	14000	4.1								

Station 3AAA (100m downstream of bridge)

	Prebreaching Survey				Draining Survey				Tidal Survey			
Depth Meters	Temp °C	Sal °/oo	Cond µmho	D. O. ppm	Temp °C	Sal °/oo	Cond µmho	D. O. ppm	Temp °C	Sal °/oo	Cond µmho	D. O. ppm
0												
1												
2												

[1]No flow out of creek.

Appendix A-10. Prebreaching Water Quality Profiles at Russian River Estuary Stations 1-4, Event III, 1 October 1999.

1-Oct-99																
	Station 1(1000 hr PDT)				Station 2 (1145 hr PDT)				Station 3 (1245 hr PDT)				Station 4 (1500 hr PDT)			
	water level, m		1.81	(5.9 ft)	water level, m		1.8	(5.9 ft)	water level, m		1.8	(5.9 ft)	water level, m		1.80	(5.9 ft)
Depth Meters	Temp °C	Sal °/oo	Cond µmho	D. O. ppm	Temp °C	Sal °/oo	Cond µmho	D. O. ppm	Temp °C	Sal °/oo	Cond µmho	D. O. ppm	Temp °C	Sal °/oo	Cond µmho	D. O. ppm
0	18.0	2.0	3080	9.7	19.0	1.0	1720	8.8	18.8	1.0	1510	8.8	19.9	0.4	820	8.7
1	18.0	2.1	3100	10.0	18.9	1.1	1900	9.6	18.8	1.0	1510	8.8	19.5	0.4	910	8.8
2	18.0	13.1	18300	20.0	19.9	12.2	18000	15.0	20.0	12.3	19000	13.2	20.2	7.0	11000	12.1
3	16.1	27.0	35000	13.1	18.0	26.0	35500	11.8	18.5	26.0	35300	8.8	19.0	26.5	37000	9.1
4	14.9	27.5	34900	8.9	16.0	28.0	36000	3.7	16.0	28.1	36300	2.7	17.5	27.5	37000	5.3
5	14.0	28.0	34900	7.4	15.0	28.5	36000	0.6	15.9	29.0	37000	0.2	17.0	27.7	37000	2.0
6	13.9	28.4	34900	4.7	15.0	29.0	36200	0.1	15	29.5	37200	0.1	16.0	29.0	37000	0.2
7	13.4	28.9	34900	4.5	15.0	29.0	36500	0.1					-	-	-	-
7.2	13.4	28.9	34900	-	-	-	-	-					-	-	-	-
8					15.0	29.0	365	0.1					15.0	29.0	36400	0.1
8.5					-	-	-	0.1					-	-	-	-
9													-	-	-	-
10													14.9	28.8	36100	0.1
11													-	-	-	-
12													14.8	28.8	36100	0.05
13													-	-	-	-
14													14.8	28.8	36100	0.05
15													-	-	-	0.05
14													-	-	-	0.05

Appendix A-11. Draining Water Quality Profiles at Russian River Estuary Stations 1-4, Event III, 5 October 1999.

5-Oct-99																
	Station 1 (0950 hr PDT)				Station 2 (1120 hr PDT)				Station 3 (1150 hr PDT)				Station 4 (1450 hr PDT)			
	water level, m 0.60 (2.0 ft)				water level, m 0.61 (2.0 ft)				water level, m 0.57 (1.9 ft)				water level, m 0.31 (1.0 ft)			
Depth Meters	Temp °C	Sal °/oo	92 μmho	D. O. ppm	Temp °C	Sal °/oo	Cond μmho	D. O. ppm	Temp °C	Sal °/oo	Cond μmho	D. O. ppm	Temp °C	Sal °/oo	Cond μmho	D. O. ppm
0	17.9	4.1	6000	8.8	18.8	3.0	5900	8.1	18.9	2.5	3590	8.5	19.0	1.9	2610	8.2
1	16.0	23.1	31100	8.8	17.6	24.3	32500	4.1	18.9	5.0	7900	8.2	19.0	1.9	2610	8.2
2	15.0	28.9	36100	8.9	16.7	27.0	35000	3.7	17.0	26.5	35100	3.8	19.0	1.9	2610	8.2
3	15.0	30.0	37900	8.9	16.0	27.1	35500	2.7	17.0	27.9	36600	1.6	17.9	27.2	37000	3.6
4	15.0	30.0	37900	9.9	15.2	28.7	36100	1.0	16.0	28.1	37200	0.2	17.0	28.0	37000	0.15
5	15.0	30.1	38000	9.0	15.0	29.0	36500	0.15	15.1	28.5	37200	0.1	16.0	28.0	37000	0.1
6	15.0	31.0	38900	9.2	14.9	29.2	36600	0.1					15.5	28.5	36500	0.1
6.9					14.8	29.2	36600	0.1					-	-	-	-
7													-	-	-	-
8													15.0	28.5	36100	0.05
9													-	-	-	-
10													14.9	28.5	36100	0.15
11													-	-	-	-
12													14.9	28.5	36100	0.05
13													-	-	-	-
14													14.9	28.5	36100	0.05
15													-	-	-	0.05

Appendix A-12. Tidal Water Quality Profiles at Russian River Estuary Stations 1-4, Event III, 7 October 1999.

7-Oct-99																
	Station 1 (0930 hr PDT)				Station 2 (1100 hr PDT)				Station 3 (1140 hr PDT)				Station 4 (1405 hr PDT)			
	water level, m 0.52 (1.7 ft)				water level, m 0.63 (2.1 ft)				water level, m 0.67 (2.2 ft)				water level, m 0.71 (2.3 ft)			
Depth Meters	Temp °C	Sal ‰	Cond µmho	D. O. ppm	Temp °C	Sal ‰	Cond µmho	D. O. ppm	Temp °C	Sal ‰	Cond µmho	D. O. ppm	Temp °C	Sal ‰	Cond µmho	D. O. ppm
0	16.1	7.1	10200	8.3	17.3	5.1	7600	8.2	17.9	4.0	5500	8.3	19.0	2.0	3000	9.0
1	15.6	24.0	31500	8.2	16.8	27.1	35900	8.0	17.0	27.0	36100	6.8	18.0	23.5	33900	7.8
2	14.1	28.0	35000	8.3	16.0	28.1	37800	8.4	16.0	28.5	37000	7.6	17.0	26.9	35200	5.2
3	14.0	29.5	36200	8.3	15.9	29.9	38000	8.3	16.0	28.5	37000	7.8	17.0	27.3	36000	5.7
4	13.9	29.8	36700	8.3	15.5	30.0	38000	8.3	16.0	28.9	37200	7.8	17.0	27.5	36200	4.5
4.5	-	-	-	-	-	-	-	-	-	-	-	7.8	-	-	-	-
5	13.9	30.2	37100	8.3	15.5	30.0	38000	8.3					16.0	29.0	37000	0.4
5.5	13.9	30.2	37100	8.3	-	-	-	-					-	-	-	-
6					15.5	30.0	38100	8.3					15.9	28.9	37000	0.2
6.5					15.5	30.0	38100	8.2					-	-	-	-
7													-	-	-	-
8													14.9	29.1	36500	0.2
9													-	-	-	-
10													14.8	29.2	36400	0.2
11													-	-	-	-
12													14.7	29.2	36100	0.2
13													-	-	-	0.2
14																

Appendix A-13. Water Quality Profiles in Willow Creek at Stations Near its Confluence with the Russian River, Event III, Breached 4 October 1999.

Station 3A (0.5 km upstream of bridge)

	Prebreaching Survey 1 October (1320 hr PDT)				Draining Survey 5 October (1230 hr PDT)				Tidal Survey 7 October (1155 hr PDT)			
Depth Meters	Temp °C	Sal °/oo	Cond µmho	D. O. ppm	Temp °C	Sal °/oo	Cond µmho	D. O. ppm	Temp °C	Sal °/oo	Cond µmho	D. O. ppm
0	19.0	1.0	1450	7.9	16.0	1.0	1490	5.3	16.9	2.1	3000	6.8
1	18.5	1.0	1500	7.4	18.9	6.2	9000	2.5	-	-	-	-
1.2	-	-	-	-	-	-	-	-	16.9	3.6	5500	7.2
2	19.9	5.3	8200	3.7								

Station 3AA (near bridge)

	Prebreaching Survey 1 October (1345 hr PDT)				Draining Survey 5 October (1245 hr PDT)				Tidal Survey 7 October (1205 hr PDT)			
Depth Meters	Temp °C	Sal °/oo	Cond µmho	D. O. ppm	Temp °C	Sal °/oo	Cond µmho	D. O. ppm	Temp °C	Sal °/oo	Cond µmho	D. O. ppm
0	19.0	1.0	1400	8.0	16.0	1.0	1600	4.2	17.5	3.2	4900	7.7
1	19.0	1.0	1400	8.0	18.0	19.5	27000	0.2	18.0	4.5	6100	5.5
1.2	-	-	-	-					18.0	17.0	24800	5.5
2	20.0	4.0	6000	3.0								

Station 3AAA (100m downstream of bridge)

	Prebreaching Survey				Draining Survey				Tidal Survey			
Depth Meters	Temp °C	Sal °/oo	Cond µmho	D. O. ppm	Temp °C	Sal °/oo	Cond µmho	D. O. ppm	Temp °C	Sal °/oo	Cond µmho	D. O. ppm
0												
1												
2												

Appendix A-14. Prebreaching Water Quality Profiles at Russian River Estuary Stations 1-4, Event IV, 30 13 October 1999.

13-Oct-99																
	Station 1(0945 hr PDT)				Station 2 (1105 hr PDT)				Station 3 (1200 hr PDT)				Station 4 (1420 hr PDT)			
	water level, m 1.89 (6.2 ft)				water level, m 1.88 (6.2 ft)				water level, m 1.88 (6.2 ft)				water level, m 1.90 (6.2 ft)			
Depth Meters	Temp °C	Sal °/oo	Cond µmho	D. O. ppm	Temp °C	Sal °/oo	Cond µmho	D. O. ppm	Temp °C	Sal °/oo	Cond µmho	D. O. ppm	Temp °C	Sal °/oo	Cond µmho	D. O. ppm
0	16.5	2.9	3900	10.1	17.0	1.2	1900	9.5	17.3	0.9	1250	9.6	18.0	0.4	800	10.0
1	16.5	2.9	3900	10.1	17.0	1.2	2110	9.5	17.5	0.9	1300	9.7	18.0	0.7	1000	10.0
2	17.9	19.1	22000	13.2	19.0	17.2	24800	8.9	19.0	15.2	22000	8.2	19.9	17.0	25000	8.1
3	16.0	27.5	35500	11.7	18.0	26.3	36000	9.9	18.0	27.0	36900	9.7	19.0	27.3	37700	8.3
4	15.1	29.1	37000	9.6	17.0	29.1	38500	7.5	17.0	29.5	38900	6.9	18.0	28.0	38000	9.0
5	15.0	29.5	37100	7.7	16.0	29.9	38100	5.7	16.5	29.4	38300	5.2	17.5	28.1	37900	8.2
6	14.8	29.6	37200	7.6	16.0	29.9	38100	5.1	16.0	29.5	38200	3.5	17.1	28.0	37500	7.0
7	14.5	30.0	37100	5.7	16.0	29.7	38000	4.8					16.8	28.3	37000	4.0
7.3	14.1	30.0	37100	5.7	-	-	-	-					-	-	-	-
8					16.0	29.9	38000	3.9					16.0	28.5	36800	0.3
8.3					15.9	29.9	38000	3.9					-	-	-	-
9													-	-	-	-
10													15.0	28.9	36000	0.1
11													-	-	-	-
12													15.0	28.9	36000	0.1
13													-	-	-	-
14													15.0	28.9	36000	0.1
15													-	-	-	0.1

Appendix A-15. Draining Water Quality Profiles at Russian River Estuary Stations 1-4, Event IV, 22 October 1999.

22-Oct-99																
	Station 1 (0950 hr PDT)				Station 2 (1120 hr PDT)				Station 3 (1155 hr PDT)				Station 4 (1455 hr PDT)			
	water level, m		0.66	(2.2 ft)	water level, m		0.81	(2.7 ft)	water level, m		0.79	(2.6 ft)	water level, m		0.49	(1.6 ft)
Depth Meters	Temp °C	Sal °/oo	92 µmho	D. O. ppm	Temp °C	Sal °/oo	Cond µmho	D. O. ppm	Temp °C	Sal °/oo	Cond µmho	D. O. ppm	Temp °C	Sal °/oo	Cond µmho	D. O. ppm
0	15.0	5.0	7000	9.9	16.0	3.0	4100	8.8	16.0	2.8	3900	8.8	16.0	2.0	2720	8.8
1	13.0	27.0	33200	7.7	17.0	24.5	32000	5.5	16.9	7.9	11100	7.8	16.0	2.0	2800	8.8
2	13.0	30.0	36000	7.7	16.0	27.0	35000	4.3	17.0	25.9	34200	3.9	16.0	2.0	2800	8.8
3	13.0	30.0	36000	7.7	15.5	27.0	35000	4.8	17.0	26.8	35500	3.0	16.0	2.0	2850	8.8
4	12.9	30.5	36300	7.7	15.0	27.6	35000	4.4	17.0	29.1	36500	1.4	18.0	28.0	38000	4.4
5	12.7	31.0	37000	7.7	16.5	29.0	37600	1.4	17.0	29.1	38900	0.6	17.0	28.5	37500	2.8
5.5	-	-	-	7.7	-	-	-	-	-	-	-	-	-	-	-	-
6					16.5	29.6	38100	0.7	-	-	-	0.5	16.9	28.5	37100	0.6
7					-	-	-	0.6					-	-	-	-
8													15.5	28.5	36200	0.2
9													-	-	-	-
10													15.0	29.0	36200	0.1
11													-	-	-	-
12													15.0	29.0	36200	0.1
13													-	-	-	-
14													15.0	29.0	36200	0.1
14.5													-	-	-	0.1

Appendix A-16. Tidal Water Quality Profiles at Russian River Estuary Stations 1-4, Event IV, 24 October 1999.

24-Oct-99																
	Station 1 (0940 hr PDT)				Station 2 (1110 hr PDT)				Station 3 (1255 hr PDT)				Station 4 (1400 hr PDT)			
	water level, m 0.41 (1.3 ft)				water level, m 0.71 (2.3 ft)				water level, m 0.84 (2.8 ft)				water level, m 0.80 (2.6 ft)			
Depth Meters	Temp °C	Sal °/oo	Cond µmho	D. O. ppm	Temp °C	Sal °/oo	Cond µmho	D. O. ppm	Temp °C	Sal °/oo	Cond µmho	D. O. ppm	Temp °C	Sal °/oo	Cond µmho	D. O. ppm
0	12.2	19.5	25000	8.5	14.5	6.1	6500	8.7	14.5	6.1	8200	8.8	15.0	7.3	10100	8.7
1	12.2	25.9	30500	7.9	13.1	28.0	33800	7.5	13.5	29.0	35300	7.4	15.0	15.0	16500	8.2
2	12.0	30.2	35400	7.6	13.0	29.1	35000	7.4	13.1	29.3	35500	7.3	13.9	27.0	33500	6.3
3	12.0	30.9	36000	7.6	12.5	29.7	35100	7.4	13.5	29.3	35800	7.3	14.9	26.1	34000	6.1
4	12.0	30.9	36000	7.6	12.5	29.7	35100	7.4	13.1	29.5	35800	7.2	14.9	27.4	34600	5.9
5	12.0	31.0	36000	7.5	13.0	29.4	35100	7.3	13.5	29.2	35900	7.2	14.9	27.4	35000	5.9
6	12.0	31.0	36000	7.3	13.0	29.4	35100	7.3	13.1	29.2	35900	7.2	14.9	27.4	35000	6.0
7					13.0	29.4	35100	7.3					15.1	28.0	35500	3.5
8													15.5	28.5	36500	0.5
9													-	-	-	-
10													15.0	28.9	36200	0.3
11													-	-	-	-
12													15.0	29.0	36500	0.2
13													-	-	-	-
14													15.0	29.0	36200	0.2
15													-	-	-	0.2

Appendix A-17. Water Quality Profiles in Willow Creek at Stations Near its Confluence with the Russian River, Event IV, Breached 21 October 1999.

Station 3A (0.5 km upstream of bridge)												
	Prebreaching Survey 13 October (1215 hr PDT)				Draining Survey 22 October (1220 hr PDT)				Tidal Survey 24 October (1200 hr PDT)			
Depth Meters	Temp °C	Sal °/oo	Cond μmho	D. O. ppm	Temp °C	Sal °/oo	Cond μmho	D. O. ppm	Temp °C	Sal °/oo	Cond μmho	D. O. ppm
0	17.0	1.0	1750	8.2	12.9	1.0	1320	4.8	12.9	1.9	2310	7.0
1	17.0	1.2	1950	7.6	12.7	1.4	1900	4.1	12.9	2.1	2910	7.0
1.4	-	-	-	-					12.9	2.3	2910	6.6
2	16.0	1.5	1940	6.4								

Station 3AA (near bridge)												
	Prebreaching Survey 13 October (1225 hr PDT)				Draining Survey 22 October (1230 hr PDT)				Tidal Survey 24 October (1215 hr PDT)			
Depth Meters	Temp °C	Sal °/oo	Cond μmho	D. O. ppm	Temp °C	Sal °/oo	Cond μmho	D. O. ppm	Temp °C	Sal °/oo	Cond μmho	D. O. ppm
0	17.5	1.0	1300	9.5	13.5	1.5	2050	5.9	13.2	3.5	4500	8.3
1	17.0	1.3	1890	8.4	13.9	2.0	2700	6.3	14.0	6.5	8900	8.5
1.3	-	-	-	-					14.0	7.0	9200	8.5
2	18.5	2.5	3700	5.2								
2.3	18.5	9.0	11000	1.2								

Station 3AAA (100m downstream of bridge)												
	Prebreaching Survey				Draining Survey				Tidal Survey			
Depth Meters	Temp °C	Sal °/oo	Cond μmho	D. O. ppm	Temp °C	Sal °/oo	Cond μmho	D. O. ppm	Temp °C	Sal °/oo	Cond μmho	D. O. ppm
0												
1												
2												

Appendix A-18. Prebreaching Water Quality Profiles at Russian River Estuary Stations 1-4, Event V, 4 November 1999.

4-Nov-99																
	Station 1(0910 hr PDT)				Station 2 (1040 hr PDT)				Station 3 (1100 hr PDT)				Station 4 (1330 hr PDT)			
	water level, m		1.73	(5.7 ft)	water level, m		1.70	(5.6 ft)	water level, m		1.67	(5.5 ft)	water level, m		1.68	(5.5 ft)
Depth Meters	Temp °C	Sal °/oo	Cond µmho	D. O. ppm	Temp °C	Sal °/oo	Cond µmho	D. O. ppm	Temp °C	Sal °/oo	Cond µmho	D. O. ppm	Temp °C	Sal °/oo	Cond µmho	D. O. ppm
0	13.2	1.3	2000	9.9	14.0	0.0	600	10.3	14.1	0.0	600	10.4	15.1	0.0	310	9.9
1	13.2	1.3	2000	9.8	14.0	1.6	2480	10.2	14.1	0.0	600	10.2	15.1	0.0	310	10.2
2	13.5	2.0	2950	11.4	14.2	15.4	19800	10.6	14.9	12.0	16000	10.1	15.5	13.9	18500	9.8
3	13.1	28.8	34600	8.7	14.0	28.0	34700	8.7	14.2	28.1	35100	8.6	15.0	28.0	35100	9.0
4	13.0	29.6	35400	8.3	13.8	30.1	37000	7.7	14.0	30.1	37000	6.7	14.6	29.0	35900	7.7
5	13.0	30.0	36000	7.7	13.5	31.0	37100	6.3	13.4	31.0	37200	4.2	14.1	29.0	35500	7.2
6	13.0	30.1	36200	7.0	13.2	31.0	37100	5.5	13.1	31.0	37200	4.0	13.9	28.5	35200	6.8
6.5	-	-	-	-	-	-	-	-	13.1	31.0	37200	3.7	-	-	-	-
7	13.0	30.3	36500	6.3	13.1	31.0	37100	5.3					-	-	-	-
8					13.1	31.0	37100	4.8					13.5	29.0	35100	6.5
9													-	-	-	-
10													13.5	29.0	35200	6.3
11													-	-	-	-
12													13.5	29.0	35200	6.3
13													-	-	-	-
14													13.5	29.0	35200	6.0
14.5													-	-	-	6.0

Appendix A-19. Draining Water Quality Profiles at Russian River Estuary Stations 1-4, Event V, 5 November 1999.

5-Nov-99																
	Station 1 (1455 hr PDT)				Station 2 (1420 hr PDT)				Station 3 (1125 hr PDT)				Station 4 (1155 hr PDT)			
	water level, m		0.93	(3.0 ft)	water level, m		0.92	(3.0 ft)	water level, m		0.97	(3.2 ft)	water level, m		0.99	(3.2 ft)
Depth Meters	Temp °C	Sal °/oo	92 µmho	D. O. ppm	Temp °C	Sal °/oo	Cond µmho	D. O. ppm	Temp °C	Sal °/oo	Cond µmho	D. O. ppm	Temp °C	Sal °/oo	Cond µmho	D. O. ppm
0	14.9	1.0	1490	10.6	15.0	1.1	1720	9.7	14.0	1.1	1690	9.3	15.0	1.0	1600	9.2
1	14.9	1.2	1780	10.4	15.0	1.1	1800	9.7	14.0	1.1	1700	9.4	15.0	1.0	1600	9.2
2	13.9	27.8	34000	9.0	14.9	25.9	33000	9.0	14.0	27.9	34500	8.5	15.1	27.3	34800	7.1
3	13.2	29.0	35200	8.6	14.0	30.0	37000	6.2	13.5	30.3	36900	5.6	14.9	28.5	35900	7.7
4	13.0	30.0	36000	7.8	13.5	31.2	37700	5.7	13.0	31.0	37000	3.6	14.0	29.0	35900	7.0
5	13.0	30.2	36300	6.3	13.2	31.3	37900	4.7	11.5	32.0	37000	3.8	13.9	29.0	35400	6.8
5.6	-	-	-	-	-	-	-	-	12.0	32.0	37000	3.8	-	-	-	-
6	13.0	30.5	36500	5.3	13.1	31.3	37900	4.30					13.5	29.1	35100	6.5
7					13.1	31.3	37900	4.2					-	-	-	-
7.5					13.1	31.3	37900	4.0					-	-	-	-
8													13.1	29.1	35200	6.4
9													-	-	-	-
10													13.1	29.1	35200	6.2
11													-	-	-	-
12													13.1	29.1	35100	6.0
13													-	-	-	-
14													13.1	29.1	35200	5.7
15													-	-		5.6

Appendix A-20. Tidal Water Quality Profiles at Russian River Estuary Stations 1-4, Event V, 14 November 1999.

14-Nov-99																
	Station 1 (0950 hr PDT)				Station 2 (1115 hr PDT)				Station 3 (1140 hr PDT)				Station 4 (1340 hr PDT)			
	water level, m		1.45	(4.8 ft)	water level, m		1.45	(4.8 ft)	water level, m		1.44	(4.7 ft)	water level, m		1.51	(4.9 ft)
Depth Meters	Temp °C	Sal °/oo	Cond µmho	D. O. ppm	Temp °C	Sal °/oo	Cond µmho	D. O. ppm	Temp °C	Sal °/oo	Cond µmho	D. O. ppm	Temp °C	Sal °/oo	Cond µmho	D. O. ppm
0	13.5	1.0	1400	10.0	14.9	0.1	510	9.0	14.4	0.0	410	8.7	15.0	0.0	300	8.9
1	13.5	1.0	1400	9.4	14.9	0.3	540	8.8	14.5	0.0	450	8.7	15.0	0.0	300	8.8
2	13.5	7.2	8500	8.7	14.2	15.2	20000	7.9	14.5	13.5	18000	7.3	14.9	11.5	15100	6.7
3	13.0	23.9	29100	8.0	14.0	23.4	29800	6.7	14.0	23.0	29000	5.9	14.9	15.0	19800	6.0
4	12.1	27.0	32100	7.4	13.9	25.1	31200	6.5	13.9	24.4	30800	4.9	14.9	16.0	21000	6.1
5	12.9	28.0	33300	7.4	13.8	25.8	32000	5.6	13.9	24.8	31000	5.0	14.9	16.5	21900	6.0
6	12.9	28.5	34100	6.9	14.0	29.0	36000	1.3	12.0	26.1	31100	4.9	14.9	17.0	22000	5.8
6.5	12.9	28.8	34100	6.4	-	-	-	-	13.9	25.0	31000	2.5	-	-	-	-
7					14.0	29.9	36900	0.7					-	-	-	-
8					14.0	30	36900	0.6					13.9	28.0	34900	2.6
9													-	-	-	-
10													13.5	29.0	35100	2.7
11													-	-	-	-
12													13.5	29.0	35200	2.1
13													-	-	-	-
14													13.2	29.5	35500	1.5
15													-	-	-	1.6

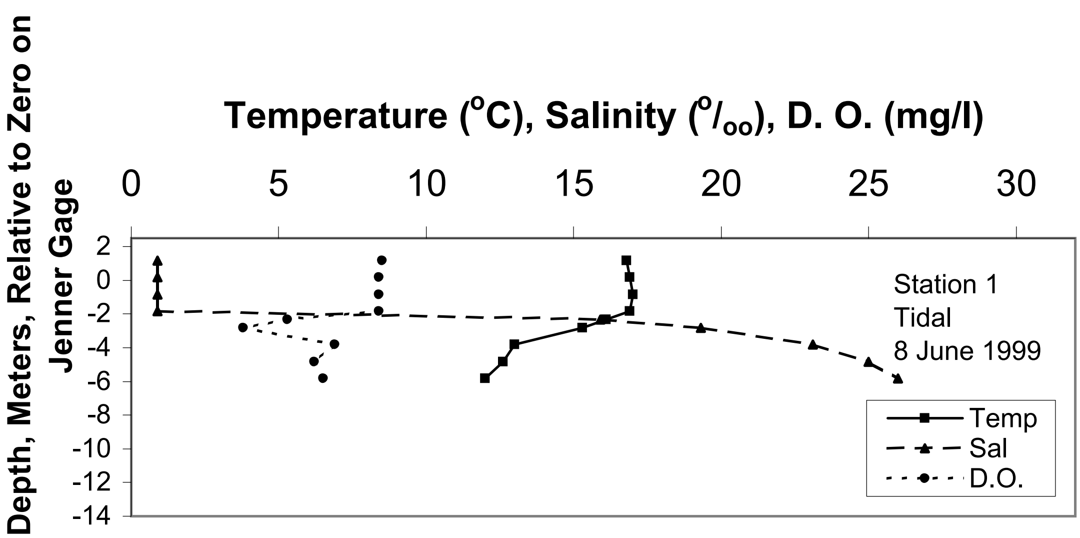
Appendix A-21. Water Quality Profiles in Willow Creek at Stations Near its Confluence with the Russian River, Event V, Breached 4 November 1999.

Station 3A (0.5 km upstream of bridge)												
	Prebreaching Survey 4 November (1400 hr PDT)				Draining Survey 5 November (1045 hr PDT)				Tidal Survey 14 November (1410 hr PDT)			
Depth Meters	Temp °C	Sal °/oo	Cond µmho	D. O. ppm	Temp °C	Sal °/oo	Cond µmho	D. O. ppm	Temp °C	Sal °/oo	Cond µmho	D. O. ppm
0	14.6	0.2	690	11.6	12.9	1.0	1260	7.7	13.9	0.3	550	7.8
1	13.0	0.5	720	10.6	15.1	14.5	19000	3.8	13.1	0.5	490	7.1
1.5	15.0	9.0	14000	5.8	15.6	14.9	20000	2.1	-	-	-	-
2	16.0	15.0	20500	0.5					13.1	1.3	1190	3.0

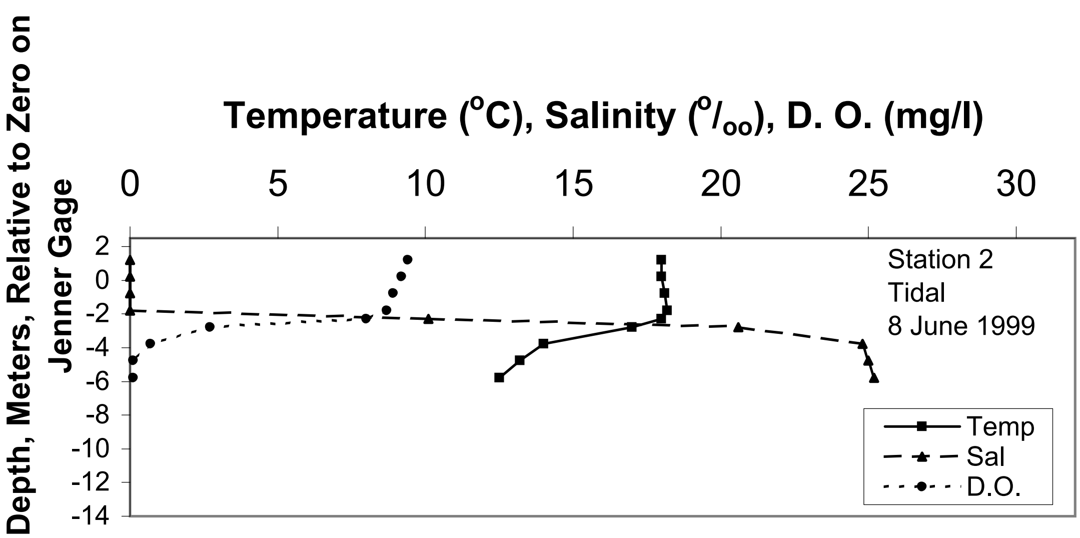
Station 3AA (near bridge)												
	Prebreaching Survey 4 November (1420 hr PDT)				Draining Survey 5 November (1100 hr PDT)				Tidal Survey 14 November (1420 hr PDT)			
Depth Meters	Temp °C	Sal °/oo	Cond µmho	D. O. ppm	Temp °C	Sal °/oo	Cond µmho	D. O. ppm	Temp °C	Sal °/oo	Cond µmho	D. O. ppm
0	14.9	0.3	610	11.4	12.8	1.0	1220	8.5	14.5	0.0	450	8.8
0.5	-	-	-	-	-	-	-	-	-	-	-	-
1	14.5	0.3	650	11.2	16.0	15.2	21000	0.7	14.0	0.4	650	7.6
1.1	-	-	-	-	-	-	-	-	-	-	-	-
1.3	-	-	-	-	16.2	17.2	24800	0.3	-	-	-	-
1.5	16.0	14.7	19000	5.7					-	-	-	-
1.7	-	-	-	-					14.0	2.2	2400	5.3
2	16.1	18.4	24900	0.4								

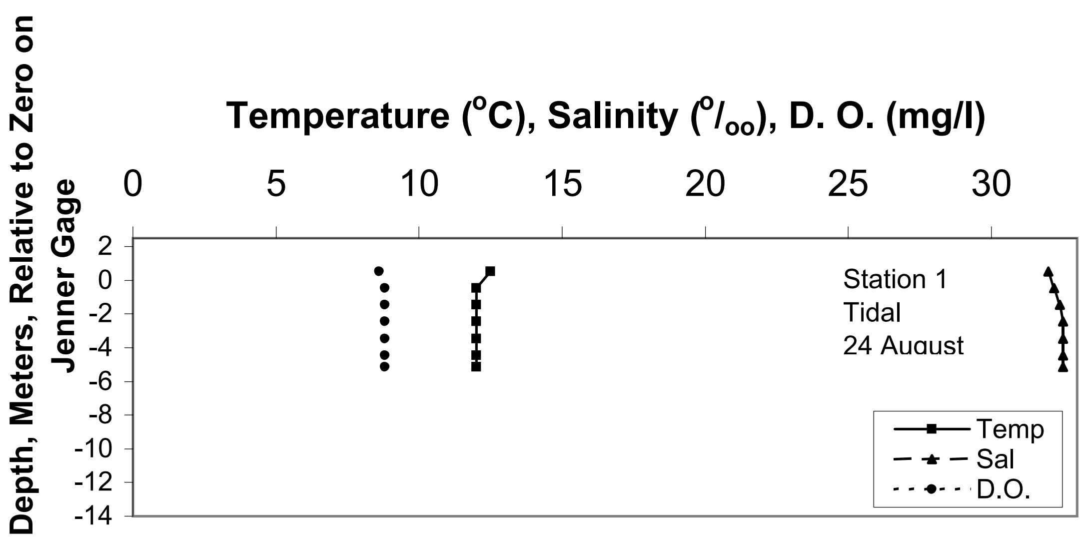
Station 3AAA (100m downstream of bridge)												
	Prebreaching Survey 4 November (1440 hr PDT)				Draining Survey 5 November (1110 hr PDT)				Tidal Survey 14 November (1430 hr PDT)			
Depth Meters	Temp °C	Sal °/oo	Cond µmho	D. O. ppm	Temp °C	Sal °/oo	Cond µmho	D. O. ppm	Temp °C	Sal °/oo	Cond µmho	D. O. ppm
0	15.1	0.3	690	11.0	14.6	1.0	1390	9.8	14.5	0.3	450	8.8
0.5	-	-	-	-	14.5	1.0	1390	9.8	-	-	-	-
1	15.0	0.3	690	10.6	13.8	1.2	1580	7.8	14.5	0.3	500	8.7
1.1	-	-	-	-	14.0	2.8	2700	5.5	-	-	-	-
1.5	15.9	3.2	4900	9.8					14.0	0.6	800	7.8
2	16.5	14.0	16300	6.0								

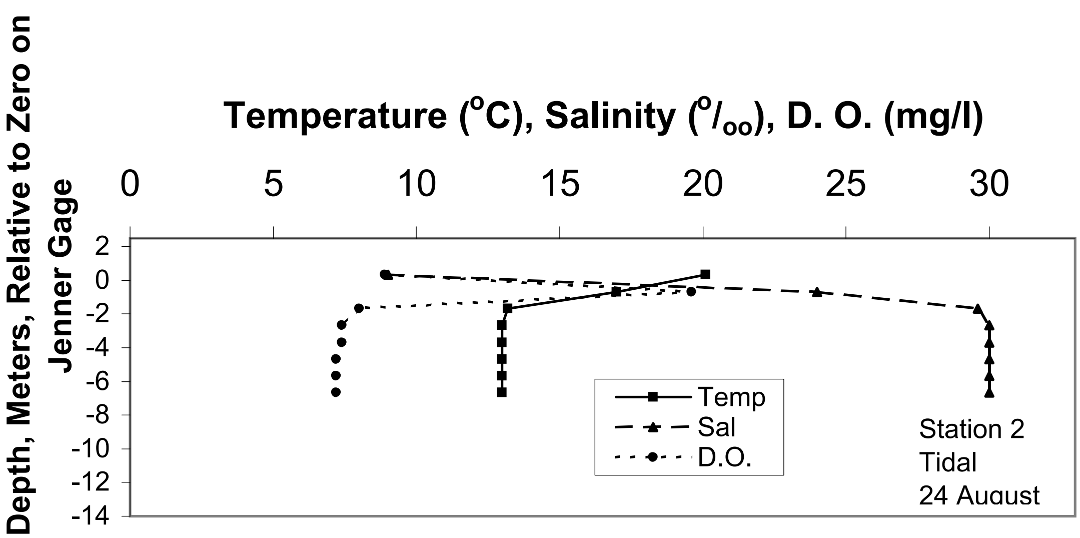
Appendix A-22. Preclosure Tidal Water Quality Profile Plots, 8 June 1999

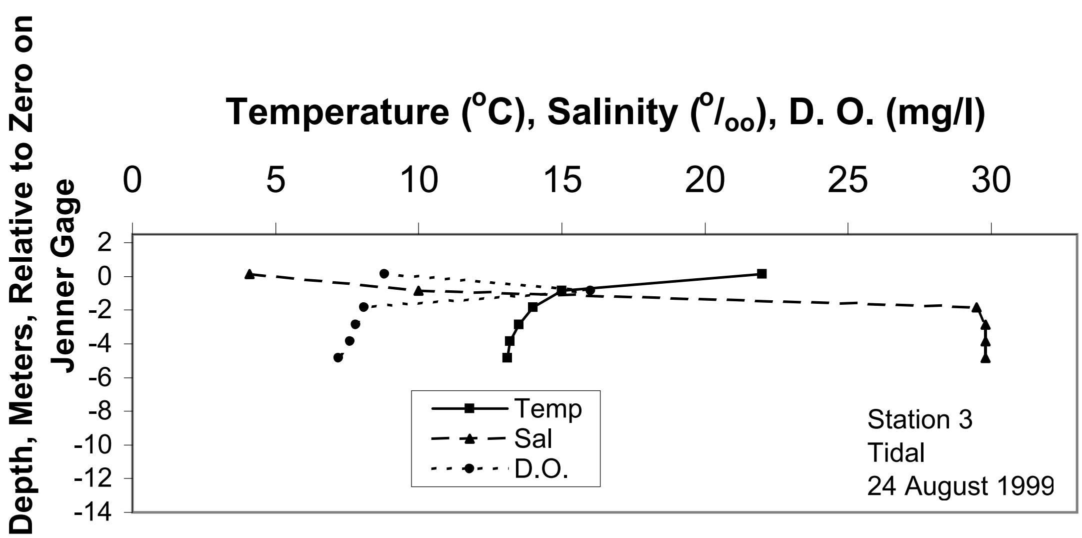


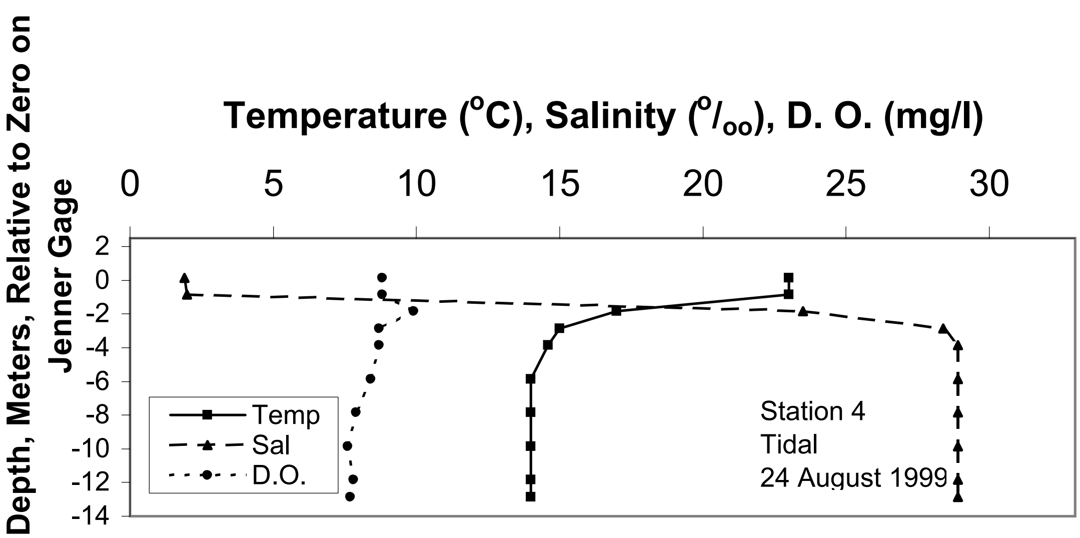
Appendix A-22. Preclosure Tidal Water Quality Profile Plots, 8 June 1999



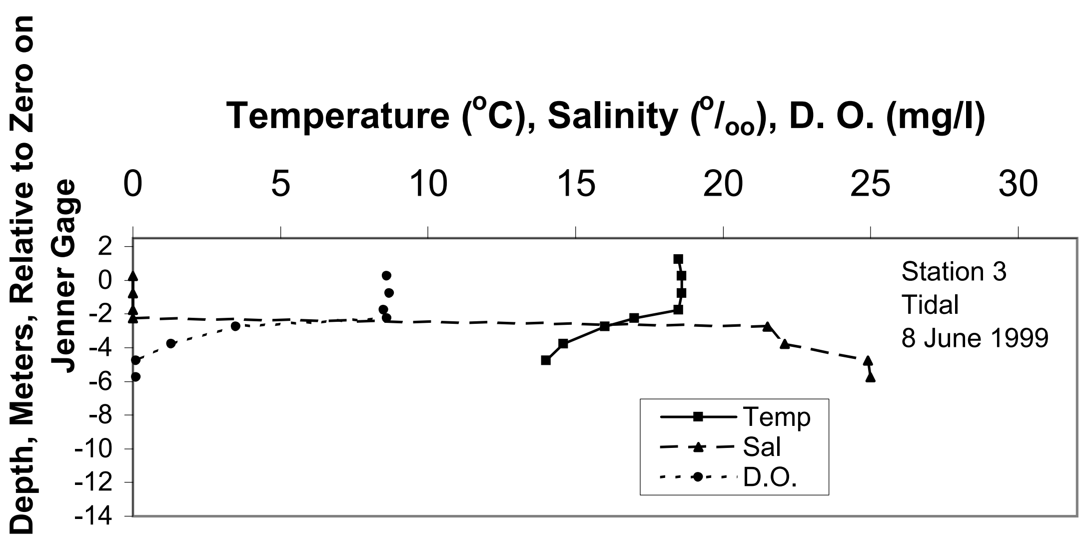

Temperature (°C), Salinity (°/oo), D. O. (mg/l)
0
5
10
15
20
25
30
2
0
-2
-4
-6
-8
-10
-12
-14
Depth, Meters, Relative to Zero on Jenner Gage
Station 1
Tidal
24 August
Temp
Sal
D.O.

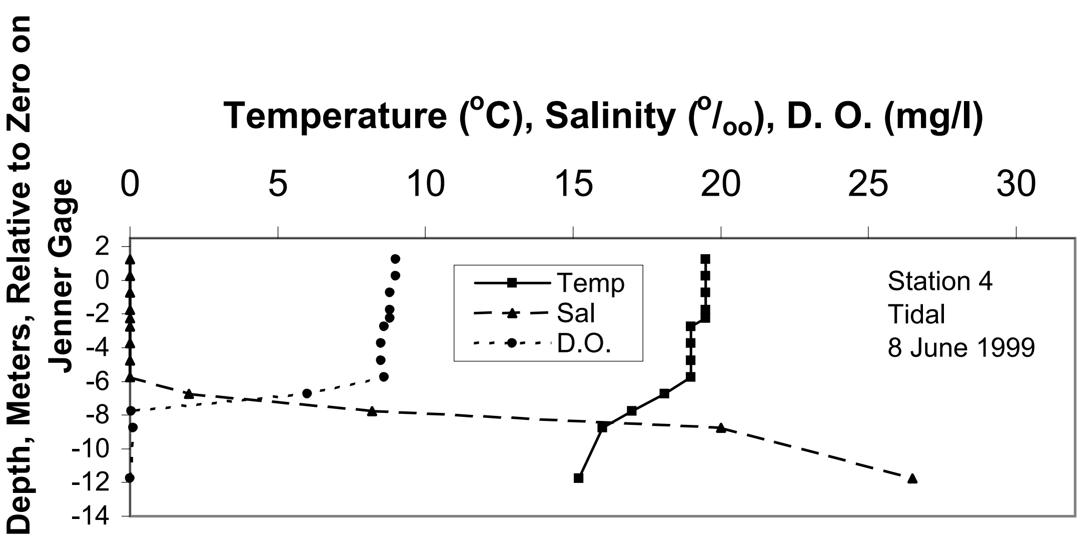

Temperature (°C), Salinity (°/oo), D. O. (mg/l)
0
5
10
15
20
25
30
Depth, Meters, Relative to Zero on Jenner Gage
2
0
-2
-4
-6
-8
-10
-12
-14
Temp
Sal
D.O.
Station 2
Tidal
24 August


Temperature (°C), Salinity (°/oo), D. O. (mg/l)
0
5
10
15
20
25
30
2
0
-2
-4
-6
-8
-10
-12
-14
Depth, Meters, Relative to Zero on Jenner Gage
Temp
Sal
D.O.
Station 3
Tidal
24 August 1999

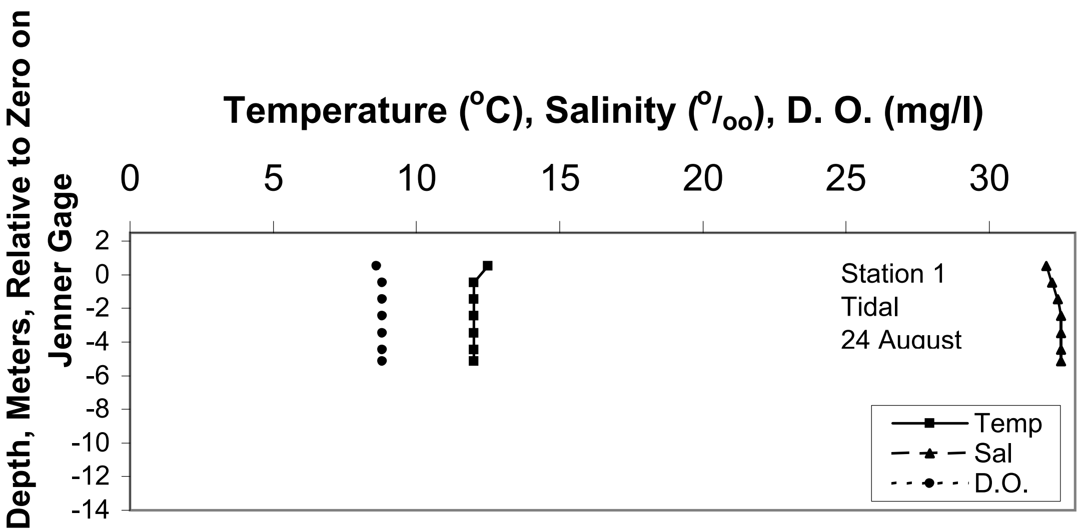

Temperature (°C), Salinity (°/oo), D. O. (mg/l)
0
5
10
15
20
25
30
2
0
-2
-4
-6
-8
-10
-12
-14
Depth, Meters, Relative to Zero on Jenner Gage
Temp
Sal
D.O.
Station 4
Tidal
24 August 1999

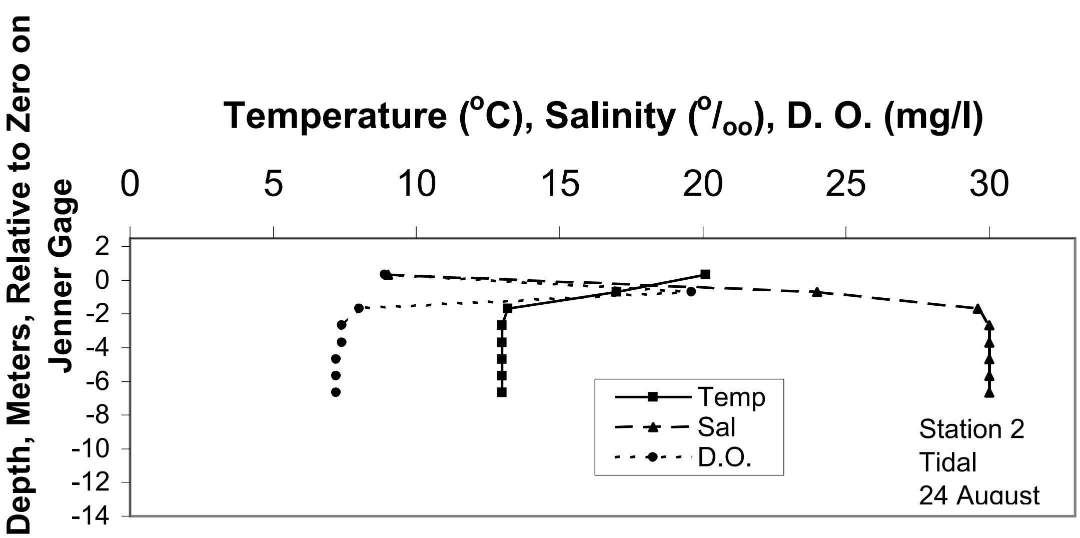
Appendix A-22. Preclosure Tidal Water Quality Profile Plots, 8 June 1999



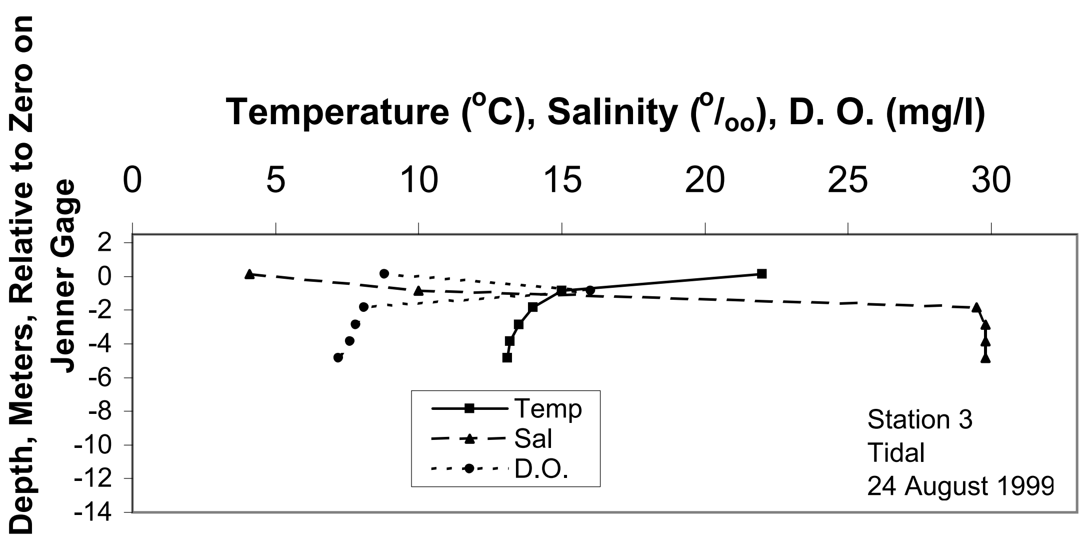

Temperature (°C), Salinity (°/oo), D. O. (mg/l)
Depth, Meters, Relative to Zero on Jenner Gage
0
5
10
15
20
25
30
2
0
-2
-4
-6
-8
-10
-12
-14
Temp
Sal
D.O.
Station 4
Tidal
8 June 1999

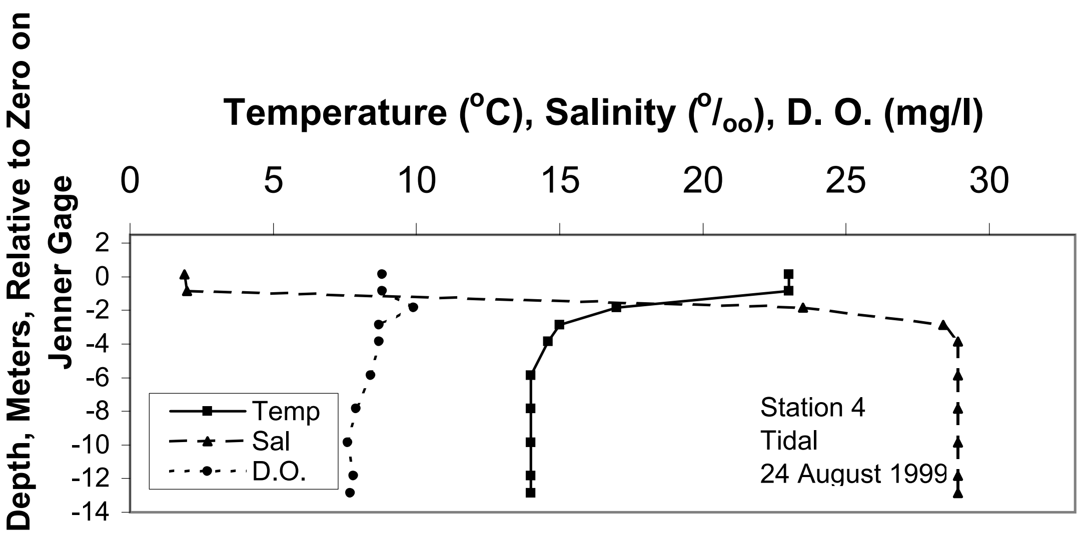
Appendix A-22. Preclosure Tidal Water Quality Profile Plots, 8 June 1999




Temperature (°C), Salinity (°/oo), D. O. (mg/l)
0
5
10
15
20
25
30
Depth, Meters, Relative to Zero on Jenner Gage
2
0
-2
-4
-6
-8
-10
-12
-14
Temp
Sal
D.O.
Station 2
Tidal
24 August

Appendix A-22. Preclosure Tidal Water Quality Profile Plots, 8 June 1999




Temperature (°C), Salinity (°/oo), D. O. (mg/l)
0
5
10
15
20
25
30
Depth, Meters, Relative to Zero on Jenner Gage
2
0
-2
-4
-6
-8
-10
-12
-14
Temp
Sal
D.O.
Station 4
Tidal
24 August 1999

Appendix B-1. Prebreaching Otter Trawl Catch Summary, Event I, 30 June 1999.

	30-Jun-99									
	Station 1 4-min tow 1020 hr PDT Avg. Depth 22 ft		Station 2 4-min tow 1125 hr PDT Avg. Depth 9 ft		Station 2 4-min tow 1145 hr PDT Avg. Depth 10 ft		Station 3 4-min tow 1155 hr PDT Avg. Depth 8 ft		Station 4 4-min tow 1245 hr PDT Avg. Depth 15 ft	
Common Name	No.	CPU	No.	CPU	No.	CPU	No.	CPU	No.	CPU
Topsmelt										
Pacific sanddab	1	0.25								
Sacramento sucker										
Pacific herring										
Prickly sculpin	3	0.75	10	2.5					13	3.25
Staghorn sculpin										
Cabezon	1	0.25								
Black rockfish	8	2								
Copper rockfish complex										
Sacramento squawfish										
Shiner surfperch										
Silver surfperch										
Pacific tomcod										
Threespine stickleback										
Tube-snout										
Lingcod										
Surf smelt										
Longfin smelt										
Unidentified osmerid larvae										
Starry flounder										
Saddleback gunnel										
Penpoint gunnel	1	0.25								
Steelhead										
Chinook salmon										
Bay pipefish										
Unidentified fish larvae										
Number of fish species	5		1		0		0		1	
Total fish	14	3.5	10	2.5	0	0	0	0	13	3.25

Invertebrates										
Crangon franciscorum										
Neomysis mercedis			100				300		300	
Cancer magister	3									
Eogammarus confervicolus			20		10		12		10	
Sphaeromatid isopods			5		10		25		10	
Other invertebrates*	ab				c		c			

Appendix B-2. Draining Otter Trawl Catch Summary, Event I, 2 July 1999.

	2-Jul-99							
	Station 1 4-min tow 1015 hr PDT Avg. Depth 16 ft		Station 2 4-min tow 1110 hr PDT Avg. Depth 6 ft		Station 3 4-min tow 1125 hr PDT Avg. Depth 5 ft		Station 4 4-min tow 1230 hr PDT Avg. Depth 14 ft	
Common Name	No.	CPU	No.	CPU	No.	CPU	No.	CPU
Topsmelt								
Pacific sanddab								
Sacramento sucker			1	0.25	10	2.5	122	30.5
Pacific herring								
Prickly sculpin	5	1.25	3	0.75	9	2.25	5	1.25
Staghorn sculpin					3	0.75		
Cabezon								
Black rockfish	8	2						
Copper rockfish complex	2	0.5						
Sacramento squawfish								
Shiner surfperch							1	0.25
Silver surfperch								
Pacific tomcod								
Threespine stickleback					8	2		
Tube-snout								
Lingcod								
Surf smelt								
Longfin smelt								
Unidentified osmerid larvae								
Starry flounder								
Saddleback gunnel								
Penpoint gunnel								
Steelhead								
Chinook salmon								
Bay pipefish							1	0.25
Unidentified fish larvae	1	0.25						
Number of fish species	4		2		4		4	
Total fish	16	4	4	1	30	7.5	129	32.25

Invertebrates								
Crangon franciscorum					1			
Neomysis mercedis	500		500		800		200	
Cancer magister								
Eogammarus confervicolus	100		200		10		200	
Sphaeromatid isopods					10			
Other invertebrates*	b		a					

Appendix B-3. Tidal Otter Trawl Catch Summary, Event I, 6 July 1999.

	6-Jul-99							
	Station 1 4-min tow 1000 hr PDT Avg. Depth 16 ft		Station 2 4-min tow 1110 hr PDT Avg. Depth 7 ft		Station 3 4-min tow 1120 hr PDT Avg. Depth 8 ft		Station 4 4-min tow 1225 hr PDT Avg. Depth 14 ft	
Common Name	No.	CPU	No.	CPU	No.	CPU	No.	CPU
Topsmelt								
Pacific sanddab								
Sacramento sucker							15	3.75
Pacific herring			8	2				
Prickly sculpin	3	0.75					12	3
Staghorn sculpin								
Cabezon								
Black rockfish	4	1						
Copper rockfish complex								
Sacramento squawfish							3	0.75
Shiner surfperch								
Silver surfperch								
Pacific tomcod								
Threespine stickleback								
Tube-snout								
Lingcod								
Surf smelt								
Longfin smelt								
Unidentified osmerid larvae								
Starry flounder								
Saddleback gunnel								
Penpoint gunnel								
Steelhead								
Chinook salmon								
Bay pipefish								
Unidentified fish larvae								
Number of fish species	2		1		0		3	
Total fish	7	1.75	8	2	0	0	30	7.5

Invertebrates								
Crangon franciscorum								
Neomysis mercedis	600		500		800		500	
Cancer magister								
Eogammarus confervicolus	300		200		50		200	
Sphaeromatid isopods			30		100			
Other invertebrates*	abd		c				c	

Appendix B-4. Interbreaching Tidal Otter Trawl Catch Summary, Event I-II, 24 August 1999.

	24-Aug-99							
	Station 1 4-min tow 1225 hr PDT Avg. Depth 17 ft		Station 2 4-min tow 1400 hr PDT Avg. Depth 5 ft		Station 3 4-min tow 1435 hr PDT Avg. Depth 5 ft		Station 4 4-min tow 1525 hr PDT Avg. Depth 10 ft	
Common Name	No.	CPU	No.	CPU	No.	CPU	No.	CPU
Topsmelt								
Pacific sanddab								
Sacramento sucker								
Pacific herring					51	12.75	1	0.25
Prickly sculpin			2	0.5	1	0.25	3	0.75
Staghorn sculpin								
Cabezon								
Black rockfish								
Copper rockfish complex								
Sacramento squawfish								
Shiner surfperch								
Silver surfperch								
Pacific tomcod								
Threespine stickleback								
Tube-snout								
Lingcod	1	0.25						
Surf smelt								
Longfin smelt								
Unidentified osmerid larvae								
Starry flounder								
Saddleback gunnel								
Penpoint gunnel								
Steelhead								
Chinook salmon								
Bay pipefish								
Unidentified fish larvae								
Number of fish species	1		1		2		2	
Total fish	1	0.25	2	0.5	52	13	4	1

Invertebrates								
Crangon franciscorum					5		1	
Neomysis mercedis	200		25		100			
Cancer magister								
Eogammarus confervicolus			25				20	
Sphaeromatid isopods	15		100		200		30	
Other invertebrates*	a				c			

Appendix B-5. Prebreaching Otter Trawl Catch Summary, Event II, 22 September 1999.

	22-Sep-99							
	Station 1 4-min tow 1000 hr PDT Avg. Depth 18 ft		Station 2 4-min tow 1115 hr PDT Avg. Depth 10 ft		Station 3 4-min tow 1135 hr PDT Avg. Depth 9 ft		Station 4 4-min tow 1240 hr PDT Avg. Depth 16 ft	
Common Name	No.	CPU	No.	CPU	No.	CPU	No.	CPU
Topsmelt								
Pacific sanddab								
Sacramento sucker								
Pacific herring								
Prickly sculpin	5	1.25	8	2			3	0.75
Staghorn sculpin								
Cabezon								
Black rockfish								
Copper rockfish complex								
Sacramento squawfish								
Shiner surfperch			1	0.25				
Silver surfperch								
Pacific tomcod								
Threespine stickleback								
Tube-snout								
Lingcod								
Surf smelt								
Longfin smelt								
Unidentified osmerid larvae								
Starry flounder								
Saddleback gunnel								
Penpoint gunnel								
Steelhead								
Chinook salmon								
Bay pipefish								
Unidentified fish larvae								
Number of fish species	1		2		0		1	
Total fish	5	1.25	9	2.25	0	0	3	0.75

Invertebrates								
Crangon franciscorum							20	
Neomysis mercedis	700						100	
Cancer magister	48		2					
Eogammarus confervicolus	25		200		50		50	
Sphaeromatid isopods			20		100			
Other invertebrates*	c		e					

Appendix B-6. Draining Otter Trawl Catch Summary, Event II, 24 September 1999.

	24-Sep-99							
	Station 1 4-min tow 0955 hr PDT Avg. Depth 13 ft		Station 2 4-min tow 1055 hr PDT Avg. Depth 7 ft		Station 3 4-min tow 1115 hr PDT Avg. Depth 6.5 ft		Station 4 4-min tow 1245 hr PDT Avg. Depth 13 ft	
Common Name	No.	CPU	No.	CPU	No.	CPU	No.	CPU
Topsmelt								
Pacific sanddab								
Sacramento sucker								
Pacific herring								
Prickly sculpin	7	1.75	8	2	4	1	14	3.5
Staghorn sculpin								
Cabezon								
Black rockfish	1	0.25						
Copper rockfish complex								
Sacramento squawfish								
Shiner surfperch								
Silver surfperch								
Pacific tomcod								
Threespine stickleback			1	0.25	9	2.25		
Tube-snout								
Lingcod								
Surf smelt					1	0.25		
Longfin smelt								
Unidentified osmerid larvae								
Starry flounder								
Saddleback gunnel								
Penpoint gunnel								
Steelhead								
Chinook salmon								
Bay pipefish								
Unidentified fish larvae								
Number of fish species	2		2		3		1	
Total fish	8	2	9	2.25	14	3.5	14	3.5

Invertebrates								
Crangon franciscorum					3		11	
Neomysis mercedis	50		200				50	
Cancer magister	1							
Eogammarus confervicolus			200		75		100	
Sphaeromatid isopods			200		100		100	
Other invertebrates*			e					

Appendix B-7. Prebreaching Otter Trawl Catch Summary, Event III, 1 October 1999.

	1-Oct-99							
	Station 1 4-min tow 1040 hr PDT Avg. Depth 16 ft		Station 2 4-min tow 1200 hr PDT Avg. Depth 8 ft		Station 3 4-min tow 1220 hr PDT Avg. Depth 8 ft		Station 4 4-min tow 1420 hr PDT Avg. Depth 15 ft	
Common Name	No.	CPU	No.	CPU	No.	CPU	No.	CPU
Topsmelt								
Pacific sanddab								
Sacramento sucker								
Pacific herring								
Prickly sculpin			1	0.25			18	4.5
Staghorn sculpin								
Cabezon								
Black rockfish								
Copper rockfish complex								
Sacramento squawfish								
Shiner surfperch								
Silver surfperch								
Pacific tomcod								
Threespine stickleback								
Tube-snout								
Lingcod								
Surf smelt								
Longfin smelt								
Unidentified osmerid larvae	15	3.75						
Starry flounder								
Saddleback gunnel	1	0.25						
Penpoint gunnel								
Steelhead								
Chinook salmon								
Bay pipefish								
Unidentified fish larvae								
Number of fish species	2		1		0		1	
Total fish	16	4	1	0.25	0	0	18	4.5

Invertebrates								
Crangon franciscorum	2						140	
Neomysis mercedis	200		25				10	
Cancer magister	3							
Eogammarus confervicolus			50		8		200	
Sphaeromatid isopods	5		200		30		200	
Other invertebrates*	e						e	

Appendix B-8. Draining Otter Trawl Catch Summary, Event III, 5 October 1999.

	5-Oct-99							
	Station 1 4-min tow 1000 hr PDT Avg. Depth 15 ft		Station 2 4-min tow 1100 hr PDT Avg. Depth 5 ft		Station 3 4-min tow 1130 hr PDT Avg. Depth 5 ft		Station 4 4-min tow 1335 hr PDT Avg. Depth 10 ft	
Common Name	No.	CPU	No.	CPU	No.	CPU	No.	CPU
Topsmelt								
Pacific sanddab								
Sacramento sucker								
Pacific herring								
Prickly sculpin	1	0.25	1	0.25			2	0.5
Staghorn sculpin								
Cabezon								
Black rockfish								
Copper rockfish complex								
Sacramento squawfish								
Shiner surfperch								
Silver surfperch								
Pacific tomcod								
Threespine stickleback								
Tube-snout	1	0.25						
Lingcod								
Surf smelt								
Longfin smelt	1	0.25						
Unidentified osmerid larvae								
Starry flounder								
Saddleback gunnel								
Penpoint gunnel								
Steelhead								
Chinook salmon								
Bay pipefish					2	0.5		
Unidentified fish larvae								
Number of fish species	3		1		1		1	
Total fish	3	0.75	1	0.25	2	0.5	2	0.5

Invertebrates								
Crangon franciscorum			30		6		15	
Neomysis mercedis	25		50		25		30	
Cancer magister	8				2			
Eogammarus confervicolus	5		50		25		100	
Sphaeromatid isopods			100		50		200	
Other invertebrates*	e							

Appendix B-9. Tidal Otter Trawl Catch Summary, Event III, 7 October 1999.

	7-Oct-99							
	Station 1 4-min tow 1010 hr PDT Avg. Depth 18 ft		Station 2 4-min tow 1050 hr PDT Avg. Depth 5.5 ft		Station 3 4-min tow 1120 hr PDT Avg. Depth 6 ft		Station 4 4-min tow 1325 hr PDT Avg. Depth 16 ft	
Common Name	No.	CPU	No.	CPU	No.	CPU	No.	CPU
Topsmelt								
Pacific sanddab								
Sacramento sucker								
Pacific herring	1	0.25						
Prickly sculpin					1	0.25		
Staghorn sculpin								
Cabezon								
Black rockfish								
Copper rockfish complex								
Sacramento squawfish								
Shiner surfperch	3	0.75						
Silver surfperch								
Pacific tomcod	1	0.25						
Threespine stickleback								
Tube-snout	1	0.25						
Lingcod								
Surf smelt								
Longfin smelt								
Unidentified osmerid larvae								
Starry flounder								
Saddleback gunnel								
Penpoint gunnel								
Steelhead								
Chinook salmon								
Bay pipefish								
Unidentified fish larvae								
Number of fish species	4		0		1		0	
Total fish	6	1.5	0	0	1	0.25	0	0

Invertebrates								
Crangon franciscorum			1		8		5	
Neomysis mercedis	25		25					
Cancer magister	6							
Eogammarus confervicolus			25		50		25	
Sphaeromatid isopods	10		50		100			
Other invertebrates*					e			

Appendix B-10. Prebreaching Otter Trawl Catch Summary, Event IV, 13 October 1999.

	13-Oct-99							
	Station 1 4-min tow 1000 hr PDT Avg. Depth 22 ft		Station 2 4-min tow 1115 hr PDT Avg. Depth 7.5 ft		Station 3 4-min tow 1515 hr PDT Avg. Depth 10 ft		Station 4 4-min tow 1335 hr PDT Avg. Depth 32 ft	
Common Name	No.	CPU	No.	CPU	No.	CPU	No.	CPU
Topsmelt								
Pacific sanddab	2	0.5						
Sacramento sucker								
Pacific herring								
Prickly sculpin	1	0.25						
Staghorn sculpin								
Cabezon								
Black rockfish								
Copper rockfish complex								
Sacramento squawfish								
Shiner surfperch								
Silver surfperch								
Pacific tomcod	2	0.5						
Threespine stickleback					39	9.75		
Tube-snout								
Lingcod								
Surf smelt								
Longfin smelt	1	0.25						
Unidentified osmerid larvae								
Starry flounder								
Saddleback gunnel								
Penpoint gunnel								
Steelhead								
Chinook salmon								
Bay pipefish								
Unidentified fish larvae								
Number of fish species	4		0		1		0	
Total fish	6	1.5	0	0	39	9.75	0	0
Invertebrates								
Crangon franciscorum	5		4				13	
Neomysis mercedis	100		20				25	
Cancer magister	21		3		2			
Eogammarus confervicolus			25		10		25	
Sphaeromatid isopods			25		30		5	
Other invertebrates*	e							

Appendix B-11. Draining Otter Trawl Catch Summary, Event IV, 22 October 1999.

	22-Oct-99							
	Station 1 4-min tow 1005 hr PDT Avg. Depth 18 ft		Station 2 4-min tow 1100 hr PDT Avg. Depth 9 ft		Station 3 4-min tow 1140 hr PDT Avg. Depth 7 ft		Station 4 4-min tow 1350 hr PDT Avg. Depth 13 ft	
Common Name	No.	CPU	No.	CPU	No.	CPU	No.	CPU
Topsmelt								
Pacific sanddab								
Sacramento sucker								
Pacific herring								
Prickly sculpin			1	0.25	1	0.25	10	2.5
Staghorn sculpin	4	1					1	0.25
Cabezon								
Black rockfish								
Copper rockfish complex								
Sacramento squawfish								
Shiner surfperch								
Silver surfperch	1	0.25						
Pacific tomcod								
Threespine stickleback							1	0.25
Tube-snout								
Lingcod								
Surf smelt								
Longfin smelt	1	0.25						
Unidentified osmerid larvae	1	0.25						
Starry flounder								
Saddleback gunnel								
Penpoint gunnel								
Steelhead								
Chinook salmon								
Bay pipefish								
Unidentified fish larvae								
Number of fish species	4		1		1		3	
Total fish	7	1.75	1	0.25	1	0.25	12	3
Invertebrates								
Crangon franciscorum			4		5		30	
Neomysis mercedis	15		10		10		50	
Cancer magister	1		5		11			
Eogammarus confervicolus			3		10		100	
Sphaeromatid isopods	15		15		30			
Other invertebrates*	e						e	

Appendix B-12. Tidal Otter Trawl Catch Summary, Event IV, 24 October 1999.

	24-Oct-99							
	Station 1 4-min tow 0947 hr PDT Avg. Depth 22 ft		Station 2 4-min tow 1120 hr PDT Avg. Depth 8 ft		Station 3 4-min tow 1140 hr PDT Avg. Depth 6 ft		Station 4 4-min tow 1345 hr PDT Avg. Depth 11 ft	
Common Name	No.	CPU	No.	CPU	No.	CPU	No.	CPU
Topsmelt								
Pacific sanddab								
Sacramento sucker								
Pacific herring								
Prickly sculpin			3	0.75	1	0.25	7	1.75
Staghorn sculpin							1	0.25
Cabezon								
Black rockfish								
Copper rockfish complex								
Sacramento squawfish								
Shiner surfperch	1	0.25						
Silver surfperch								
Pacific tomcod	1	0.25						
Threespine stickleback								
Tube-snout								
Lingcod								
Surf smelt								
Longfin smelt	1	0.25						
Unidentified osmerid larvae								
Starry flounder								
Saddleback gunnel								
Penpoint gunnel								
Steelhead								
Chinook salmon								
Bay pipefish	1	0.25						
Unidentified fish larvae								
Number of fish species	4		1		1		2	
Total fish	4	1	3	0.75	1	0.25	8	2

Invertebrates								
Crangon franciscorum			3		6		16	
Neomysis mercedis			20		30		50	
Cancer magister	4		1					
Eogammarus confervicolus					15			
Sphaeromatid isopods			200		200		20	
Other invertebrates*								

Appendix B-13. Prebreaching Otter Trawl Catch Summary, Event V, 4 November 1999.

	4-Nov-99							
	Station 1 4-min tow 0920 hr PDT Avg. Depth 21 ft		Station 2 4-min tow 1020 hr PDT Avg. Depth 8 ft		Station 3 4-min tow 1055 hr PDT Avg. Depth 9 ft		Station 4 4-min tow 1232 hr PDT Avg. Depth 15 ft	
Common Name	No.	CPU	No.	CPU	No.	CPU	No.	CPU
Topsmelt								
Pacific sanddab	2	0.5						
Sacramento sucker								
Pacific herring								
Prickly sculpin							3	0.75
Staghorn sculpin								
Cabezon								
Black rockfish								
Copper rockfish complex								
Sacramento squawfish								
Shiner surfperch								
Silver surfperch								
Pacific tomcod								
Threespine stickleback							1	0.25
Tube-snout								
Lingcod								
Surf smelt								
Longfin smelt								
Unidentified osmerid larvae								
Starry flounder								
Saddleback gunnel								
Penpoint gunnel								
Steelhead								
Chinook salmon								
Bay pipefish								
Unidentified fish larvae								
Number of fish species	1		0		0		2	
Total fish	2	0.5	0	0	0	0	4	1
Invertebrates								
Crangon franciscorum			3				27	
Neomysis mercedis	20		30				40	
Cancer magister			1					
Eogammarus confervicolus			20		5		5	
Sphaeromatid isopods			50		100		15	
Other invertebrates*								

Appendix B-14. Draining Otter Trawl Catch Summary, Event V, 5 November 1999.

	5-Nov-99							
	Station 1 4-min tow 1505 hr PDT Avg. Depth 22 ft		Station 2 4-min tow 1410 hr PDT Avg. Depth 6 ft		Station 3 4-min tow 1350 hr PDT Avg. Depth 6 ft		Station 4 4-min tow 1215 hr PDT Avg. Depth 12 ft	
Common Name	No.	CPU	No.	CPU	No.	CPU	No.	CPU
Topsmelt								
Pacific sanddab							1	0.25
Sacramento sucker								
Pacific herring								
Prickly sculpin	2	0.5					14	3.5
Staghorn sculpin								
Cabezon								
Black rockfish								
Copper rockfish complex								
Sacramento squawfish								
Shiner surfperch	4	1						
Silver surfperch								
Pacific tomcod								
Threespine stickleback								
Tube-snout								
Lingcod								
Surf smelt								
Longfin smelt	2	0.5						
Unidentified osmerid larvae	2	0.5						
Starry flounder								
Saddleback gunnel								
Penpoint gunnel								
Steelhead								
Chinook salmon								
Bay pipefish							1	0.25
Unidentified fish larvae								
Number of fish species	4		0		0		3	
Total fish	10	2.5	0	0	0	0	16	4

Invertebrates								
Crangon franciscorum			7				21	
Neomysis mercedis	50		30		20		200	
Cancer magister	1							
Eogammarus confervicolus			50		30		50	
Sphaeromatid isopods			50		50			
Other invertebrates*	f							

Appendix B-15. Tidal Otter Trawl Catch Summary, Event V, 14 November 1999.

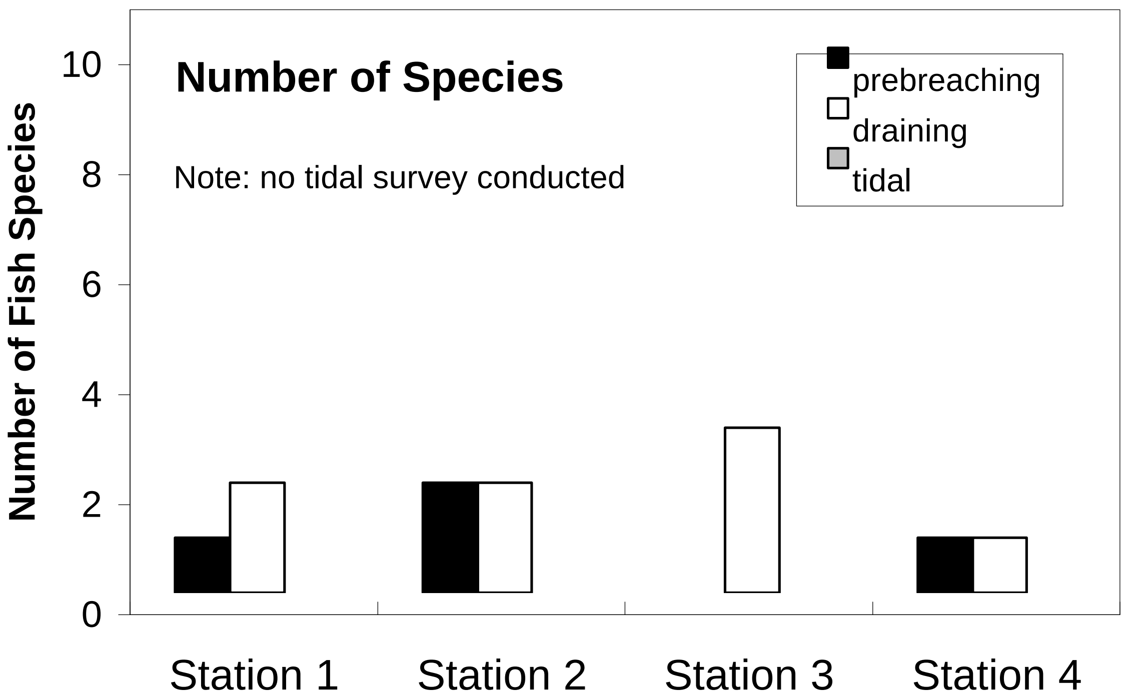
	14-Nov-99							
	Station 1 4-min tow 1000 hr PDT Avg. Depth 22 ft		Station 2 4-min tow 1100 hr PDT Avg. Depth 7 ft		Station 3 4-min tow 1125 hr PDT Avg. Depth 7.5 ft		Station 4 4-min tow 1220 hr PDT Avg. Depth 15 ft	
Common Name	No.	CPU	No.	CPU	No.	CPU	No.	CPU
Topsmelt								
Pacific sanddab								
Sacramento sucker								
Pacific herring								
Prickly sculpin							1	0.25
Staghorn sculpin								
Cabezon								
Black rockfish								
Copper rockfish complex								
Sacramento squawfish								
Shiner surfperch								
Silver surfperch								
Pacific tomcod								
Threespine stickleback							1	0.25
Tube-snout								
Lingcod								
Surf smelt								
Longfin smelt								
Unidentified osmerid larvae	1	0.25						
Starry flounder								
Saddleback gunnel								
Penpoint gunnel								
Steelhead								
Chinook salmon								
Bay pipefish								
Unidentified fish larvae								
Number of fish species	1		0		0		2	
Total fish	1	0.25	0	0	0	0	2	0.5

Invertebrates								
Crangon franciscorum	1		2				28	
Neomysis mercedis	6		30		5		10	
Cancer magister								
Eogammarus confervicolus			15		40		200	
Sphaeromatid isopods			50		40		200	
Other invertebrates*								

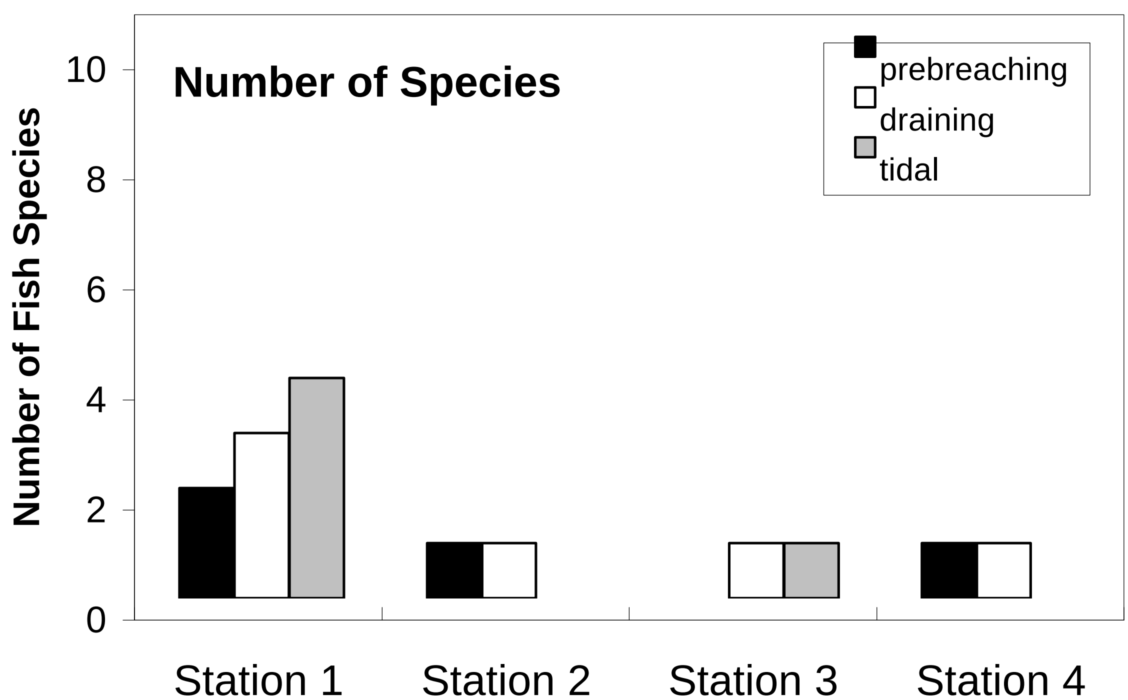
Key to "other invertebrates" in Appendix B-1 through B-15.

a	idoteid isopods
b	*Cancer* sp. (tiny juveniles)
c	*Corophium* sp.
d	ascidians
e	*Crangon nigricauda*
f	*Octopus rubescens*

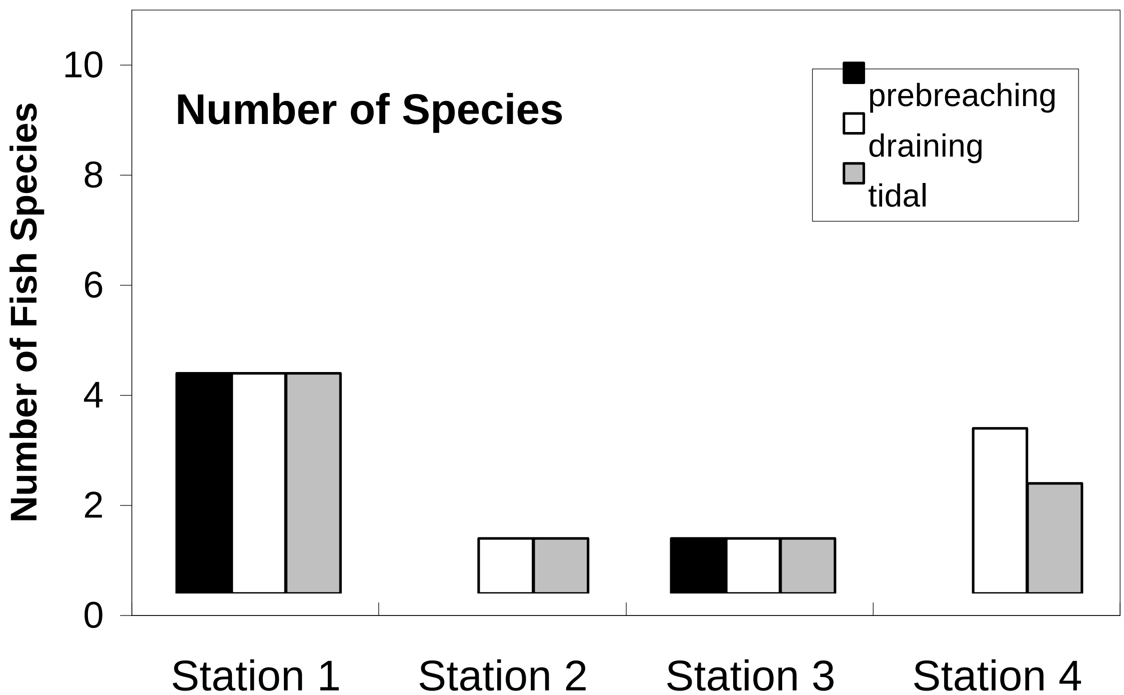
Appendix B-17. Fish Species and Catch in Otter Trawls, Event II, Breached 23 September 1999.



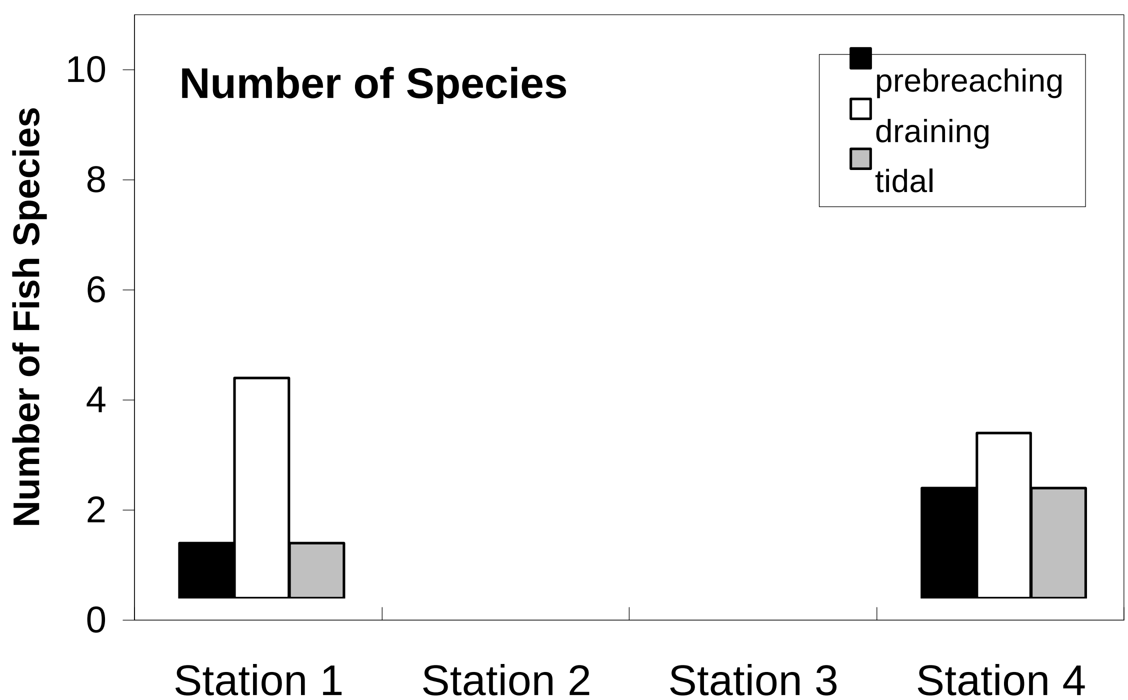
Appendix B-18. Fish Species and Catch in Otter Trawls, Event III, Breached 4 October 1999.



Appendix B-19. Fish Species and Catch in Otter Trawls, Event IV, Breached 21 October 1999.



Appendix B-20. Fish Species and Catch in Otter Trawls, Event V, Breached 4 November 1999.



Appendix B-21. Prebreaching Beach Seine Catch Summary, Event I, 30 June 1999.

	30-Jun-99				
	Stn 1	Stn 1	Stn 2	Stn 3	Stn 4
Common Name	1050 hr PDT	1105 hr PDT	no seine	1435 hr PDT	1305 hr PDT
Topsmelt					
Pacific sanddab					
Sacramento sucker				9	24
Pacific herring					
Prickly sculpin					
Staghorn sculpin					
Cabezon					
Black rockfish					
Copper rockfish complex					
Sacramento squawfish				41	
Shiner surfperch					
Silver surfperch					
Pacific tomcod					
Threespine stickleback					
Tube-snout					
Lingcod					
Surf smelt					
Longfin smelt					
Unidentified osmerid larvae					
Starry flounder					
Saddleback gunnel					
Penpoint gunnel					
Steelhead					
Chinook salmon					
Bay pipefish					
Unidentified fish larvae					
Number of fish species	0	0	-	2	1
Total fish	0	0	-	50	24

Appendix B-22. Draining Beach Seine Catch Summary, Event I, 2 July 1999.

Common Name	2-Jul-99 Stn 1 1045 hr PDT	Stn 2 no seine	Stn 3 1150 hr PDT	Stn 4 1345 hr PDT
Topsmelt				
Pacific sanddab				
Sacramento sucker	12		220	
Pacific herring				
Prickly sculpin				
Staghorn sculpin	6			
Cabezon				
Black rockfish				
Copper rockfish complex				
Sacramento squawfish				
Shiner surfperch				
Silver surfperch				
Pacific tomcod				
Threespine stickleback			5	
Tube-snout				
Lingcod				
Surf smelt				
Longfin smelt				
Unidentified osmerid larvae				
Starry flounder				
Saddleback gunnel				
Penpoint gunnel				
Steelhead				
Chinook salmon				
Bay pipefish				
Unidentified fish larvae				
Number of fish species	2	-	2	0
Total fish	18	-	225	0

Appendix B-23. Tidal Beach Seine Catch Summary, Event I, 6 July 1999.

Common Name	6-Jul-99 Stn 1 1030 hr PDT	Stn 2 no seine	Stn 3 1450 hr PDT	Stn 4 1210 hr PDT
Topsmelt				
Pacific sanddab				
Sacramento sucker			423	514
Pacific herring	17		1	
Prickly sculpin	15		1	3
Staghorn sculpin	2			
Cabezon				
Black rockfish				
Copper rockfish complex				
Sacramento squawfish				1
Shiner surfperch				
Silver surfperch				
Pacific tomcod				
Threespine stickleback			2	2
Tube-snout				
Lingcod				
Surf smelt				
Longfin smelt				
Unidentified osmerid larvae				
Starry flounder				
Saddleback gunnel				
Penpoint gunnel				
Steelhead				
Chinook salmon			1	
Bay pipefish				
Unidentified fish larvae				
Number of fish species	3	-	5	4
Total fish	34	-	428	520

Appendix B-24. Interbreaching Tidal Beach Seine Catch Summary, Event I-II, 24 August 1999.

	24-Aug-99			
	Stn 1	Stn 2	Stn 3	Stn 4
Common Name	1250 hr PDT	no seine	1500 hr PDT	1600 hr PDT
Topsmelt				
Pacific sanddab				
Sacramento sucker				1
Pacific herring	2			21
Prickly sculpin				
Staghorn sculpin				
Cabezon				
Black rockfish				
Copper rockfish complex				
Sacramento squawfish				
Shiner surfperch				
Silver surfperch				
Pacific tomcod				
Threespine stickleback			1	15
Tube-snout				
Lingcod				
Surf smelt	4			
Longfin smelt				
Unidentified osmerid larvae				
Starry flounder				
Saddleback gunnel				
Penpoint gunnel				
Steelhead			1	
Chinook salmon				
Bay pipefish				
Unidentified fish larvae				
Number of fish species	2	-	2	3
Total fish	6	-	2	37

Invertebrates				
Cancer magister	1			

Appendix B-25. Prebreaching Beach Seine Catch Summary, Event II, 22 September 1999.

	22-Sep-99			
Common Name	Stn 1 1035 hr PDT	Stn 2 no seine	Stn 3 1200 hr PDT	Stn 4 1300 hr PDT
Topsmelt				
Pacific sanddab				
Sacramento sucker				2
Pacific herring				
Prickly sculpin				
Staghorn sculpin				
Cabezon				
Black rockfish				
Copper rockfish complex				
Sacramento squawfish				
Shiner surfperch				
Silver surfperch				
Pacific tomcod				
Threespine stickleback				
Tube-snout				
Lingcod				
Surf smelt				
Longfin smelt				
Unidentified osmerid larvae				
Starry flounder				
Saddleback gunnel				
Penpoint gunnel				
Steelhead			2	
Chinook salmon				
Bay pipefish				
Unidentified fish larvae				
Number of fish species	0	-	1	1
Total fish	0	-	2	2

Appendix B-26. Draining Beach Seine Catch Summary, Event II, 24 September 1999.

	24-Sep-99			
	Stn 1	Stn 2	Stn 3	Stn 4
Common Name	1030 hr PDT	no seine	1145 hr PDT	1345 hr PDT
Topsmelt				
Pacific sanddab	1			
Sacramento sucker				
Pacific herring	1			
Prickly sculpin	1			1
Staghorn sculpin				
Cabezon				
Black rockfish				
Copper rockfish complex				
Sacramento squawfish				
Shiner surfperch				1
Silver surfperch				
Pacific tomcod				
Threespine stickleback			10	21
Tube-snout				
Lingcod				
Surf smelt	1			
Longfin smelt				
Unidentified osmerid larvae				
Starry flounder				
Saddleback gunnel				
Penpoint gunnel				
Steelhead				1
Chinook salmon				
Bay pipefish				
Unidentified fish larvae				
Number of fish species	4	-	1	4
Total fish	4	-	10	24

Invertebrates				
Cancer magister	11			
Crangon franciscorum	4			

Appendix B-27. Prebreaching Beach Seine Catch Summary, Event III, 1 October 1999.

	1-Oct-99			
	Stn 1	Stn 2	Stn 3	Stn 4
Common Name	1115 hr PDT	no seine	1400 hr PDT	1450 hr PDT
Topsmelt				
Pacific sanddab				
Sacramento sucker			12	
Pacific herring				
Prickly sculpin				
Staghorn sculpin				
Cabezon				
Black rockfish				
Copper rockfish complex				
Sacramento squawfish			3	
Shiner surfperch				
Silver surfperch				
Pacific tomcod				
Threespine stickleback				
Tube-snout				
Lingcod				
Surf smelt				
Longfin smelt				
Unidentified osmerid larvae				
Starry flounder				
Saddleback gunnel				
Penpoint gunnel				
Steelhead				1
Chinook salmon				
Bay pipefish				
Unidentified fish larvae				
Number of fish species	0	-	2	1
Total fish	0	-	15	1

Appendix B-28. Draining Beach Seine Catch Summary, Event III, 5 October 1999.

	5-Oct-99			
	Stn 1	Stn 2	Stn 3	Stn 4
Common Name	1040 hr PDT	no seine	1245 hr PDT	1435 hr PDT
Topsmelt	10			
Pacific sanddab				
Sacramento sucker			3	292
Pacific herring				
Prickly sculpin	2			
Staghorn sculpin				
Cabezon				
Black rockfish				
Copper rockfish complex				
Sacramento squawfish				3
Shiner surfperch				
Silver surfperch				
Pacific tomcod				
Threespine stickleback			2	57
Tube-snout				
Lingcod				
Surf smelt				
Longfin smelt				
Unidentified osmerid larvae				
Starry flounder				
Saddleback gunnel				
Penpoint gunnel				
Steelhead			3	
Chinook salmon				
Bay pipefish				
Unidentified fish larvae				
Number of fish species	2	-	3	3
Total fish	12	-	8	352

Invertebrates				
Cancer magister	84		1	
Crangon franciscorum	31			

Appendix B-29. Tidal Beach Seine Catch Summary, Event III, 7 October 1999.

Common Name	7-Oct-99 Stn 1 1030 hr PDT	Stn 2 no seine	Stn 3 1238 hr PDT	Stn 4 1345 hr PDT
Topsmelt	18			
Pacific sanddab				
Sacramento sucker				
Pacific herring				
Prickly sculpin	1		1	1
Staghorn sculpin				
Cabezon				
Black rockfish				
Copper rockfish complex				
Sacramento squawfish				
Shiner surfperch				
Silver surfperch				
Pacific tomcod				
Threespine stickleback				54
Tube-snout				
Lingcod				
Surf smelt			1	
Longfin smelt				
Unidentified osmerid larvae				
Starry flounder				
Saddleback gunnel				
Penpoint gunnel				
Steelhead				
Chinook salmon				
Bay pipefish				
Unidentified fish larvae				
Number of fish species	2	-	2	2
Total fish	19	-	2	55

Invertebrates				
Cancer magister	57			
Crangon franciscorum	3			

Appendix B-30. Prebreaching Beach Seine Catch Summary, Event IV, 13 October 1999.

	13-Oct-99			
Common Name	Stn 1 0850 hr PDT	Stn 2 no seine	Stn 3 1310 hr PDT	Stn 4 1405 hr PDT
Topsmelt	1			
Pacific sanddab				
Sacramento sucker			18	
Pacific herring				
Prickly sculpin				
Staghorn sculpin				
Cabezon				
Black rockfish				
Copper rockfish complex				
Sacramento squawfish			1	
Shiner surfperch				
Silver surfperch				
Pacific tomcod				
Threespine stickleback				
Tube-snout				
Lingcod				
Surf smelt				
Longfin smelt				
Unidentified osmerid larvae				
Starry flounder				
Saddleback gunnel				
Penpoint gunnel				
Steelhead			1	
Chinook salmon				
Bay pipefish				
Unidentified fish larvae				
Number of fish species	1	-	3	0
Total fish	1	-	20	0

Appendix B-31. Draining Beach Seine Catch Summary, Event IV, 22 October 1999.

	22-Oct-99			
Common Name	Stn 1 1045 hr PDT	Stn 2 no seine	Stn 3 1315 hr PDT	Stn 4 1410 hr PDT
Topsmelt				
Pacific sanddab				
Sacramento sucker			2	2
Pacific herring				
Prickly sculpin				2
Staghorn sculpin				
Cabezon				
Black rockfish				
Copper rockfish complex				
Sacramento squawfish				
Shiner surfperch				
Silver surfperch				
Pacific tomcod				
Threespine stickleback			1	838
Tube-snout				
Lingcod				
Surf smelt				
Longfin smelt				
Unidentified osmerid larvae				
Starry flounder				
Saddleback gunnel				
Penpoint gunnel				
Steelhead				
Chinook salmon				
Bay pipefish				
Unidentified fish larvae				
Number of fish species	0	-	2	3
Total fish	0	-	3	842

Invertebrates				
Cancer magister	1			
Crangon franciscorum	2			

Appendix B-32. Tidal Beach Seine Catch Summary, Event IV, 24 October 1999.

	24-Oct-99			
Common Name	Stn 1 1035 hr PDT	Stn 2 no seine	Stn 3 1310 hr PDT	Stn 4 1445 hr PDT
Topsmelt	11		6	
Pacific sanddab				
Sacramento sucker				
Pacific herring				
Prickly sculpin				
Staghorn sculpin				
Cabezon				
Black rockfish				
Copper rockfish complex				
Sacramento squawfish				
Shiner surfperch				
Silver surfperch				
Pacific tomcod				
Threespine stickleback			51	5
Tube-snout				
Lingcod				
Surf smelt	4			
Longfin smelt				
Unidentified osmerid larvae				
Starry flounder				
Saddleback gunnel				
Penpoint gunnel				
Steelhead				
Chinook salmon				
Bay pipefish				
Unidentified fish larvae				
Number of fish species	2	-	2	1
Total fish	15	-	57	5

Invertebrates				
Cancer magister	4		7	
Crangon franciscorum				

Appendix B-33. Prebreaching Beach Seine Catch Summary, Event V, 4 November 1999.

	4-Nov-99			
Common Name	Stn 1 0950 hr PDT	Stn 2 no seine	Stn 3 1135 hr PDT	Stn 4 1310 hr PDT
Topsmelt				
Pacific sanddab				
Sacramento sucker				
Pacific herring				
Prickly sculpin				
Staghorn sculpin				
Cabezon				
Black rockfish				
Copper rockfish complex				
Sacramento squawfish				
Shiner surfperch				
Silver surfperch				
Pacific tomcod				
Threespine stickleback			1	1
Tube-snout				
Lingcod				
Surf smelt				
Longfin smelt				
Unidentified osmerid larvae				
Starry flounder				
Saddleback gunnel				
Penpoint gunnel				
Steelhead				
Chinook salmon				
Bay pipefish				
Unidentified fish larvae				
Number of fish species	0	-	1	1
Total fish	0	-	1	1

Appendix B-34. Draining Beach Seine Catch Summary, Event V, 5 November 1999.

	5-Nov-99			
	Stn 1	Stn 2	Stn 3	Stn 4
Common Name	1545 hr PDT	no seine	1345 hr PDT	1255 hr PDT
Topsmelt	9		2	
Pacific sanddab				
Sacramento sucker				
Pacific herring				
Prickly sculpin				
Staghorn sculpin				
Cabezon				
Black rockfish				
Copper rockfish complex				
Sacramento squawfish				
Shiner surfperch				
Silver surfperch				
Pacific tomcod				
Threespine stickleback			1	150
Tube-snout				
Lingcod				
Surf smelt				
Longfin smelt				
Unidentified osmerid larvae				
Starry flounder				
Saddleback gunnel				
Penpoint gunnel				
Steelhead				
Chinook salmon				
Bay pipefish				
Unidentified fish larvae				
Number of fish species	1	-	2	1
Total fish	9	-	3	150

Appendix B-35. Tidal Beach Seine Catch Summary, Event V, 14 November 1999.

	14-Nov-99			
Common Name	Stn 1 1015 hr PDT	Stn 2 no seine	Stn 3 1200 hr PDT	Stn 4 1250 hr PDT
Topsmelt	18			
Pacific sanddab				
Sacramento sucker				
Pacific herring				
Prickly sculpin	1			
Staghorn sculpin				
Cabezon				
Black rockfish				
Copper rockfish complex				
Sacramento squawfish				
Shiner surfperch				
Silver surfperch				
Pacific tomcod				
Threespine stickleback	1		2	
Tube-snout				
Lingcod				
Surf smelt				
Longfin smelt				
Unidentified osmerid larvae	1			
Starry flounder	1			
Saddleback gunnel				
Penpoint gunnel				
Steelhead				
Chinook salmon				
Bay pipefish				
Unidentified fish larvae				
Number of fish species	5	-	1	0
Total fish	22	-	2	0