BIOLOGICAL AND WATER QUALITY MONITORING IN THE RUSSIAN RIVER ESTUARY, 1997

SECOND ANNUAL REPORT

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I. SUMMARY

This report summarizes the results for the second year of a field 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 and after breaching. The 1996 study design was modified for 1997 by including studies made on three dates for each event: a prebreaching survey, a draining survey, and a tidal survey. This resulted in an improved characterization of the effect of each breaching event on the estuary.

In 1997 the Russian River estuary mouth first closed March 30, and the sandbar was breached twelve times between March and early November. The MSC field team studied seven breaching events (comprising all breachings following closures of 7 days or more). This is in contrast to 1996 when the river mouth did not close until July and was breached only seven times.

Water quality profiles made at deep channel sites showed stratification (saline water overlain by brackish or fresh water). Near-bottom dissolved oxygen at these sites typically is reduced or absent during bar-closed conditions and renewed by tidal action following breaching. The length of time required to oxygenate the saline layers is shorter at shallow stations and those nearest the river mouth.

A finding of a 1992-1993 study (Heckel, 1994) was a wedge of saline, anoxic water killing mysids and fish as it drained from Willow Creek following a breaching event. This did not occur during either the 1996 or 1997 studies.

The estuary contains a diverse assemblage of marine, estuarine, and freshwater fish and invertebrate species. The estuary alternates between a tidal estuary (bar-open) and a coastal lagoon (bar-closed). The 1996 report concluded that the bar-open state is, in general, beneficial to the biota. This conclusion is further supported by the 1997 findings. Among the benefits of an open bar are the following:

- Tidal exchange helps keep the saline water layers oxygenated, and re-supplies marine plankton used as food by some of the organisms in the estuary.

- Food-rich mud flats and beaches exposed at low tides are available to wading birds and foraging mammals.

- Migrating salmonids and other fishes can enter or leave the estuary at any time. Steelhead smolts were found in the estuary throughout the study period in 1996, and both steelhead and coho salmon smolts were found in the estuary in 1997.

- Harbor seals use their preferred haulout sites at the mouth and at the snag area between Willow Creek and Sheephouse Creek.

The present management plan of breaching the sandbar when the river rises to 7 to 9 feet at Jenner appears appropriate in light of the findings of the 1992-1993 and both 1996 and 1997 studies. This plan limits bar-closed episodes to 7 to 10 days duration, and avoids flooding of riverside properties. Other conclusions derived from the 1997 study are that the estuary biota exhibits high variability from year to year, and that crowds of curious onlookers have a bigger impact on pinniped behavior than does the breaching operation itself.

The two-year study has shown that the breaching activity may have a beneficial impact on fish and seals. If continued monitoring is necessary for regulatory requirements, we recommend that a greater emphasis be placed on sampling salmonid smolts, and that tissue samples be provided for DNA analysis by an existing research program. Crowd control efforts at the breaching site should be continued throughout the breaching day, even after the SCWA breaching crew has left the site.

II. INTRODUCTION

BACKGROUND

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. Merritt Smith Consulting (MSC) was selected by the Sonoma County Water Agency (SCWA) to implement the monitoring element of the Management Plan during artificial breaching events in 1996 and 1997.

The results of the 1996 study program were presented in a previous report (MSC 1997), which included some recommended modifications to the study protocols for use in the 1997 program. This report presents the results of the 1997 study program.

STUDY PROGRAM

The study program conducted during 1996 included the following elements:

- Pre- and post-breaching water quality profiles (depth, temperature, salinity, conductivity, and dissolved oxygen) at four stations, and continuous recording of temperature, salinity, and dissolved oxygen near the river bottom at three stations during breaching events.

- Pre- and post-breaching sampling of fish and epi-benthic invertebrates at four stations, by means of otter trawl and beach seine, and of planktonic invertebrates at two stations, by means of plankton trawl net.

- Observations of pinniped behavior near the river mouth before, during, and after breaching events

In 1996 the study design was to conduct the pre-breaching surveys on the day before breaching events, and the post-breaching surveys the day following breaching events. Unanticipated events (mainly unauthorized premature breachings and failed attempts at authorized breachings) limited the team's success in adhering to the planned schedule. Additionally, water quality sampling during the 1996 study revealed that more than one day and one or two tidal cycles following breaching was necessary before the estuary flushed and water quality returned to conditions typical of bar-open periods. Therefore, the study program was modified for 1997 in the following ways:

- Pre-breaching surveys were conducted after the river mouth had been closed at least

seven days, but not necessarily on the day before breaching.

- "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 three to five days after breaching, so that the data collected would be representative of typical bar-open, tidal circulation in the estuary.

- Recording temperature/salinity/dissolved oxygen sensors were deployed at three estuary locations throughout the study period, not just during breaching events, as was the case in the 1996 study.

- Pinniped observations were made on the same schedule as in 1996, i.e., before, during, and after three breaching events.

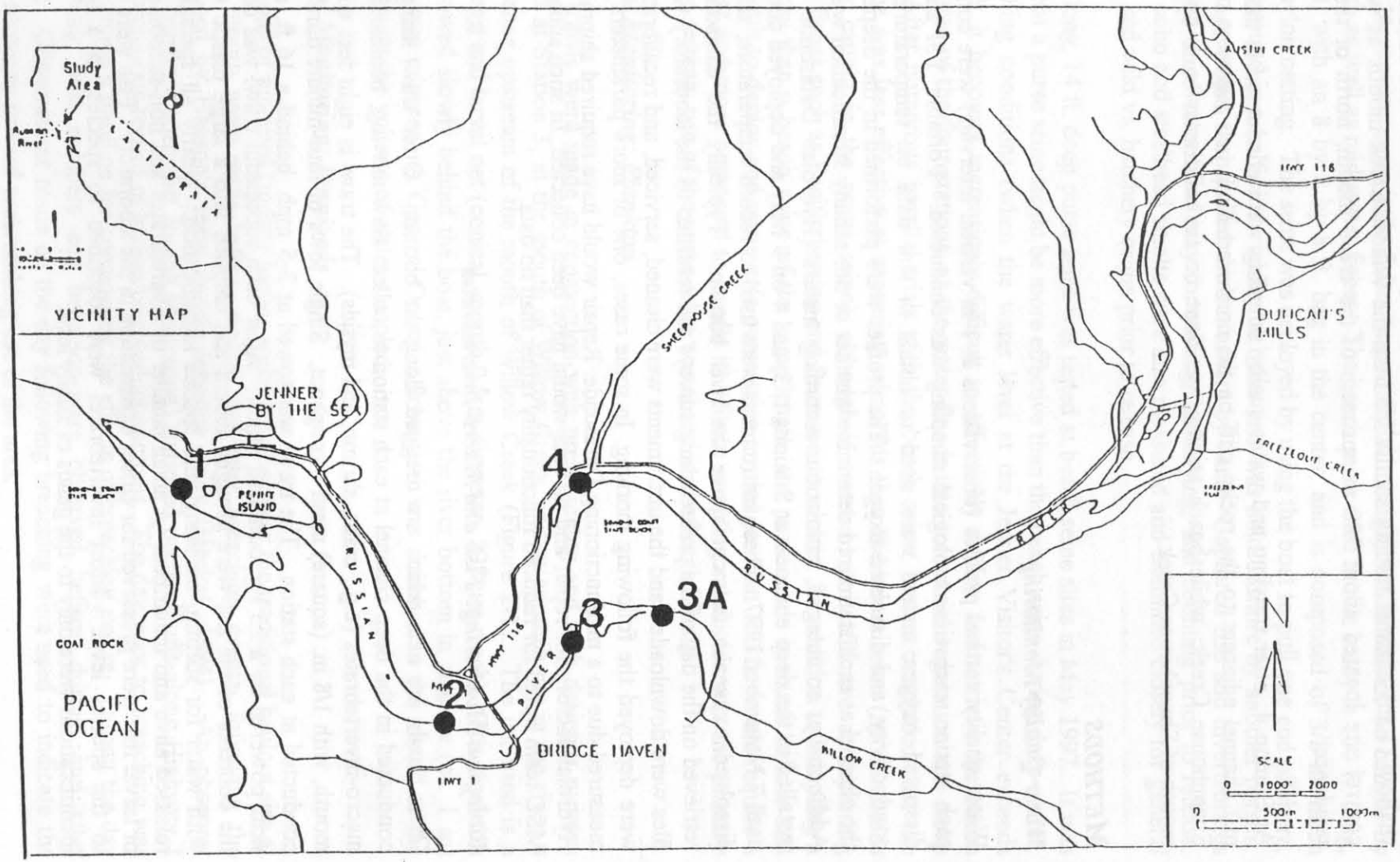
The station locations are shown in Figure 2-1, and are the same sites used in 1996. Stations 2, 3, and 4 are at the same locations as the corresponding stations used for biological and water quality sampling in the previous study (Heckel, 1994).

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, beach seining was conducted on the north shore opposite the station location shown in Figure 2-1 (otter trawls and water quality profiles were taken 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 river bank 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 prebreaching survey, and on other surveys whenever the creek was navigable, water quality profiles were also taken inside Willow Creek at a location about 0.5 km upstream from the bridge where the water was about 2 m deep at high water. This

Figure 2-1. Map of the Russian River Estuary, Showing Sampling Stations for 1997 Study.



site is shown as Station 3A in Figure 2-1. Station 3 plankton trawls were conducted in the shallow (1 m) channel leading southward from the Willow Creek mouth, as well as at a control site located about 300 m upstream of the creek mouth, north of the Ranger's residence.

At Station 4, otter trawling and water quality sampling were conducted in the deep (14 m.) channel adjacent to the rocky cliff on the northwest bank just below the mouth of Sheephouse Creek, while beach seining was done on the southeast bank opposite the mouth of Sheephouse Creek.

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 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. Additionally, submerged, continuous-recording meters (Hydrolab Datasonde III) were installed in the deep channels at Stations 1, 3, and 4 on 9 May and deployed continuously until 7 November 1997. These instruments were used to record temperature, salinity, and dissolved oxygen a few cm above the river bottom. Typically the datasondes were retrieved on the day of the prebreaching surveys and returned to the laboratory where data files were downloaded and the instruments were cleaned, serviced, and recalibrated. They were deployed the following morning. In some cases, one or more parameters were not measured due to a malfunctioning Datasonde. Repair would have required shipment to the Hydrolab factory for repair and no data would have been collected. In such situations, the MSC team opted for reduced functionality rather than no data.

Biological Monitoring: Fish and Macro-Invertebrates

Otter trawls are nets which are dragged along the bottom. 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 is eight feet wide at the mouth, with 1/8 in. (square) mesh throughout. Single tows of four-minute duration were conducted at each station. The trawl was towed at 3-5 mph. behind a 16 ft. aluminum skiff powered by a 25 hp. 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. 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 coho and steelhead smolts were also measured and examined closely for general condition and wild vs. hatchery origin prior to release.

A 100 ft. long, 14 ft. deep purse seine was tested at beach seine sites in May 1997. It was thought that a purse seine might be more effective than the beach seine during deep-water, pre-breaching conditions (when the water level at the Jenner Visitor's Center exceeds about 6 ft, it becomes increasingly difficult to effectively deploy and retrieve the beach seine at three of the four stations, as the water floods into terrestrial vegetation and steep banks). After numerous parallel trials with the beach seine, it was concluded that the purse seine was less effective at capturing salmonids than the beach seine (no salmonids were ever caught in the purse seine), although it seemed more effective at capturing schooling fishes such as Pacific herring and Sacramento sucker. In addition to sampling a smaller area than a beach seine of the same length, the purse seine is much bulkier and more difficult to deploy and retrieve (a purse seine any longer than 100 ft. would require a bigger boat and more personnel to handle it). Since sampling salmonids was the primary goal of the seining, use of the purse seine was abandoned after the trials.

Biological Monitoring: Plankton

Plankton trawls were made in conjunction with prebreaching and with draining surveys conducted at Station 3, at the mouth of Willow Creek, and at another site in the river a short distance upstream of the mouth of Willow Creek (Figure 2-1). The net used is a standard egg and larval net (conical, mouth 0.5 m diameter, 505 µm mesh). The plankton net was towed slowly behind the boat, just above the river bottom in shallow (ca. 1 m) water for two minutes. A General Oceanics flowmeter was attached to the mouth of the net to estimate the volume of water sampled.

Biological Monitoring: Pinnipeds

Observations of pinniped (mostly harbor seals) behavior near the traditional haulout site at the river mouth were made before, during, and after breaching events, following the method used by Hanson's team in the previous study (Heckel, 1994). An observer (pinniped behavior specialist Joseph Mortenson) stationed on the bluffs along Highway 1 made a continuous record of human/pinniped interactions. The day prior to breaching was used to provide a baseline for considering the effects of breaching *per se*. During the day of breaching, seal numbers and behavior were observed before, during, and after breaching. Observations made on the day following breaching were used to indicate the extent of recovery toward prebreaching use of the area.

III. RESULTS

BREACHING EVENTS IN 1997

The study plan for 1997 was to conduct surveys in conjunction with up to 7 breaching events, to be spread out over the months between the first closure and the last. Table 3-1 summarizes the 1997 berm closures and breachings. A more detailed account of events surrounding each breaching can be found in Appendix D-1.

Table 3-1. Summary of 1997 Berm Closures and Breachings.

Date Closed	Days Closed	Date Breached	Days open	Study Event #
30 March	1	31 March	18	not studied
18 April	5	23 April (N)[1]	12	not studied
2 May	1	3 May (N)[1]	12	not studied
15 May	7	22 May	11	I
2 June	7[2]	9 June	7	II
16 June	11	26 June	44	III
9 August	10	20 August	19	IV
9 September	10	19 September	7	V
26 September	3	29 September	4	not studied
3 October	8	11 October	15	VI
26 October	8	3 November	4	VII
7 November	?	?	?	not studied

[1]Natural breaching; all others done by SCWA.

[2]Berm was open for about one hour during an attempted breach on 6 June.

The bar was closed 3 times between late April and early May, but in each of these events the river remained closed for only one to five days before it was breached. Closures beginning with the middle of May were associated with lower river outflows, and were of 7 to 11 days in duration. There were seven such closures during 1997, and each was studied according to the plan outlined above. (A brief closure in late September of only 3 days was not studied.) Table 3-2 lists the days on which field surveys were done in 1997.

Two breachings were studied in June, and one breaching each in May, August, September, October, and November. No breachings occurred in July. The 1997 study plan enabled the study team to accomplish the goal of three surveys (prebreaching, draining, tidal) for each of seven events.

Table 3-2. Summary of 1997 Field Surveys.

Event	Prebreaching Survey	Draining Survey	Tidal Survey
I	20 May	23 May	27 May
II	6 June	10 June	13 June
III	22-23 June	28 June	1 July
IV	18 August	21 August	26 August
V	16 September	20 September	23 September
VI	10 October	12 October	15 October
VII	31 October	4 November	7 November

WATER QUALITY MONITORING

In situ *Profiles*

Water quality profiles were made at Stations 1 through 4 on twenty-one dates in 1997. These are listed in Table 3-2. The complete data are given in Appendices A-1 through A-21. Prebreaching, draining, and tidal profiles are illustrated graphically for three breaching events which typify water quality changes associated with breaching during 1997 (event I, breached 22 May; event IV, breached 20 August, and event VII, breached 3 November). These plots are given in Appendices A-22 through A-33.

As was the case in 1992-1993 and 1996, prebreaching profiles at the deeper stations showed a stratified water column with fresh (or brackish) water overlaying a pocket of saline water. Dissolved oxygen in the deeper water typically was reduced or absent after a few days of bar-closed conditions. Station 1 profiles during the draining phase usually showed that dissolved oxygen was mixed into the saline bottom layer, although the salinity stratification remained (Appendix A-22, A-26). Near-bottom dissolved oxygen at the other stations was also renewed by tidal action following breaching events, but depending upon the depth and distance from the mouth, mixing occurred later. For example, at Stations 2 and 3, dissolved oxygen was often not mixed to the bottom until the tidal survey (see Appendix A-23, A-24, A-27). Station 4, being deepest and farthest from the mouth sometimes had near-bottom dissolved oxygen mixed by the tidal survey (Appendix A-33), but more typically did not mix until a few days later. Datasonde

records (see below) show that near-bottom layers at Station 4 sometimes remained anoxic (did not mix) between breaching events.

Water quality profiles made in Willow Creek (Station 3A) during prebreaching surveys never showed anoxia. The lowest dissolved oxygen value recorded for Station 3A was 4.9 mg/L during the draining survey made on 4 November. Creek water, as was found in 1996, was mostly fresh. Thus, the finding of the 1992-1993 study--the saline, anoxic water with dead mysids entering the estuary from Willow Creek following breaching--was not found in either 1996 or 1997. Plankton tows made in 1996 and in 1997 (see below) confirm that the marsh/creek water was not salty or anoxic.

Datasonde Records

Datasonde records of water quality conditions near the bottom are shown for Stations 1, 3, and 4 in Appendix A-32 through A-34. Appendix A-35 shows that at Station 1 the near-bottom dissolved oxygen typically was reduced during bar-closed conditions but increased quickly after breaching events. The records for Station 1 are incomplete after mid-September due to instrument malfunction. Records for Station 3 (Appendix A-35) show a clear pattern of near-bottom anoxia developing within a week of berm closure, followed by increases in dissolved oxygen due to tidal mixing within a few days following breaching. At Station 4 (Appendix A-36) the same general pattern was found, although dissolved oxygen was often not mixed to the bottom until 10 days after breaching. Dissolved oxygen was not mixed to the bottom at Station 4 at all following the breaching of 20 August (Appendix A-35). Data was not collected at Station 4 between mid-June and mid-August due to an inadvertent power loss to the Datasonde.

BIOLOGICAL MONITORING

Fish and Macro-Invertebrates

A list of all the fish species captured by otter trawl and seine in 1996 and 1997 is provided in Table 3-3, showing 34 species representing 18 families. Seven species caught in 1996 were not caught in 1997, and 10 species caught in 1997 were not caught in 1996. Also listed in Table 3-3 are the 24 species in 17 families captured in the 1992-1993 Russian River Estuary study (Heckel, 1994). Sixteen of the species captured in 1996 or 1997were also captured 1992-1993. Such variability is typical of estuaries. Oceanic conditions, climatology, runoff, variable physical nature of estuaries in general, normal year-to-year variability in fish population size, reproductive success, etc. all combine to cause a great deal of year-to-year variability in species caught. Studies at nearby estuaries showed similar variability both from year to year and between estuaries (Commins et al., 1990, 1996). The number of species and list of species observed each year is heavily influenced by sporadic invasions of estuaries by marine species. A great number of nearshsore species may occasionally venture into the mouths of estuaries (e.g., sculpins such as buffalo sculpin, bull sculpin, smoothhead sculpin, cabezon, ling cod, Pacific tomcod, kelp greenling, various surfperches besides shiners, also midshipmen, juvenile rockfish, etc). The number of species that are typical of California estuaries is

quite small (staghorn and prickly sculpin, a few gobies, topsmelt, jacksmelt, surfsmelt, shiner surfperch, stickleback, starry flounder, English sole, bay pipefish, are nearly always represented in the yearly catch), compared to the number of marine and freshwater species likely to occur sporadically in the catches.

Table 3-3. Fish Species Caught in the Russian River Estuary, 1992-93, 1996, and 1997.					
Family	**Scientific Name**	**Common Name**	**92-93**	**96**	**97**
Atherinidae	*Atherinops affinis*	Topsmelt		X	X
Bothidae	*Citharichthys sordidus*	Pacific sanddab	X	X	X
Catostomidae	*Catostomus occidentalis*	Sacramento sucker	X	X	X
Centrarchidae	*Lepomis cyanellus*	Green sunfish	X	X	
	Lepomis macrochirus	Bluegill		X	
	Micropterus dolomieui	Smallmouth bass		X	X
Clupeidae	*Clupea harengus pallasii*	Pacific herring	X	X	X
Cottidae	*Artedius lateralis*	Smoothhead sculpin			X
	Cottus asper	Prickly sculpin	X	X	X
	Enophrys bison	Buffalo sculpin			X
	Enophrys taurina	Bull sculpin			X
	Leptocottus armatus	Staghorn sculpin	X	X	X
	Scorpaenichthys marmoratus	Cabezon		X	X
	Sebastes sp.	Unknown Juv. Sebastes	X		X
Cyprinidae	*Cyprinus carpio*	Carp	X		
	Lavinia symmetricus navarroensis	Navarro roach	X	X	
	Mylopharodon concephalus	Hardhead	X		
	Ptychocheilus grandis	Sacramento squawfish		X	
Embiotocidae	*Cymatogaster aggregata*	Shiner surfperch	X	X	X
	Hyperprosopon anale	Spotfin surfperch			X
	Hyperprosopon argenteum	Walleye surfperch		X	
	Hysterocarpus traskii	Russian River tuleperch		X	
Engraulididae	*Engraulis mordax*	Northern anchovy	X		X
Gadidae	*Gadus macrocephalus*	Pacific tomcod		X	X
Gasterosteidae	*Gasterosteus aculeatus*	Threespine stickleback	X	X	X

Table 3-3. Fish Species Caught in the Russian River Estuary, 1992-93, 1996, and 1997.					
Family	**Scientific Name**	**Common Name**	**92-93**	**96**	**97**
Gobiesocidae	*Gobiesox maendricus*	Northern clingfish	X		
Gobiidae	*Clevelandia ios*	Arrow goby		X	
Hexagrammidae	*Hexagrammos decagrammus*	Kelp greenling			X
	Ophiodon elongatus	Lingcod		X	X
Osmeridae	*Hypomesus pretiosus*	Surf smelt	X	X	X
	Spirinchus thaleichthys	Longfin smelt			X
Pleuronectidae	*Isopsetta ischyra*	Hybrid sole	X	X	X
	Parophrys vetulus	English sole	X	X	X
	Platichthys stellatus	Starry flounder	X	X	X
	Psettichthys melanostictus	Sand sole	X		
Pholididae	*Pholis ornata*	Saddleback gunnel			X
Poecillidae	*Gambusia affinis*	Mosquitofish	X		
Salmonidae	*Oncorhynchus mykiss*	Steelhead	X	X	X
	Oncorhynchus kisutch	Coho salmon			X
	Oncorhynchus tshawytscha	Chinook salmon	X		
Sciaenidae	*Genyonemus lineatus*	White croaker	X		
Syngnathidae	*Syngnathus griseolineatus*	Bay pipefish	X	X	X

Otter trawls typically sample epibenthic and benthic species, and at most stations trawls were deployed in deep channels with saline near-bottom layers. Trawl catches therefore included marine-estuarine benthic species. The 1997 otter trawl catch is summarized in Table 3-4. Prickly sculpin comprised 45 percent of the entire catch and were abundant at each station, as were they in 1996 (MSC, 1997). Of the species each representing at least 1 percent of the total catch, all but Sacramento sucker are common estuarine species in this region. Sacramento sucker are generally considered to be strictly freshwater fish (Moyle, 1976). As shown in Table 3-4, nearly all the Sacramento sucker caught in the trawls were caught at Station 3, which is the one station at which it is not possible to do bottom trawls in the deepest channel (owing to massive submerged trees and rock outcrops). Instead, the otter trawling at Station 3 was always done in relatively shallow water (usually only 4-7 ft deep), meaning that a good portion of each trawl at that station was done either in fresh water or low-salinity water (< 2 ppt).

Table 3-4. Total Catch in Otter Trawls in Russian River Estuary, 1997						
Common Name	**Stn 1**	**Stn 2**	**Stn 3**	**Stn 4**	**total**	**%**
Prickly sculpin	153	353	718	367	1591	44.7
English sole	321	86	4	15	426	12.0
Sacramento sucker	0	2	388	7	397	11.1
Pacific herring	31	9	219	93	352	9.9
Pacific sanddab	245	5	1	0	251	7.0
Shiner surfperch	87	19	64	25	195	5.5
Starry flounder	9	5	26	71	111	3.1
Bay pipefish	2	13	33	52	100	2.8
Staghorn sculpin	18	15	4	6	43	1.2
Surf smelt	28	0	3	0	31	0.9
Threespine stickleback	1	4	7	4	16	0.4
Cabezon	13	0	0	0	13	0.4
Longfin smelt	12	0	0	0	12	0.3
Pacific tomcod	5	0	0	0	5	0.1
Topsmelt	1	0	2	0	3	0.1
Buffalo sculpin	3	0	0	0	3	0.1
Lingcod	3	0	0	0	3	0.1
Steelhead	1	0	1	1	3	0.1
Unknown Juv. Sebastes	2	0	0	0	2	0.1
Kelp greenling	2	0	0	0	2	0.1
Bull sculpin	1	0	0	0	1	0.0
Spotfin surfperch	1	0	0	0	1	0.0
Northern anchovy	0	1	0	0	1	0.0
Hybrid sole	0	0	0	1	1	0.0
Saddleback gunnel	1	0	0	0	1	0.0
Total	**940**	**512**	**1470**	**642**	**3564**	**100.0**

Complete data for each trawl and station are provided in Appendix Tables B-1 through B-21, which also include the data for invertebrates captured in otter trawls. Otter trawl

fish catches for each station and date are displayed graphically in Appendices B-22 through B-35. Analysis of the trawl data provided in Appendix B shows no apparent trends in pre- versus post-breaching species captured, number of species, or number of individuals. High variability is the most obvious feature of the data. Three juvenile steelhead were caught by otter trawl in 1997.

Beach seines sample the whole water column in shallow (up to 8 feet) near-shore areas. These areas are typically fresh or brackish, so marine species are not usually caught. Beach seines surround an area, isolating the fish within; they are more effective at catching fast-swimming species (including salmonids) than bottom trawls. Fish captured by beach seine in 1997 are summarized in Table 3-5, which shows 16 species captured, with 69 percent of the total represented by topsmelt alone, followed by Sacramento sucker (18 percent). Topsmelt dominated the catch by beach seine in 1996 as well (MSC, 1997). Thirteen of the 16 species caught by beach seine in 1997 were also captured by beach seine in 1996. Both steelhead and coho salmon smolts were captured by beach seine in 1997. Complete catch data for beach seining (and purse seining) are tabulated in Appendices B-36 through B-57, and are displayed graphically in Appendices B-58 through B-71.

Table 3-5. Total Catch in Beach Seines in Russian River Estuary, 1997

Common Name	Stn 1	Stn 2	Stn 3	Stn 4	total	%
Topsmelt	1891	225	1094	246	3456	68.6
Sacramento sucker	2	13	522	391	928	18.4
Pacific herring	18	32	138	14	202	4.0
Shiner surfperch	23	57	5	13	98	1.9
Starry flounder	2	1	69	10	82	1.6
Surf smelt	0	17	56	0	73	1.4
Threespine stickleback	3	0	48	4	55	1.1
Prickly sculpin	0	5	16	33	54	1.1
Steelhead	2	4	17	11	34	0.7
Coho salmon	10	5	2	1	18	0.4
Staghorn sculpin	8	3	1	4	16	0.3
English sole	0	0	1	13	14	0.3
Bay pipefish	1	0	2	1	4	0.1
Pacific sanddab	0	0	0	2	2	0.0
Smoothhead sculpin	1	0	0	1	2	0.0
Smallmouth bass	0	1	0	0	1	0.0

Total	**1961**	**363**	**1971**	**744**	**5039**	**100.0**

Appendix Tables B-36 and B-37 include results of parallel trials of the purse seine with the beach seine at each station. Not shown are a number of aborted attempts to deploy the purse seine when winds and currents led to impossible tangles of boat, net, and submerged objects. The purse seine appeared to be more effective at capturing some schooling fishes (mainly juvenile Sacramento sucker and, in one case, Pacific herring), but the purse seine did not capture any salmonids, which may have escaped under the lead line. We could more effectively fish with the beach seine than with the purse seine during draining and tidal surveys. Given the difficulty of deployment and uncertainty of any advantage to using the purse seine during high-water prebreaching surveys, further use of the purse seine was abandoned. We were able to get a sample with the beach seine at high water at every station except Station 2, although Appendix Figures B-58 through B-71 reveal a trend of smaller catches during pre-breach surveys. The same trend was noted in 1996 (MSC, 1997), and is most likely a reflection of both the difficulty of retrieving the seine at high water by pulling it through flooded emergent and terrestrial vegetation and debris, and of the fact that such habitat is less likely to be used by fish for foraging or resting than would be habitat that is normally submerged.

Fish species found in beach seines reflect seasonal patterns of reproduction and migration. Early in the summer (May and June, events I, II, and III), the beach seine catches were dominated by young-of-the-year Sacramento sucker (20-40 mm length). Later in the summer (Events V, VI and VII) the dominant fish were topsmelt of mixed size.

A total of 34 steelhead were captured by beach seine in 1997. The catches were scattered throughout the summer, as shown in Appendix B-72. Those caught in May and June included 13 young-of-the-year juveniles from 51 to 82 mm fork length (including 2 of the 3 caught in otter trawls). All but a couple of these small juveniles appeared to be typical parr, (i.e., not smolts or pre-smolts), whereas all but one of the larger fish appeared to be smolts (with bright silvery, deciduous scales obscuring parr marks) on their way to sea. The one exception was a 410 mm. hatchery-reared "half-pounder" male caught on September 20th, a draining day. (A half-pounder is a small adult that has spent only one year at sea before returning to fresh water to spawn). Figure 3-1 shows the size distribution of all the steelhead captured in 1997. Three year classes appear to be represented (not including the half-pounder). All the steelhead but the half-pounder appeared to be of wild origin (no fin deformities or other marks characteristic of hatchery-reared fish). (Warm Springs Hatchery plans to institute a program for marking coho and steelhead smolts to enable anglers to distinguish between wild and hatchery fish.)

Analysis of Appendix B-72 reveals no tendency for smolts to be clustered at stations nearest the river mouth nor for greater numbers to be caught on pre-breaching surveys (both of which might be expected if the bar-closed condition were impeding their seaward movement). Twelve steelhead were caught on pre-breach surveys, 15 on draining surveys, and 9 on tidal surveys. However, as mentioned above, beach seining is

not as effective on pre-breach surveys as it is on post-breach surveys, so the relative abundance of steelhead during bar-closed periods may be under-represented by the data.

Eighteen coho smolts were caught by beach seine in May and June (Appendix B-73). None were caught during pre-breach surveys, 13 were caught on draining surveys, and 5 during tidal surveys (including one caught during the preliminary trials on May 9th). The size distribution of the coho is shown in Figure 3-2. All of the smolts presumably came from eggs spawned by wild fish in December 1996 or January 1997. (No coho smolts were released by the Warm Springs Hatchery in 1997 before or during the 1997 study; their last release was in December 1996--Armando Quinones, *personal communication*).

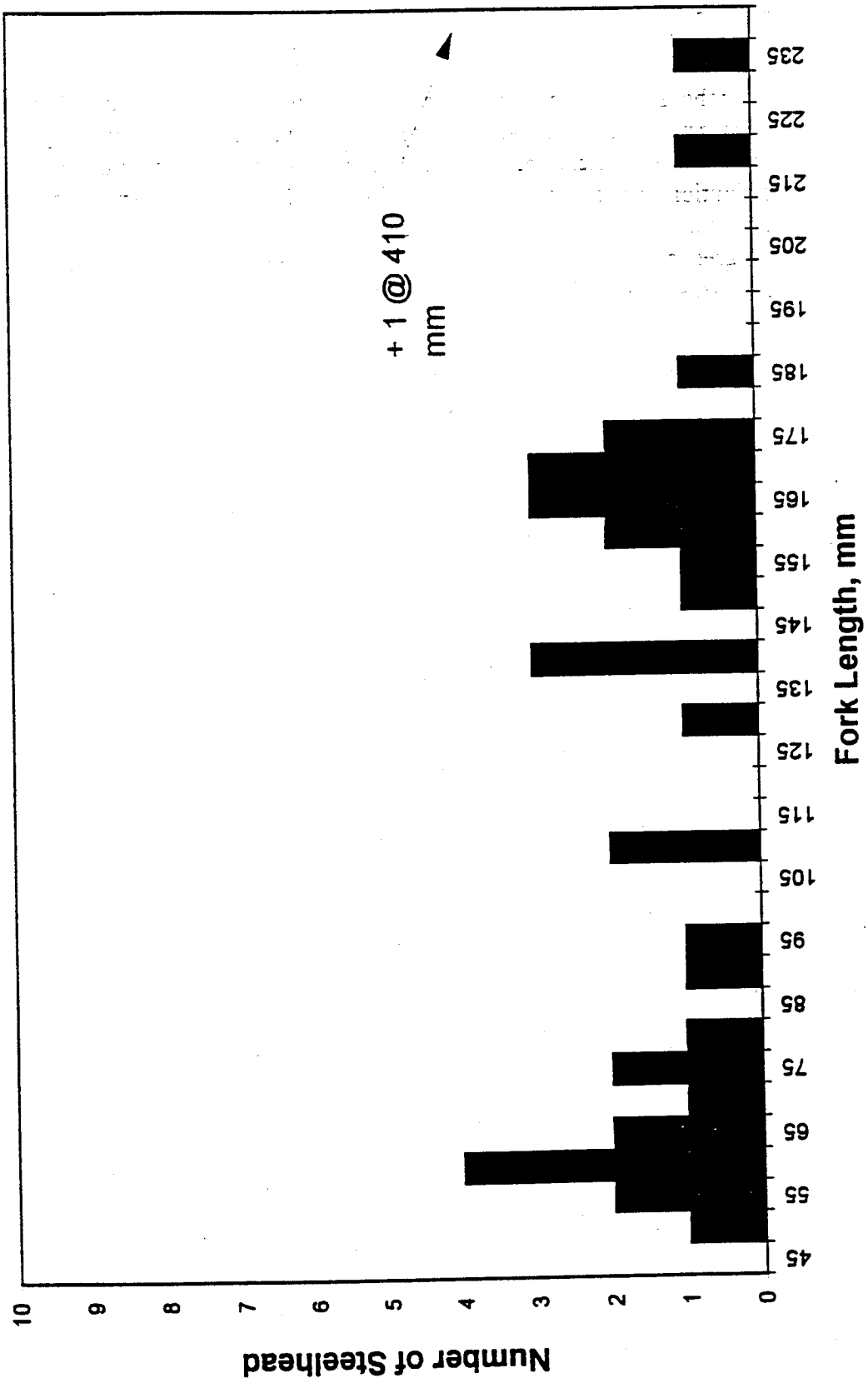
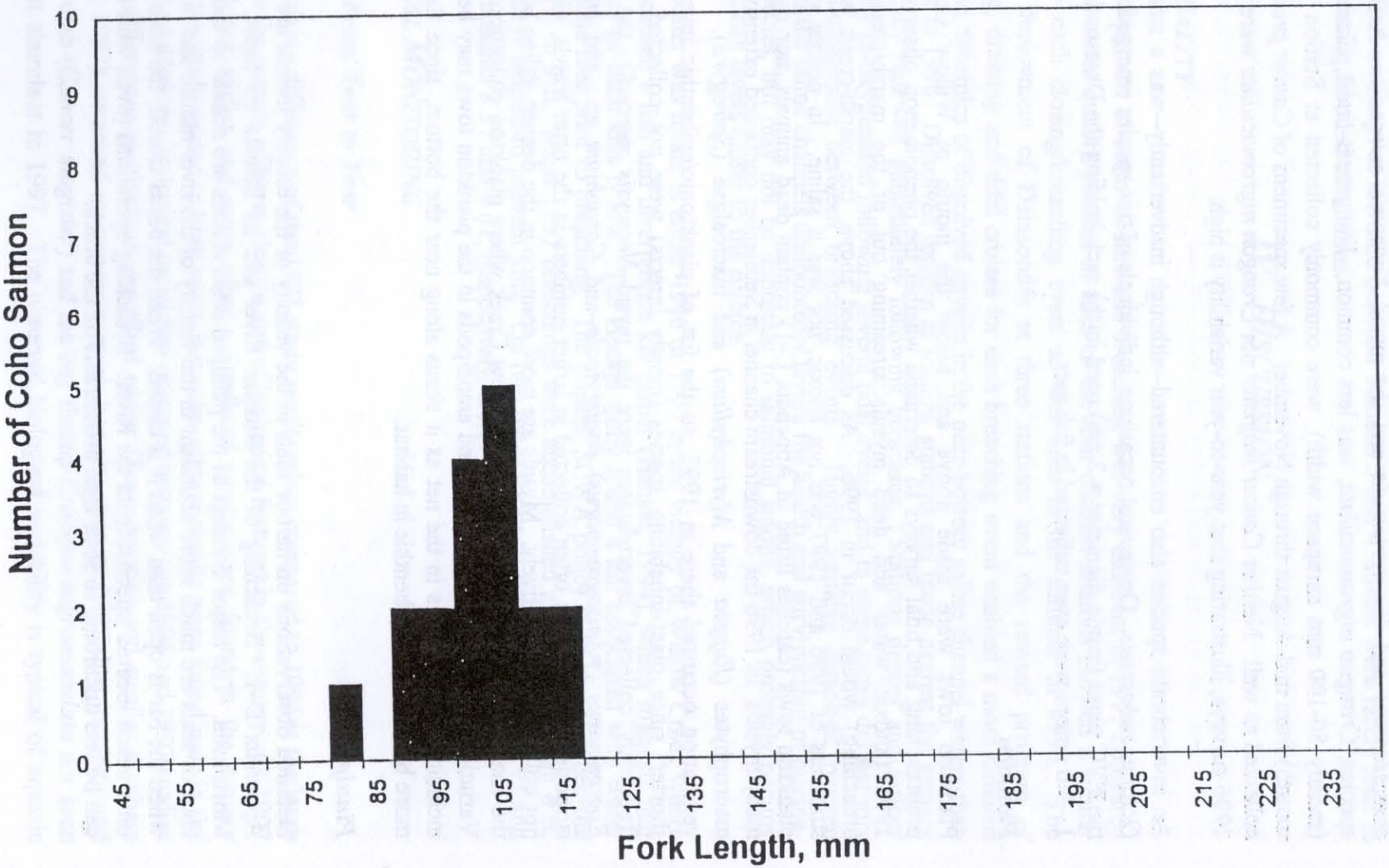


Figure 3-1. Steelhead captured in the Russian River Estuary, 1997

Figure 3-2. Coho Salmon captured in the Russian River Estuary, 1997



Macro-invertebrates collected in otter trawls are included in the Appendix (Tables B-1 to B-21). The most common invertebrates collected were the estuarine shrimps *Crangon franciscorum* and *C. nigricauda* and the mysid *Neomysis mercedis.* A third shrimp species, *Crangon nigromaculata,* was less common. Dungeness crabs, *Cancer magister* (mostly 50-100 mm carapace width), were commonly collected at Station 1 (near the mouth) from mid-August through November. A few specimens of *Cancer productus* were collected as well. Neither *Cancer magister* nor *Crangon nigromaculata* were collected in 1996 surveys, illustrating that year-to-year variability is high.

An invertebrate species also encountered--although inadvertently--was a small octopus, *Octopus rubescens*. On several occasions, individuals of this species emerged from within the PVC pipes (inside diameter = 2 cm) used in the rack holding the Datasonde at Station 1. No octopi were ever collected in fish nets.

Plankton

Plankton tows were made above and below the mouth of Willow Creek during prebreaching and tidal surveys to determine whether the phenomenon observed in 1992-1993 (anoxic water and dead mysids streaming out of the marsh/creek following breaching) would occur in 1996. As discussed above, the marsh/creek water in the summers of 1996 and 1997 was not anoxic, nor was it saline. In neither year did the plankton tows (catches listed in Appendix C-1) contain dead animals, nor did it contain many mysids. In 1996 the downstream channel in September contained extensive stands of macrophytes (*Ruppia* and *Myriophyllum*) and macroalgae (*Spirogyra*). Very little vegetation occurred there in 1997, so the list of planktonic/epibenthic invertebrates is shorter, since plant-inhabiting species (mostly insects) were not collected. The only frequently collected invertebrates were the mysid *Neomysis mercedis,* the amphipods *Eogammarus* (=*Anisogammarus*) *confervicola* and *Corophium* sp., and sphaeromatid isopods. *Neomysis* is often collected in larger numbers in the otter trawls, although it is not collected quantitatively. Mysids are more common in the deeper, saline layers than in the shallows up- and downstream of Willow Creek where plankton collections are made. Variations in numbers of isopods and amphipods in the plankton tows may be due to the inclusion of sediments in the net as it skims along near the bottom, since these may be more benthic than epibenthic in habitat.

Pinnipeds

Detailed observations on harbor seals in the vicinity of the estuary mouth are included in Appendix D-1, “Breaching of the Russian River and its Effects on Seals,” by Joseph Mortenson. The major findings of the pinniped observations are similar to those of 1996: Harbor seals are much more abundant in the vicinity of the river mouth and in the estuary when the bar is open than when it is closed. When the bar is closed, the seals congregate on a beach located upcoast from the River. Breaching operations (even with a bulldozer) can be less disturbing to seals than pedestrians on the beach.

In 1997, as in 1996, observations made during pre- and postbreaching 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. Seals were rarely seen in the estuary during flooded conditions.

IV. DISCUSSION

WATER QUALITY

Although the pattern of berm closure and breaching was very different in 1997 compared to 1996, the water quality profiles at each of the four channel stations showed a similar response to each closing/breaching event as was seen in the summer of 1996. The continuous deployment of Datasondes at three stations and the revised program of prebreaching, draining and tidal cruises for each breaching event enabled a more detailed picture of the dynamics of dissolved oxygen in the near-bottom saline channel waters than was possible in 1996. Dissolved oxygen at shallow stations and those nearest the estuary mouth typically renewed immediately following breaching. Stations deeper and farther upstream only re-oxygenated following several tidal cycles, and in some cases did not mix at all or re-oxygenate between breaching events. Highly variable dissolved oxygen conditions in the saline channels undoubtedly favors the health and survivorship of marine-estuarine species, but may not be important to salmonid smolts, which probably occupy fresh or brackish layers closer to the surface.

No anoxic water was found in either 1996 or 1997 in the vicinity of Willow Creek where such water caused a fish and invertebrate kill earlier (Heckel, 1994), which suggests that the frequency of such kills is low. The Heckel study found a kill associated with water levels over nine feet prior to breaching. The present SCWA policy is to breach when the level attains 6 to 9 ft. Most 1997 breachings were accomplished at levels less than 8 ft, which may have helped to prevent kills. On two dates (prior to breaching events VI and VII), levels reached 8.37 and 8.61, respectively, the 1997 maxima.

BIOLOGICAL MONITORING

Variability From Year to Year

The most striking difference of the 1997 study results when compared to 1996 is the large variability in the pattern of berm closure and of biological features in the estuary. In 1997 the berm closed earlier and more often. Steelhead smolts were found in the estuary throughout the study period in both years, but coho salmon smolts were found only in the second year. Additional biological variability observed between the 1996 and 1997 studies include the differences in plankton described earlier (fewer species and smaller numbers collected in 1997); attached macrophytes much less abundant in 1997 than in 1996; and Dungeness crab (*Cancer magister*) and the bay shrimp *Crangon nigromaculata* not seen in 1996, but abundant in 1997. The observed biological variability is typical of aquatic systems and demonstrates the necessity for doing multi-

year studies to support conclusions about how an ecosystem functions.

Sampling Bias

The problem of effectively sampling salmonids during high water (prebreaching) conditions remains to be solved. In times past, gillnets would be the obvious choice for unbiased sampling during high or low-water conditions (e.g., as used in studies of Estero Americano and Estero de San Antonio in 1989-1990—Commins, et al, 1990; Commins, et al, 1996). However, the mortality caused by gillnets now precludes their use for sampling wild steelhead or coho in this region, since both species are now listed as Threatened Species under the Endangered Species Act. Directional fyke nets installed perpendicular to the shore could be effective, but there is always some risk of fish mortality associated with them, as well (either through small fish gilling themselves, or through attacks by mink, otter, or human poachers (Roth, et al, 1995; Fawcett, et al, 1996). Under the circumstances, beach seining may still be the best method, even with the limitation that numbers of fish caught at high water cannot be compared directly to the numbers caught at the same stations after breaching. At the very least, the beach seining has provided valuable evidence that juvenile steelhead and coho use the estuary during the summer months and must therefore be considered in relation to artificial breaching and other human activities. Shapovalov and Taft (1954), in their definitive study of steelhead and coho in Wadell Creek, found that although most smolts migrated in winter and spring, some fish migrated during every month of the year.

Pinniped Behavior

The bar-closed condition discouraged seals from hauling out at their apparently preferred location on Jenner Beach immediately adjacent to the mouth of the Russian River. Seals may prefer the beach at the River mouth under bar-open conditions because prey may be more abundant there or because the environment is otherwise preferable. Breaching may thus represent a benefit to the seals. Pinnipeds are precluded from hauling out near the inlet for several hours after the breaching process has occurred because of the large number of pedestrians that sometimes are attracted to the site by the breaching activity. The behavior of the pedestrians is regulated by SCWA personnel during the breaching event, but behavior is usually not regulated after SCWA leave the site to allow seals unimpeded access to the site.

V. CONCLUSIONS

The 1997 study confirms most of the conclusions made following the earlier studies (Heckel, 1994; MSC, 1997). The estuary has a biota that is adapted to survival in an environment that alternates between being a tidal estuary and a coastal lagoon, and, in general, the bar-open state is more beneficial to the local biota. The present management plan of breaching the sandbar when the river rises to 7 to 9 feet appears appropriate and should be continued. Additional conclusions derived from the 1997 study program are as follows:

- The biota of the estuary exhibits high variability from one year to the next. Even with this wide variability, the results of the study indicate that the breaching activity is beneficial to biota in the Russian River estuary.

- Smolts of wild coho and steelhead use the estuary during the summer, and breaching provides an intermittent avenue to the sea. The tributary origin of these wild fish is unknown.

- When the bar is open, seals congregate near the inlet. When the bar is closed, seals haul out at other locations where, presumably, prey is less abundant or the environment is otherwise less preferable.

- Crowds of curious people who gather at the breaching site after the SCWA breaching crews leave the site have more impact on pinniped behavior than does the breaching process itself.

VI. RECOMMENDATIONS

Monitoring of physical and biological conditions in the estuary during the bar-closure/breaching season conducted thus far may be sufficient evidence that breaching is not causing adverse impacts to fish and seals, and that breaching may be beneficial. If monitoring must continue to meet regulatory requirements, recommendations are as follows:

- In light of the increasing concern about the status of remaining wild stocks of steelhead and coho salmon (both species are now federally listed as Threatened Species), future summer monitoring should be more focussed on effectively sampling salmonids in the estuary. The best approach would be to increase the beach seining effort by making replicate hauls, and to sample more sites (spanning the range of shallow-water habitats available). The numbers captured on a given sampling day per habitat type could then be related to the proportional representation of each habitat type within the estuary, so that a rough estimate of the numbers of smolts in the estuary could be made. The use of fyke netting as a means of sampling smolts should also be considered, with the understanding that fyke nets would have to be closely monitored around the clock when in use to prevent incidental fish mortality or human vandalism. Such information is also expected to complement studies being

conducted throughout the watershed regarding the abundance and behavior of salmonids.

- The salmonid sampling program should be coordinated with genetics researchers from the Bodega Marine Laboratory or other institutions so that tissue samples of wild smolts are obtained each time smolts are captured. DNA analysis and archiving may eventually lead to identification of the natal tributary streams of smolts found in the estuary and to valuable information about the timing of outmigration, run strength, and other aspects of their population biology.

Also, the breaching activity could be modified to minimize impacts on seals as follows:

- Exclusion of humans from the beach during and especially following breaching operations would minimize effects on harbor seals and increase visitor safety.

V. REFERENCES

PERSONAL CONTACTS

Bill Cox, California Department of Fish and Game
Tom Hablett, National Marine Fisheries Service
Rich Lawton, California State Parks
Armando Quinones, CDFG, Warm Springs Hatchery

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VI. APPENDIX

Appendix A – 1. Prebreaching Water Quality Profiles, Event I, 20 May 1997

20-May-97																				
	Station 1(1040 hr PDT)				Station 2 (1145 hr PDT)				Station 3 (1215 hr PDT)				Station 3A (1230 hr PDT)				Station 4 (1300 hr PDT)			
Depth	Temp	Sal	Cond	D. O.	Temp	Sal	Cond	D. O.	Temp	Sal	Cond	D. O.	Temp	Sal	Cond	D. O.	Temp	Sal	Cond	D. O.
Meters	°C	°/oo	μmho	ppm	°C	°/oo	μmho	ppm	°C	°/oo	μmho	ppm	°C	°/oo	μmho	ppm	°C	°/oo	μmho	ppm
0	21.0	1.6	2100	9.4	22.0	0.7	820	8.2	22.0	0.6	670	8.0	21.2	0.7	630	7.2	22.5	0.7	520	8.2
1	-	-	-	-	-	-	-	-	22.0	0.7	690	8.0	21.0	0.8	640	6.8	-	-	-	-
2	21.0	1.6	2100	9.2	22.0	1.2	1490	7.7	21.8	0.7	690	8.0	17.0	0.7	450	4.6	22.5	0.7	610	7.9
3	21.0	20.3	30200	12.4	21.0	13.4	20300	7.9	21.5	8.9	14000	7.6					20.0	18.5	26800	6.0
4	14.1	23.0	34000	9.9	16.5	26.1	34300	5.2	14.5	28.0	34600	3.3					17.0	24.5	32800	3.3
4.3	-	-	-	-	-	-	-	-	13.5	28.0	34500	1.4					-	-	-	-
5	13.5	27.5	34000	8.1	13.3	28.3	34100	3.2									16.0	25.3	33000	2.8
6	12.7	28.1	34000	6.8	12.5	28.4	34000	2.4									-	-	-	-
7	12.0	29.0	34200	6.3	12.0	28.7	34000	2.0									15.2	26.0	33400	3.0
8	-	-	-	-	12.0	28.7	34000	1.7									-	-	-	-
9	-	-	-	-	12.0	28.7	34000	-									-	-	-	-
10	-	-	-	-													15.0	25.1	33600	2.8
11	11.5	29.5	34500	3.4													-	-	-	-
12																	-	-	-	2.6
13																				
14																				

Appendix A – 2. Draining Water Quality Profiles, Event I, 23 May 1997

23-May-97																
	Station 1 (1630 hr PDT)				Station 2 (1555 hr PDT)				Station 3 (1500 hr PDT)				Station 4 (1420 hr PDT)			
Depth	Temp	Sal	Cond	D. O.	Temp	Sal	Cond	D. O.	Temp	Sal	Cond	D. O.	Temp	Sal	Cond	D. O.
Meters	°C	°/oo	µmho	ppm	°C	°/oo	µmho	ppm	°C	°/oo	µmho	ppm	°C	°/oo	µmho	ppm
0	20.5	4.0	620	7.6	21.0	3.2	4580	8.0	21.0	2.9	3800	7.5	21.0	1.1	1330	7.9
1	20.5	22.8	32800	8.0	19.0	12.0	17700	6.5	20.0	6.0	8100	7.0	-	-	-	-
2	14.0	29.8	36200	10.4	15.0	26.0	33000	8.0	15.1	25.1	32100	4.4	20.9	1.7	2280	7.5
3	13.5	30.2	37000	11.4	14.5	26.0	33000	7.3	14.2	26.0	32500	4.1	20.8	2.0	2600	7.5
4	13.2	31.0	37200	11.0	14.0	26.0	33200	4.5	-	-	-	-	20.8	3.9	3900	7.3
5	-	-	-	-	-	-	-	-	12.5	27.7	34000	0.7	15.7	25.5	33000	1.8
5.5	-	-	-	-	-	-	-	-	12.2	28.7	34000	0.6	-	-	-	-
6	13.2	31.2	37500	10.8	12.7	28.3	34000	1.0					15.1	26.0	32200	1.8
7	-	-	-	-	-	-	-	-					-	-	-	-
7.5	-	-	-	-	12.2	28.5	34000	0.7					-	-	-	-
8	-	-	-	-									15.0	26.0	32200	1.8
8.5	13.1	31.4	37700	10.5									-	-	-	-
9													-	-	-	-
10													15.0	26.0	32200	1.4
11													-	-	-	-
12													15.0	26.0	32400	1.0
13																
14																

Appendix A – 3. Tidal Water Quality Profiles, Event I, 27 May 1997

27-May-97																
	Station 1(0730 hr PDT)				Station 2 (0910 hr PDT)				Station 3 (1020 hr PDT)				Station 4 (1130 hr PDT)			
Depth	Temp	Sal	Cond	D. O.	Temp	Sal	Cond	D. O.	Temp	Sal	Cond	D. O.	Temp	Sal	Cond	D. O.
Meters	°C	°/oo	μmho	ppm	°C	°/oo	μmho	ppm	°C	°/oo	μmho	ppm	°C	°/oo	μmho	ppm
0	18.0	5.0	7700	8.2	19.3	3.6	5700	8.5	20.0	2.5	3450	8.6	21.0	0.7	780	9.3
1	15.0	21.0	27200	7.9	18.0	13.1	18900	7.8	19.0	9.8	14000	7.0	20.8	0.7	880	9.3
2	11.9	28.7	33800	8.1	13.4	29.0	35000	7.8	14.5	28.0	35000	7.1	16.0	25.0	33000	6.3
3	11.5	29.2	34000	8.1	12.8	29.5	35000	7.5	13.8	28.7	35200	6.6	15.2	26.0	33300	6.5
4	11.4	29.7	34000	8.1	12.1	30.6	35000	7.3	13.5	28.7	35000	6.6	15.0	26.0	33300	6.6
5	11.2	29.8	34300	8.0	12.0	29.8	35000	7.3	13.0	28.9	35000	6.6	-	-	-	-
6	11.1	30.0	34700	8.0	12.0	29.8	35000	7.3					15.0	26.0	33500	6.5
7	11.0	30.4	34800	7.8	12.0	29.8	35000	7.3					-	-	-	-
7.5	-	-	-	-	-	-	-	7.3					-	-	-	-
8	11.0	30.7	35000	7.5									14.8	26.4	33500	6.5
9													-	-	-	-
10													14.8	26.4	33500	6.4
11													-	-	-	-
12													14.8	25.4	33500	6.4
13													-	-	-	6.3
14																

Appendix A – 4. Prebreaching Water Quality Profiles, Event II, 6 June 1997

6-Jun-97																				
	Station 1(0830 hr PDT)				Station 2 (1015 hr PDT)				Station 3 (1155 hr PDT)				Station 3A (1215 hr PDT)				Station 4 (1435 hr PDT)			
Depth	Temp	Sal	Cond	D. O.	Temp	Sal	Cond	D. O.	Temp	Sal	Cond	D. O.	Temp	Sal	Cond	D. O.	Temp	Sal	Cond	D. O.
Meters	°C	°/oo	µmho	ppm	°C	°/oo	µmho	ppm	°C	°/oo	µmho	ppm	°C	°/oo	µmho	ppm	°C	°/oo	µmho	ppm
0	18.0	3.0	3800	8.7	20.8	1.1	1900	8.6	21.0	1.2	1450	8.6	20.5	1.1	1900	7.8	23.0	0.9	900	8.6
1	17.8	4.3	6400	8.8	20.0	2.0	2900	8.6	21.0	1.2	1460	8.5	17.0	0.8	1200	6.5	23.0	0.9	900	8.6
2	17.0	4.5	6500	8.8	19.0	7.0	10400	8.5	19.0	7.5	11400	8.6	18.0	4.8	6800	7.9	21.0	6.0	9500	8.5
3	17.0	23.0	28500	8.6	18.2	20.8	29000	7.7	18.0	18.0	24900	7.9	17.0	5.8	8100	6.7	18.0	25.5	34500	4.4
4	14.9	24.0	30000	7.8	15.2	28.0	35900	3.7	14.9	29.0	35500	3.4					16.1	28.0	35900	3.8
5	14.0	25.1	32000	6.7	14.5	28.9	36000	3.1	13.9	29.0	35500	2.7					-	-	-	-
6	14.1	25.1	32000	5.9	13.8	29.2	36000	2.5	13.1	29.5	35400	1.2					15.1	28.5	36000	2.8
7	13.5	26.7	33000	5.9	13.0	29.5	36000	-									-	-	-	-
8	13.0	27.9	33900	5.5													14.9	28.3	35800	2.4
9	12.0	28.9	34000	5.3													-	-	-	-
10	12.0	28.5	34000	5.0													14.9	28.3	35900	1.9
11																	-	-	-	-
12																	14.9	28.3	35900	1.9
13																				
14																				

Appendix A – 5. Draining Water Quality Profiles, Event II, 10 June 1997

10-Jun-97																
	Station 1(0935 hr PDT)				Station 2 (1110 hr PDT)				Station 3 (1245 hr PDT)				Station 4 (1415 hr PDT)			
Depth	Temp	Sal	Cond	D. O.	Temp	Sal	Cond	D. O.	Temp	Sal	Cond	D. O.	Temp	Sal	Cond	D. O.
Meters	°C	°/oo	μmho	ppm	°C	°/oo	μmho	ppm	°C	°/oo	μmho	ppm	°C	°/oo	μmho	ppm
0	20.5	3.4	4900	7.3	20.0	1.6	2300	7.4	20.5	0.5	1000	7.4	21.0	1.0	2000	8.1
1	20.7	3.5	5200	7.3	21.0	1.6	2500	7.2	21.0	1.5	2200	7.3	21.0	1.5	2000	7.9
2	20.7	3.5	5200	6.0	21.0	2.5	3300	6.9	18.0	26.0	35200	1.8	21.5	2.0	3000	7.4
3	17.0	25.2	34000	2.4	16.0	27.0	35000	1.6	15.0	29.0	36000	1.4	17.0	27.0	35500	2.5
4	15.2	27.9	35100	1.9	14.5	27.0	35000	1.2	14.0	29.0	35000	-	16.0	28.0	36000	2.1
5	14.0	28.8	35100	3.1	13.5	28.8	35000	0.6	13.0	29.0	35000	0.6	15.0	28.0	360	1.6
6	13.5	29.2	35200	2.7	13.0	29.0	35000	0.4					-	-	-	-
7	13.1	29.5	35200	2.4	13.0	29.0	35000	0.3					-	-	-	-
8													15.0	28.0	36000	1.2
9													-	-	-	-
10													-	-	-	-
11													-	-	-	-
12													15.0	28.0	36000	1.0
13																
14																

Appendix A – 6. Tidal Water Quality Profiles, Event II, 13 June 1997

13-Jun-97																
	Station 1(0815 hr PDT)				Station 2 (0930 hr PDT)				Station 3 (1035 hr PDT)				Station 4 (1200 hr PDT)			
Depth	Temp	Sal	Cond	D. O.	Temp	Sal	Cond	D. O.	Temp	Sal	Cond	D. O.	Temp	Sal	Cond	D. O.
Meters	°C	°/oo	µmho	ppm	°C	°/oo	µmho	ppm	°C	°/oo	µmho	ppm	°C	°/oo	µmho	ppm
0	16.5	4.0	5500	8.9	18.5	2.0	2500	8.5	21.0	1.0	2000	8.3	21.5	0.5	1000	8.3
1	16.5	6.0	8200	8.7	18.0	8.7	12500	7.8	21.0	1.0	2000	8.1	21.5	0.5	1000	8.2
2	12.0	24.5	32500	8.6	14.5	28.0	35000	6.4	15.0	27.0	34500	3.6	21.5	0.5	1000	8.2
3	12.0	27.0	34500	8.5	13.5	29.0	35500	6.5	14.0	28.2	34800	4.3	19.0	21.5	30000	1.1
4	11.0	31.5	35500	8.0	13.0	30.0	35500	6.6	14.0	28.0	34800	4.4	16.0	26.5	34500	1.1
5	11.0	31.5	36000	8.2	13.0	30.0	35500	6.8	14.0	28.1	35000	5.0	-	-	-	-
6	11.0	32.0	36000	8.2	13.0	30.0	35500	6.8					16.0	26.5	34500	1.0
7	11.0	32.0	360	8.2	13.0	30.0	355	6.8					-	-	-	-
8													-	-	-	-
9													15.5	27.0	34500	0.8
10													-	-	-	-
11													-	-	-	-
12													15.5	25.5	32500	0.6
13																
14																

Appendix A – 7. Prebreaching Water Quality Profiles, Event III, 22 June 1997

22-Jun-97																				
	Station 1(0805 hr PDT)				Station 2 (0900 hr PDT)				Station 3 (0930 hr PDT)				Station 3A (1000 hr PDT)				Station 4 (1045 hr PDT)			
Depth	Temp	Sal	Cond	D. O.	Temp	Sal	Cond	D. O.	Temp	Sal	Cond	D. O.	Temp	Sal	Cond	D. O.	Temp	Sal	Cond	D. O.
Meters	°C	°/oo	µmho	ppm	°C	°/oo	µmho	ppm	°C	°/oo	µmho	ppm	°C	°/oo	µmho	ppm	°C	°/oo	µmho	ppm
0	17.2	5.3	7800	9.2	18.9	2.2	2730	8.7	19.8	1.8	2230	8.5	17.1	0.9	940	7.0	20.6	0.9	1100	8.5
1	17.2	5.3	7800	9.2	18.9	3.1	4210	8.7	20.0	1.8	2140	8.3	19.0	2.5	3200	7.2	21.7	2.6	3450	8.5
1.4	-	-	-	-	-	-	-	-	-	-	-	-	19.0	2.5	3400	7.2	-	-	-	-
2	17.9	6.2	9100	9.0	18.8	6.1	9300	8.3	19.1	6.6	10000	7.8					21.0	5.8	9000	8.0
3	18.0	15.4	22700	9.0	18.3	19.0	22000	7.8	18.8	17.4	25000	7.2					19.5	24.0	34000	9.8
4	15.1	26.1	33800	10.2	15.2	26.6	34200	4.4	15.0	27.3	33900	3.9					17.5	25.4	34200	5.5
5	13.5	27.8	34200	8.5	13.9	27.8	34400	2.5									16.2	26.1	34200	3.2
6	12.9	28.2	34000	7.2	13.2	28.5	34500	2.1									-	-	-	-
7	12.3	28.4	34000	6.6	13.0	28.5	34500	1.1									-	-	-	-
8	12.0	28.9	34000	5.8	12.8	29.0	34500	0.7									15.0	27.0	34200	0.3
9	11.9	28.9	340	4.4													-	-	-	-
10																	14.8	27.0	34200	0.2
11																	-	-	-	-
12																	14.7	27.0	34200	-
13																	-	-	-	-
14																	-	-	-	-
15																	14.4	27.1	34200	-

Appendix A – 8. Draining Water Quality Profiles, Event III, 28 June 1997

28-Jun-97																				
	Station 1(0815 hr PDT)				Station 2 (0945 hr PDT)				Station 3 (1045 hr PDT)				Station 3A* (1110 hr PDT)				Station 4 (1315 hr PDT)			
Depth	Temp	Sal	Cond	D. O.	Temp	Sal	Cond	D. O.	Temp	Sal	Cond	D. O.	Temp	Sal	Cond	D. O.	Temp	Sal	Cond	D. O.
Meters	°C	°/oo	µmho	ppm	°C	°/oo	µmho	ppm	°C	°/oo	µmho	ppm	°C	°/oo	µmho	ppm	°C	°/oo	µmho	ppm
0	19.5	2.8	4300	7.7	20.8	0.2	2050	7.6	21.0	1.4	1880	7.3	-	-	-	-	22.5	1.0	1220	7.5
0.15	-	-	-	-	-	-	-	-	-	-	-	-	19.5	1.5	2180	7.4	-	-	-	-
1	19.0	3.5	7000	7.3	20.8	2.8	4200	7.1	21.0	1.4	1880	7.2					22.5	1.0	1220	7.4
2	11.5	22.5	26500	7.8	15.0	23.3	30200	6.7	16.9	21.0	28600	4.3					22.5	1.0	1300	7.3
3	11.0	23.0	27500	7.9	13.1	25.2	31000	6.9	15.0	23.7	30800	4.6					22.2	1.2	1720	7.0
4	11.0	23.5	27800	8.0	12.9	25.7	31200	6.8	14.5	28.0	34700	0.7					17.0	25.3	33500	1.3
4.5	-	-	-	-	-	-	-	-	-	-	-	0.7					-	-	-	-
5	10.9	23.5	27900	8.1	13.1	28.4	34500	0.8	14.0	28.1	34800	-					16.0	25.7	33800	0.4
6	10.9	20.6	25000	8.2	13.0	28.7	34800	0.6									15.3	26.5	33900	0.2
7	10.8	22.5	26500	8.1													-	-	-	-
8	10.8	21.0	25300	8.1													15.0	26.8	33900	0.2
9	10.8	21.0	26000	-													-	-	-	-
10																	15.0	26.7	33900	0.2
11																	-	-	-	-
12																	15.0	26.7	33900	0.1
13																				
14																				

Appendix A – 9. Tidal Water Quality Profiles, Event III, 1 July 1997

1-Jul-97																
	Station 1(0915 hr PDT)				Station 2 (1000 hr PDT)				Station 3 (1025 hr PDT)				Station 4 (1100 hr PDT)			
Depth	Temp	Sal	Cond	D. O.	Temp	Sal	Cond	D. O.	Temp	Sal	Cond	D. O.	Temp	Sal	Cond	D. O.
Meters	°C	°/oo	µmho	ppm	°C	°/oo	µmho	ppm	°C	°/oo	µmho	ppm	°C	°/oo	µmho	ppm
0	16.5	12.2	16500	8.4	19.6	7.0	10400	7.8	20.0	5.2	8000	7.7	21.0	3.5	5300	7.6
1	13.0	24.8	30500	8.1	16.0	21.7	29100	7.4	16.5	18.9	25200	7.2	20.0	7.3	12000	7.2
2	11.8	28.4	33000	8.1	13.0	27.3	33200	7.6	13.0	28.0	33900	7.0	17.0	26.0	32000	5.6
3	11.5	28.0	33900	8.2	12.5	28.0	33800	7.6	12.6	28.0	33800	7.0	14.9	22.2	32500	5.7
4	11.2	29.2	33900	8.2	12.2	28.4	33800	7.6	12.2	28.4	33900	6.9	14.0	296.5	32900	6.1
5	11.5	29.2	33900	8.2	12.0	28.8	34000	7.5					-	-	-	-
6	11.5	29.5	34000	8.1	12.0	28.8	34000	7.4					14.0	26.5	33000	6.3
6.5	-	-	-	-	12.0	28.8	34000	7.4					-	-	-	-
7	11.5	29.5	34000	8.0									-	-	-	-
8	11.5	29.6	34000	8.0									13.9	26.9	33000	6.2
9	-	-	-	8.0									-	-	-	-
10													13.9	27.0	33100	6.1
11													-	-	-	-
12													13.9	27.0	33100	6.1
13													-	-	-	-
14													139.0	27.0	33100	6.2

Appendix A – 10. Prebreaching Water Quality Profiles, Event IV, 18 August 1997

18-Aug-97																				
	Station 1 (0920 hr PDT)				Station 2 (1530 hr PDT)				Station 3 (1505 hr PDT)				Station 3A (1450 hr PDT)				Station 4 (1325 hr PDT)			
Depth	Temp	Sal	Cond	D. O.	Temp	Sal	Cond	D. O.	Temp	Sal	Cond	D. O.	Temp	Sal	Cond	D. O.	Temp	Sal	Cond	D. O.
Meters	°C	°/oo	µmho	ppm	°C	°/oo	µmho	ppm	°C	°/oo	µmho	ppm	°C	°/oo	µmho	ppm	°C	°/oo	µmho	ppm
0	18.0	2.0	2480	9.1	21.0	1.0	1310	8.0	21.0	0.7	760	8.0	21.0	0.7	770	7.4	21.5	0.5	4850	7.9
1	18.0	2.0	2500	9.0	21.0	1.1	1400	8.2	21.0	0.7	750	8.0	21.0	0.8	770	7.3	21.0	0.5	4900	7.9
2	18.3	2.0	2540	9.0	20.5	3.2	4000	8.7	21.0	3.0	4100	9.5	21.0	2.6	4000	7.3	21.0	3.2	4200	8.8
2.5	19.5	10.0	14500	10.0	-	-	-	-	-	-	-	-					-	-	-	-
3	19.0	21.5	31500	10.0	21.5	20.0	35500	13.8	21.9	19.2	29000	14.5					22.0	22.0	33000	8.5
4	17.7	24.9	34000	6.2	18.0	25.4	34700	3.2	18.0	24.5	33900	2.1					19.6	25.2	35500	5.0
5	16.0	26.0	34000	6.4	16.0	26.0	34000	2.3	16.0	25.7	33600	1.9					18.5	25.7	35300	3.4
5.9	-	-	-	-	-	-	-	-	15.0	26.3	33800	0.4					-	-	-	-
6	15.0	26.9	34000	4.9	14.8	26.5	34000	1.1									-	-	-	-
7	14.7	27.0	34000	3.2	14.5	26.7	34000	0.4									17.2	26.2	35000	2.3
8	14.5	27.0	34000	2.5	-	-	-	-									-	-	-	-
9	14.3	27.0	34000	1.6	14.0	27.0	33500	0.2									17.0	26.4	35000	1.8
10	14.0	27.1	34000	1.5													-	-	-	-
11																	16.9	26.4	35000	1.2
12																	-	-	-	-
13																	-	-	-	-
14																	16.9	26.5	35000	0.9

Appendix A – 11. Draining Water Quality Profiles, Event IV, 21 August 1997

21-Aug-97																
	Station 1 (0915 hr PDT)				Station 2 (1510 hr PDT)				Station 3 (1450 hr PDT)				Station 4 (1340 hr PDT)			
Depth	Temp	Sal	Cond	D. O.	Temp	Sal	Cond	D. O.	Temp	Sal	Cond	D. O.	Temp	Sal	Cond	D. O.
Meters	°C	°/oo	μmho	ppm	°C	°/oo	μmho	ppm	°C	°/oo	μmho	ppm	°C	°/oo	μmho	ppm
0	19.0	5.3	8000	7.7	22.5	5.3	8500	7.5	22.8	4.5	7200	7.0	22.0	2.2	3120	7.2
1	20.0	5.4	8100	7.4	20.0	19.0	27500	10.8	20.0	17.5	25200	5.5	21.8	2.4	3420	7.0
2	19.4	11.0	16300	6.9	17.8	23.0	31800	8.7	17.9	22.8	31500	5.6	21.5	2.9	4400	7.0
3	17.2	23.9	32200	7.8	17.5	23.9	32500	8.9	17.5	23.8	32200	6.4	21.5	3.6	5800	7.0
4	16.8	25.3	33800	8.8	17.2	24.3	32900	8.6	17.2	24.0	32600	6.1	21.5	3.8	6000	6.9
5	16.4	26.3	34700	9.0	17.0	24.4	33000	9.2	17.1	24.0	32800	5.9	19.0	23.5	32000	3.0
6	16.0	27.2	35200	8.9	17.0	24.5	32000	8.1					17.8	25.0	34000	1.7
7	16.2	27.0	35200	8.5	16.5	24.9	33000	0.3					17.5	25.5	34500	1.4
8	-	-	-	8.0	-	-	-	-					17.3	25.5	34500	1.2
8.5					-	-	-	0.3					-	-	-	-
9													-	-	-	-
10													17.2	25.9	34700	0.6
11													-	-	-	-
12													17.1	26.0	35000	0.4
13													-	-	-	-
14													17.2	26.0	34800	0.2

Appendix A – 12. Tidal Water Quality Profiles, Event IV, 26 August 1997

26-Aug-97																
	Station 1 (0905 hr PDT)				Station 2 (1400 hr PDT)				Station 3 (1330 hr PDT)				Station 4 (1300 hr PDT)			
Depth	Temp	Sal	Cond	D. O.	Temp	Sal	Cond	D. O.	Temp	Sal	Cond	D. O.	Temp	Sal	Cond	D. O.
Meters	°C	°/oo	µmho	ppm	°C	°/oo	µmho	ppm	°C	°/oo	µmho	ppm	°C	°/oo	µmho	ppm
0	20.0	0.0	100	7.8	24.0	3.0	4900	7.8	23.9	2.0	2900	8.1	23.5	1.0	1140	8.0
1	18.9	0.3	320	8.0	20.0	22.9	32500	9.1	20.0	22.2	32500	8.7	23.0	1.0	1300	8.1
2	16.8	26.0	33700	7.6	18.5	25.2	35000	8.4	19.0	24.0	34800	8.8	21.0	22.0	32000	9.1
3	16.4	26.2	34200	7.6	18.0	26.1	35500	8.5	18.4	25.2	35000	7.8	19.9	24.0	33100	8.6
4	16.1	26.5	34700	7.7	18.0	26.5	36000	8.0	18.0	25.9	35100	7.1	19.5	24.0	33900	8.4
5	16.0	27.1	35000	7.6	18.0	26.8	36000	7.5	18.0	26.0	35200	6.8	19.0	24.1	34000	7.8
6	16.0	27.2	35100	7.6	17.8	27.0	36200	7.2					18.9	24.1	34000	5.4
7	16.0	27.5	35400	7.5	17.8	27.1	36100	6.9					18.0	25.5	34700	0.7
8	16.0	27.5	35500	7.6	17.5	27.1	36200	6.7					17.0	26.5	35000	0.4
9													17.0	26.5	35000	0.3
10													17.0	26.5	35000	0.3
11													-	-	-	-
12													17.0	26.5	35000	0.3
13													-	-	-	-
14													17.0	26.5	35000	0.3

Appendix A – 13. Prebreaching Water Quality Profiles, Event V, 16 September 1997

16-Sep-97																				
	Station 1 (1005 hr PDT)				Station 2 (1740 hr PDT)				Station 3 (1715 hr PDT)				Station 3A (1345 hr PDT)				Station 4 (1610 hr PDT)			
Depth	Temp	Sal	Cond	D. O.	Temp	Sal	Cond	D. O.	Temp	Sal	Cond	D. O.	Temp	Sal	Cond	D. O.	Temp	Sal	Cond	D. O.
Meters	°C	°/oo	µmho	ppm	°C	°/oo	µmho	ppm	°C	°/oo	µmho	ppm	°C	°/oo	µmho	ppm	°C	°/oo	µmho	ppm
0	19.0	2.9	3900	8.2	21.0	1.9	2520	8.4	21.5	1.0	1400	8.2	21.0	1.2	1550	7.4	21.9	0.2	30	8.3
1	19.2	3.0	4050	8.3	21.2	2.0	2800	8.3	21.5	1.0	1400	8.1	20.8	1.2	1600	7.4	21.8	0.2	33	8.2
2	19.1	3.2	4220	8.3	21.3	2.2	3100	8.2	21.7	2.6	3850	8.0	19.7	1.5	1900	6.5	22.6	0.2	39	8.5
3	22.0	21.3	32900	10.4	23.2	19.8	31000	8.8	23.5	17.1	27000	7.9					24.5	19.8	32300	8.3
4	20.2	24.5	35300	11.6	21.0	24.5	36000	6.7	21.0	24.6	36000	6.5					23.3	21.1	32800	8.0
5	19.0	25.4	35300	11.4	19.5	25.5	36000	4.1	19.0	25.6	36000	3.1					21.9	22.9	34100	6.3
6	17.8	26.0	35500	8.9	18.2	26.0	35500	2.7	17.9	26.6	36000	1.4					20.5	24.7	35500	4.7
7	17.0	26.3	35200	7.5	17.1	26.3	35000	0.6									20.0	24.6	34300	4.6
8	16.5	27.2	35200	4.9	16.9	26.4	35000	0.3									19.4	24.8	35000	4.1
8.8	-	-	-	-	16.0	27.1	35000	0.3									-	-	-	-
9	16.1	27.0	35200	2.7													-	-	-	-
10																	19.0	26.0	36100	2.6
11																	-	-	-	-
12																	17.9	26.9	35300	0.8
13																	-	-	-	-
14																	17.3	26.1	35200	0.2

Appendix A – 14. Draining Water Quality Profiles, Event V, 20 September 1997

20-Sep-97																
	Station 1 (0845 hr PDT)				Station 2 (1500 hr PDT)				Station 3 (1440 hr PDT)				Station 4 (1345 hr PDT)			
Depth	Temp	Sal	Cond	D. O.	Temp	Sal	Cond	D. O.	Temp	Sal	Cond	D. O.	Temp	Sal	Cond	D. O.
Meters	°C	°/oo	μmho	ppm	°C	°/oo	μmho	ppm	°C	°/oo	μmho	ppm	°C	°/oo	μmho	ppm
0	20.3	3.7	5600	7.9	22.2	3.4	5200	7.6	22.2	3.0	4400	7.6	20.8	1.6	2040	7.4
1	20.7	3.8	5800	7.8	19.0	18.0	26000	7.1	21.0	12.2	18500	7.4	21.0	1.7	2270	7.4
2	20.8	3.9	6000	7.8	17.0	23.1	31300	5.9	20.1	22.0	32000	5.9	21.0	1.9	2350	7.4
3	20.0	19.3	28400	7.6	17.3	24.0	32300	5.6	20.0	23.1	33000	5.3	21.0	1.9	2380	7.5
4	19.5	23.5	33700	6.6	16.4	24.0	32100	5.8	20.0	23.6	33600	5.3	21.0	3.5	6000	7.5
4.5	-	-	-	-	-	-	-	-	20.0	24.2	34200	-	-	-	-	-
5	19.7	25.2	35700	4.5	16.0	24.5	32800	5.8	-	-	-	2.6	21.0	22.5	34000	3.5
6	18.0	25.9	35300	4.8	16.5	25.0	33200	5.1					20.3	24.5	35200	2.8
7	17.5	26.1	35200	2.9	17.0	26.0	34000	4.4					20.0	24.7	35500	2.3
8	17.2	26.1	35200	2.6	16.7	25.6	35200	0.6					19.8	25.1	35500	2.1
9					16.4	26.3	35000	0.4					-	-	-	-
10													19.0	25.1	35100	0.5
11													-	-	-	-
12													18.0	25.3	35000	0.5
13													-	-	-	-
14													18.0	25.3	34700	0.3

Appendix A – 15. Tidal Water Quality Profiles, Event V, 23 September 1997

23-Sep-97																
	Station 1 (0930 hr PDT)				Station 2 (1410 hr PDT)				Station 3 (1355 hr PDT)				Station 4 (1315 hr PDT)			
Depth	Temp	Sal	Cond	D. O.	Temp	Sal	Cond	D. O.	Temp	Sal	Cond	D. O.	Temp	Sal	Cond	D. O.
Meters	°C	°/oo	μmho	ppm	°C	°/oo	μmho	ppm	°C	°/oo	μmho	ppm	°C	°/oo	μmho	ppm
0	16.8	9.0	12500	8.1	20.5	6.0	9300	7.9	21.0	3.3	4750	8.1	20.8	1.2	1630	7.7
1	14.8	23.4	30400	8.1	17.9	19.0	25000	8.3	18.8	15.0	22000	9.8	20.5	1.3	1630	7.7
2	13.6	25.7	32000	8.2	15.4	24.8	32000	9.2	16.0	24.0	31800	10.2	17.9	19.8	28000	8.8
3	13.5	26.3	32500	8.3	15.0	25.3	32400	9.3	15.4	24.5	32500	10.2	17.5	22.9	36200	8.8
4	13.5	26.6	33000	8.3	14.8	25.7	32700	9.3	15.0	25.5	32500	9.3	17.0	23.8	32200	8.2
5	13.5	26.8	33000	8.3	14.7	25.7	32800	9.1	14.9	25.8	33000	8.9	17.0	24.1	32500	7.8
5.6	-	-	-	-	-	-	-	-	-	-	-	8.7	-	-	-	-
6	13.4	27.2	33300	8.2	14.7	25.9	33000	8.9					17.0	24.3	32800	7.8
7	13.3	27.4	33500	8.2	14.7	26.0	33000	8.9					-	-	-	-
8	13.3	27.5	33600	-	14.7	25.9	33000	8.8					17.5	25.5	34700	5.7
9					14.7	26.1	33100	8.4					-	-	-	-
10													18.4	27.0	36000	0.6
11													-	-	-	-
12													18.2	26.0	35500	0.3
13													-	-	-	-
14													18.1	26.2	35700	0.2

Appendix A – 16. Prebreaching Water Quality Profiles, Event VI, 10 October 1997

10-Oct-97																				
	Station 1 (0830 hr PDT)				Station 2 (1540 hr PDT)				Station 3 (1505 hr PDT)				Station 3A (1450 hr PDT)				Station 4 (1335 hr PDT)			
Depth	Temp	Sal	Cond	D. O.	Temp	Sal	Cond	D. O.	Temp	Sal	Cond	D. O.	Temp	Sal	Cond	D. O.	Temp	Sal	Cond	D. O.
Meters	°C	°/oo	µmho	ppm	°C	°/oo	µmho	ppm	°C	°/oo	µmho	ppm	°C	°/oo	µmho	ppm	°C	°/oo	µmho	ppm
0	14.8	4.5	6000	9.8	17.7	2.5	3050	9.6	17.2	1.5	1820	9.7	17.4	1.6	2000	9.4	18.0	0.8	820	9.2
1	15.0	4.5	6000	9.8	16.5	5.1	7200	9.7	17.4	2.0	2390	9.7	16.0	2.9	3650	6.0	17.9	0.9	800	9.3
2	15.3	5.2	7000	9.7	16.5	9.2	13100	10.0	16.3	8.3	11900	9.6	17.8	10.4	14800	6.8	17.0	8.6	12200	9.1
3	16.7	15.6	21600	8.5	18.0	16.4	23500	9.7	18.0	16.0	22800	8.7					19.0	17.5	23500	8.1
4	17.8	20.4	28300	7.9	18.2	21.7	30200	6.6	18.2	21.8	30800	6.0					19.7	21.7	31000	6.5
5	17.7	21.5	30000	6.9	17.7	23.2	32000	5.4	17.5	23.1	32300	4.8					18.8	24.0	33500	5.2
6	17.5	22.4	31000	6.3	17.2	24.4	32900	3.4	16.0	25.6	33300	0.8					18.0	24.3	33500	3.7
7	17.0	23.5	31500	4.9	16.0	25.6	33500	1.5									17.3	24.3	33000	3.7
8	16.9	23.5	31700	4.6	15.5	26.0	33500	1.1									16.8	24.7	32900	3.7
9	16.8	23.7	32000	3.6	15.2	26.2	33500	1.0									-	-	-	-
10	-	-	-	2.4													16.1	25.0	32600	3.2
11																	-	-	-	-
12																	16.1	25.0	32600	2.9
13																	-	-	-	-
14																	16.1	25.0	325	2.7

Appendix A – 17. Draining Water Quality Profiles, Event VI, 12 October 1997

12-Oct-97																
	Station 1 (0955 hr PDT)				Station 2 (1530 hr PDT)				Station 3 (1515 hr PDT)				Station 4 (1400 hr PDT)			
Depth	Temp	Sal	Cond	D. O.	Temp	Sal	Cond	D. O.	Temp	Sal	Cond	D. O.	Temp	Sal	Cond	D. O.
Meters	°C	°/oo	μmho	ppm	°C	°/oo	μmho	ppm	°C	°/oo	μmho	ppm	°C	°/oo	μmho	ppm
0	15.3	4.7	5800	8.7	18.2	4.7	7000	8.0	18.5	4.3	6100	7.7	17.2	3.5	4650	7.6
1	17.0	5.9	8300	8.3	18.0	5.0	7200	7.9	18.2	4.4	6500	7.7	17.2	3.6	5200	7.6
2	17.0	9.4	13200	7.9	18.0	5.5	8000	7.9	19.0	6.1	9500	7.7	17.2	3.6	5200	7.6
3	14.8	18.0	23800	7.5	18.0	21.0	29700	4.2	17.0	23.3	31900	3.3	17.2	18.5	25000	6.6
4	14.1	20.7	21400	7.3	17.0	23.8	32100	2.2	16.1	25.0	32800	1.4	17.2	23.3	32000	3.2
5	13.9	22.1	28000	7.0	16.0	25.0	33000	1.1	16.0	25.1	33000	1.3	16.5	24.0	32100	3.0
6	13.9	22.8	28800	6.6	16.0	25.2	33200	0.8					16.0	24.5	32200	3.0
7	15.0	24.5	31500	5.1	15.7	25.2	32800	0.6					15.5	25.0	32300	2.7
8	15.0	24.8	31800	4.8	15.5	26.0	33400	0.5					15.5	25.0	32400	2.3
9													-	-	-	-
10													15.5	25.2	32500	2.2
11													-	-	-	-
12													15.5	25.3	32600	2.0
13																
14																

Appendix A – 18. Tidal Water Quality Profiles, Event VI, 15 October 1997

15-Oct-97																
	Station 1 (1105 hr PDT)				Station 2 (1530 hr PDT)				Station 3 (1455 hr PDT)				Station 4 (1300hr PDT)			
Depth	Temp	Sal	Cond	D. O.	Temp	Sal	Cond	D. O.	Temp	Sal	Cond	D. O.	Temp	Sal	Cond	D. O.
Meters	°C	°/oo	µmho	ppm	°C	°/oo	µmho	ppm	°C	°/oo	µmho	ppm	°C	°/oo	µmho	ppm
0	12.9	26.0	31400	8.4	16.8	14.8	20700	8.2	17.8	13.1	18800	8.0	17.1	12.3	17200	8.0
1	12.9	26.3	31800	8.5	16.0	16.8	23000	8.2	16.5	15.8	21800	8.2	16.0	15.0	20800	8.0
2	12.9	26.6	32100	8.5	14.7	22.0	28400	8.1	15.4	19.4	26500	8.2	15.0	19.0	25000	7.8
3	12.9	26.9	32400	8.5	13.9	24.1	30400	8.2	14.0	22.6	30500	8.2	14.9	20.2	26300	7.8
4	12.8	27.0	32600	8.5	13.5	24.9	31000	8.2	14.0	24.3	30800	8.2	14.8	21.0	27200	7.6
5	12.8	27.0	32600	8.6	13.4	25.2	31100	8.2	13.7	24.7	31000	8.2	14.5	22.4	28500	7.2
6	12.8	27.2	32800	8.5	13.1	25.7	31500	8.2					14.5	23.0	29500	6.4
7	12.8	27.3	32800	8.5	13.0	25.9	31600	8.2					14.7	23.5	29800	6.2
8	12.8	27.4	33000	8.5	13.0	26.0	31800	8.2					14.8	23.5	30200	5.6
9	12.8	27.5	33100	8.5									15.1	24.3	31500	1.8
10													15.9	25.0	32800	1.6
11													-	-	-	-
12													16.0	25.3	33000	1.4
13													-	-	-	-
14													16.0	25.3	33100	1.3

Appendix A – 19. Prebreaching Water Quality Profiles, Event VII, 31 October 1997

31-Oct																				
	Station 1 (1315 hr PDT)				Station 2 (1640 hr PDT)				Station 3 (1625 hr PDT)				Station 3A (1615 hr PDT)				Station 4 (1540 hr PDT)			
Depth	Temp	Sal	Cond	D. O.	Temp	Sal	Cond	D. O.	Temp	Sal	Cond	D. O.	Temp	Sal	Cond	D. O.	Temp	Sal	Cond	D. O.
Meters	°C	°/₀₀	µmho	ppm	°C	°/₀₀	µmho	ppm	°C	°/₀₀	µmho	ppm	°C	°/₀₀	µmho	ppm	°C	°/₀₀	µmho	ppm
0	14.9	5.3	6900	8.8	15.9	2.4	2850	9.5	16.5	1.0	900	9.7	16.5	0.7	710	8.7	16.5	0.6	650	9.7
1	15.0	7.0	9800	10.0	15.9	2.5	2900	10.0	16.0	1.5	2000	9.7	16.0	0.8	740	8.3	16.5	0.9	650	9.9
2	15.0	12.0	16000	9.8	14.9	4.0	5500	10.0	14.5	4.0	5200	9.7	15.5	5.3	7800	9.4	14.9	4.2	5900	9.8
3	14.5	20.0	25400	9.2	15.5	18.1	24000	8.5	15.2	15.9	21000	8.7					16.0	16.0	22000	8.4
4	15.0	24.0	30900	9.6	15.0	23.5	30500	6.5	15.0	22.9	30000	6.5					16.0	22.0	29000	7.8
5	15.0	24.9	31500	9.1	15.0	24.2	31100	6.4	14.5	24.0	30900	6.0					-	-	-	-
6	14.0	25.1	32000	8.4	14.5	25.0	32000	6.0	14.0	25.0	31100	4.0					15.0	23.4	30000	6.4
7	14.0	26.1	32300	7.2	14.2	25.2	32000	5.3	14.0	25.1	31400	2.7					-	-	-	-
8	13.9	26.8	32500	6.6	14.0	25.8	32100	4.6									14.5	24.0	30400	5.6
9					14.0	26.0	32500	4.0									-	-	-	-
10					14.0	26.0	32500	3.7									14.1	24.5	30900	4.4
11																	-	-	-	-
12																	14.0	24.9	31000	3.8
13																	-	-	-	-
14																	13.0	25.9	31100	3.7

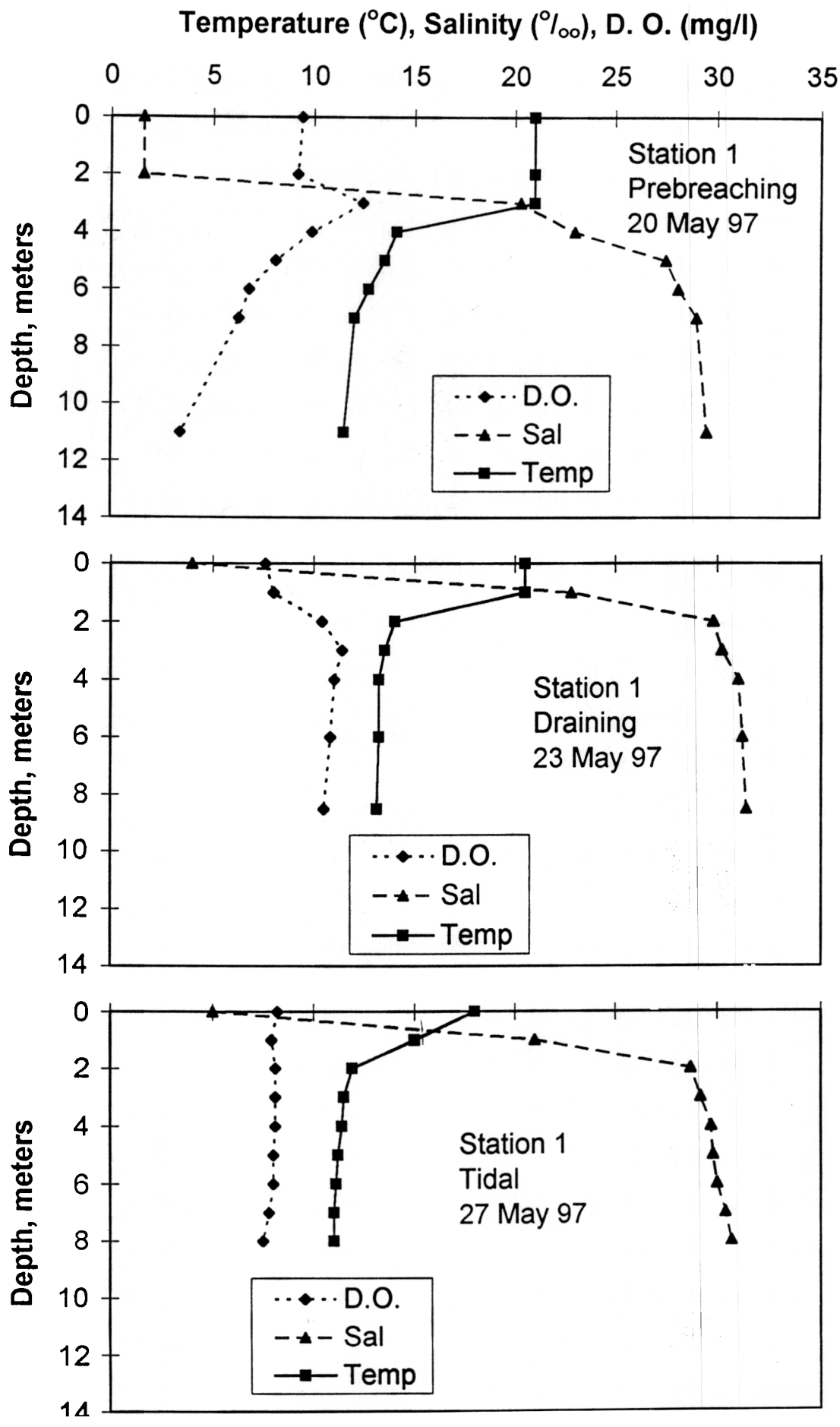
Appendix A – 20. Draining Water Quality Profiles, Event VII, 4 November 1997

	Station 1 (0900 hr PDT)				Station 2 (1420 hr PDT)				Station 3 (1350 hr PDT)				Station 3A (1340 hr PDT)				Station 4 (1245 hr PDT)			
Depth	Temp	Sal	Cond	D. O.	Temp	Sal	Cond	D. O.	Temp	Sal	Cond	D. O.	Temp	Sal	Cond	D. O.	Temp	Sal	Cond	D. O.
Meters	°C	°/oo	µmho	ppm	°C	°/oo	µmho	ppm	°C	°/oo	µmho	ppm	°C	°/oo	µmho	ppm	°C	°/oo	µmho	ppm
0	15.5	5.2	7500	8.4	17.0	4.7	6500	8.3	17.0	3.4	4600	8.5	14.9	2.0	2120	4.9	16.5	2.0	2500	8.2
1	15.5	5.9	7900	8.4	16.5	7.1	10300	8.0	17.0	6.0	9000	8.2	14.8	2.0	2400	-	16.0	3.0	4100	8.1
2	15.0	16.0	22000	8.3	15.0	19.0	25000	7.6	16.0	13.0	17800	7.5					16.0	3.5	4900	8.2
3	15.0	18.2	25000	8.4	15.0	21.3	27900	7.8	15.1	16.0	21100	7.0					16.0	3.5	4900	8.0
4	15.0	21.2	27000	8.3	15.0	22.0	28600	7.8	15.0	17.1	23000	7.4					16.0	3.9	5100	8.0
5	14.9	24.0	31000	8.3	15.0	22.8	29200	7.8	15.0	18.0	23700	7.4					16.0	4.0	5500	8.1
6	14.8	25.0	31000	8.1	15.0	23.0	29900	7.8									16.0	4.1	5700	8.0
7	14.5	26.1	32000	8.3	15.0	23.2	30000	7.9									-	-	-	-
8	14.5	26.5	32700	8.2	15.0	23.3	30100	7.8									16.0	4.5	6000	8.0
9					15.0	23.5	30400	7.9									-	-	-	-
9.5					15.0	23.6	30500	7.8									-	-	-	-
10																	16.0	6.0	8100	7.6
11																	-	-	-	-
12																	15.1	15.0	20000	3.8
13																	-	-	-	-
14																	15.0	22.0	28000	1.6

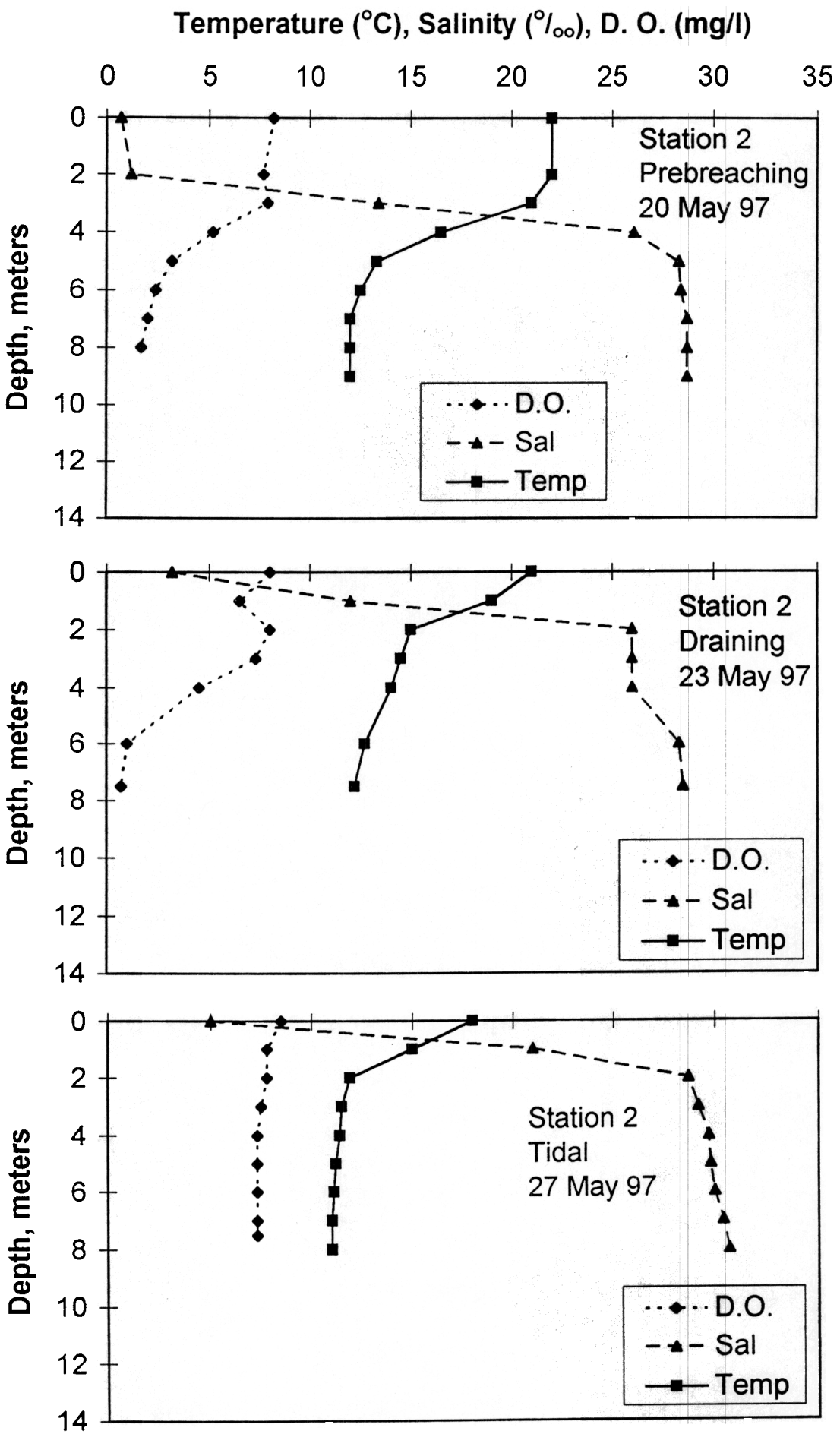
Appendix A – 21. Draining Water Quality Profiles, Event VII, 7 November 1997

7-Nov-97																
	Station 1 (0945 hr PDT)				Station 2 (1550 hr PDT)				Station 3 (1515 hr PDT)				Station 4 (1435 hr PDT)			
Depth	Temp	Sal	Cond	D. O.	Temp	Sal	Cond	D. O.	Temp	Sal	Cond	D. O.	Temp	Sal	Cond	D. O.
Meters	°C	°/oo	µmho	ppm	°C	°/oo	µmho	ppm	°C	°/oo	µmho	ppm	°C	°/oo	µmho	ppm
0	13.1	7.0	9100	9.2	13.5	5.7	10000	9.4	14.9	3.4	4400	9.6	15.0	2.3	3000	9.3
1	13.1	7.3	9800	9.2	13.8	7.9	10200	9.0	14.5	6.8	9000	9.0	15.0	14.2	20000	8.7
2	14.5	21.8	28000	8.1	14.2	21.1	27100	8.6	14.9	18.4	24200	9.2	15.5	20.3	27000	8.7
3	14.5	23.5	30100	8.5	14.5	23.4	30000	8.2	15.0	22.0	28900	8.6	15.5	22.0	29000	8.6
4	14.5	25.0	31500	8.2	14.9	24.5	31200	8.0	14.0	23.8	30800	8.1	15.0	23.0	29900	8.0
5	14.5	25.2	32000	8.1	14.6	25.0	31900	8.2	14.5	24.4	31200	7.5	15.0	23.5	30300	7.8
6	14.5	25.6	32200	8.0	14.5	25.2	32000	7.9					15.0	23.8	30500	7.8
7	14.5	26.0	32500	8.0	14.5	25.5	32200	7.8					-	-	-	-
8	14.5	26.0	32500	7.9	14.5	25.7	32500	7.6					15.0	23.9	30900	7.7
9	14.5	26.0	32800	7.4									-	-	-	-
10													15.0	24.0	31000	7.5
11													-	-	-	-
12													15.0	24.1	31000	7.3
13													-	-	-	-
14													15.0	24.5	30000	7.3

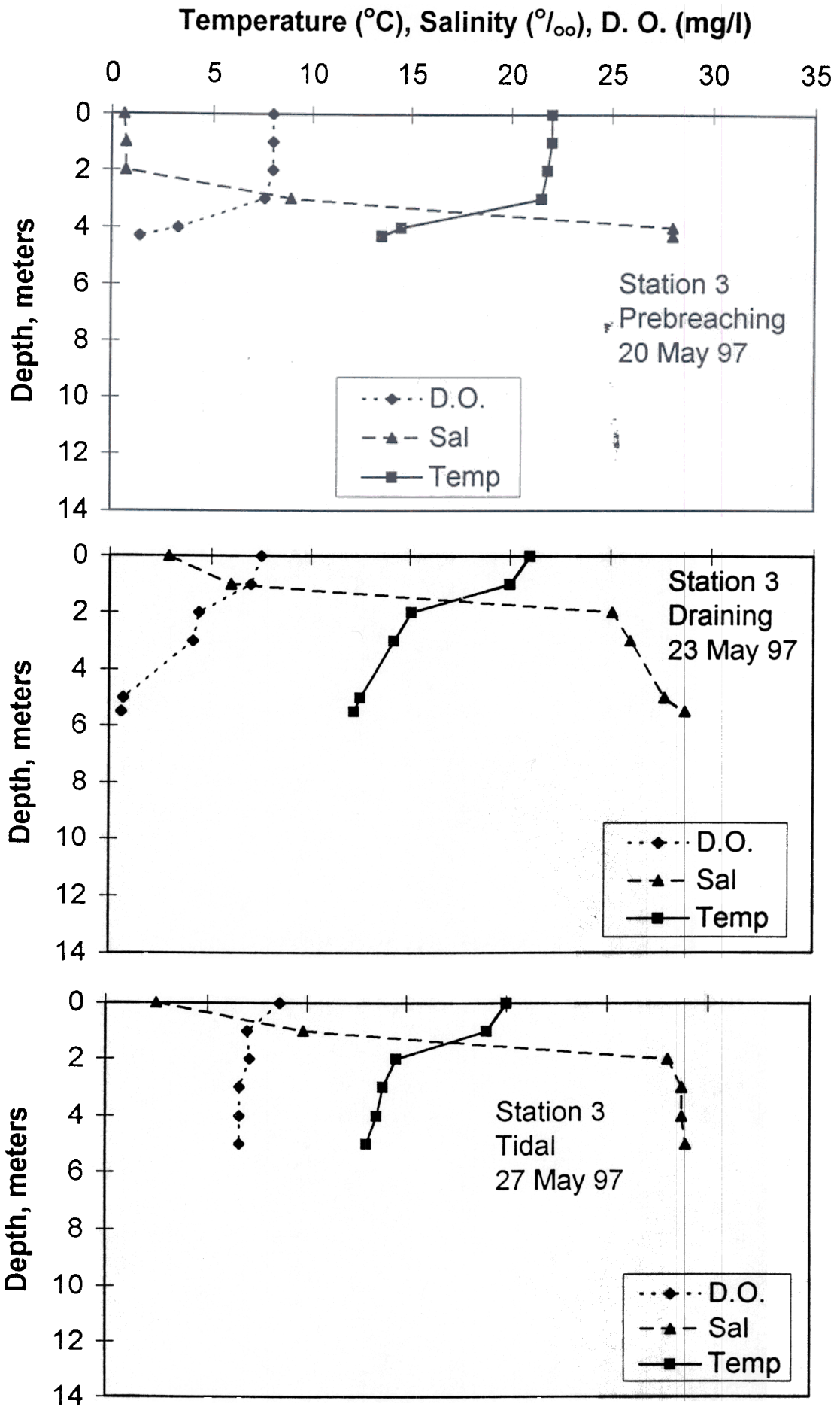
Appendix A-22. Water Quality Profile Plots, Station 1, Event I



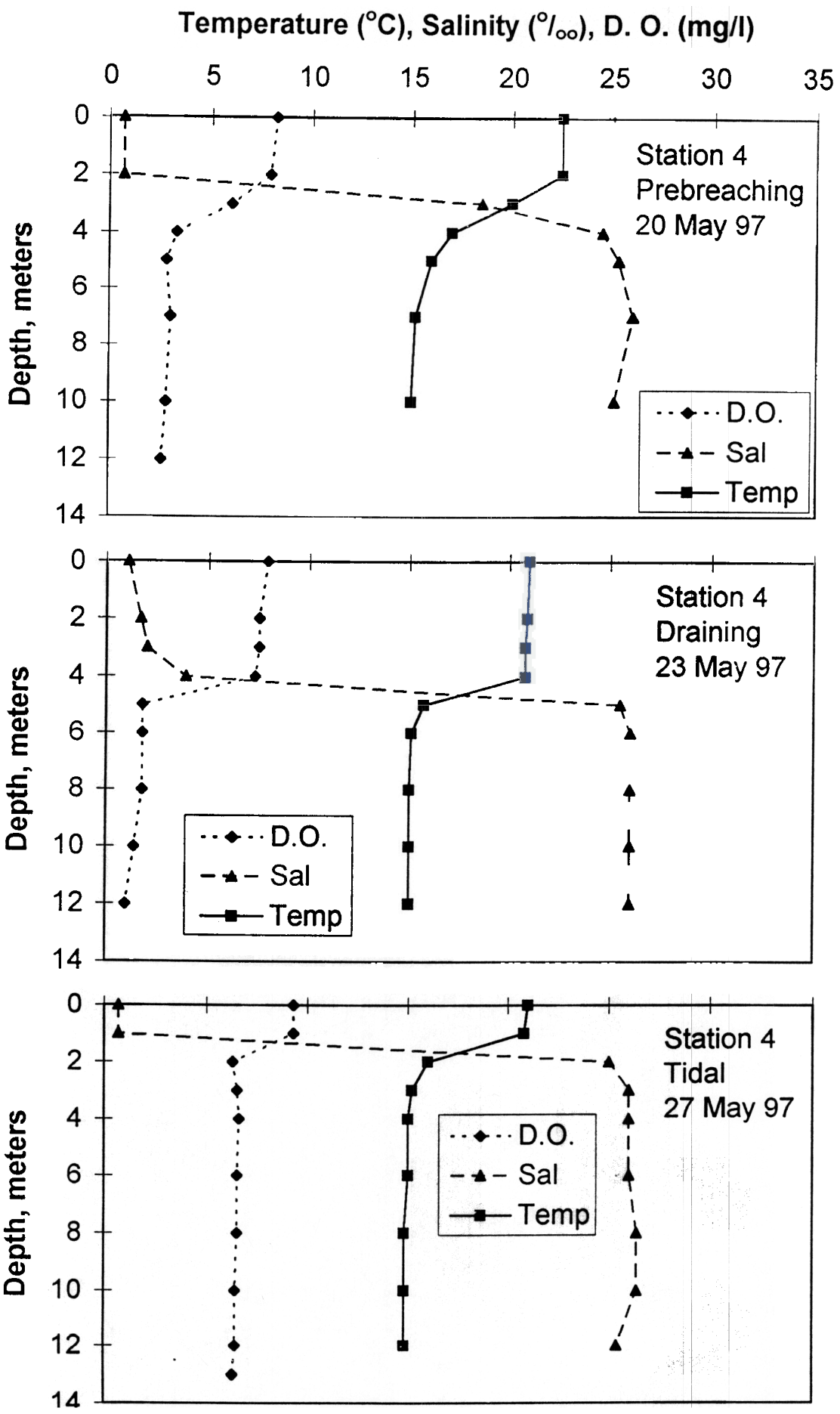
Appendix A-23. Water Quality Profile Plots, Station 2, Event I



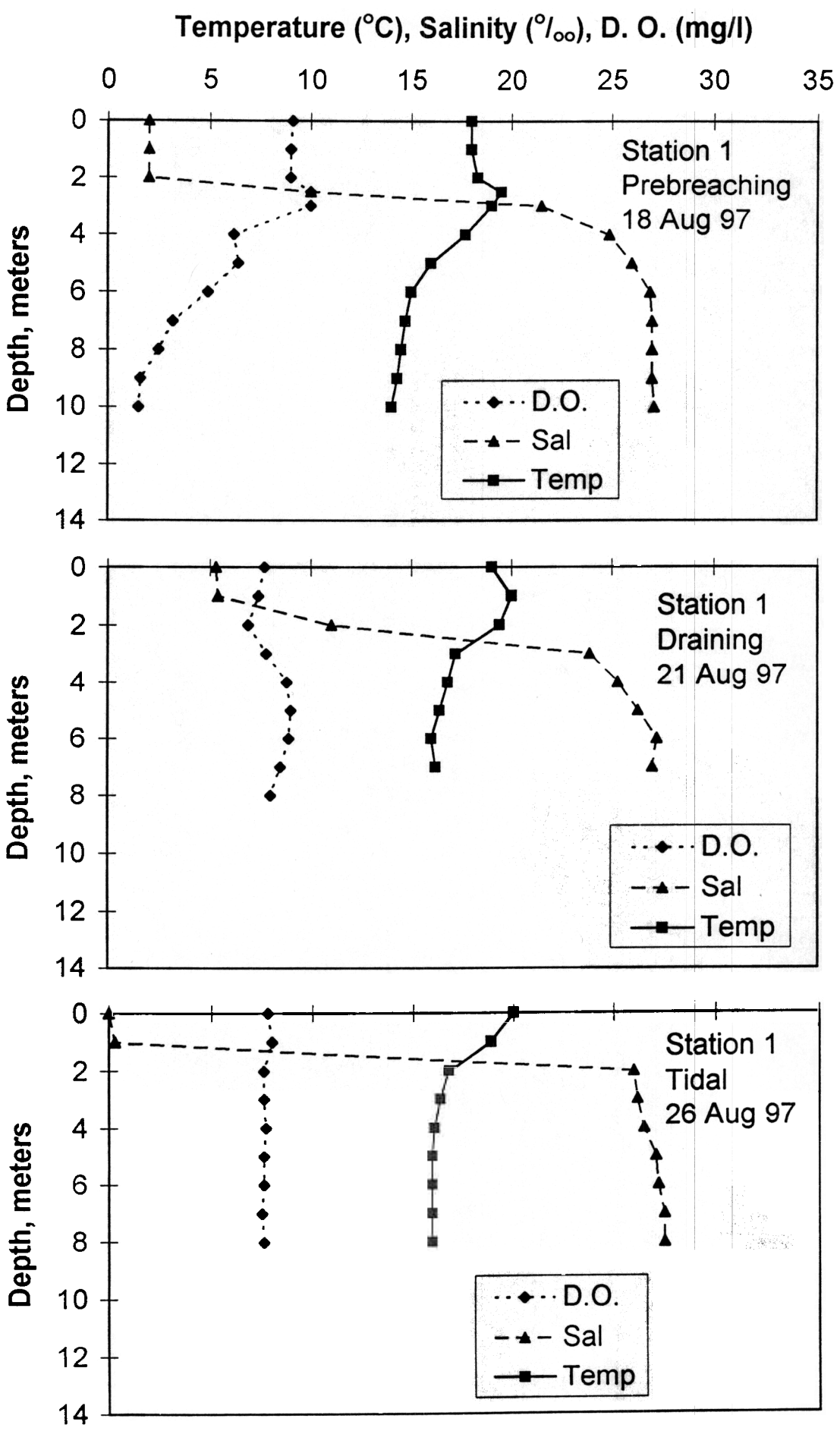
Appendix A-24. Water Quality Profile Plots, Station 3, Event



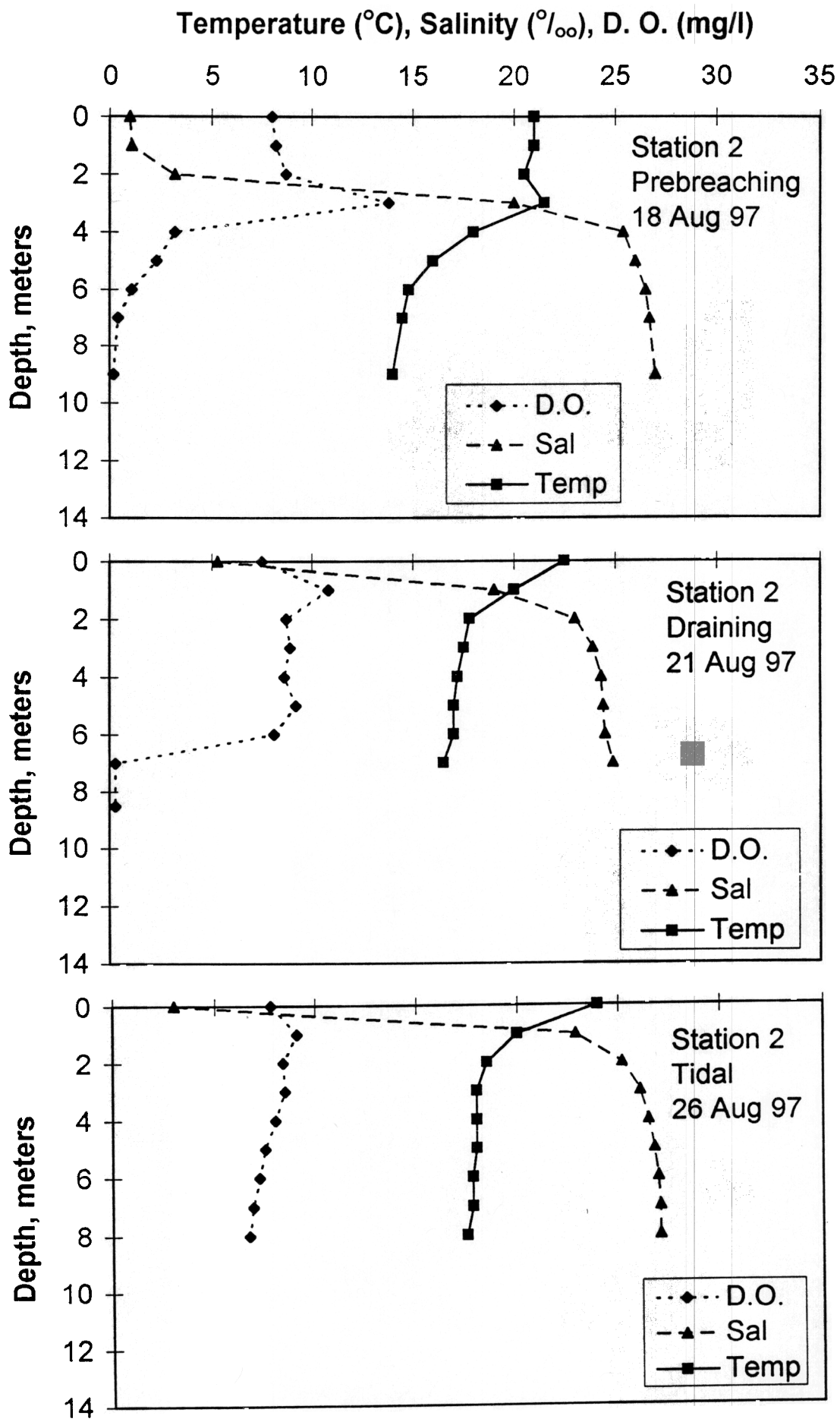
Appendix A-25. Water Quality Profile Plots, Station 4, Event I



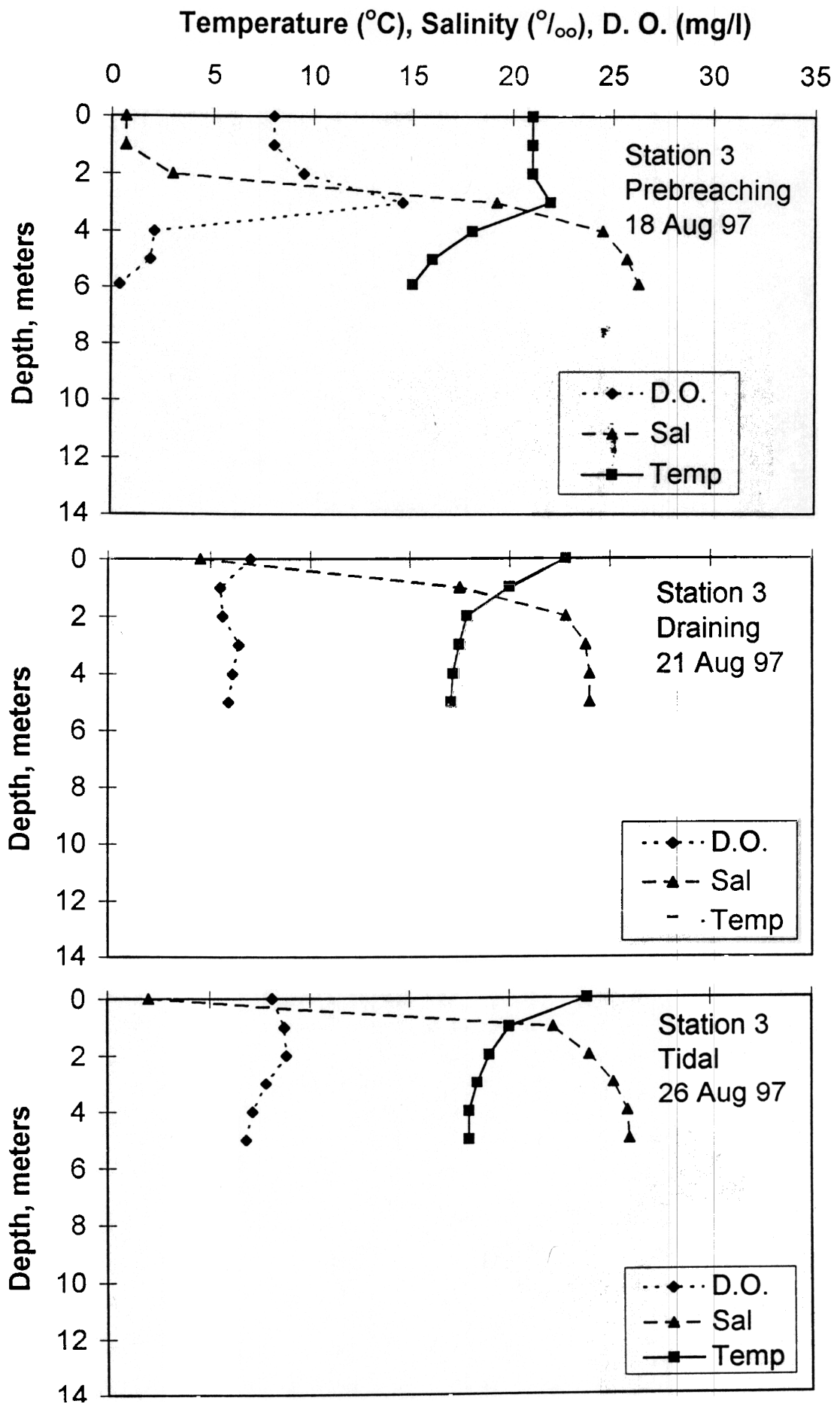
Appendix A-26. Water Quality Profile Plots, Station 1, Event IV



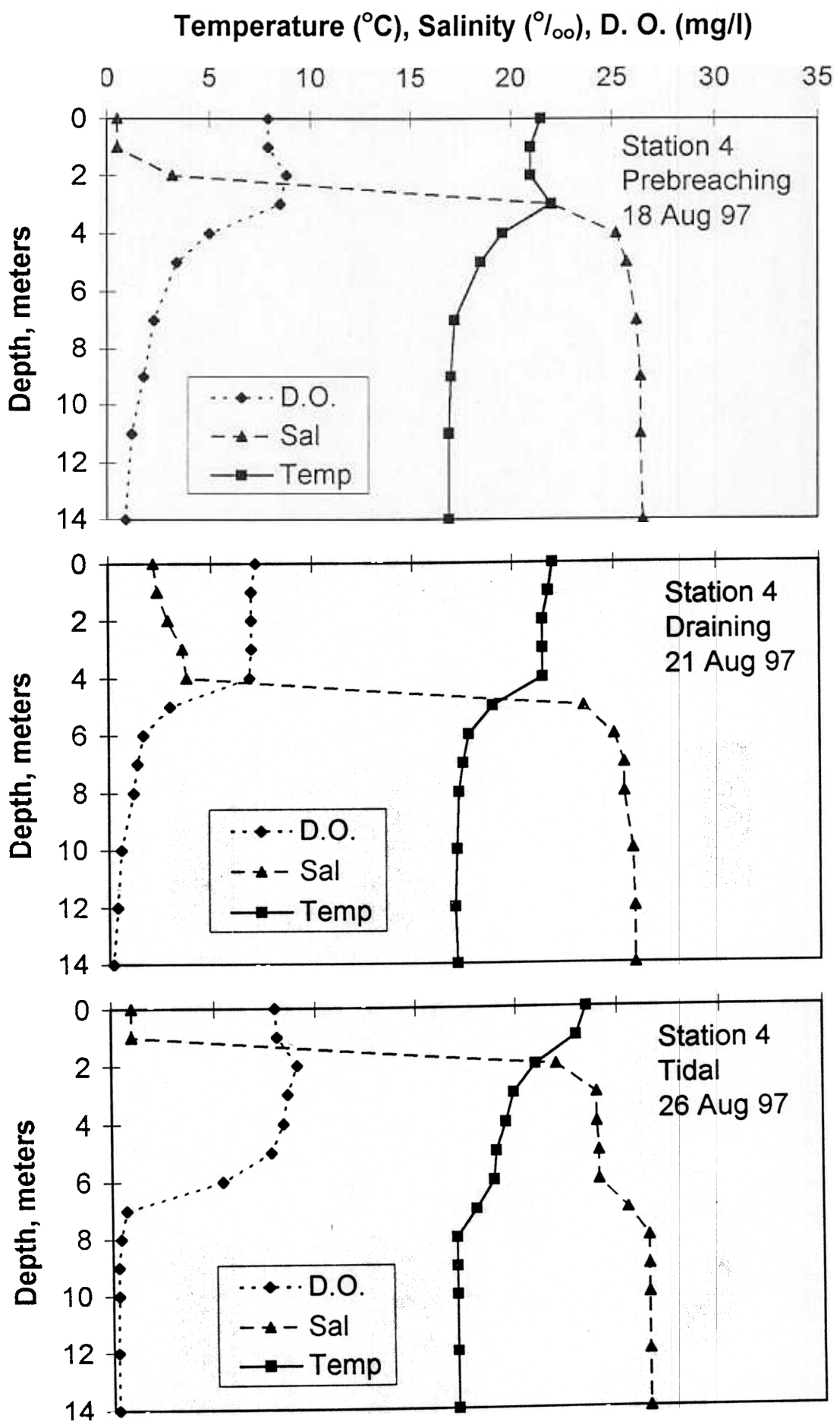
Appendix A-27. Water Quality Profile Plots, Station 2, Event IV



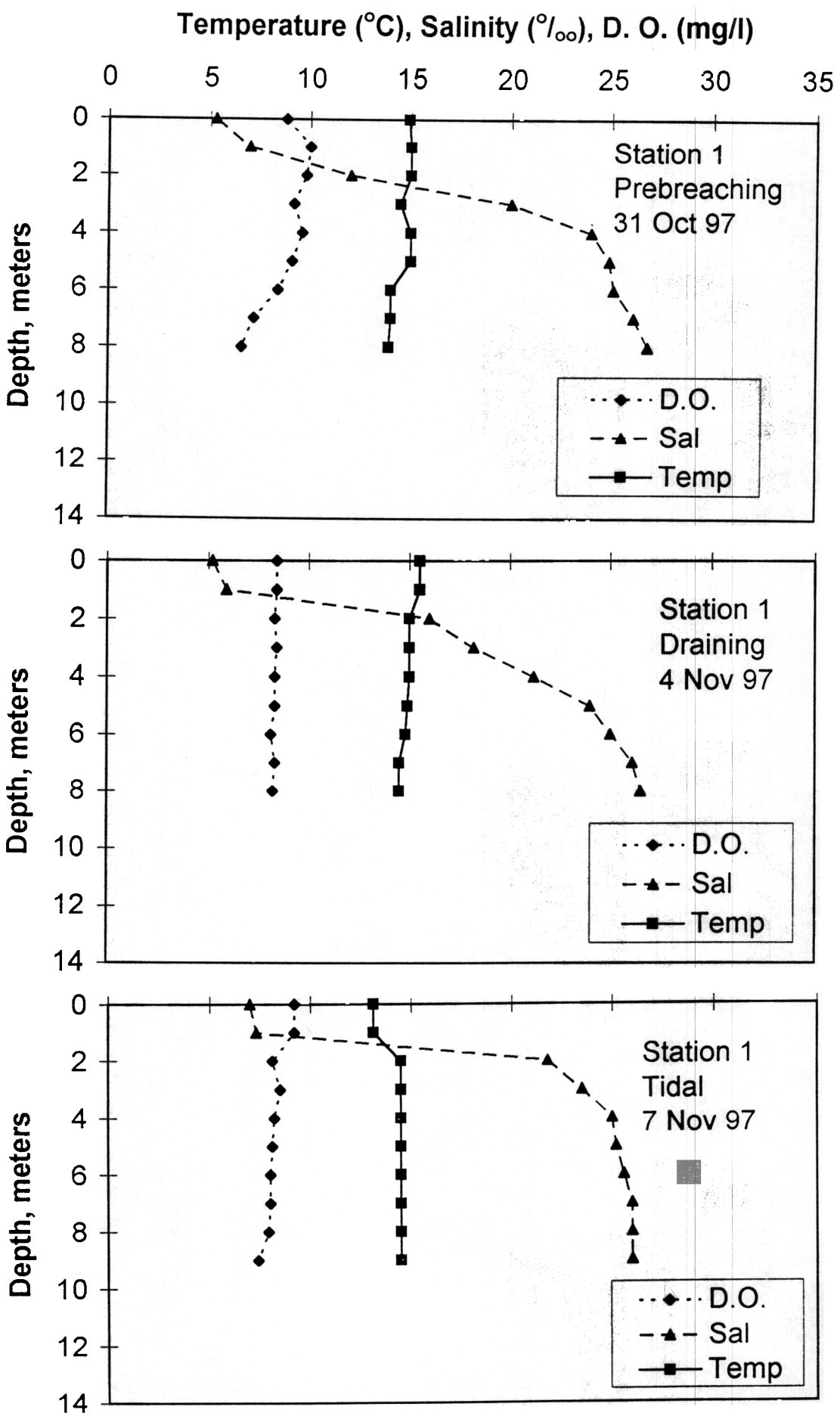
Appendix A-28. Water Quality Profile Plots, Station 3, Event IV



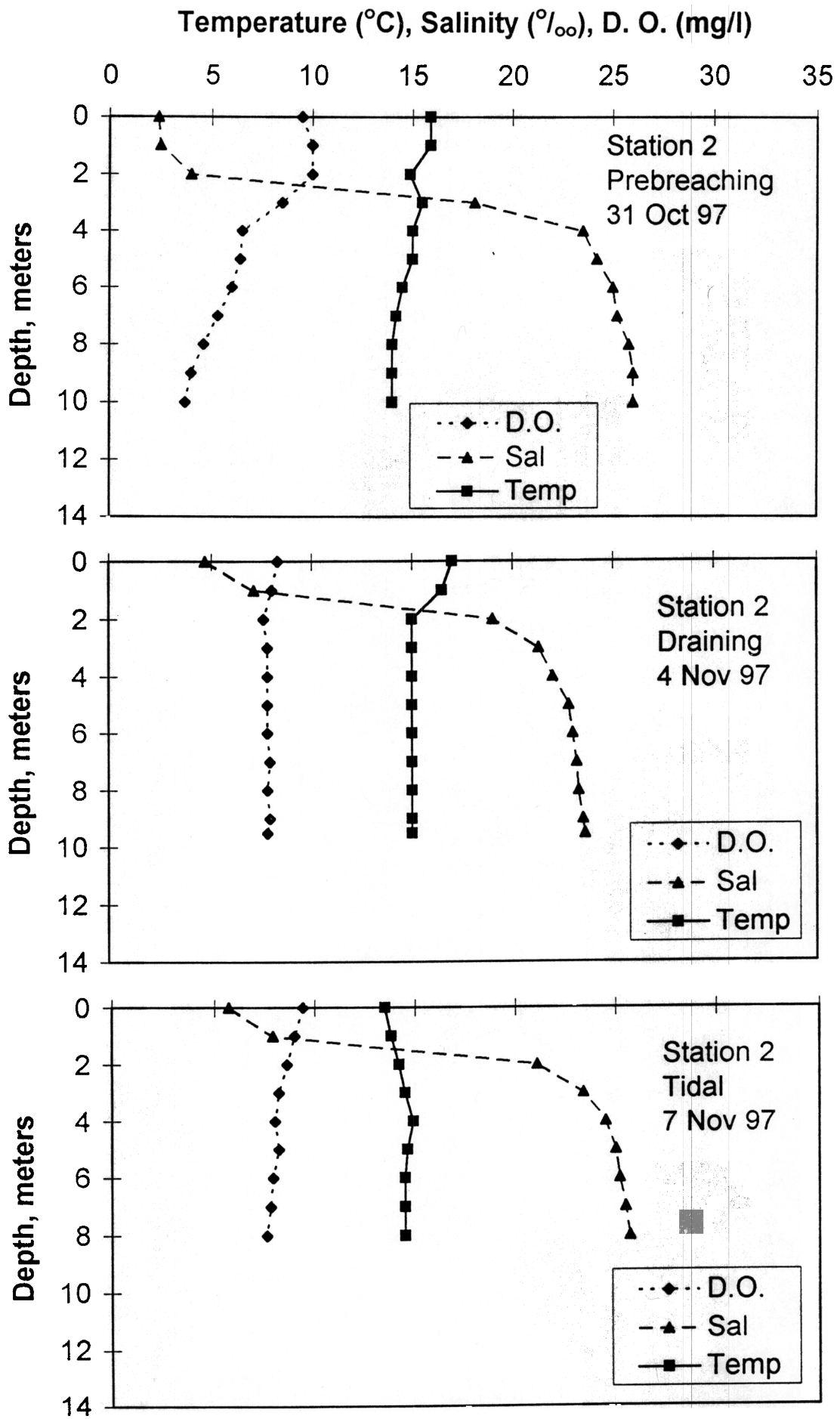
Appendix A-29. Water Quality Profile Plots, Station 4, Event IV



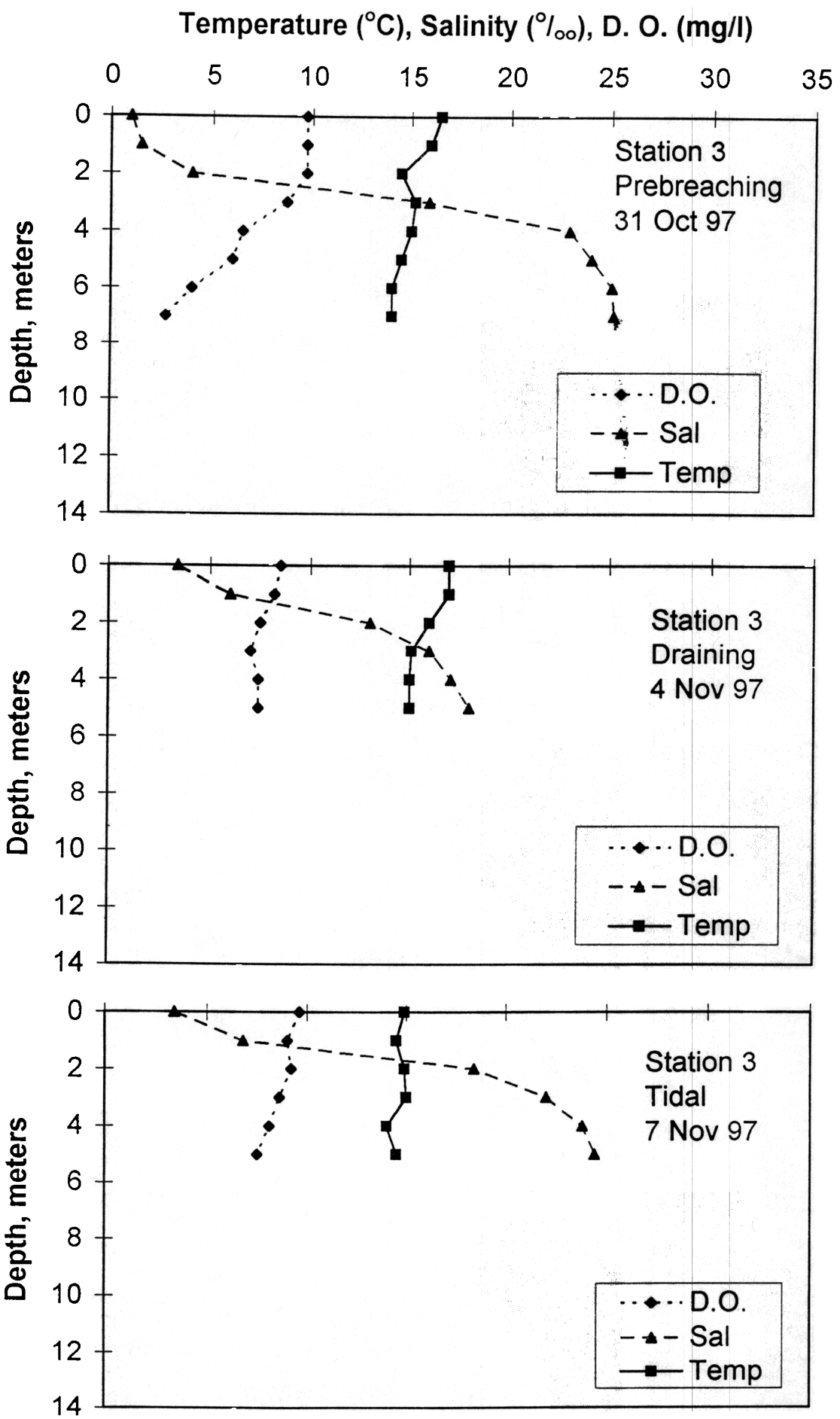
Appendix A-30. Water Quality Profile Plots, Station 1, Event VII



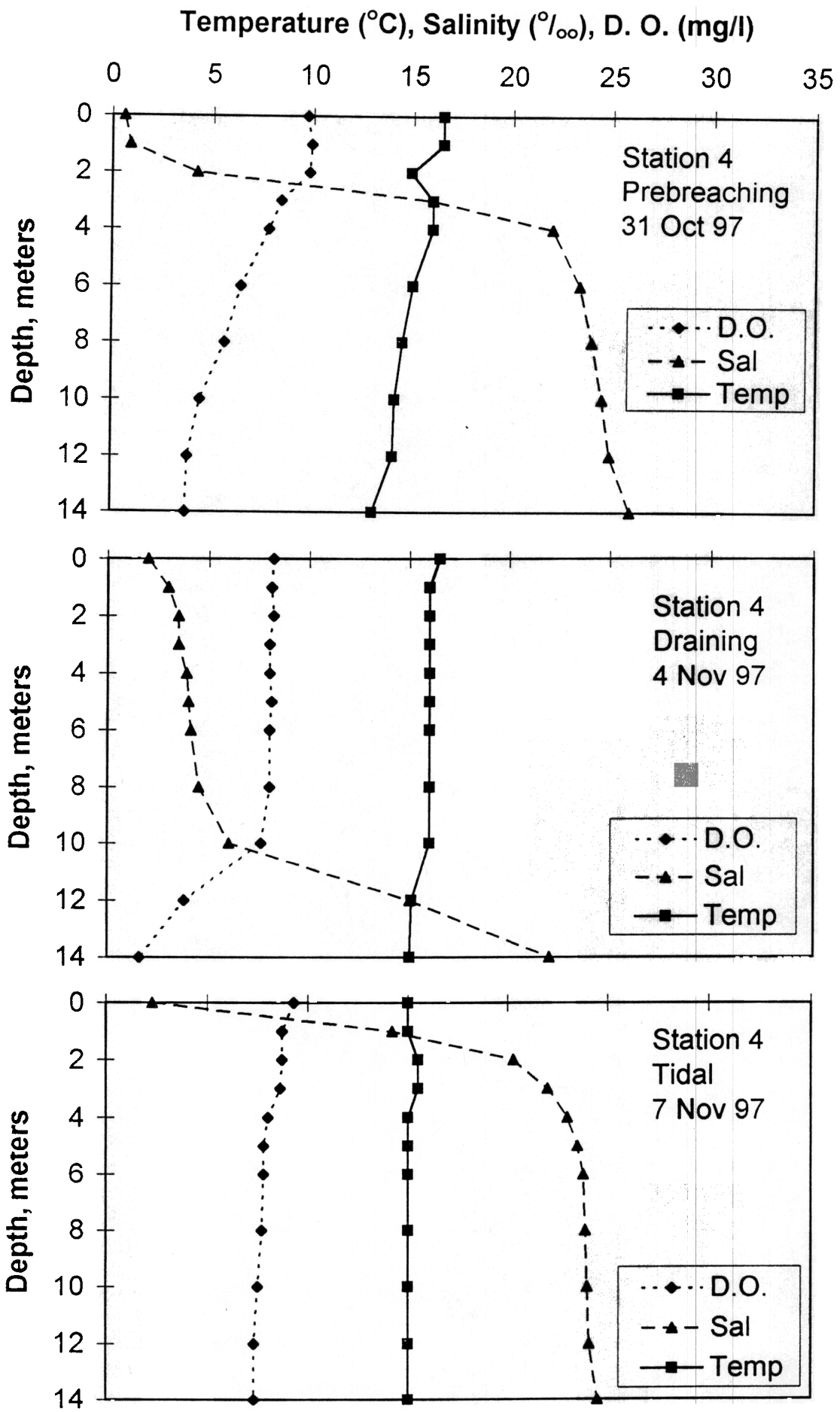
Appendix A-31. Water Quality Profile Plots, Station 2, Event VII



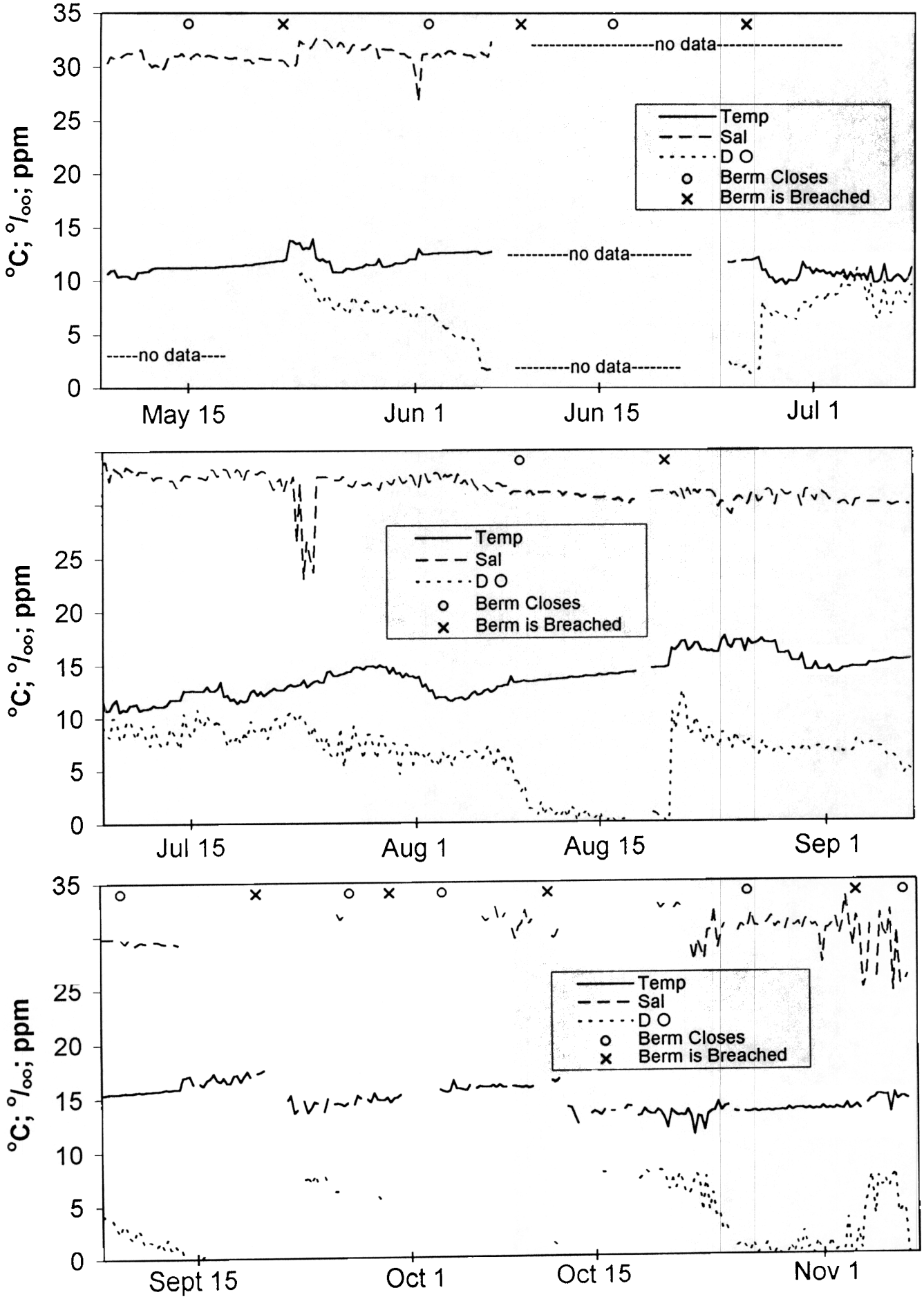
Appendix A-32. Water Quality Profile Plots, Station 3, Event VII



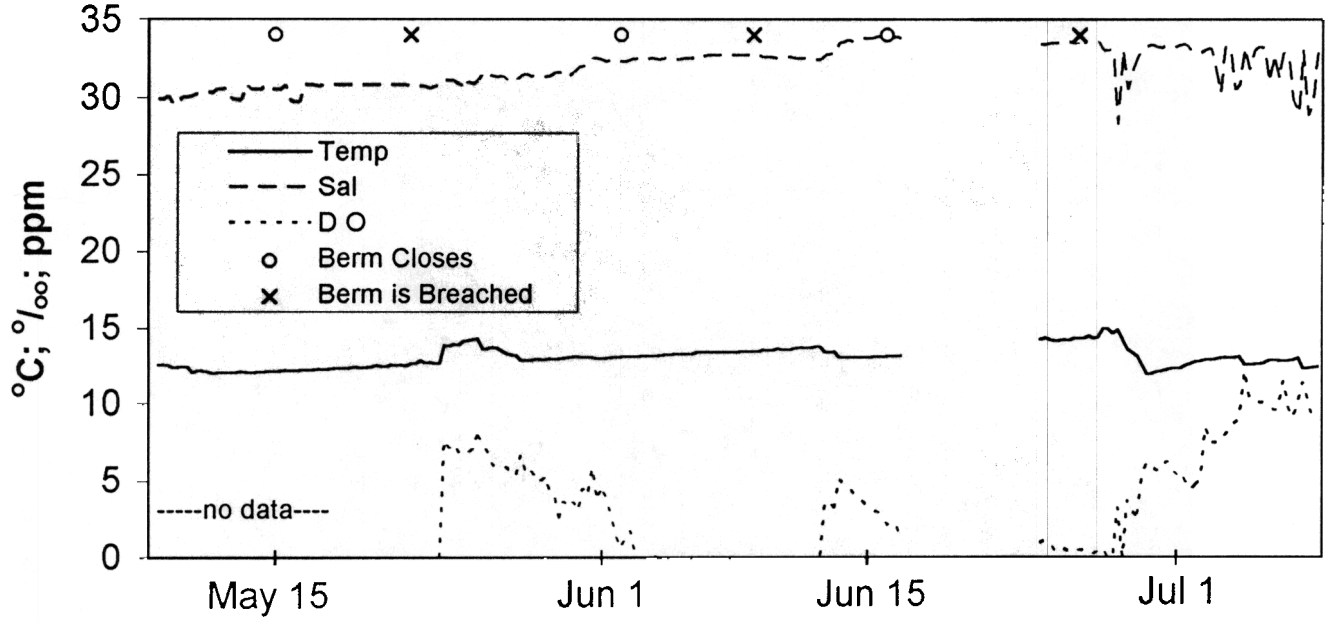
Appendix A-33. Water Quality Profile Plots, Station 4, Event VII

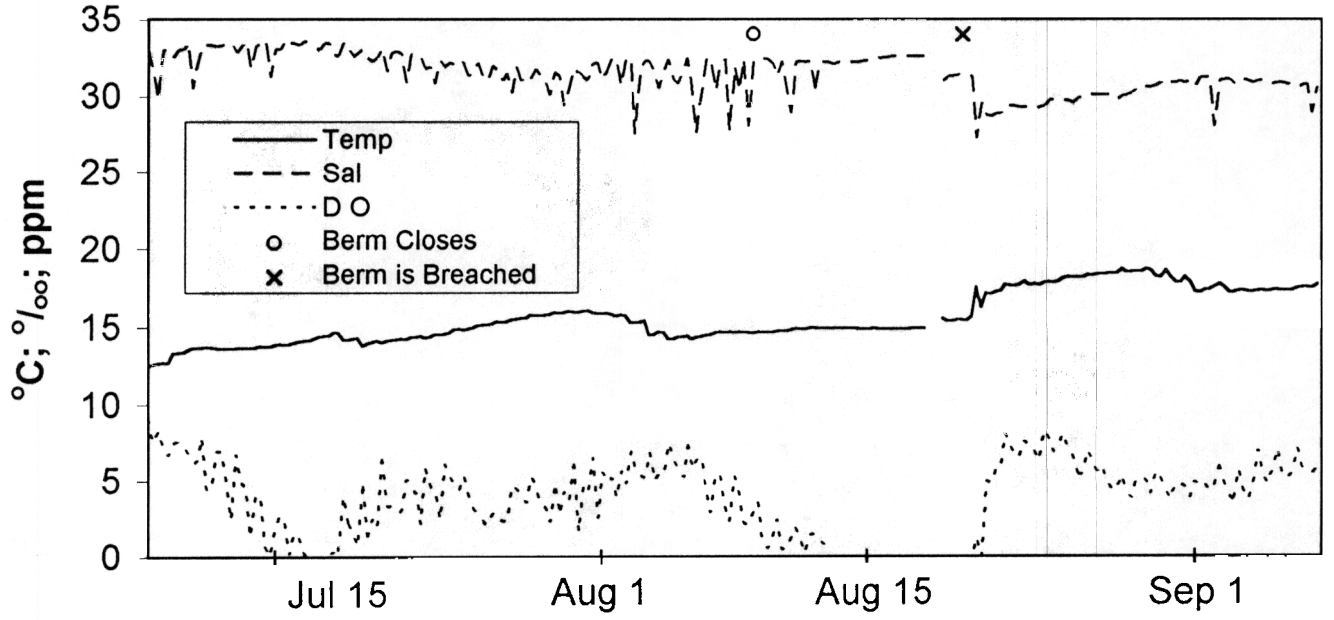


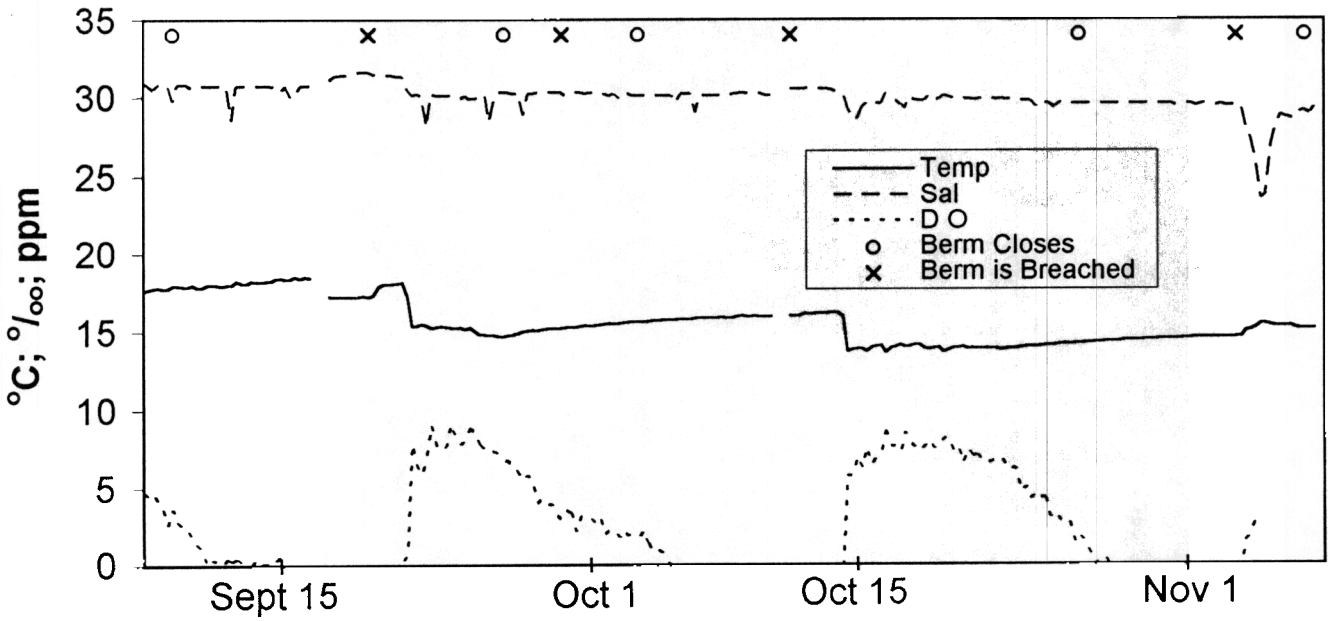
Appendix A-34. 1997 Datasonde Record, Station 1.



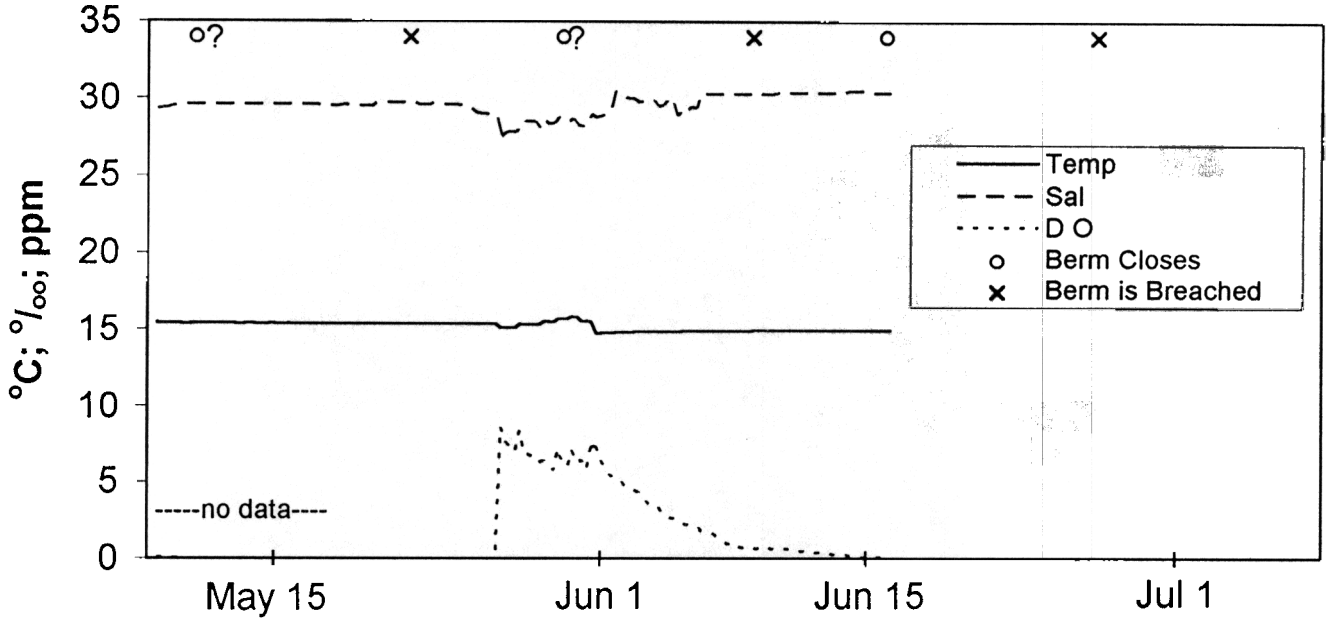
Appendix A-35. 1997 Datasonde Record, Station 3.

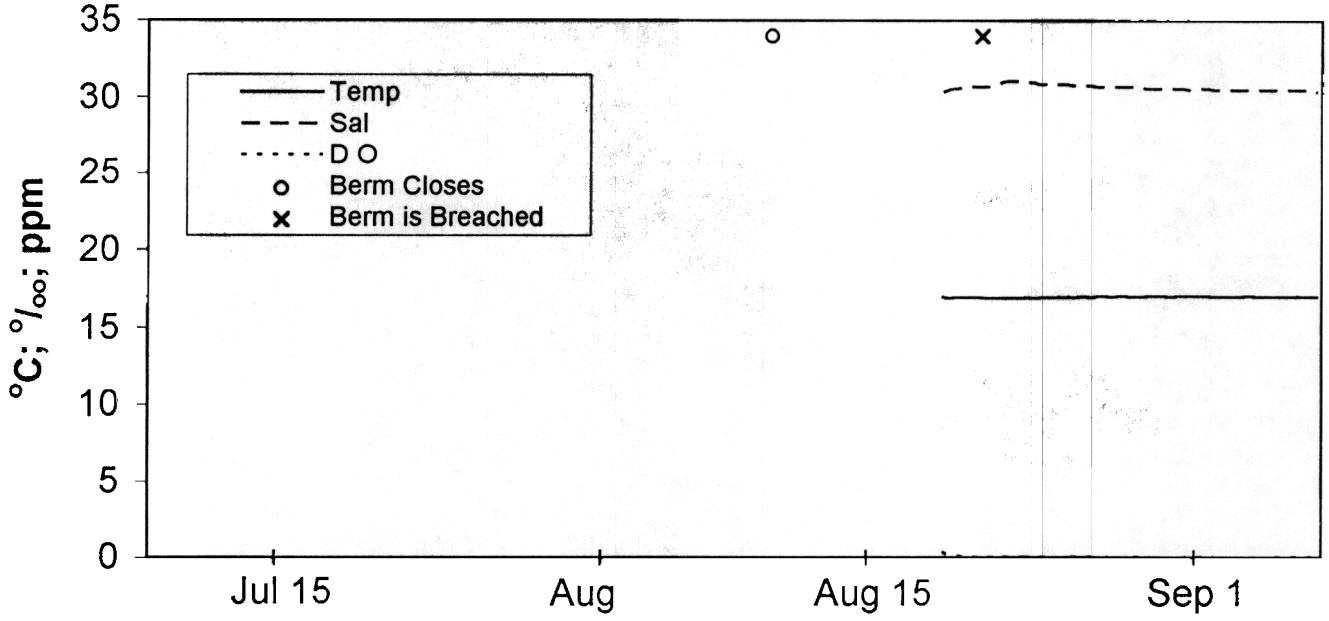


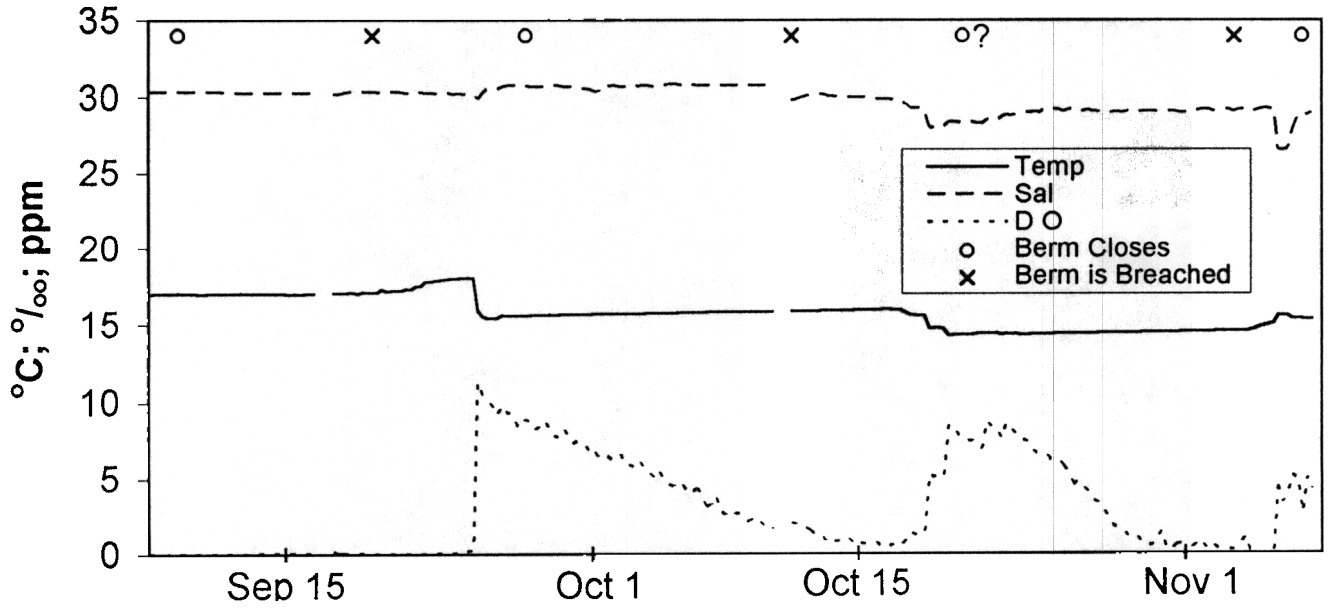




Appendix A-36. 1997 Datasonde Record, Station 4.







Appendix B-1. Prebreaching Otter Trawl Catch Summary, Event I, 20 May 1997

	20-May-97							
	Station 1 4-min tow 1810 hr PDT		Station 2 4-min tow 1630 hr PDT		Station 3 4-min tow 1515 hr PDT		Station 4 4-min tow 1400 hr PDT	
Common Name	No.	CPU	No.	CPU	No.	CPU	No.	CPU
Topsmelt								
Pacific sanddab	39	9.75						
Sacramento sucker			1	0.25	161	40.25		
Smallmouth bass								
Pacific herring	1	0.25						
Smoothhead sculpin								
Prickly sculpin			20	5	291	72.75	4	1
Buffalo sculpin								
Bull sculpin								
Staghorn sculpin	2	0.5	2	0.5				
Cabezon	1	0.25						
Unknown Juv. Sebastes	1	0.25						
Shiner surfperch							1	0.25
Spotfin surfperch								
Northern anchovy								
Pacific tomcod	1	0.25						
Threespine stickleback								
Kelp greenling	2	0.5						
Lingcod								
Surf smelt								
Longfin smelt								
Hybrid sole								
English sole	30	7.5	31	7.75				
Starry flounder			1	0.25	11	2.75	9	2.25
Saddleback gunnel								
Steelhead								
Coho salmon								
Bay pipefish								
Number of fish species	8		5		3		3	
Total fish	77	19.25	55	13.75	463	115.75	14	3.5
Invertebrates								
Crangon franciscorum								
Crangon nigricauda	50		200					
Crangon nigromaculata								
Neomysis mercedis			150		1000's		30	
Cancer magister			1					
Cancer productus								
Other invertebrates*	b		bf				a	

Appendix B-2. Draining Otter Trawl Catch Summary, Event I, 23 May 1997

	23-May-97							
	Station 1 4-min tow 0810 hr PDT		Station 2 4-min tow 1000 hr PDT		Station 3 4-min tow 1030 hr PDT		Station 4 4- min tow 1200 hr PDT	
Common Name	No.	CPU	No.	CPU	No.	CPU	No.	CPU
Topsmelt								
Pacific sanddab	46	11.5	1	0.25				
Sacramento sucker								
Smallmouth bass								
Pacific herring	1	0.25						
Smoothhead sculpin								
Prickly sculpin	2	0.5	10	2.5	5	1.25	62	15.5
Buffalo sculpin								
Bull sculpin								
Staghorn sculpin	1	0.25					1	0.25
Cabezon	9	2.25						
Unknown Juv. *Sebastes*	1	0.25						
Shiner surfperch								
Spotfin surfperch								
Northern anchovy			1	0.25				
Pacific tomcod								
Threespine stickleback								
Kelp greenling								
Lingcod	2	0.5						
Surf smelt								
Longfin smelt								
Hybrid sole							1	0.25
English sole	120	30	11	2.75			3	0.75
Starry flounder			1	0.25	2	0.5	13	3.25
Saddleback gunnel								
Steelhead								
Coho salmon								
Bay pipefish								
Number of fish species	8		5		2		5	
Total fish	182	45.5	24	6	7	1.75	80	20
Invertebrates								
Crangon franciscorum								
Crangon nigricauda	50	150						
Crangon nigromacuiata								
Neomysis mercedis		125			100's		1000's	
Cancer magister								
Cancer productus								
Other invertebrates*	bg							

Appendix B-3. Tidal Otter Trawl Catch Summary, Event I, 27 May 1997

	27-May-97							
	Station 1 4-min tow 0800 hr PDT		Station 2 4-min tow 0920 hr PDT		Station 3 4-min tow 1035 hr PDT		Station 4 4- min tow 1155 hr PDT	
Common Name	No.	CPU	No.	CPU	No.	CPU	No.	CPU
Topsmelt					2			
Pacific sanddab	23							
Sacramento sucker								
Smallmouth bass								
Pacific herring							50	
Smoothhead sculpin								
Prickly sculpin	1		4		79		4	
Buffalo sculpin								
Bull sculpin								
Staghorn sculpin			9					
Cabezon								
Unknown Juv. Sebastes								
Shiner surfperch								
Spotfin surfperch								
Northern anchovy								
Pacific tomcod								
Threespine stickieback								
Kelp greenling								
Lingcod								
Surf smelt								
Longfin smelt								
Hybrid sole								
English sole	13		24				1	
Starry flounder	2				3		5	
Saddleback gunnel								
Steelhead								
Coho salmon								
Bay pipefish								
Number of fish species	4		3		3		4	
Total fish	39	0	37	0	84	0	60	0

Invertebrates								
Crangon franciscorum	5							
Crangon nigricauda			20		4		15	
Crangon nigromaculata								
Neomysis mercedis			200		300		x	
Cancer magister								
Cancer productus								
Other invertebrates*			e					

Appendix B-4. Prebreaching Otter Trawl Catch Summary, Event II, 6 June 1997

	6-Jun-97							
	Station 1 4-min tow 0920 hr PDT		Station 2 4-min tow 1038 hr PDT		Station 3 4-min tow 1315 hr PDT		Station 4 4- min tow 1500 hr PDT	
Common Name	No.	CPU	No.	CPU	No.	CPU	No.	CPU
Topsmelt								
Pacific sanddab	23	5.75						
Sacramento sucker								
Smallmouth bass								
Pacific herring	1	0.25	1	0.25				
Smoothhead sculpin								
Prickly sculpin	1	0.25	22	5.5	14	3.5	17	4.25
Buffalo sculpin	1	0.25						
Bull sculpin								
Staghorn sculpin								
Cabezon	3	0.75						
Unknown Juv. Sebastes								
Shiner surfperch								
Spotfin surfperch								
Northern anchovy								
Pacific tomcod								
Threespine stickleback								
Kelp greenling								
Lingcod								
Surf smelt								
Longfin smelt								
Hybrid sole								
English sole	34	8.5	6	1.5	2	0.5	2	0.5
Starry flounder							7	1.75
Saddleback gunnel								
Steelhead								
Coho salmon								
Bay pipefish								
Number of fish species	6		3		2		3	
Total fish	63	15.75	29	7.25	16	4	26	6.5
Invertebrates								
Crangon franciscorum								
Crangon nigricauda	29		35		2		3	
Crangon nigromaculata								
Neomysis mercedis			50		250		200	
Cancer magister								
Cancer productus								
Other invertebrates*	a		af		af		a	

Appendix B-5. Draining Otter Trawl Catch Summary, Event II, 10 June 1997

	10-Jun-97							
	Station 1 4-min tow 1000 hr PDT		Station 2 4-min tow 1140 hr PDT		Station 3 4-min tow 1320 hr PDT		Station 4 4- min tow 1430 hr PDT	
Common Name	No.	CPU	No.	CPU	No.	CPU	No.	CPU
Topsmelt								
Pacific sanddab	1	0.25						
Sacramento sucker					1	0.25		
Smallmouth bass								
Pacific herring								
Smoothhead sculpin								
Prickly sculpin			21	5.25	7	1.75	49	12.25
Buffalo sculpin	2	0.5						
Bull sculpin								
Staghorn sculpin								
Cabezon								
Unknown Juv. Sebastes								
Shiner surfperch								
Spotfin surfperch								
Northern anchovy								
Pacific tomcod								
Threespine stickleback					1	0.25		
Kelp greenling								
Lingcod	1	0.25						
Surf smelt								
Longfin smelt	3	0.75						
Hybrid sole								
English sole	42	10.5	3	0.75			5	1.25
Starry flounder					2	0.5	4	1
Saddleback gunnel								
Steelhead	1	0.25					1	0.25
Coho salmon								
Bay pipefish							2	0.5
Number of fish species	6		2		4		5	
Total fish	50	12.5	24	6	11	2.75	61	15.25

invertebrates								
Crangon franciscorum								
Crangon nigricauda	78		6		3		14	
Crangon nigromaculata								
Neomysis mercedis			500		300		1000	
Cancer magister	1							
Cancer productus								
Other invertebrates*	a							

Appendix B-6. Tidal Otter Trawl Catch Summary, Event II, 13 June 1997

	13-Jun-97							
	Station 1 4-min tow 0830 hr PDT		Station 2 4-min tow 0940 hr PDT		Station 3 4-min tow 1045 hr PDT		Station 4 4- min tow 1220 hr PDT	
Common Name	No.	CPU	No.	CPU	No.	CPU	No.	CPU
Topsmelt								
Pacific sanddab	9	2.25						
Sacramento sucker					3	0.75	2	0.5
Smallmouth bass								
Pacific herring					2	0.5	31	7.75
Smoothhead sculpin								
Prickly sculpin	1	0.25	26	6.5	73	18.25	17	4.25
Buffalo sculpin								
Bull sculpin								
Staghorn sculpin	2	0.5	1	0.25			3	0.75
Cabezon								
Unknown Juv. Sebastes								
Shiner surfperch							11	2.75
Spotfin surfperch								
Northern anchovy								
Pacific tomcod								
Threespine stickleback								
Kelp greenling								
Lingcod								
Surf smelt								
Longfin smelt								
Hybrid sole								
English sole	36	9					2	0.5
Starry flounder	1	0.25			2	0.5	7	1.75
Saddleback gunnel								
Steelhead								
Coho salmon								
Bay pipefish			1	0.25			3	0.75
Number of fish species	5		3		4		8	
Total fish	49	12.25	28	7	80	20	76	19

Invertebrates								
Crangon franciscorum								
Crangon nigricauda	77		119		11		11	
Crangon nigromaculata								
Neomysis mercedis	30		100		750		500	
Cancer magister	2							
Cancer productus								
Other invertebrates*			af		af		a	

Appendix B-7. Prebreaching Otter Trawl Catch Summary, Event III, 22-23 June 1997

	22-23 June 1997							
	Station 1 4-min tow 0820 hr PDT 23-Jun		Station 2 4-min tow 1430 hr PDT 22-Jun		Station 3 4-min tow 1400 hr PDT 22-Jun		Station 4 4- min tow 1155 hr PDT 22-Jun	
Common Name	No.	CPU	No.	CPU	No.	CPU	No.	CPU
Topsmelt								
Pacific sanddab								
Sacramento sucker					198	49.5		
Smallmouth bass								
Pacific herring	1	0.25			2	0.5	5	1.25
Smoothhead sculpin								
Prickly sculpin	16	4	35	8.75	14	3.5	28	7
Buffalo sculpin								
Bull sculpin								
Staghorn sculpin								
Cabezon								
Unknown Juv. Sebastes								
Shiner surfperch								
Spotfin surfperch								
Northern anchovy								
Pacific tomcod								
Threespine stickleback								
Kelp greenling								
Lingcod								
Surf smelt								
Longfin smelt								
Hybrid sole								
English sole			7	1.75			1	0.25
Starry flounder			1	0.25			4	1
Saddleback gunnel								
Steelhead					1	0.25		
Coho salmon								
Bay pipefish								
Number of fish species	2		3		4		4	
Total fish	17	4.25	43	10.75	215	53.75	38	9.5
Invertebrates								
Crangon franciscorum								
Crangon nigricauda			120				14	
Crangon nigromaculata								
Neomysis mercedis			120		1000		25	
Cancer magister								
Cancer productus	1							
Other invertebrates*	af		a		af			

Appendix B-8. Draining Otter Trawl Catch Summary, Event III, 28 June 1997

	28-Jun-97							
	Station 1 4-min tow 0845 hr PDT		Station 2 4-min tow 1025 hr PDT		Station 3 4-min tow 1140 hr PDT		Station 4 4- min tow 1335 hr PDT	
Common Name	No.	CPU	No.	CPU	No.	CPU	No.	CPU
Topsmelt	1	0.25						
Pacific sanddab	16	4	1	0.25				
Sacramento sucker			1	0.25	24	6	5	1.25
Smallmouth bass								
Pacific herring	1	0.25	3	0.75	192	48	2	0.5
Smoothhead sculpin								
Prickly sculpin	5	1.25	25	6.25	33	8.25	41	10.25
Buffalo sculpin								
Bull sculpin								
Staghorn sculpin	1	0.25	1	0.25	1	0.25	1	0.25
Cabezon								
Unknown Juv. Sebastes								
Shiner surfperch					3	0.75	1	0.25
Spotfin surfperch	1	0.25						
Northern anchovy								
Pacific tomcod								
Threespine stickleback								
Kelp greenling								
Lingcod								
Surf smelt								
Longfin smelt								
Hybrid sole								
English sole	4	1	1	0.25			1	0.25
Starry flounder	1	0.25	1	0.25	1	0.25	8	2
Saddleback gunnel								
Steelhead								
Coho salmon								
Bay pipefish					1	0.25	5	1.25
Number of fish species	8		7		7		8	
Total fish	30	7.5	33	8.25	255	63.75	64	16

invertebrates								
Crangon franciscorum	4						2	
Crangon nigricauda	18		22		4		9	
Crangon nigromaculata								
Neomysis mercedis	30		150		500		2000	
Cancer magister								
Cancer productus								
Other invertebrates*	af		af		af			

Appendix B-9. Tidal Otter Trawl Catch Summary, Event III, 1 July 1997

	1-Jul-97							
	Station 1 4-min tow 1500 hr PDT		Station 2 4-min tow 1345 hr PDT		Station 3 4-min tow 1330 hr PDT		Station 4 4- min tow 1200 hr PDT	
Common Name	No.	CPU	No.	CPU	No.	CPU	No.	CPU
Topsmelt								
Pacific sanddab	4	1						
Sacramento sucker					1	0.25		
Smallmouth bass								
Pacific herring	1	0.25	3	0.75	18	4.5		
Smoothhead sculpin								
Prickly sculpin	15	3.75	45	11.25	67	16.75	25	6.25
Buffalo sculpin								
Bull sculpin								
Staghorn sculpin	3	0.75	1	0.25				
Cabezon								
Unknown Juv. Sebastes								
Shiner surfperch							1	0.25
Spotfin surfperch								
Northern anchovy								
Pacific tomcod								
Threespine stickleback								
Kelp greenling								
Lingcod								
Surf smelt								
Longfin smelt								
Hybrid sole								
English sole	19	4.75	1	0.25				
Starry flounder					2	0.5	3	0.75
Saddleback gunnel								
Steelhead								
Coho salmon								
Bay pipefish	1	0.25					3	0.75
Number of fish species	6		4		4		4	
Total fish	43	10.75	50	12.5	88	22	32	8

Invertebrates								
Crangon franciscorum	4							
Crangon nigricauda	46		139				5	
Crangon nigromaculata								
Neomysis mercedis	25		200		50		300	
Cancer magister								
Cancer productus								
Other invertebrates*			af					

Appendix B-10. Prebreaching Otter Trawl Catch Summary, Event IV, 18 August 1997

	18-Aug-97							
	Station 1 4-min tow 1025 hr PDT		Station 2 4-min tow 1138 hr PDT		Station 3 4-min tow 1200 hr PDT		Station 4 4- min tow 1300 hr PDT	
Common Name	No.	CPU	No.	CPU	No.	CPU	No.	CPU
Topsmelt								
Pacific sanddab	4	1						
Sacramento sucker								
Smallmouth bass								
Pacific herring								
Smoothhead sculpin								
Prickly sculpin	3	0.75	1	0.25			10	2.5
Buffalo sculpin								
Bull sculpin								
Staghorn sculpin	1	0.25						
Cabezon								
Unknown Juv. Sebastes								
Shiner surfperch								
Spotfin surfperch								
Northern anchovy								
Pacific tomcod								
Threespine stickleback								
Kelp greenling								
Lingcod								
Surf smelt								
Longfin smelt								
Hybrid sole								
English sole								
Starry flounder			1	0.25	1	0.25	1	0.25
Saddleback gunnel								
Steelhead								
Coho salmon								
Bay pipefish					1	0.25	1	0.25
Number of fish species	3		2		2		3	
Total fish	8	2	2	0.5	2	0.5	12	3

Invertebrates								
Crangon franciscorum	7		3		1		196	
Crangon nigricauda			54		3			
Crangon nigromaculata								
Neomysis mercedis	6							
Cancer magister	5							
Cancer productus								
Other invertebrates*			adf		adfi			

Appendix B-11. Draining Otter Trawl Catch Summary, Event IV, 21 August 1997

	21-Aug-97							
	Station 1 4-min tow 0950 hr PDT		Station 2 4-min tow 1110 hr PDT		Station 3 4-min tow 1140 hr PDT		Station 4 4- min tow 1325 hr PDT	
Common Name	No.	CPU	No.	CPU	No.	CPU	No.	CPU
Topsmelt								
Pacific sanddab	5	1.25						
Sacramento sucker								
Smallmouth bass								
Pacific herring								
Smoothhead sculpin								
Prickly sculpin	1	0.25	32	8	20	5	6	1.5
Buffalo sculpin								
Bull sculpin								
Staghorn sculpin							1	0.25
Cabezon								
Unknown Juv. Sebastes								
Shiner surfperch	1	0.25						
Spotfin surfperch								
Northern anchovy								
Pacific tomcod								
Threespine stickleback	1	0.25			1	0.25		
Kelp greenling								
Lingcod								
Surf smelt								
Longfin smelt								
Hybrid sole								
English sole								
Starry flounder	2	0.5						
Saddleback gunnel								
Steelhead								
Coho salmon								
Bay pipefish			3	0.75	8	2	12	3
Number of fish species	5		2		3		3	
Total fish	10	2.5	35	8.75	29	7.25	19	4.75
Invertebrates								
Crangon franciscorum	44		243		145		59	
Crangon nigricauda								
Crangon nigromaculata								
Neomysis mercedis	6				100		20	
Cancer magister	5							
Cancer productus								
Other invertebrates*	f		af		af		af	

Appendix B-12. Tidal Otter Trawl Catch Summary, Event IV, 26 August 1997

	26-Aug-97							
	Station 1 4-min tow 0930 hr PDT		Station 2 4-min tow 1035 hr PDT		Station 3 4-min tow 1100 hr PDT		Station 4 4- min tow 1140 hr PDT	
Common Name	No.	CPU	No.	CPU	No.	CPU	No.	CPU
Topsmelt								
Pacific sanddab	13	3.25						
Sacramento sucker								
Smallmouth bass								
Pacific herring	5	1.25						
Smoothhead sculpin								
Prickly sculpin	1	0.25	15	3.75	3	0.75	8	2
Buffalo sculpin								
Bull sculpin								
Staghorn sculpin			1	0.25				
Cabezon								
Unknown Juv. Sebastes								
Shiner surfperch	9	2.25						
Spotfin surfperch								
Northern anchovy								
Pacific tomcod								
Threespine stickleback			3	0.75	2	0.5	1	0.25
Kelp greenling								
Lingcod								
Surf smelt								
Longfin smelt								
Hybrid sole								
English sole	1	0.25						
Starry flounder							2	0.5
Saddleback gunnel								
Steelhead								
Coho salmon								
Bay pipefish			1	0.25	2	0.5	3	0.75
Number of fish species	5		4		3		4	
Total fish	29	7.25	20	5	7	1.75	14	3.5
Invertebrates								
Crangon franciscorum	18		277		121		37	
Crangon nigricauda								
Crangon nigromaculata								
Neomysis mercedis			50		20		100	
Cancer magister	11							
Cancer productus								
Other invertebrates*			af		af		af	

Appendix B-13. Prebreaching Otter Trawl Catch Summary, Event V, 16 September 1997

	16-Sep-97							
	Station 1 4-min tow 1150 hr PDT		Station 2 4-min tow 1300 hr PDT		Station 3 4-min tow 1430 hr PDT		Station 4 4- min tow 1520 hr PDT	
Common Name	No.	CPU	No.	CPU	No.	CPU	No.	CPU
Topsmelt								
Pacific sanddab	9	2.25						
Sacramento sucker								
Smallmouth bass								
Pacific herring	18	4.5						
Smoothhead sculpin								
Prickly sculpin	54	13.5	2	0.5	2	0.5	18	4.5
Buffalo sculpin								
Bull sculpin								
Staghorn sculpin	4	1						
Cabezon								
Unknown Juv. Sebastes								
Shiner surfperch	18	4.5	14	3.5			7	1.75
Spotfin surfperch								
Northern anchovy								
Pacific tomcod								
Threespine stickleback					1	0.25		
Kelp greenling								
Lingcod								
Surf smelt	21	5.25						
Longfin smelt								
Hybrid sole								
English sole	4	1	1	0.25				
Starry flounder	2	0.5					1	0.25
Saddleback gunnel	1	0.25						
Steelhead								
Coho salmon								
Bay pipefish	1	0.25			9	2.25	8	2
Number of fish species	10		3		3		4	
Total fish	132	33	17	4.25	12	3	34	8.5

Invertebrates								
Crangon franciscorum	220		84		11		42	
Crangon nigricauda								
Crangon nigromaculata								
Neomysis mercedis			10		20			
Cancer magister	40		2					
Cancer productus	2							
Other invertebrates*					af			

Appendix B-14. Draining Otter Trawl Catch Summary, Event V, 20 September 1997

	20-Sep-97							
	Station 1 4-min tow 1050 hr PDT		Station 2 4-min tow 1150 hr PDT		Station 3 4-min tow 1215 hr PDT		Station 4 4- min tow 1310 hr PDT	
Common Name	No.	CPU	No.	CPU	No.	CPU	No.	CPU
Topsmelt								
Pacific sanddab	32	8						
Sacramento sucker								
Smallmouth bass								
Pacific herring			2	0.5	4	1		
Smoothhead sculpin								
Prickly sculpin	14	3.5	50	12.5	41	10.25	3	0.75
Buffalo sculpin								
Bull sculpin								
Staghorn sculpin	3	0.75			2	0.5		
Cabezon								
Unknown Juv. Sebastes								
Shiner surfperch	36	9	5	1.25	48	12		
Spotfin surfperch								
Northern anchovy								
Pacific tomcod								
Threespine stickleback					1	0.25		
Kelp greenling								
Lingcod								
Surf smelt	1	0.25			1	0.25		
Longfin smelt								
Hybrid sole								
English sole	2	0.5						
Starry flounder							4	1
Saddleback gunnel								
Steelhead								
Coho salmon								
Bay pipefish			3	0.75	4	1	8	2
Number of fish species	6		4		7		3	
Total fish	88	22	60	15	101	25.25	15	3.75
Invertebrates								
Crangon franciscorum	59		58		49		78	
Crangon nigricauda	1							
Crangon nigromaculata								
Neomysis mercedis					5			
Cancer magister	38		1					
Cancer productus								
Other invertebrates*	c				f			

Appendix B-15. Tidal Otter Trawl Catch Summary, Event V, 23 September 1997

	23-Sep-97							
	Station 1 4-min tow 0950 hr PDT		Station 2 4-min tow 1105 hr PDT		Station 3 4-min tow 1130 hr PDT		Station 4 4- min tow 1200 hr PDT	
Common Name	No.	CPU	No.	CPU	No.	CPU	No.	CPU
Topsmelt								
Pacific sanddab	5	1.25						
Sacramento sucker								
Smallmouth bass								
Pacific herring					1	0.25	5	1.25
Smoothhead sculpin								
Prickly sculpin	3	0.75	12	3	19	4.75	18	4.5
Buffalo sculpin								
Bull sculpin								
Staghorn sculpin								
Cabezon								
Unknown Juv. Sebastes								
Shiner surfperch					13	3.25	3	0.75
Spotfin surfperch								
Northern anchovy								
Pacific tomcod								
Threespine stickleback					1	0.25		
Kelp greenling								
Lingcod								
Surf smelt					1	0.25		
Longfin smelt								
Hybrid sole								
English sole	1	0.25			2	0.5		
Starry flounder							1	0.25
Saddleback gunnel								
Steelhead								
Coho salmon								
Bay pipefish					5	1.25		
Number of fish species	3		1		7		4	
Total fish	9	2.25	12	3	42	10.5	27	6.75
invertebrates								
Crangon franciscorum	10		223		13		59	
Crangon nigricauda								
Crangon nigromaculata								
Neomysis mercedis			20		20			
Cancer magister	12							
Cancer productus	1							
Other invertebrates*					af			

Appendix B-16. Prebreaching Otter Trawl Catch Summary, Event VI, 10 October 1997

	10-Oct-97							
	Station 1 4-min tow 0925 hr PDT		Station 2 4-min tow 1150 hr PDT		Station 3 4-min tow 1210 hr PDT		Station 4 4- min tow 1240 hr PDT	
Common Name	No.	CPU	No.	CPU	No.	CPU	No.	CPU
Topsmelt								
Pacific sanddab	9	2.25						
Sacramento sucker								
Smallmouth bass								
Pacific herring								
Smoothhead sculpin								
Prickly sculpin	10	2.5	9	2.25	2	0.5	11	2.75
Buffalo sculpin								
Bull sculpin								
Staghorn sculpin								
Cabezon								
Unknown Juv. Sebastes								
Shiner surfperch	2	0.5						
Spotfin surfperch								
Northern anchovy								
Pacific tomcod								
Threespine stickleback							2	0.5
Kelp greenling								
Lingcod								
Surf smelt	6	1.5						
Longfin smelt								
Hybrid sole								
English sole	5	1.25						
Starry flounder							1	0.25
Saddleback gunnel								
Steelhead								
Coho salmon								
Bay pipefish			2	0.5			1	0.25
Number of fish species	5		2		1		4	
Total fish	32	8	11	2.75	2	0.5	15	3.75

Invertebrates								
Crangon franciscorum	20		70		23		44	
Crangon nigricauda								
Crangon nigromaculata								
Neomysis mercedis	1		30		15		20	
Cancer magister	25				2			
Cancer productus	1							
Other invertebrates*							e	

Appendix B-17. Draining Otter Trawl Catch Summary, Event VI, 12 October 1997

	12-Oct-97							
	Station 1 4-min tow 1020 hr PDT		Station 2 4-min tow 1130 hr PDT		Station 3 4-min tow 1200 hr PDT		Station 4 4- min tow 1250 hr PDT	
Common Name	No.	CPU	No.	CPU	No.	CPU	No.	CPU
Topsmelt								
Pacific sanddab	3	0.75						
Sacramento sucker								
Smallmouth bass								
Pacific herring								
Smoothhead sculpin								
Prickly sculpin	8	2	13	3.25	19	4.75	28	7
Buffalo sculpin								
Bull sculpin								
Staghorn sculpin	1	0.25						
Cabezon								
Unknown Juv. Sebastes								
Shiner surfperch	13	3.25						
Spotfin surfperch								
Northern anchovy								
Pacific tomcod	1	0.25						
Threespine stickleback								
Kelp greenling								
Lingcod								
Surf smelt								
Longfin smelt								
Hybrid sole								
English sole	7	1.75						
Starry flounder	1	0.25					1	0.25
Saddleback gunnel								
Steelhead								
Coho salmon								
Bay pipefish			3	0.75			6	1.5
Number of fish species	7		2		1		3	
Total fish	34	8.5	16	4	19	4.75	35	8.75
Invertebrates								
Crangon franciscorum	6		152		51		68	
Crangon nigricauda	2							
Crangon nigromaculata	6							
Neomysis mercedis			100		50		25	
Cancer magister	9				1			
Cancer productus	3							
Other invertebrates*					f			

Appendix B-18. Tidal Otter Trawl Catch Summary, Event VI, 15 October 1997

	15-Oct-97							
	Station 1 4-min tow 1130 hr PDT		Station 2 4-min tow 1535 hr PDT		Station 3 4-min tow 1445 hr PDT		Station 4 4- min tow 1330 hr PDT	
Common Name	No.	CPU	No.	CPU	No.	CPU	No.	CPU
Topsmelt								
Pacific sanddab	3	0.75						
Sacramento sucker								
Smallmouth bass								
Pacific herring								
Smoothhead sculpin								
Prickly sculpin	8	2	5	1.25	20	5	11	2.75
Buffalo sculpin								
Bull sculpin	1	0.25						
Staghorn sculpin								
Cabezon								
Unknown Juv. Sebastes								
Shiner surfperch							1	0.25
Spotfin surfperch								
Northern anchovy								
Pacific tomcod								
Threespine stickleback			1	0.25				
Kelp greenling								
Lingcod								
Surf smelt								
Longfin smelt								
Hybrid sole								
English sole			1	0.25				
Starry flounder								
Saddleback gunnel								
Steelhead								
Coho salmon								
Bay pipefish								
Number of fish species	3		3		1		2	
Total fish	12	3	7	1.75	20	5	12	3

Invertebrates								
Crangon franciscorum	6		149		14		75	
Crangon nigricauda								
Crangon nigromaculata	6							
Neomysis mercedis			200		200		15	
Cancer magister	20				3			
Cancer productus								
Other invertebrates*					adf		f	

Appendix B-19. Prebreaching Otter Trawl Catch Summary, Event VII, 31 October 1997

	31-Oct-97							
	Station 1 4-min tow 1330 hr PST		Station 2 4-min tow 1415 hr PST		Station 3 4-min tow 1430 hr PST		Station 4 4- min tow 1510 hr PST	
Common Name	No.	CPU	No.	CPU	No.	CPU	No.	CPU
Topsmelt								
Pacific sanddab			1	0.25				
Sacramento sucker								
Smallmouth bass								
Pacific herring								
Smoothhead sculpin								
Prickly sculpin	7	1.75			5	1.25	1	0.25
Buffalo sculpin								
Bull sculpin								
Staghorn sculpin								
Cabezon								
Unknown Juv. Sebastes								
Shiner surfperch								
Spotfin surfperch								
Northern anchovy								
Pacific tomcod								
Threespine stickieback								
Kelp greenling								
Lingcod								
Surf smelt								
Longfin smelt								
Hybrid sole								
English sole								
Starry flounder					1	0.25		
Saddleback gunnel								
Steelhead								
Coho salmon								
Bay pipefish								
Number of fish species	1		1		2		1	
Total fish	7	1.75	1	0.25	6	1.5	1	0.25
Invertebrates								
Crangon franciscorum	8		13		3		46	
Crangon nigricauda	2							
Crangon nigromaculata	2							
Neomysis mercedis					12		20	
Cancer magister	3						1	
Cancer productus	1							
Other invertebrates*					f			

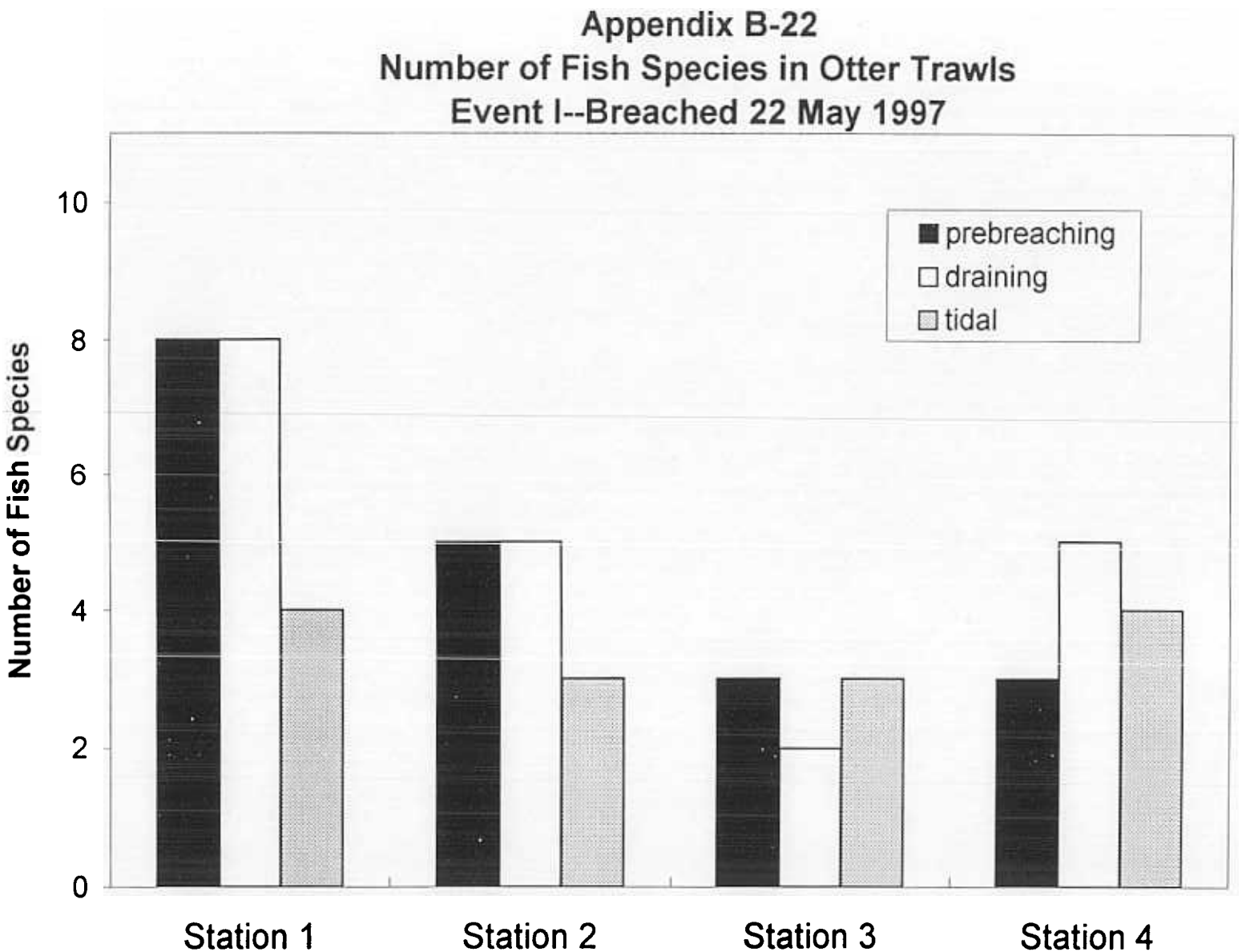
Appendix B-20. Draining Otter Trawl Catch Summary, Event VII, 4 November 1997

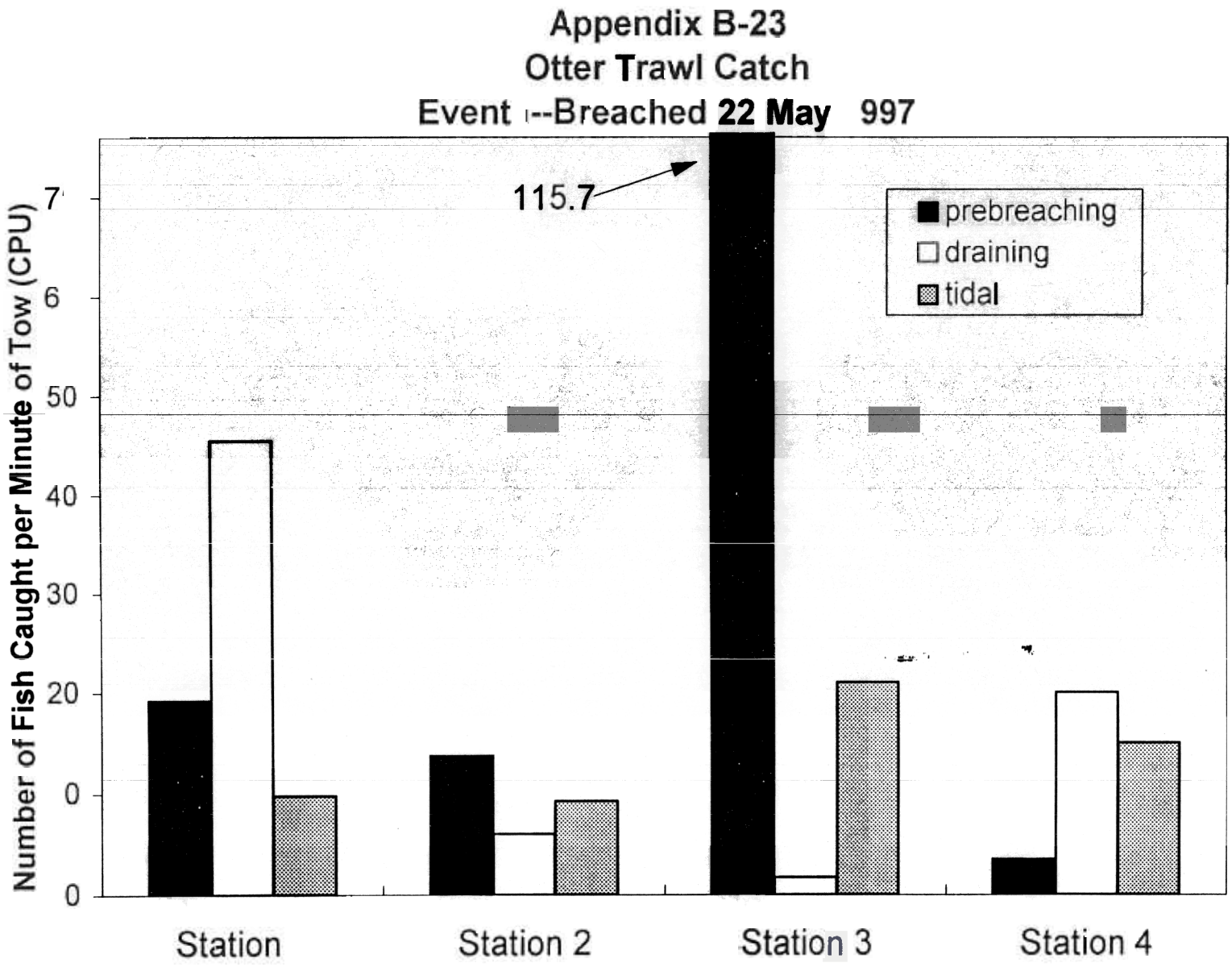
	4-Nov-97									
	Station 1 4-min tow 0930 hr PST		Station 2 4-min tow 1040 hr PST		Station 3 4-min tow 1105 hr PST		Station 3 4- min tow 1110 hr PST		Station 4 4- min tow 1150 hr PST	
Common Name	No.	CPU	No.	CPU	No.	CPU	No.	CPU	No.	CPU
Topsmelt										
Pacific sanddab	1	0.25								
Sacramento sucker										
Smallmouth bass										
Pacific herring	2	0.5								
Smoothhead sculpin										
Prickly sculpin			3	0.75	1	0.25	2	0.5	4	1
Buffalo sculpin										
Bull sculpin										
Staghorn sculpin					1	0.25				
Cabezon										
Unknown Juv. Sebastes										
Shiner surfperch	8	2								
Spotfin surfperch										
Northern anchovy										
Pacific tomcod										
Threespine stickleback									1	0.25
Kelp greenling										
Lingcod										
Surf smelt										
Longfin smelt										
Hybrid sole										
English sole										
Starry flounder							1	0.25		
Saddleback gunnel										
Steelhead										
Coho salmon										
Bay pipefish					2	0.5				
Number of fish species	3		1		3		2		2	
Total fish	11	2.75	3	0.75	4	1	3	0.75	5	1.25
Invertebrates										
Crangon franciscorum	2		39		6		2			
Crangon nigricauda	24									
Crangon nigromaculata										
Neomysis mercedis			50				10		25	
Cancer magister	16									
Cancer productus										
Other invertebrates*	h		f				f		f	

Appendix B-21. Tidal Otter Trawl Catch Summary, Event VII, 7 November 1997

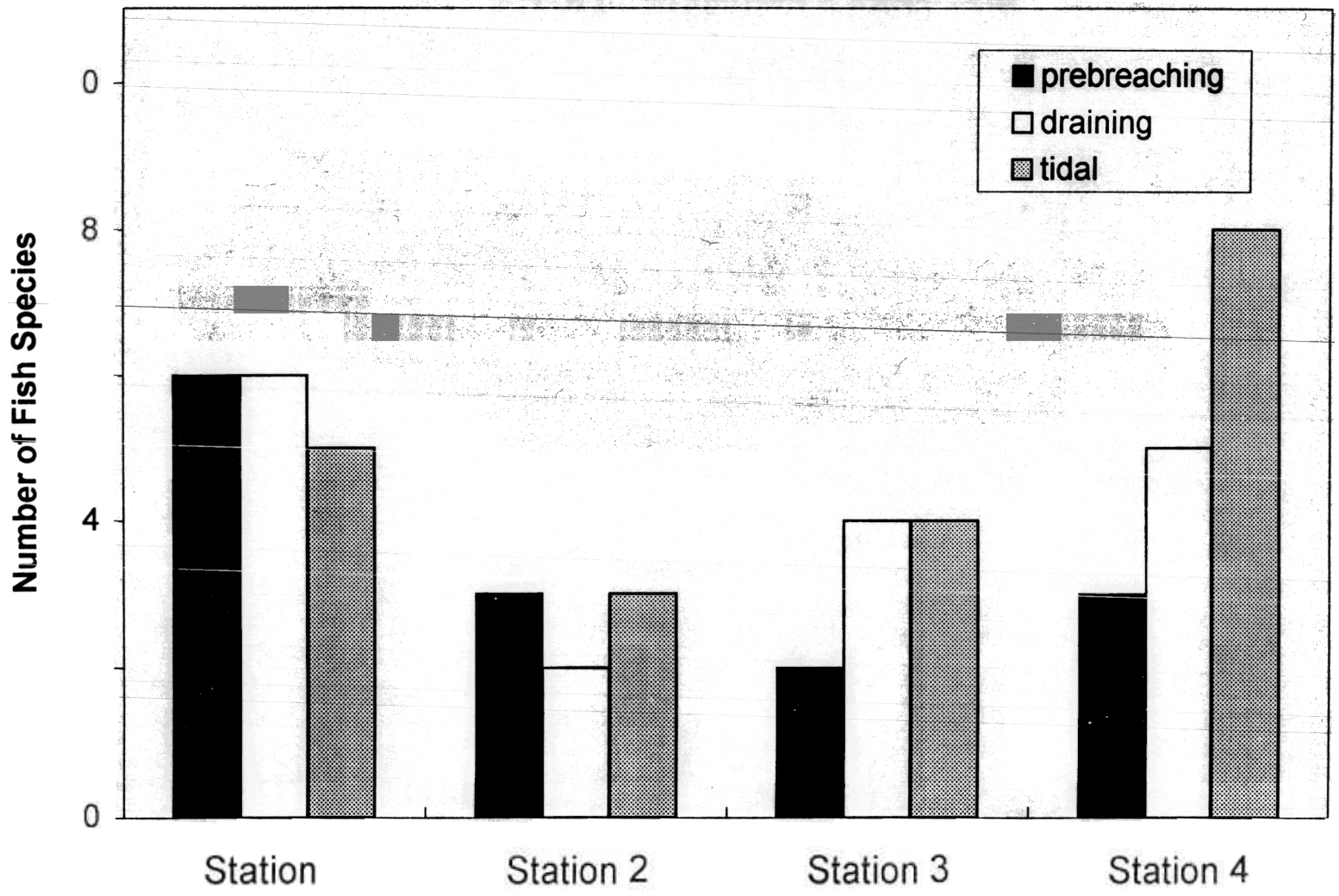
	7-Nov-97							
	Station 1 4-min tow 1100 hr PST		Station 2 4-min tow 1205 hr PST		Station 3 4-min tow 1220 hr PST		Station 4 4- min tow 1400 hr PST	
Common Name	No.	CPU	No.	CPU	No.	CPU	No.	CPU
Topsmelt								
Pacific sanddab			2	0.5	1	0.25		
Sacramento sucker								
Smallmouth bass								
Pacific herring								
Smoothhead sculpin								
Prickly sculpin	3	0.75	3	0.75	1	0.25	2	0.5
Buffalo sculpin								
Bull sculpin								
Staghorn sculpin								
Cabezon								
Unknown Juv. Sebastes								
Shiner surfperch								
Spotfin surfperch								
Northern anchovy								
Pacific tomcod	3	0.75						
Threespine stickleback								
Kelp greenling								
Lingcod								
Surf smelt					1	0.25		
Longfin smelt	9	2.25						
Hybrid sole								
English sole	3	0.75						
Starry flounder								
Saddleback gunnel								
Steelhead								
Coho salmon								
Bay pipefish					1	0.25		
Number of fish species	4		2		4		1	
Total fish	18	4.5	5	1.25	4	1	2	0.5
Invertebrates								
Crangon franciscorum	2		12		8		26	
Crangon nigricauda	25							
Crangon nigromaculata	10							
Neomysis mercedis			25		50		30	
Cancer magister	3							
Cancer productus								
Other invertebrates*					af		f	

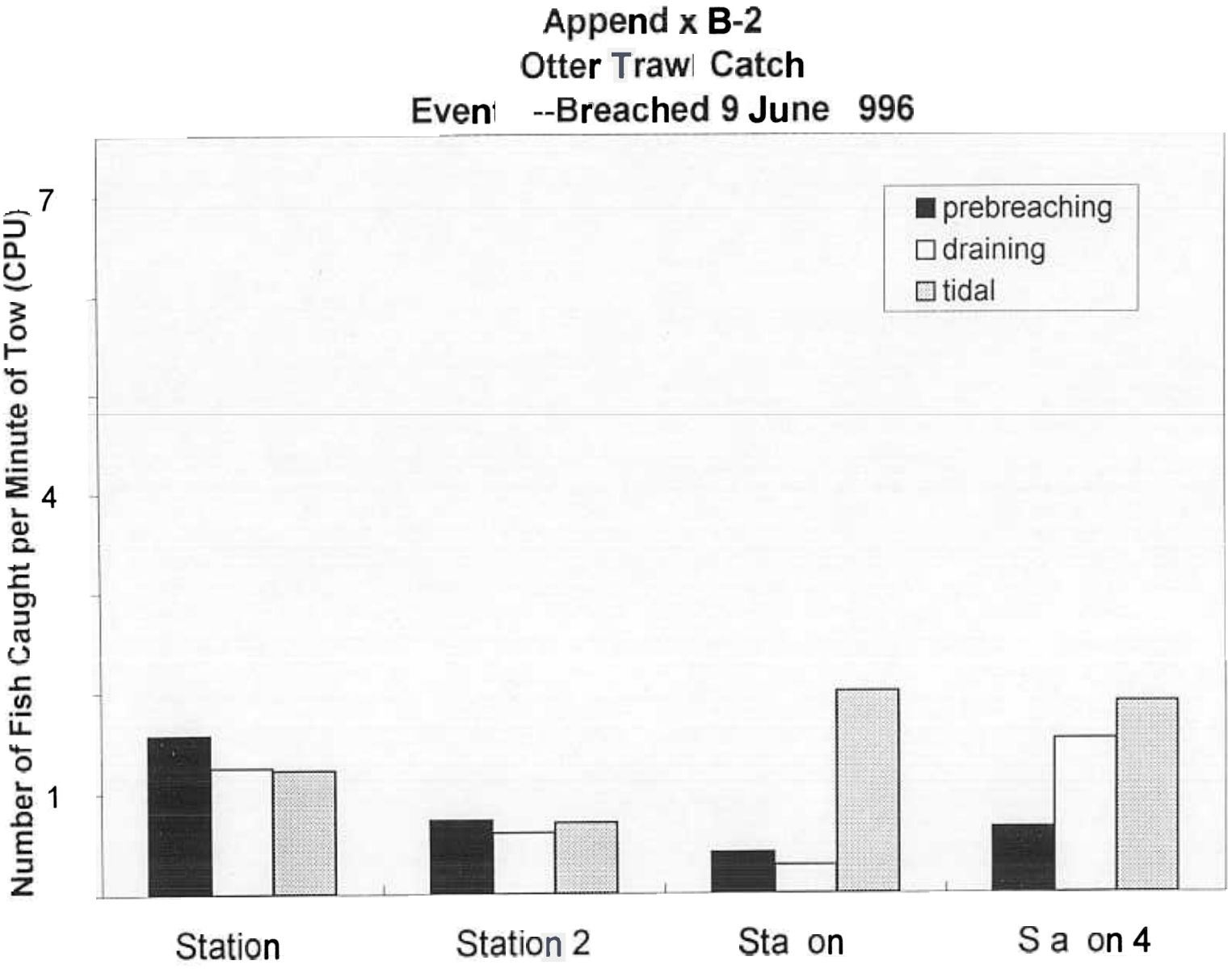
*Other invertebrates	code
amphipods	a
Anisogammarus	b
Cancer gracilis	c
Corophium	d
ctenophores	e
isopods	f
large jellyfishes	g
polychaetes	h
sea slug	i


Appendix B-22
Number of Fish Species in Otter Trawls
Event I--Breached 22 May 1997
Number of Fish Species
0
2
4
6
8
10
prebreaching
draining
tidal
Station 1
Station 2
Station 3
Station 4

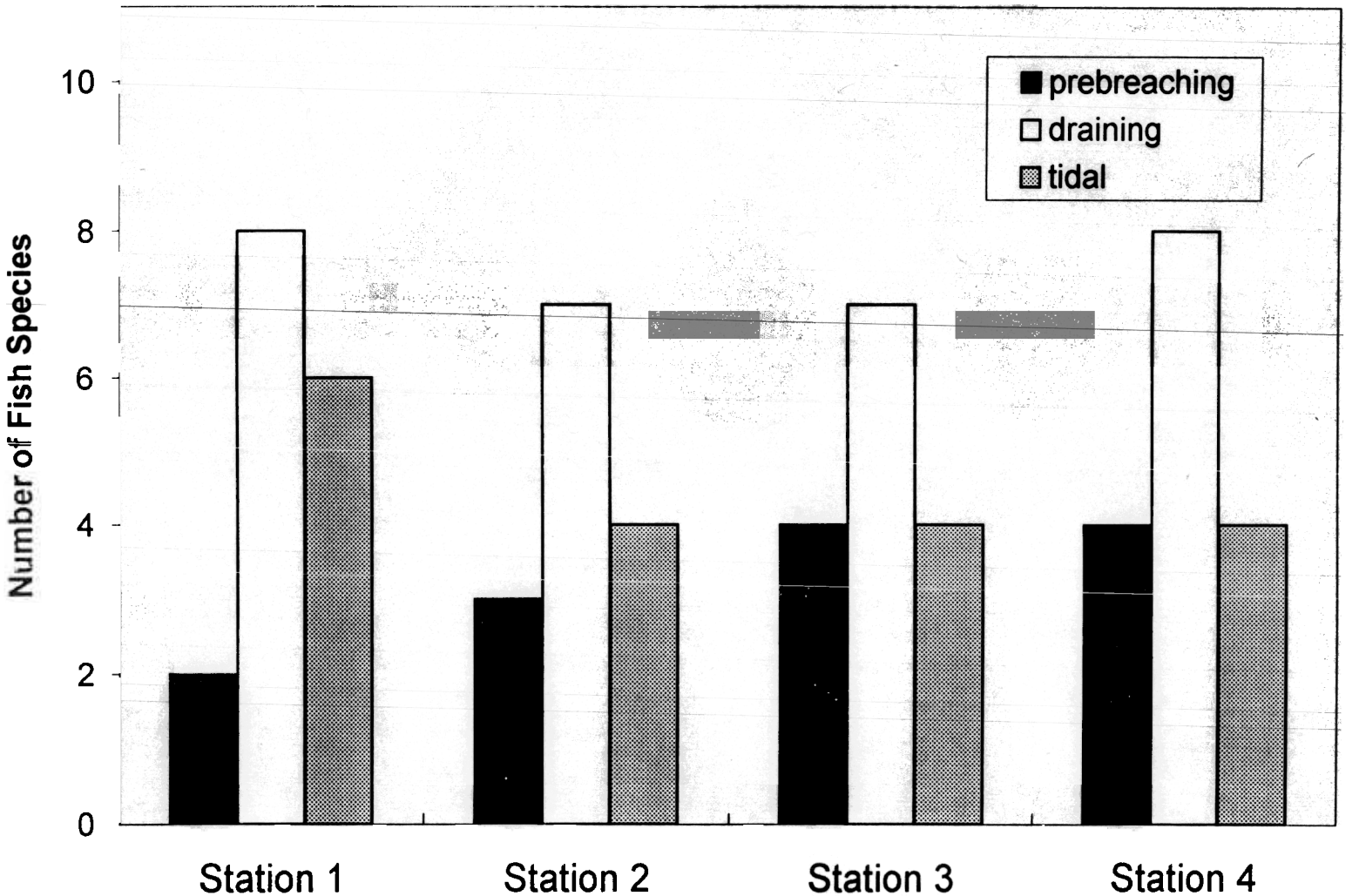

Appendix B-23
Otter Trawl Catch
Event --Breached 22 May 997
115.7
prebreaching
draining
tidal
Number of Fish Caught per Minute of Tow (CPU)
7
6
50
40
30
20
0
0
Station
Station 2
Station 3
Station 4

Appendix B-24
Number of Fish Species in Otter Trawls
Event II--Breached 9 June 1997

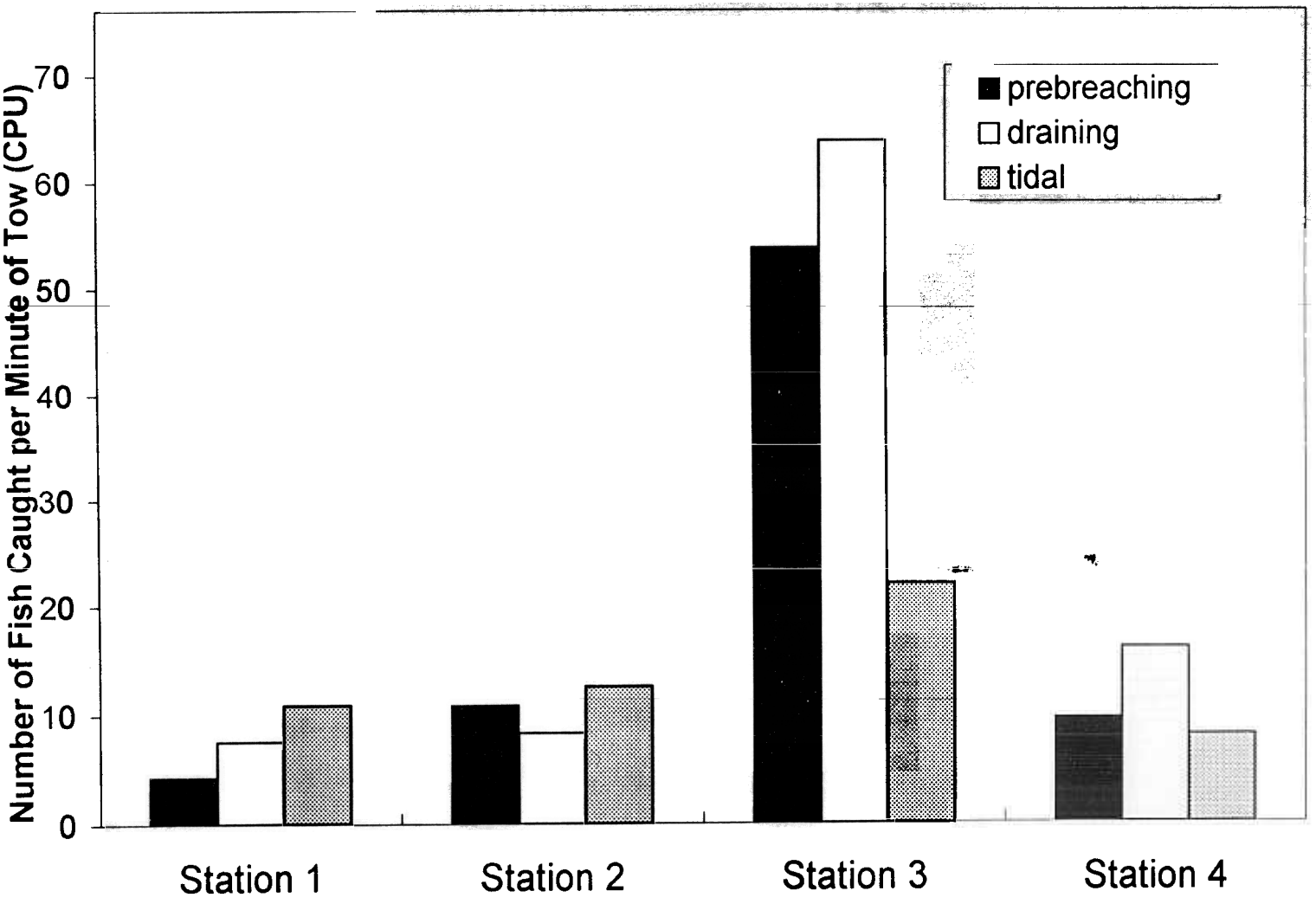



Append x B-2
Otter Trawl Catch
Event --Breached 9 June 996
Number of Fish Caught per Minute of Tow (CPU)
7
4
1
prebreaching
draining
tidal
Station
Station 2
Sta on
S a on 4

Appendix B-26
Number of Fish Species in Otter Trawls
Event III--Breached 27 June 1997



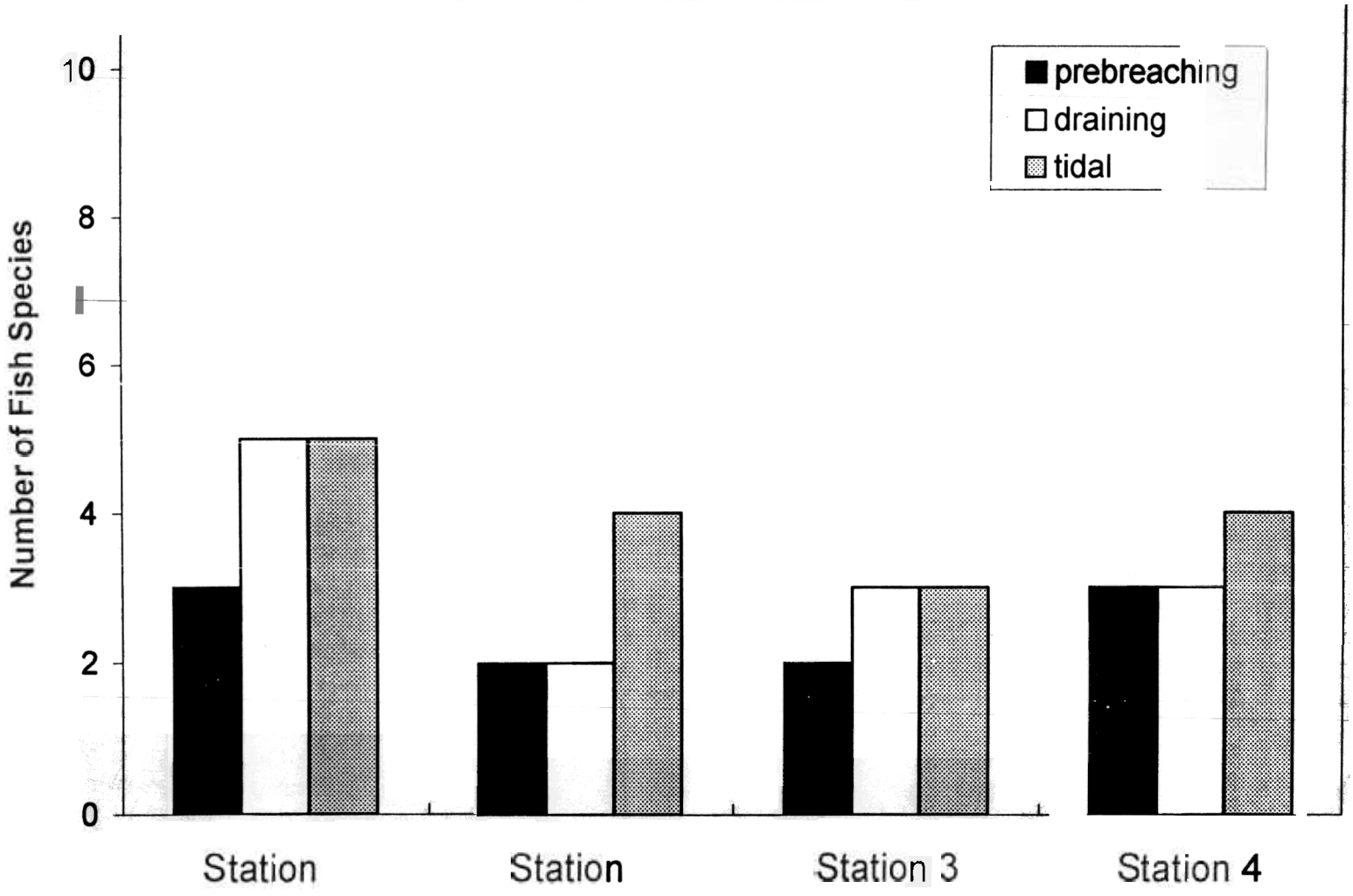
Appendix B-27
Otter Trawl Catch
Event III--Breached 27 June 1996



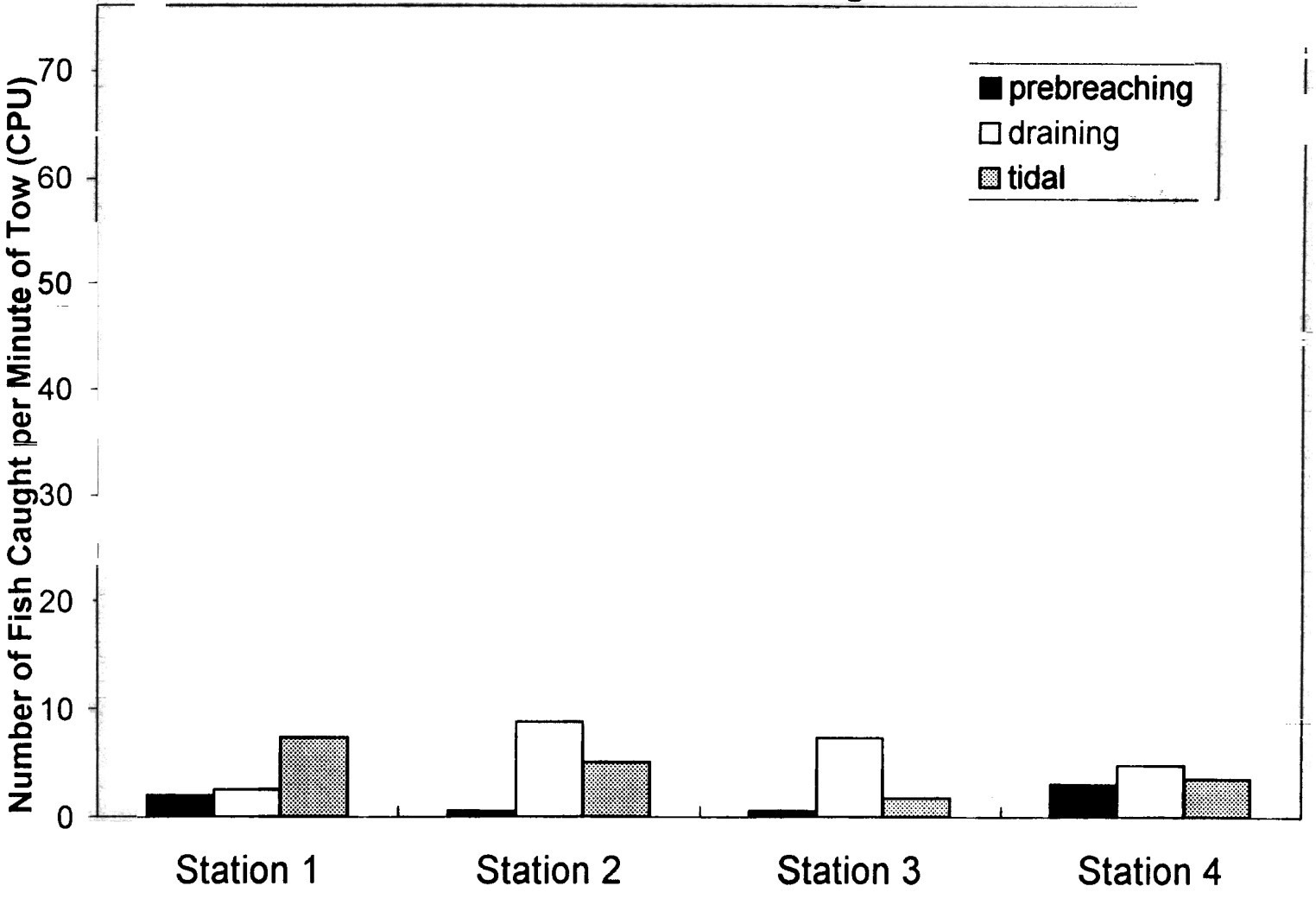
Append x B-28

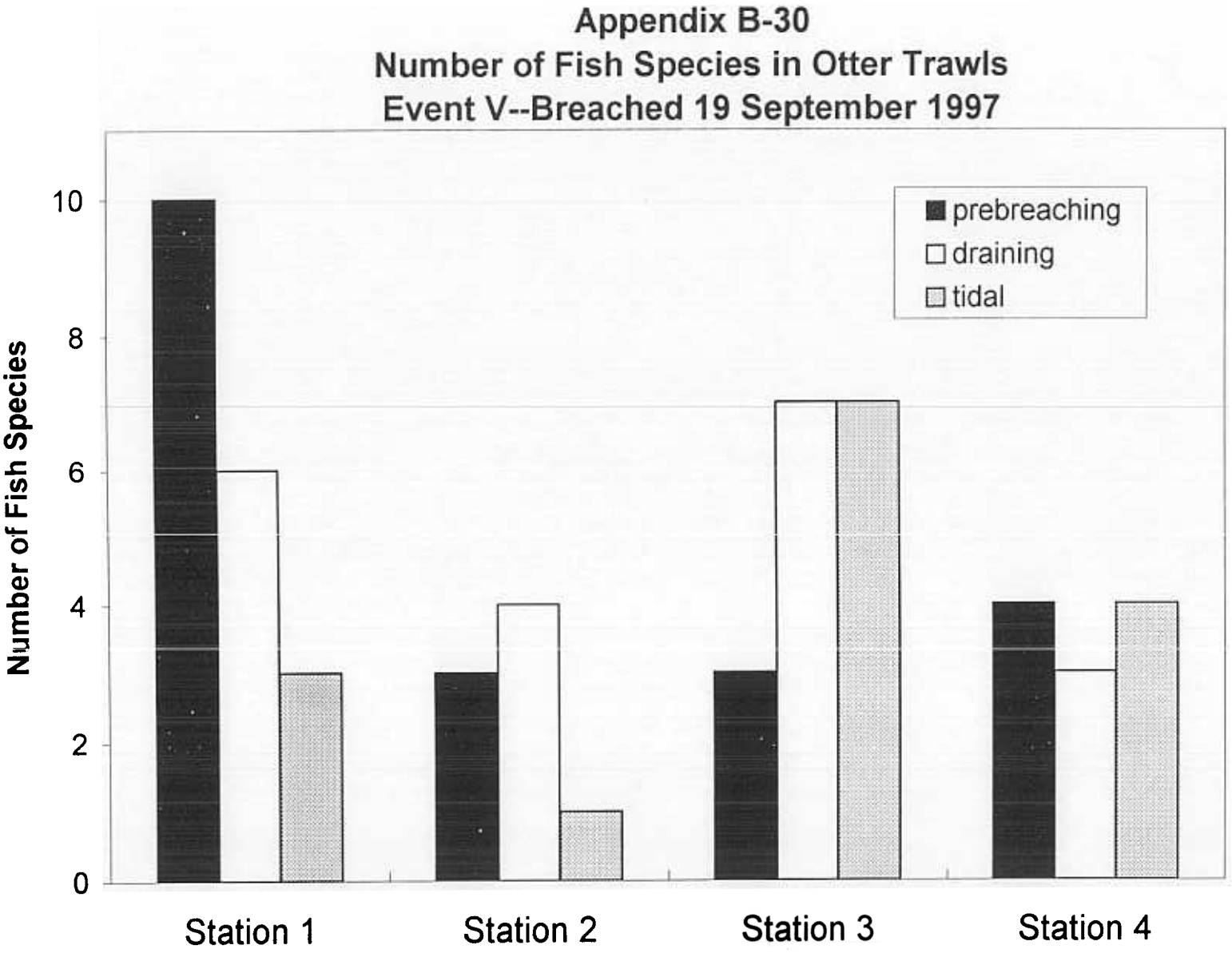
Number of Fish Species in Otter Trawls

Event IV--Breached 20 Augus 997

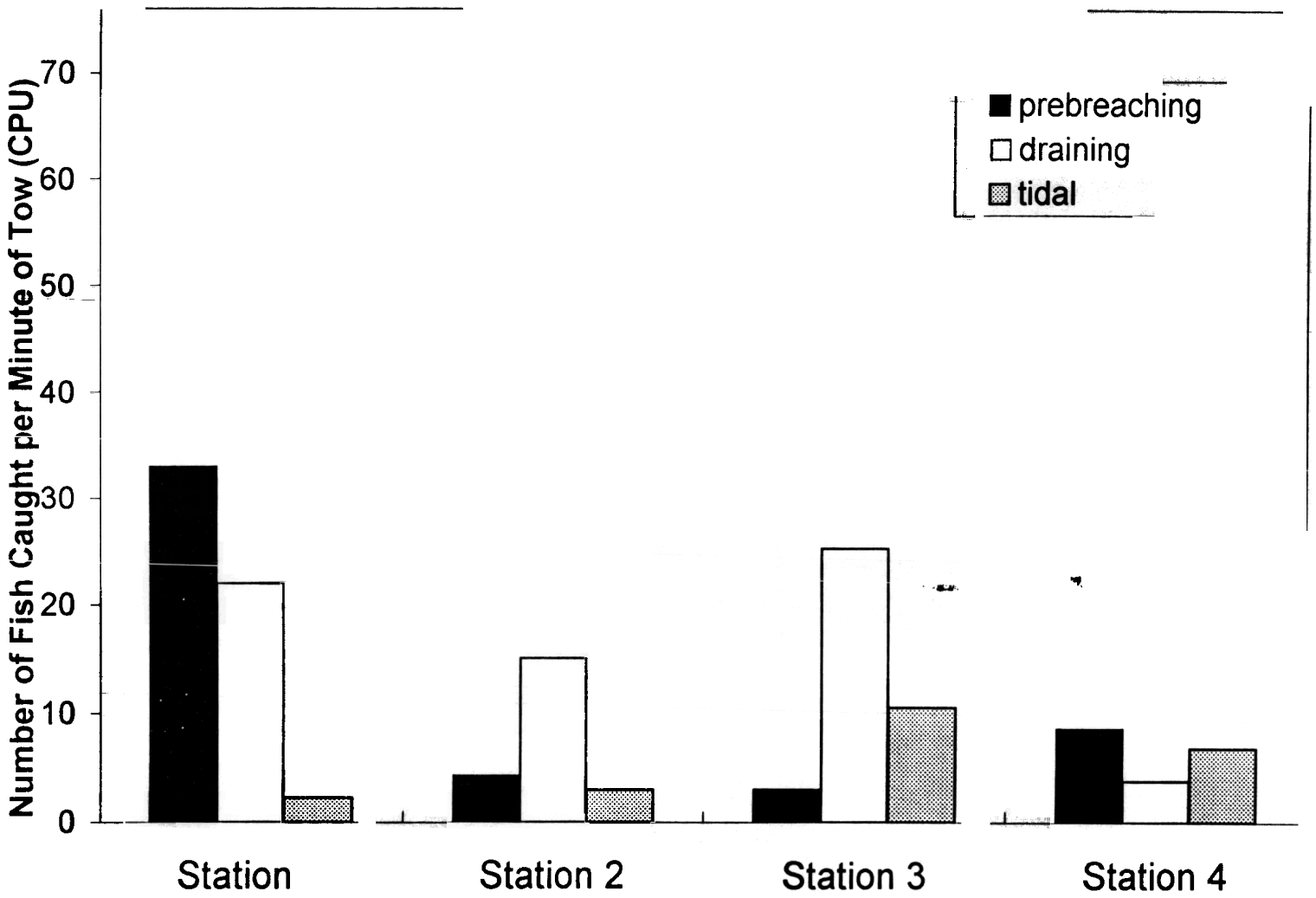


Appendix B-29
Otter Trawl Catch
Event IV--Breached 20 August 1996

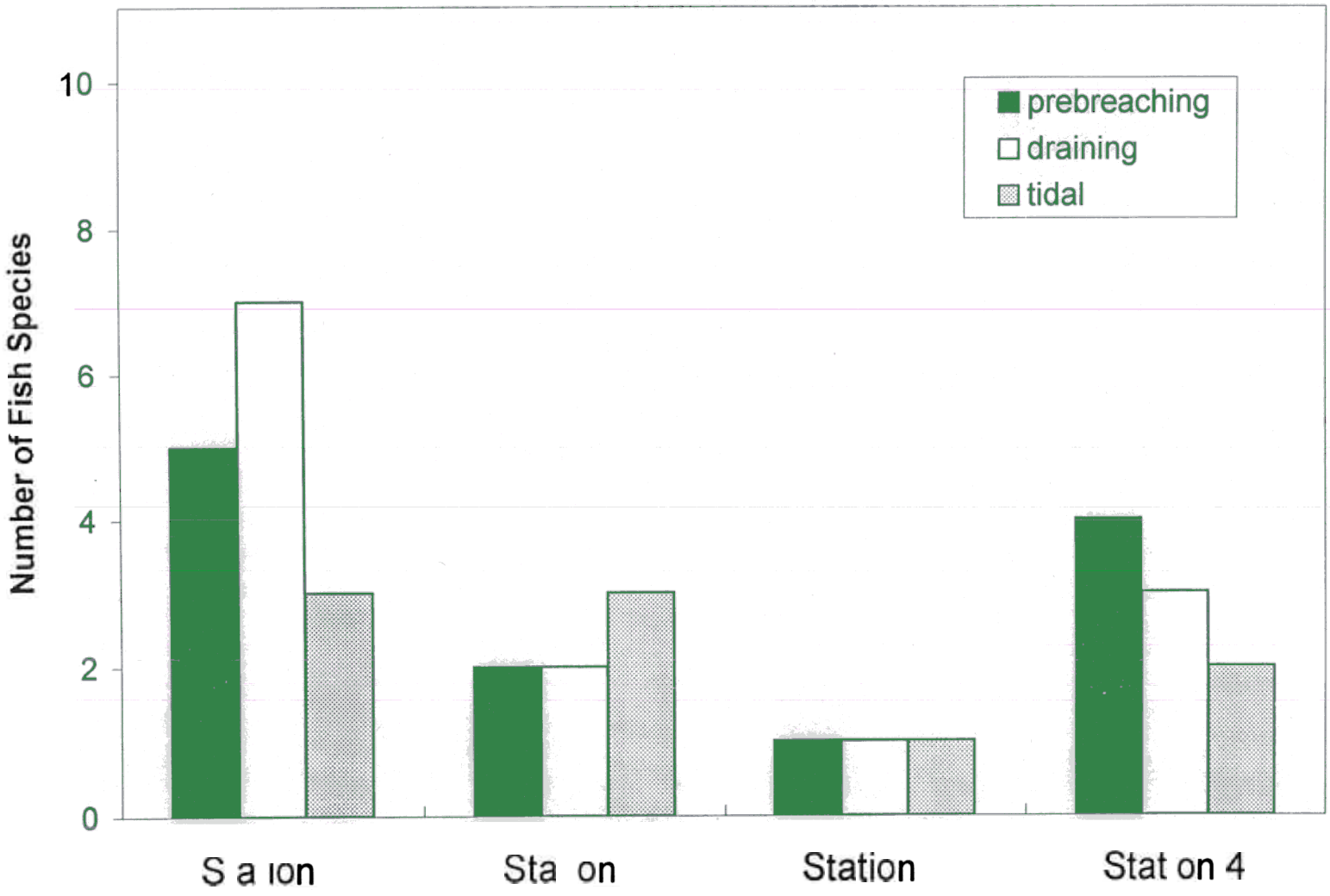



Appendix B-30
Number of Fish Species in Otter Trawls
Event V--Breached 19 September 1997
Number of Fish Species
0
2
4
6
8
10
prebreaching
draining
tidal
Station 1
Station 2
Station 3
Station 4

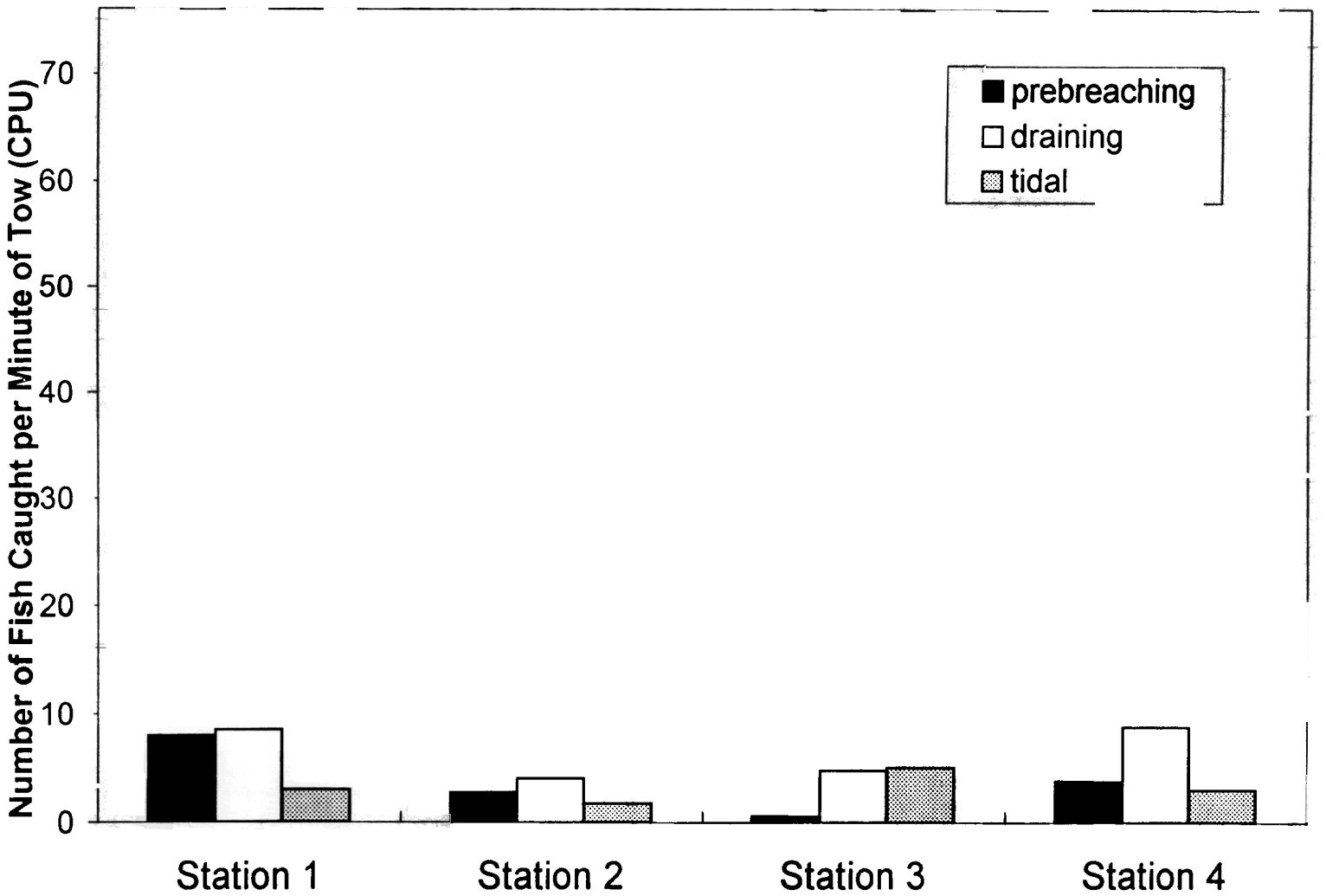
Appendix B-31
Otter Trawl Catch



Append x B-3
Number of Fish Species in Otter Trawl
Event VI--Breached 11 October 1997



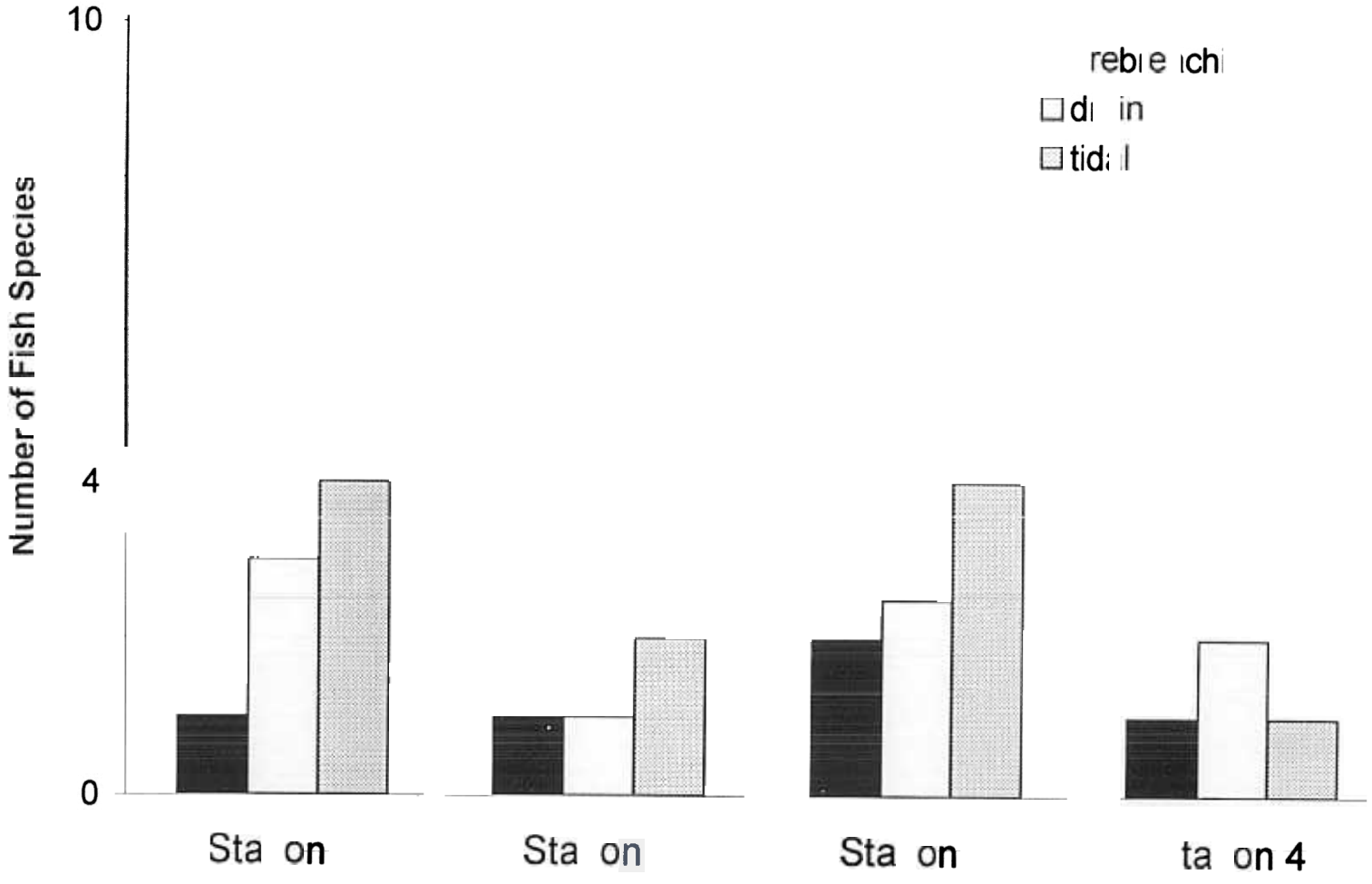
Appendix B-33
Otter Trawl Catch
Event VI--Breached 11 October 1996



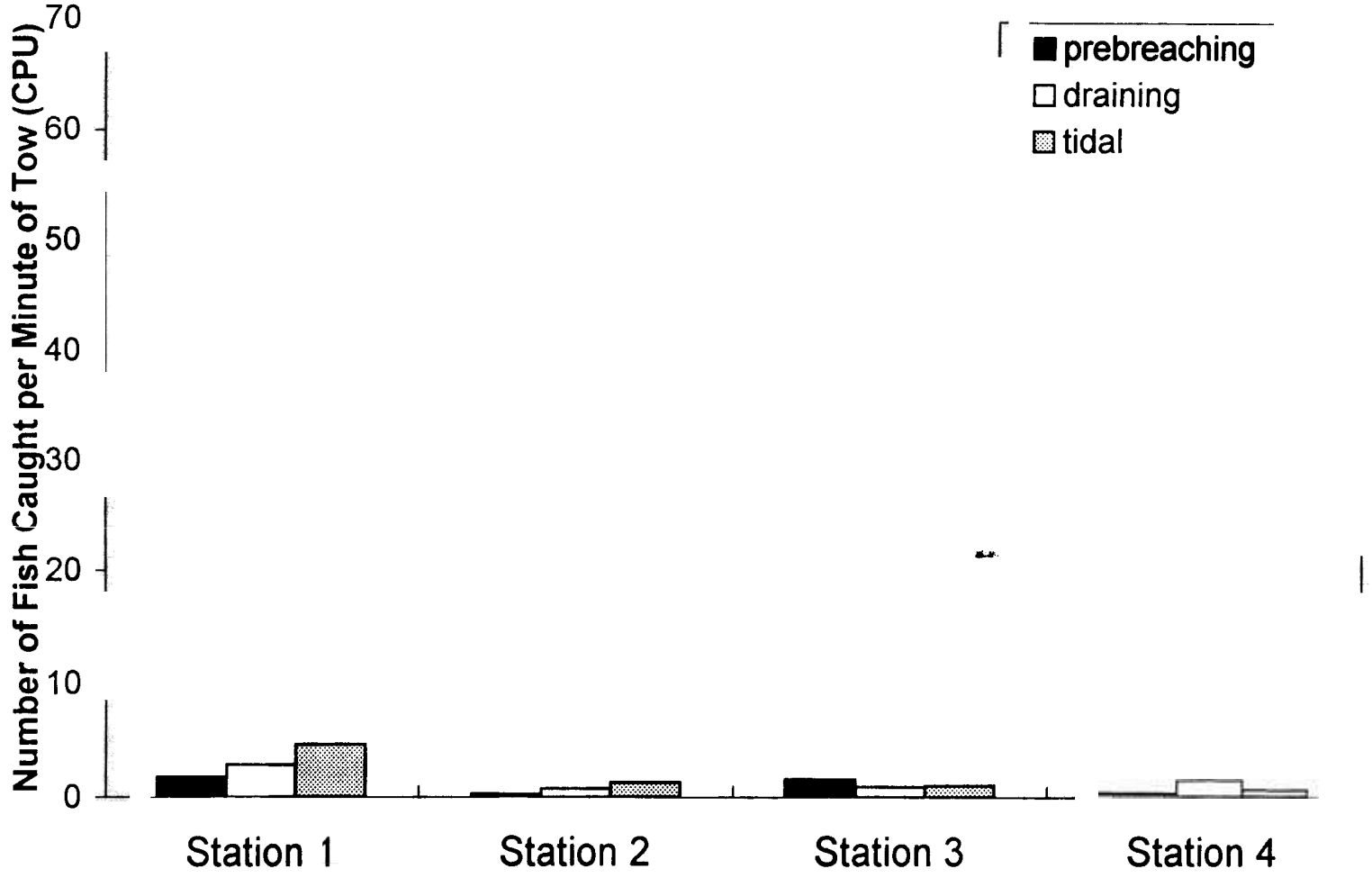
Append x B-34

Number o F h Species n Otter Trawl

Event VII--Breached 3 November 997



Appendix B-35
Otter Trawl Catch
Event VII--Breached 3 November 1996



Appendix B-36. Preliminary trials comparing beach seines with purse seines deployed along shore, 9 May 1997

	9-May-97			
	Station 3		Station 4	
Common Name	beach seine	purse seine	beach seine	purse seine
Topsmelt				
Pacific sanddab				2
Sacramento sucker			3	11
Smallmouth bass				
Pacific herring	2	123		4
Smoothhead sculpin				
Prickly sculpin		9	1	8
Buffalo sculpin				
Bull sculpin				
Staghorn sculpin			2	1
Cabezon				
Unknown Juv. Sebastes				
Shiner surfperch				
Spotfin surfperch				
Northern anchovy				
Pacific tomcod				
Threespine stickleback				
Kelp greenling				
Lingcod				
Surf smelt				
Longfin smelt				
Hybrid sole				
English sole			5	8
Starry flounder		57		
Saddleback gunnel				
Steelhead	3		1	
Coho salmon			1	
Bay pipefish		1		
Number of fish species	2	4	6	6
Total fish	5	190	13	34
Salmonid species caught	1	0	2	0

Appendix B-37. Prebreaching Beach Seine Catch Summary, Event I, 20 May 1997

	20-May-97						
	Stn 1 1850 hr PDT		Stn 2 1730 hr PDT	Stn 3 1600 hr PDT		Stn 4 1430 hr PDT	
Common Name	Beach Seine	Purse Seine	Purse Seine	Beach Seine	Purse Seine	Beach Seine	Purse Seine
Topsmelt							
Pacific sanddab							
Sacramento sucker		2	1	36	100	6	50
Smallmouth bass							
Pacific herring		5					
Smoothhead sculpin							
Prickly sculpin							
Buffalo sculpin							
Bull sculpin							
Staghorn sculpin		1	1				
Cabezon							
Unknown Juv. Sebastes							
Shiner surfperch							
Spotfin surfperch							
Northern anchovy							
Pacific tomcod							
Threespine stickleback					1		
Kelp greenling							
Lingcod							
Surf smelt							
Longfin smelt							
Hybrid sole							
English sole							
Starry flounder					1		
Saddleback gunnel							
Steelhead				1			
Coho salmon							
Bay pipefish							
Number of fish species	0	3	2	2	3	1	1
Total fish	0	8	2	37	102	6	50
Salmonid species caught	0	0	0	1	0	0	0

Appendix B-38. Draining Beach Seine Catch Summary, Event I, 23 May 1997

Common Name	23-May-97 Stn 1 0850 hr PDT	Stn 2 0940 hr PDT	Stn 3 1100 hr PDT	Stn 4 1215 hr PDT
Topsmelt				
Pacific sanddab				
Sacramento sucker		1	100	9
Smallmouth bass				
Pacific herring	1	4		
Smoothhead sculpin				
Prickly sculpin		1	1	1
Buffalo sculpin				
Bull sculpin				
Staghorn sculpin	1			
Cabezon				
Unknown Juv. Sebastes				
Shiner surfperch			1	
Spotfin surfperch				
Northern anchovy				
Pacific tomcod				
Threespine stickleback			3	
Kelp greenling				
Lingcod				
Surf smelt				
Longfin smelt				
Hybrid sole				
English sole				
Starry flounder				3
Saddleback gunnel				
Steelhead	2			1
Coho salmon	6	1		
Bay pipefish	1			
Number of fish species	5	4	4	4
Total fish	11	7	105	14

Appendix B-39. Tidal Beach Seine Catch Summary, Event 27 May 1997

Common Name	27-May-97 Stn 1 0845 hr PDT	Stn 2 1000 hr PDT	Stn 3 1100 hr PDT	Stn 4 1215 hr PDT
Topsmelt	74		1	
Pacific sanddab				
Sacramento sucker				
Smallmouth bass				
Pacific herring				1
Smoothhead sculpin				
Prickly sculpin				1
Buffalo sculpin				
Bull sculpin				
Staghorn sculpin				1
Cabezon				
Unknown Juv. Sebastes				
Shiner surfperch	2			2
Spotfin surfperch				
Northern anchovy				
Pacific tomcod				
Threespine stickleback				
Kelp greenling				
Lingcod				
Surf smelt				
Longfin smelt				
Hybrid sole				
English sole				
Starry flounder			2	4
Saddleback gunnel				
Steelhead				
Coho salmon		3	1	
Bay pipefish				
Number of fish species	2	1	3	5
Total fish	76	3	4	9

Appendix B-40. Prebreaching Beach Seine Catch Summary, Event II, 6 June 1997

Common Name	6-Jun-97 Stn 1 0950 hr PDT	Stn 2 no tow	Stn 3 1330 hr PDT	Stn 4 1515 hr PDT
Topsmelt	1			
Pacific sanddab				
Sacramento sucker			50	
Smallmouth bass				
Pacific herring				
Smoothhead sculpin				
Prickly sculpin				
Buffalo sculpin				
Bull sculpin				
Staghorn sculpin				
Cabezon				
Unknown Juv. Sebastes				
Shiner surfperch				1
Spotfin surfperch				
Northern anchovy				
Pacific tomcod				
Threespine stickleback				
Kelp greenling				
Lingcod				
Surf smelt				
Longfin smelt				
Hybrid sole				
English sole				
Starry flounder				
Saddleback gunnel				
Steelhead				
Coho salmon				
Bay pipefish				
Number of fish species	1	-	1	1
Total fish	1	-	50	1

Appendix B-41. Draining Beach Seine Catch Summary, Event II, 10 June 1997

Common Name	10-Jun-97 Stn 1 1040 hr PDT	Stn 2 1200 hr PDT	Stn 3 1330 hr PDT	Stn 4 1500 hr PDT
Topsmelt				
Pacific sanddab				
Sacramento sucker		9	52	9
Smallmouth bass				
Pacific herring				
Smoothhead sculpin	1			
Prickly sculpin		1	2	1
Buffalo sculpin				
Bull sculpin				
Staghorn sculpin	4	2		
Cabezon				
Unknown Juv. Sebastes				
Shiner surfperch		8		5
Spotfin surfperch				
Northern anchovy				
Pacific tomcod				
Threespine stickleback				
Kelp greenling				
Lingcod				
Surf smelt				
Longfin smelt				
Hybrid sole				
English sole				
Starry flounder			1	
Saddleback gunnel				
Steelhead		2		4
Coho salmon	4			
Bay pipefish				
Number of fish species	3	5	3	4
Total fish	9	22	55	19

Appendix B-42. Tidal Beach Seine Catch Summary, Event II, 13 June 1997

Common Name	13-Jun-97 Stn 1 0900 hr PDT	Stn 2 1000 hr PDT	Stn 3 1112 hr PDT	Stn 4 1250 hr PDT
Topsmelt				
Pacific sanddab				
Sacramento sucker			133	223
Smallmouth bass				
Pacific herring	8		9	2
Smoothhead sculpin				
Prickly sculpin			1	2
Buffalo sculpin				
Bull sculpin				
Staghorn sculpin				
Cabezon				
Unknown Juv. Sebastes				
Shiner surfperch			2	
Spotfin surfperch				
Northern anchovy				
Pacific tomcod				
Threespine stickleback			3	
Kelp greenling				
Lingcod				
Surf smelt				
Longfin smelt				
Hybrid sole				
English sole				
Starry flounder	1		5	1
Saddleback gunnel				
Steelhead		1		
Coho salmon				
Bay pipefish				
Number of fish species	2	1	6	4
Total fish	9	1	153	228

Appendix B-43. Prebreaching Beach Seine Catch Summary, Event III, 22-23 June 1997

Common Name	22-23 June 1997			
	Stn 1 0810 hr PDT 23-Jun	Stn 2 no tow 22-Jun	Stn 3 1345 hr PDT 22-Jun	Stn 4 1300 hr PDT 22-Jun
Topsmelt				
Pacific sanddab				
Sacramento sucker				47
Smallmouth bass				
Pacific herring				
Smoothhead sculpin				
Prickly sculpin				5
Buffalo sculpin				
Bull sculpin				
Staghorn sculpin				
Cabezon				
Unknown Juv. Sebastes				
Shiner surfperch				
Spotfin surfperch				
Northern anchovy				
Pacific tomcod				
Threespine stickleback				
Kelp greenling				
Lingcod				
Surf smelt				
Longfin smelt				
Hybrid sole				
English sole				
Starry flounder				
Saddleback gunnel				
Steelhead			1	2
Coho salmon				
Bay pipefish				
Number of fish species	0	-	1	3
Total fish	0	-	1	54

Appendix B-44. Draining Beach Seine Catch Summary, Event III, 28 June 1997

Common Name	28-Jun-97 Stn 1 0910 hr PDT	Stn 2 1010 hr PDT	Stn 3 1130 hr PDT	Stn 4 1400 hr PDT
Topsmelt				
Pacific sanddab				
Sacramento sucker			14	2
Smallmouth bass				
Pacific herring	3	5		
Smoothhead sculpin				1
Prickly sculpin		2	2	10
Buffalo sculpin				
Bull sculpin				
Staghorn sculpin	1			
Cabezon				
Unknown Juv. Sebastes				
Shiner surfperch	21	43	2	
Spotfin surfperch				
Northern anchovy				
Pacific tomcod				
Threespine stickleback			4	
Kelp greenling				
Lingcod				
Surf smelt				
Longfin smelt				
Hybrid sole				
English sole			1	
Starry flounder		1		1
Saddleback gunnel				
Steelhead				2
Coho salmon		1	1	
Bay pipefish				
Number of fish species	3	5	6	5
Total fish	25	52	24	16

Appendix B-45. Tidal Beach Seine Catch Summary, Event III, 1 July 1997

	1-Jul-97				
	Stn 1	Stn 2	Stn 3	Stn 4	
Common Name	1440 hr PDT	1415 hr PDT	1300 hr PDT	1215 hr PDT	1230 hr PDT
Topsmelt		1			
Pacific sanddab					
Sacramento sucker			36	12	13
Smallmouth bass					
Pacific herring		21			
Smoothhead sculpin					
Prickly sculpin				1	
Buffalo sculpin					
Bull sculpin					
Staghorn sculpin			1		
Cabezon					
Unknown Juv. Sebastes					
Shiner surfperch				1	4
Spotfin surfperch					
Northern anchovy					
Pacific tomcod					
Threespine stickleback				1	1
Kelp greenling					
Lingcod					
Surf smelt					
Longfin smelt					
Hybrid sole					
English sole					
Starry flounder					
Saddleback gunnel					
Steelhead			1		
Coho salmon					
Bay pipefish					
Number of fish species	0	2	3	4	3
Total fish	0	22	38	15	18

Appendix B-46. Prebreaching Beach Seine Catch Summary, Event IV, 18 August 1997

Common Name	18-Aug-97 Stn 1 1050 hr PDT	Stn 2 no tow	Stn 3 1420 hr PDT	Stn 4 1315 hr PDT
Topsmelt				
Pacific sanddab				
Sacramento sucker				1
Smallmouth bass				
Pacific herring				
Smoothhead sculpin				
Prickly sculpin				
Buffalo sculpin				
Bull sculpin				
Staghorn sculpin				
Cabezon				
Unknown Juv. Sebastes				
Shiner surfperch				
Spotfin surfperch				
Northern anchovy				
Pacific tomcod				
Threespine stickleback				
Kelp greenling				
Lingcod				
Surf smelt				
Longfin smelt				
Hybrid sole				
English sole				
Starry flounder				
Saddleback gunnel				
Steelhead				
Coho salmon				
Bay pipefish				
Number of fish species	0	-	0	1
Total fish	0	-	0	1

Appendix B-47. Draining Beach Seine Catch Summary, Event IV, 21 August 1997

Common Name	21-Aug-97			
	Stn 1 1010 hr PDT	Stn 2 1050 hr PDT	Stn 3 1150 hr PDT	Stn 4 1335 hr PDT
Topsmelt				
Pacific sanddab				
Sacramento sucker		1		5
Smallmouth bass				
Pacific herring			1	
Smoothhead sculpin				
Prickly sculpin				
Buffalo sculpin				
Bull sculpin				
Staghorn sculpin				
Cabezon				
Unknown Juv. Sebastes				
Shiner surfperch		5		
Spotfin surfperch				
Northern anchovy				
Pacific tomcod				
Threespine stickleback	3		14	
Kelp greenling				
Lingcod				
Surf smelt				
Longfin smelt				
Hybrid sole				
English sole				
Starry flounder				
Saddleback gunnel				
Steelhead				
Coho salmon				
Bay pipefish				
Number of fish species	1	2	2	1
Total fish	3	6	15	5

Appendix B-48. Tidal Beach Seine Catch Summary, Event IV, 26 August 1997

Common Name	26-Aug-97 Stn 1 0945 hr PDT	Stn 2 1010 hr PDT	Stn 3 1105 hr PDT	Stn 4 1210 hr PDT
Topsmelt	25			
Pacific sanddab				
Sacramento sucker				
Smallmouth bass				
Pacific herring		2	3	
Smoothhead sculpin				
Prickly sculpin				
Buffalo sculpin				
Bull sculpin				
Staghorn sculpin				
Cabezon				
Unknown Juv. Sebastes				
Shiner surfperch				
Spotfin surfperch				
Northern anchovy				
Pacific tomcod				
Threespine stickleback			2	
Kelp greenling				
Lingcod				
Surf smelt		1		
Longfin smelt				
Hybrid sole				
English sole				
Starry flounder				
Saddleback gunnel				
Steelhead				
Coho salmon				
Bay pipefish			1	
Number of fish species	1	2	3	0
Total fish	25	3	6	0

Appendix B-49. Prebreaching Beach Seine Catch Summary, Event V, 16 September 1997

Common Name	16-Sep-97			
	Stn 1 1225 hr PDT	Stn 2 no tow	Stn 3 1445 hr PDT	Stn 4 1550 hr PDT
Topsmelt	1			
Pacific sanddab				
Sacramento sucker				
Smallmouth bass				
Pacific herring				
Smoothhead sculpin				
Prickly sculpin				
Buffalo sculpin				
Bull sculpin				
Staghorn sculpin				
Cabezon				
Unknown Juv. Sebastes				
Shiner surfperch				
Spotfin surfperch				
Northern anchovy				
Pacific tomcod				
Threespine stickleback				
Kelp greenling				
Lingcod				
Surf smelt				
Longfin smelt				
Hybrid sole				
English sole				
Starry flounder				
Saddleback gunnel				
Steelhead				
Coho salmon				
Bay pipefish				
Number of fish species	1	-	0	0
Total fish	1	-	0	0

Appendix B-50. Draining Beach Seine Catch Summary, Event V, 20 September 1997

Common Name	20-Sep-97 Stn 1 1115 hr PDT	Stn 2 1135 hr PDT	Stn 3 1230 hr PDT	Stn 4 1300 hr PDT
Topsmelt	54	2		
Pacific sanddab				
Sacramento sucker			1	
Smallmouth bass		1		
Pacific herring	1			7
Smoothhead sculpin				
Prickly sculpin				
Buffalo sculpin				
Bull sculpin				
Staghorn sculpin				
Cabezon				
Unknown Juv. Sebastes				
Shiner surfperch				
Spotfin surfperch				
Northern anchovy				
Pacific tomcod				
Threespine stickleback			3	
Kelp greenling				
Lingcod				
Surf smelt				
Longfin smelt				
Hybrid sole				
English sole				
Starry flounder			2	
Saddleback gunnel				
Steelhead		1	1	
Coho salmon				
Bay pipefish				
Number of fish species	2	3	4	1
Total fish	55	4	7	7

Appendix B-51. Tidal Beach Seine Catch Summary, Event V, 23 September 1997

Common Name	23-Sep-97			
	Stn 1 1010 hr PDT	Stn 2 1035 hr PDT	Stn 3 1140 hr PDT	Stn 4 1220 hr PDT
Topsmelt	900	2	102	
Pacific sanddab				
Sacramento sucker				
Smallmouth bass				
Pacific herring				
Smoothhead sculpin				
Prickly sculpin			1	2
Buffalo sculpin				
Bull sculpin				
Staghorn sculpin				
Cabezon				
Unknown Juv. Sebastes				
Shiner surfperch				
Spotfin surfperch				
Northern anchovy				
Pacific tomcod				
Threespine stickleback				1
Kelp greenling				
Lingcod				
Surf smelt				
Longfin smelt				
Hybrid sole				
English sole				
Starry flounder				1
Saddleback gunnel				
Steelhead				
Coho salmon				
Bay pipefish				
Number of fish species	1	1	2	3
Total fish	900	2	103	4

Appendix B-52. Prebreaching Beach Seine Catch Summary, Event VI, 10 October 1997

	10-Oct-97			
Common Name	Stn 1 0945 hr PDT	Stn 2 no tow	Stn 3 1220 hr PDT	Stn 4 1255 hr PDT
Topsmelt	15			1
Pacific sanddab				
Sacramento sucker				
Smallmouth bass				
Pacific herring				
Smoothhead sculpin				
Prickly sculpin				
Buffalo sculpin				
Bull sculpin				
Staghorn sculpin	1			
Cabezon				
Unknown Juv. Sebastes				
Shiner surfperch				
Spotfin surfperch				
Northern anchovy				
Pacific tomcod				
Threespine stickleback				
Kelp greenling				
Lingcod				
Surf smelt				
Longfin smelt				
Hybrid sole				
English sole				
Starry flounder				
Saddleback gunnel				
Steelhead			4	1
Coho salmon				
Bay pipefish				
Number of fish species	2	-	1	2
Total fish	16	-	4	2

Appendix B-53. Draining Beach Seine Catch Summary, Event VI, 12 October 1997

Common Name	12-Oct-97			
	Stn 1 1040 hr PDT	Stn 2 1120 hr PDT	Stn 3 1215 hr PDT	Stn 4 1305 hr PDT
Topsmelt	350	47	71	9
Pacific sanddab				
Sacramento sucker				
Smallmouth bass				
Pacific herring				
Smoothhead sculpin				
Prickly sculpin				
Buffalo sculpin				
Bull sculpin				
Staghorn sculpin				
Cabezon				
Unknown Juv. Sebastes				
Shiner surfperch		1		
Spotfin surfperch				
Northern anchovy				
Pacific tomcod				
Threespine stickleback			10	1
Kelp greenling				
Lingcod				
Surf smelt				
Longfin smelt				
Hybrid sole				
English sole				
Starry flounder				
Saddleback gunnel				
Steelhead				
Coho salmon				
Bay pipefish				1
Number of fish species	1	2	2	3
Total fish	350	48	81	11

Appendix B-54. Tidal Beach Seine Catch Summary, Event VI, 15 October 1997

	15-Oct-97			
Common Name	Stn 1 1145 hr PDT	Stn 2 1550 hr PDT	Stn 3 1425 hr PDT	Stn 4 1400 hr PDT
Topsmelt	385	135	420	227
Pacific sanddab				
Sacramento sucker				
Smallmouth bass				
Pacific herring				
Smoothhead sculpin				
Prickly sculpin				1
Buffalo sculpin				
Bull sculpin				
Staghorn sculpin				
Cabezon				
Unknown Juv. Sebastes				
Shiner surfperch				
Spotfin surfperch				
Northern anchovy				
Pacific tomcod				
Threespine stickleback			8	
Kelp greenling				
Lingcod				
Surf smelt			20	
Longfin smelt				
Hybrid sole				
English sole				
Starry flounder				
Saddleback gunnel				
Steelhead				
Coho salmon				
Bay pipefish				
Number of fish species	1	1	3	2
Total fish	385	135	448	228

Appendix B-55. Prebreaching Beach Seine Catch Summary, Event VII, 31 October 1997

Common Name	31-Oct-97			
	Stn 1 1400 hr PST	Stn 2 no tow	Stn 3 1445 hr PST	Stn 4 1535 hr PST
Topsmelt	30			
Pacific sanddab				
Sacramento sucker				
Smallmouth bass				
Pacific herring				
Smoothhead sculpin				
Prickly sculpin				
Buffalo sculpin				
Bull sculpin				
Staghorn sculpin				
Cabezon				
Unknown Juv. Sebastes				
Shiner surfperch				
Spotfin surfperch				
Northern anchovy				
Pacific tomcod				
Threespine stickleback				
Kelp greenling				
Lingcod				
Surf smelt				
Longfin smelt				
Hybrid sole				
English sole				
Starry flounder	1		1	
Saddleback gunnel				
Steelhead			2	
Coho salmon				
Bay pipefish				
Number of fish species	2	-	2	0
Total fish	31	-	3	0

Appendix B-56. Draining Beach Seine Catch Summary, Event VII, 4 November 1997

Common Name	4-Nov-97 Stn 1 0940 hr PST	Stn 2 1010 hr PST	Stn 3 1120 hr PST	Stn 4 1205 hr PST
Topsmelt	22			
Pacific sanddab				
Sacramento sucker		1		
Smallmouth bass				
Pacific herring				
Smoothhead sculpin				
Prickly sculpin				
Buffalo sculpin				
Bull sculpin				
Staghorn sculpin				
Cabezon				
Unknown Juv. Sebastes				
Shiner surfperch				
Spotfin surfperch				
Northern anchovy				
Pacific tomcod				
Threespine stickleback				
Kelp greenling				
Lingcod				
Surf smelt		14	26	
Longfin smelt				
Hybrid sole				
English sole				
Starry flounder				
Saddleback gunnel				
Steelhead			1	
Coho salmon				
Bay pipefish				
Number of fish species	1	2	2	0
Total fish	22	15	27	0

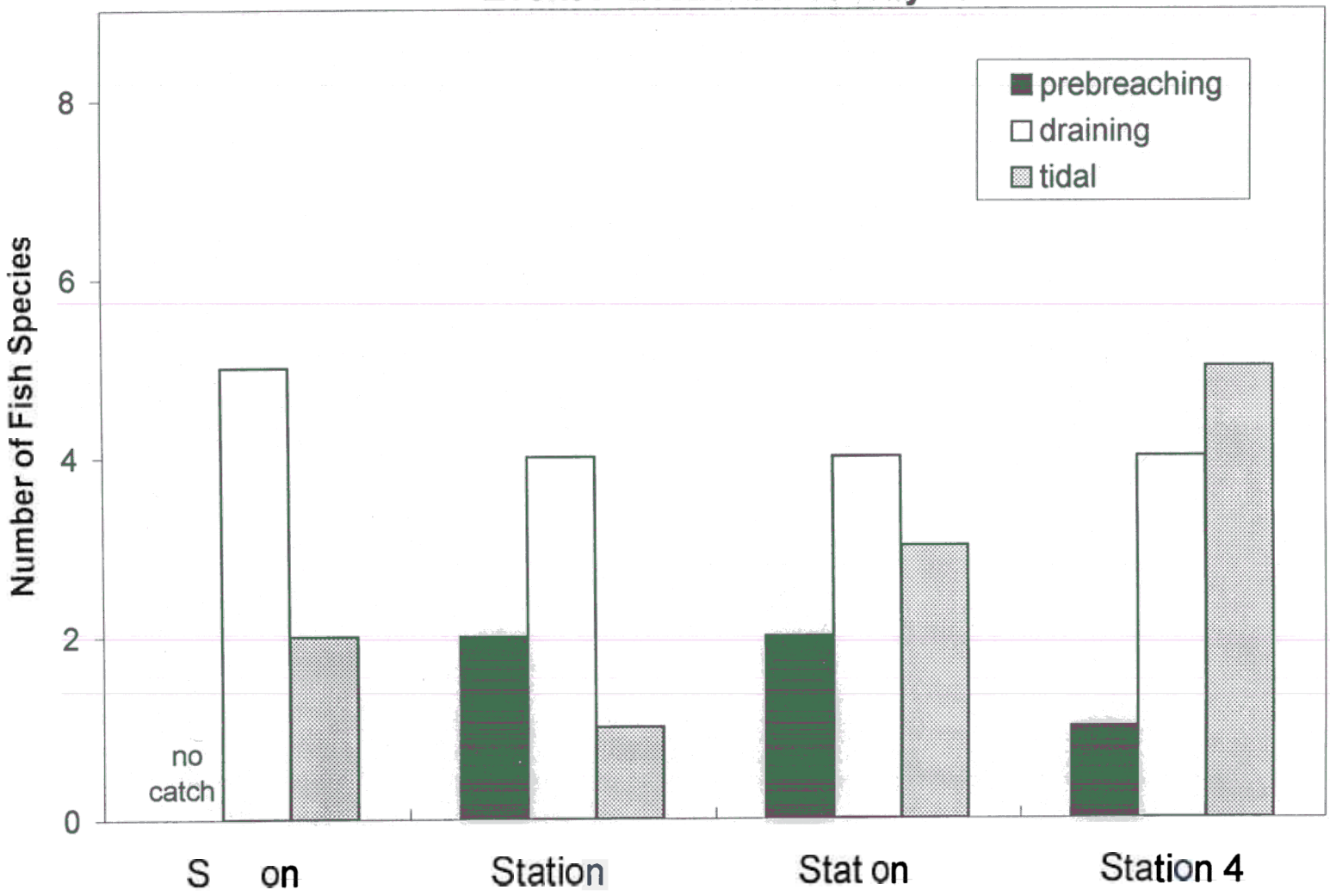
Appendix B-57. Tidal Beach Seine Catch Summary, Event VII, 7 November 1997

	7-Nov-97			
Common Name	Stn 1 1115 hr PST	Stn 2 1145 hr PST	Stn 3 1330 hr PST	Stn 4 1420 hr PST
Topsmelt	34	38	500	9
Pacific sanddab				
Sacramento sucker				
Smallmouth bass				
Pacific herring				
Smoothhead sculpin				
Prickly sculpin		1		
Buffalo sculpin				
Bull sculpin				
Staghorn sculpin				
Cabezon				
Unknown Juv. Sebastes				
Shiner surfperch				
Spotfin surfperch				
Northern anchovy				
Pacific tomcod				
Threespine stickleback				
Kelp greenling				
Lingcod				
Surf smelt		2	10	
Longfin smelt				
Hybrid sole				
English sole				
Starry flounder				
Saddleback gunnel				
Steelhead			3	
Coho salmon				
Bay pipefish				
Number of fish species	1	3	3	1
Total fish	34	41	513	9

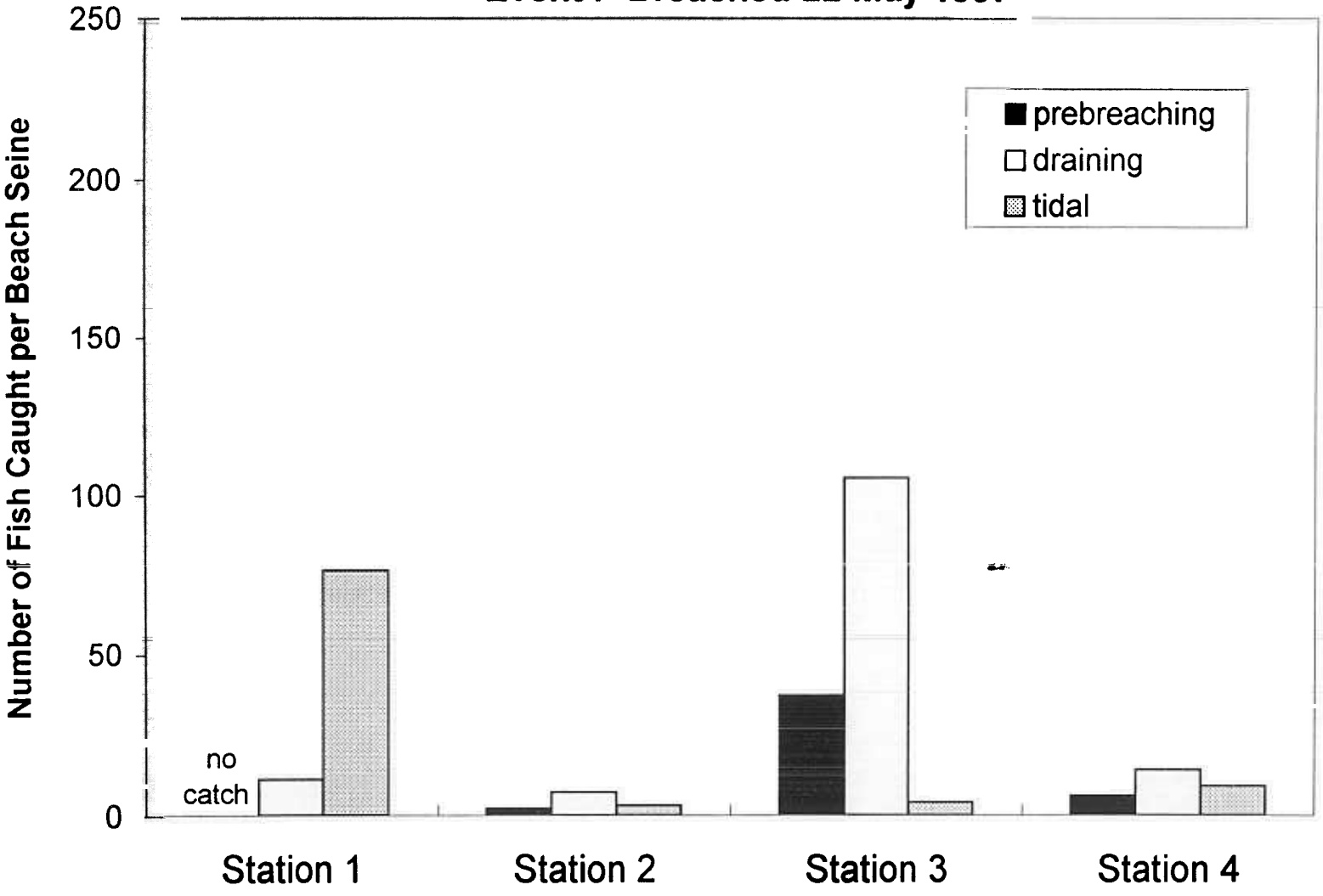
Appendix B-58

Number of Fish Species in Beach Seines

Event I--Breached 22 May 1997



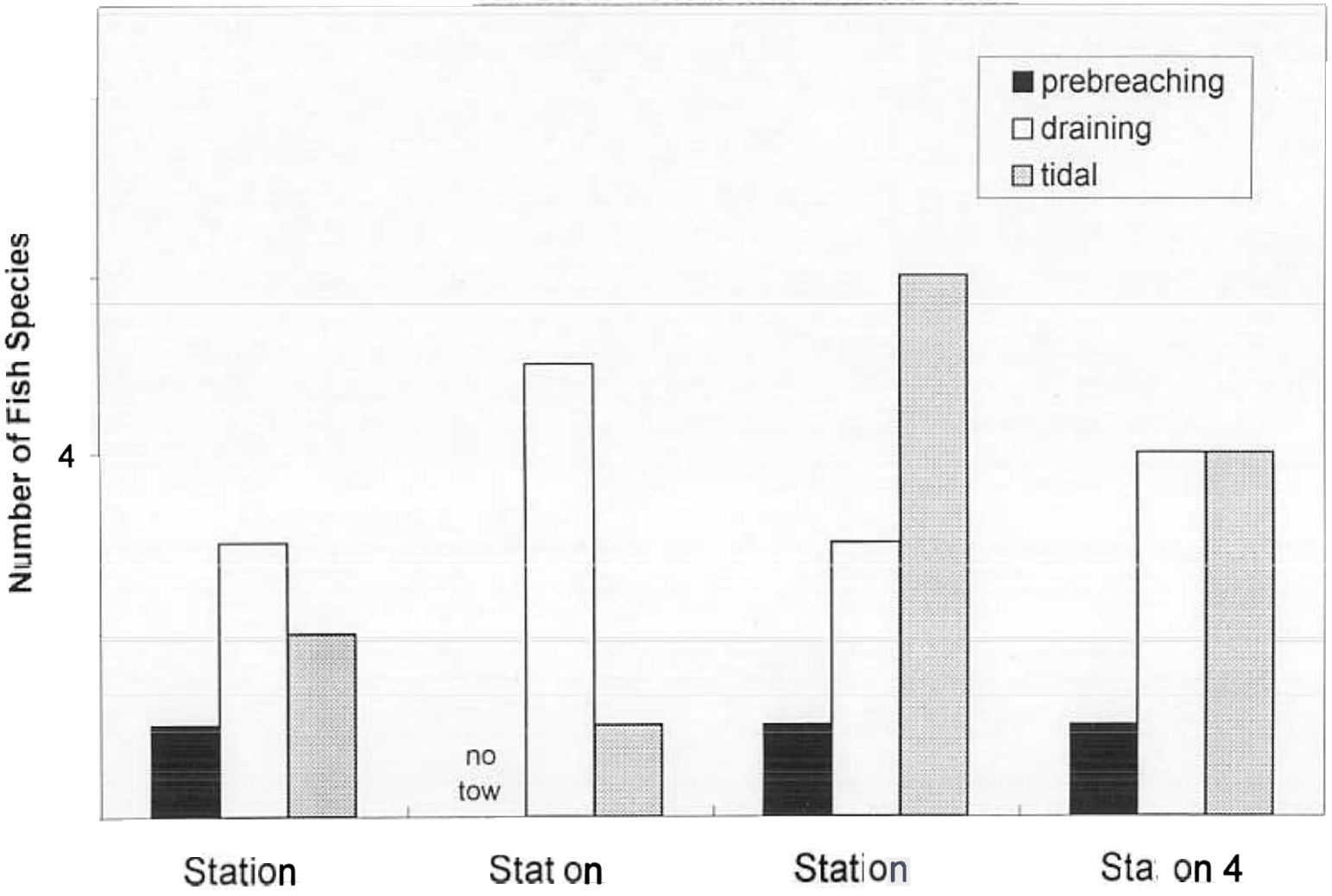
Appendix B-59
Beach Seine Catch
Event I--Breached 22 May 1997



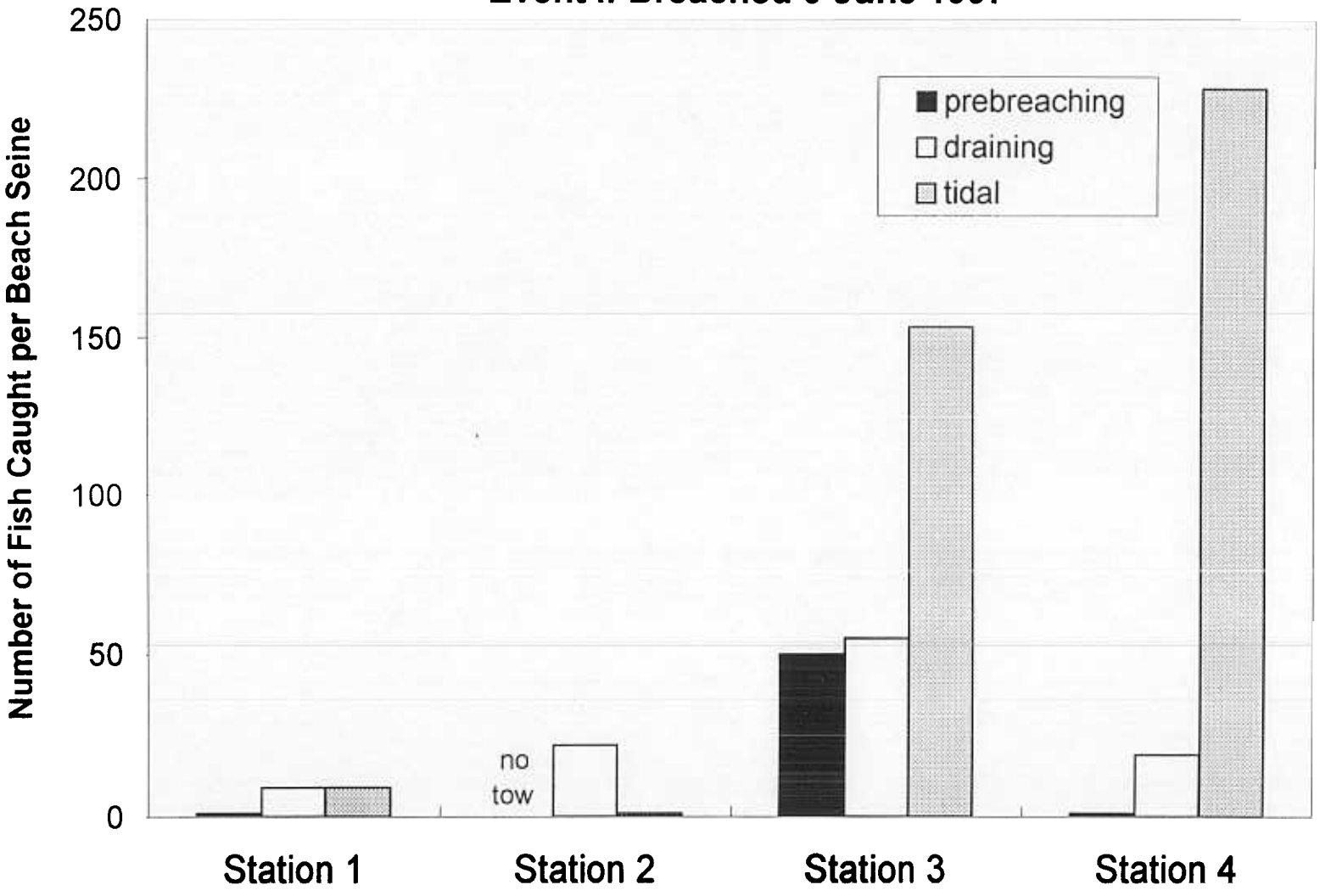
Appendix B-60

Number o F h Species n Beach Se nes

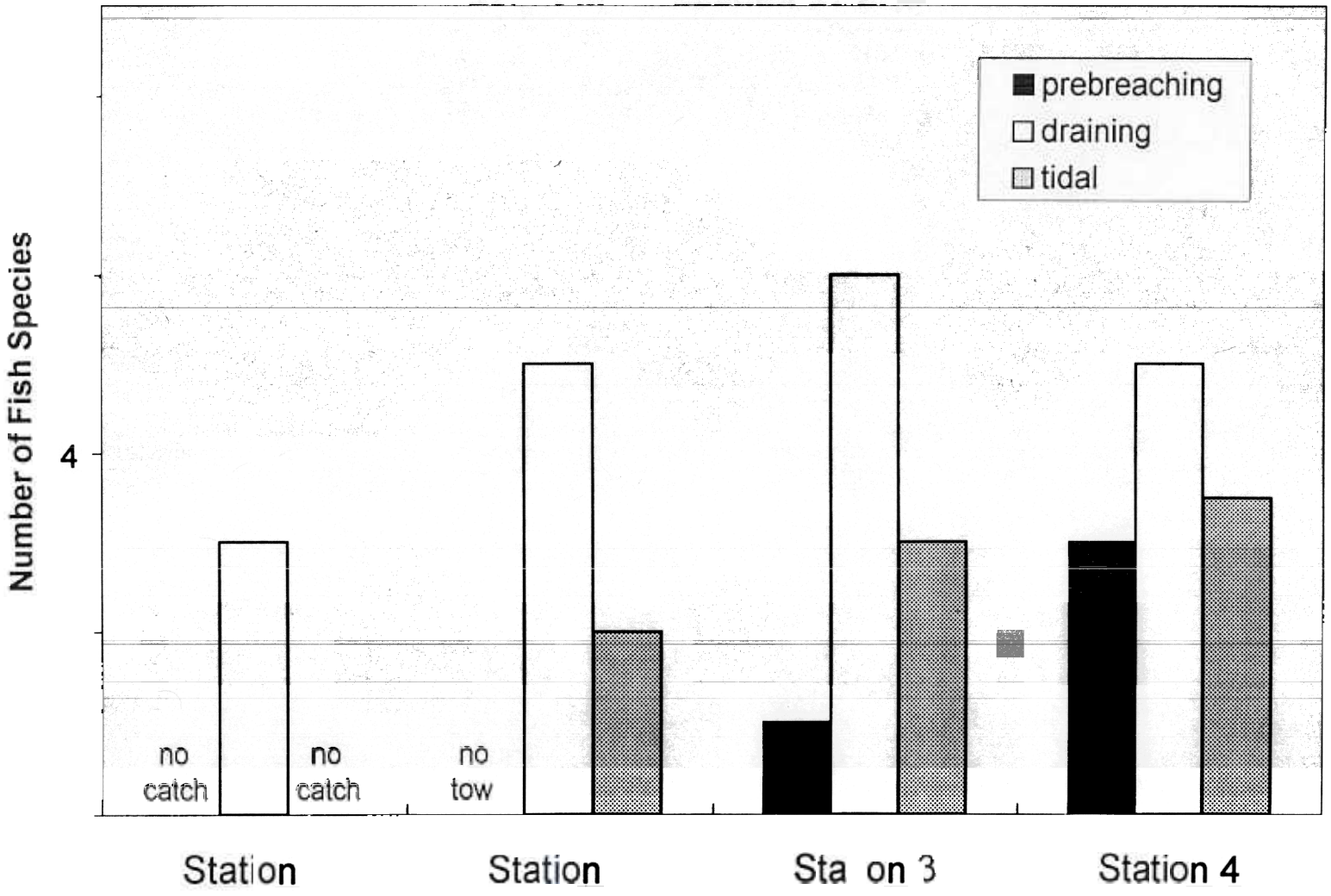
Event II--Breached 9 June 1997



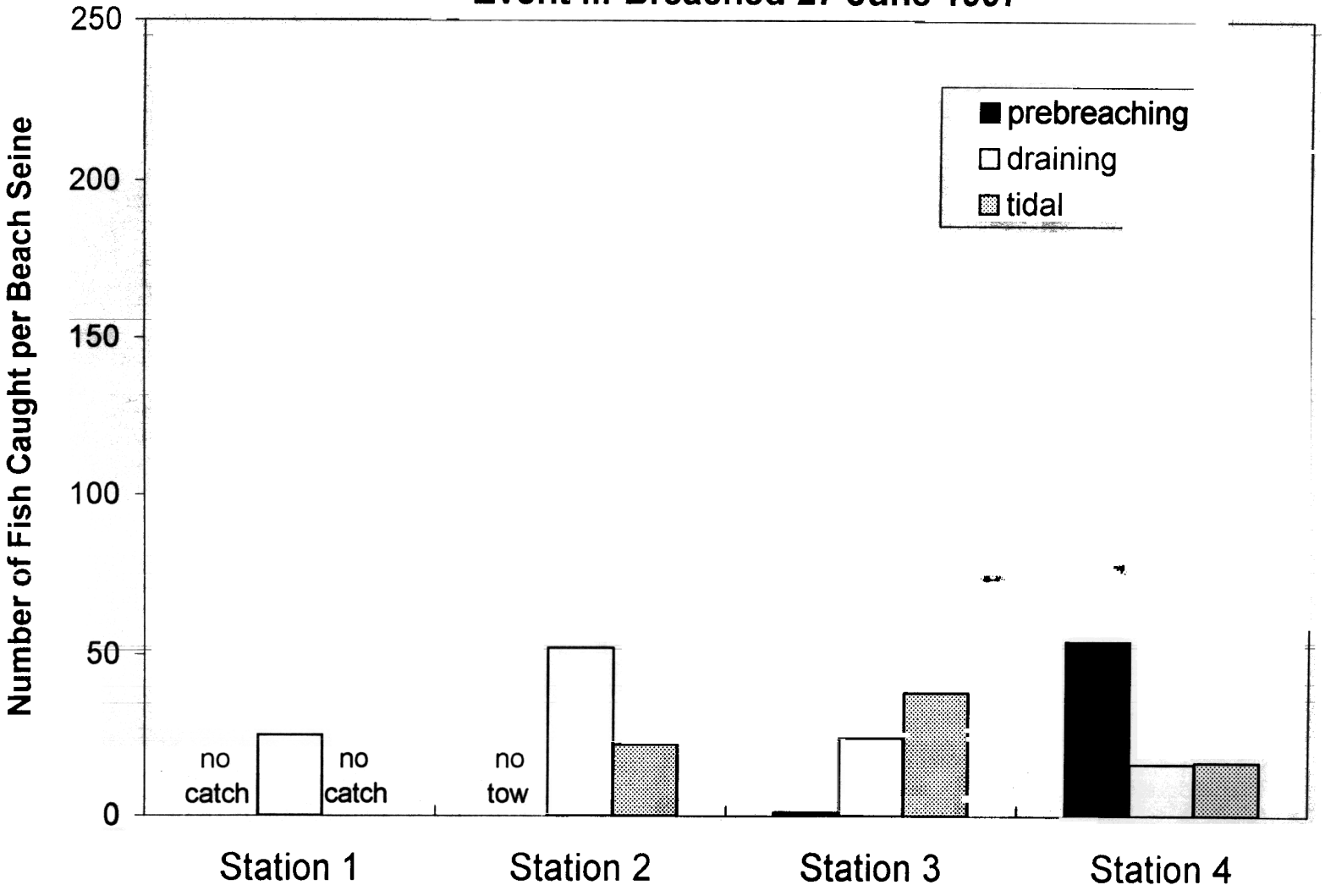
Appendix B-61
Beach Seine Catch
Event II-Breached 9 June 1997



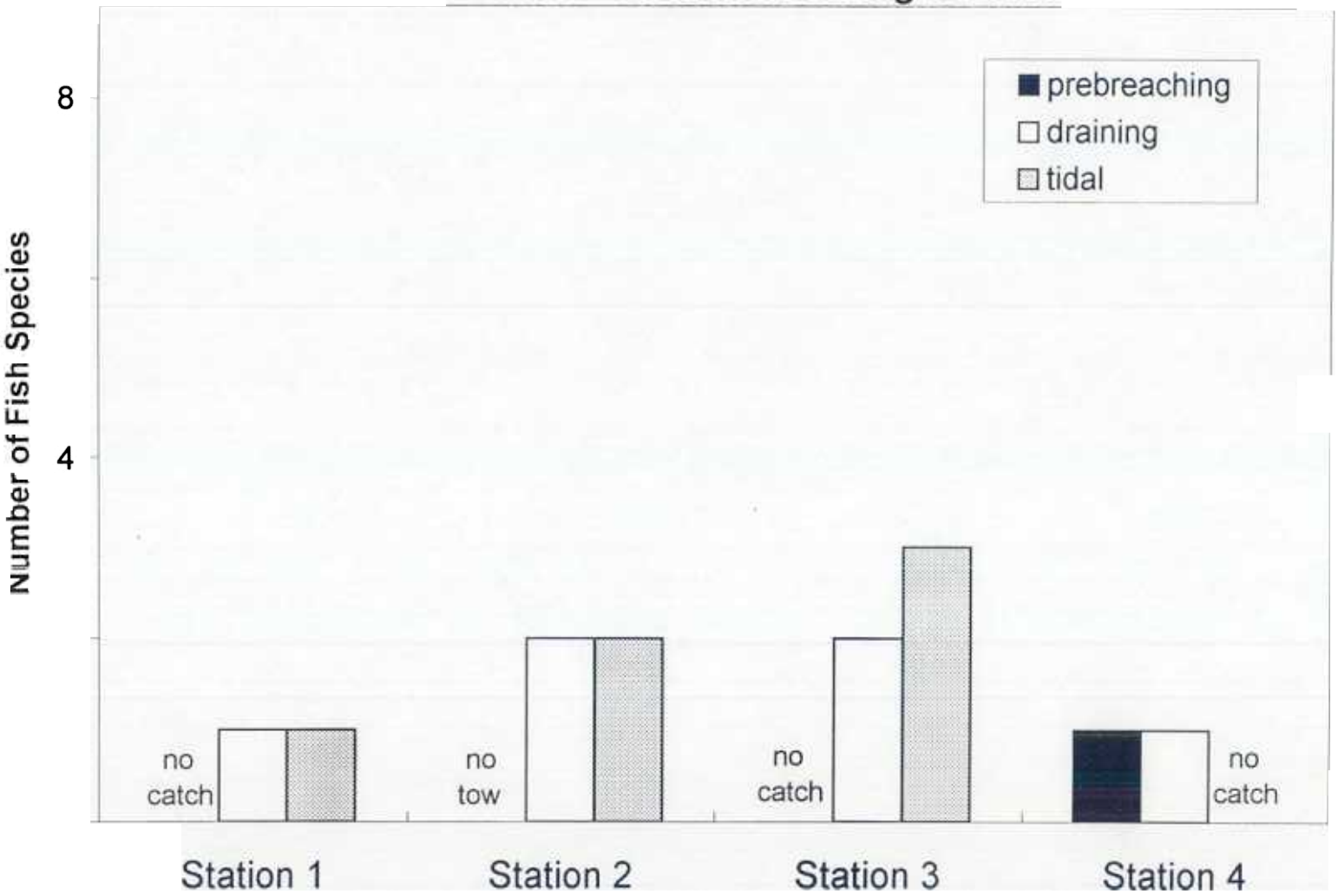
Appendix B-62
Number o Fish Species in Beach Se ne
Event III Breached 27 June 997



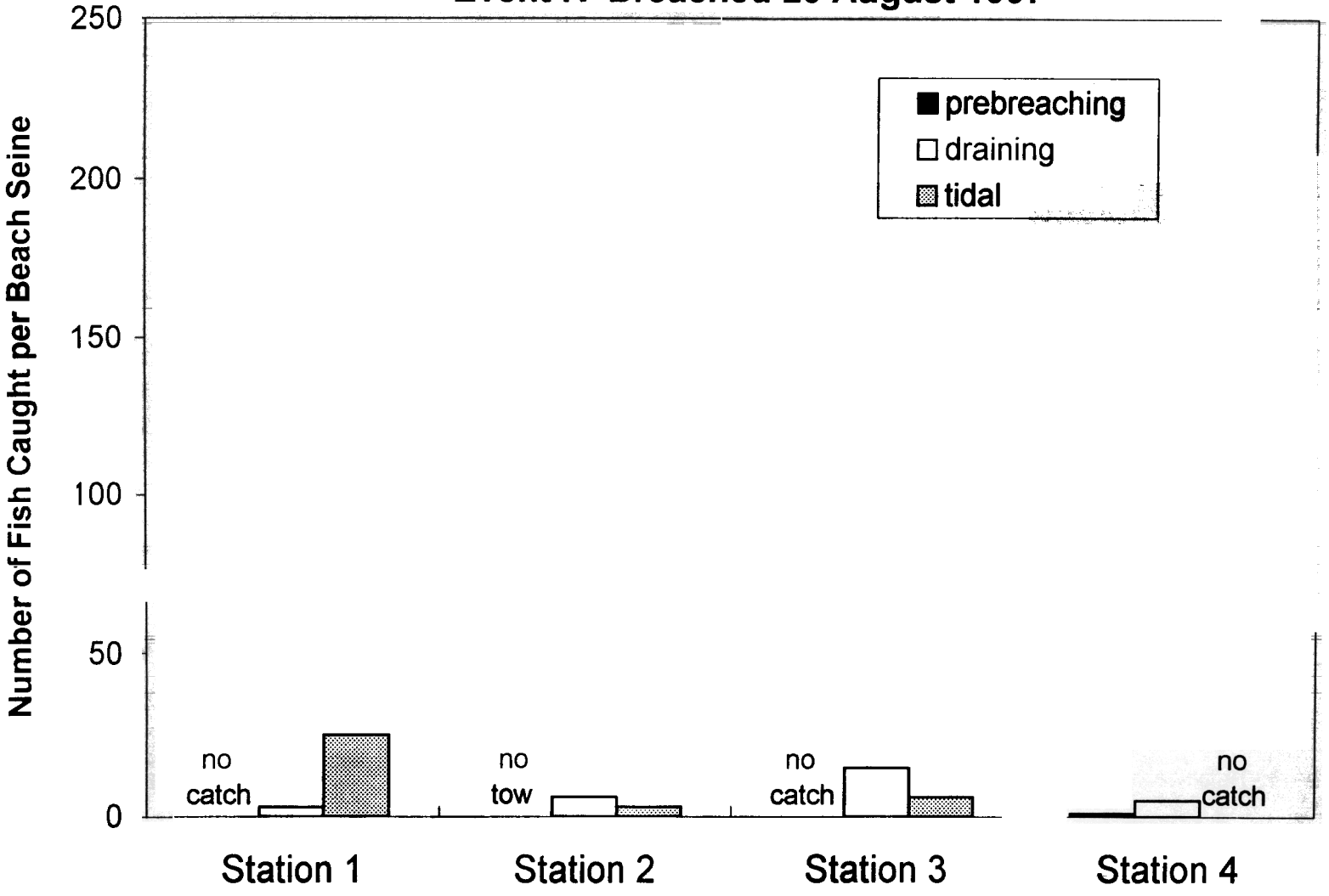
Appendix B-63
Beach Seine Catch
Event III-Breached 27 June 1997



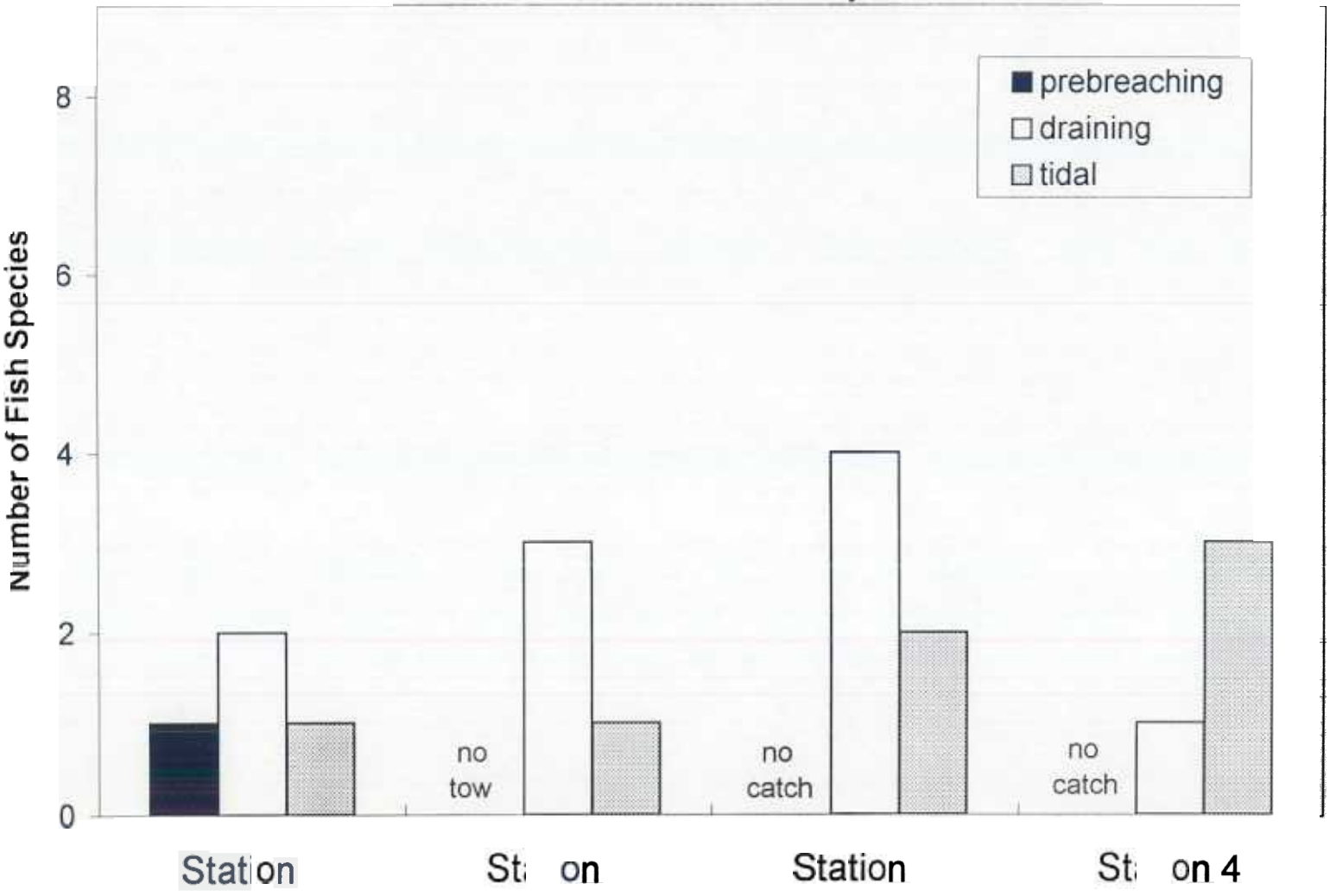
Appendix B-64
Number o F h Species in Beach Se ne
Event IV--Breached 20 August 1997



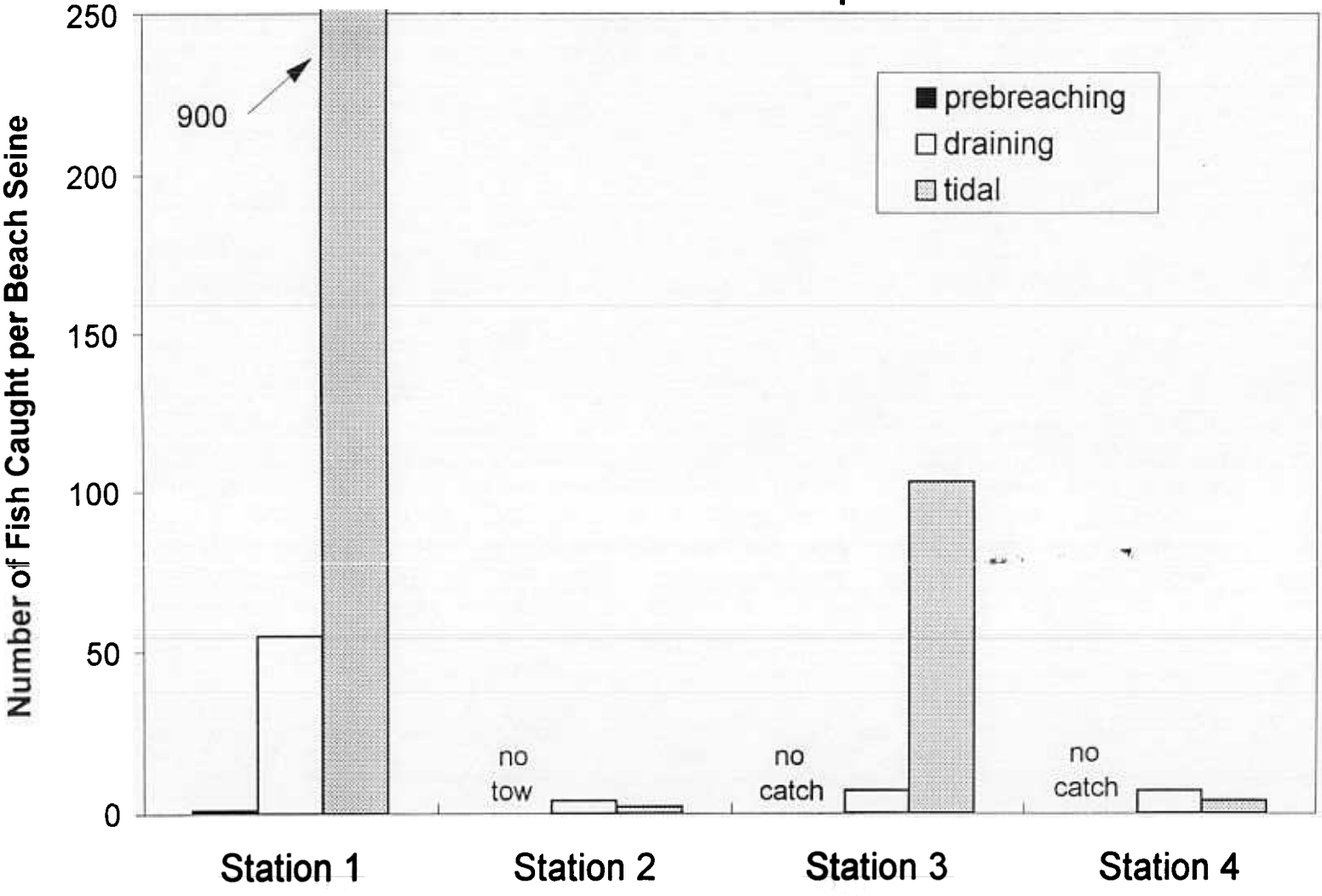
Appendix B-65
Beach Seine Catch
Event IV-Breached 20 August 1997



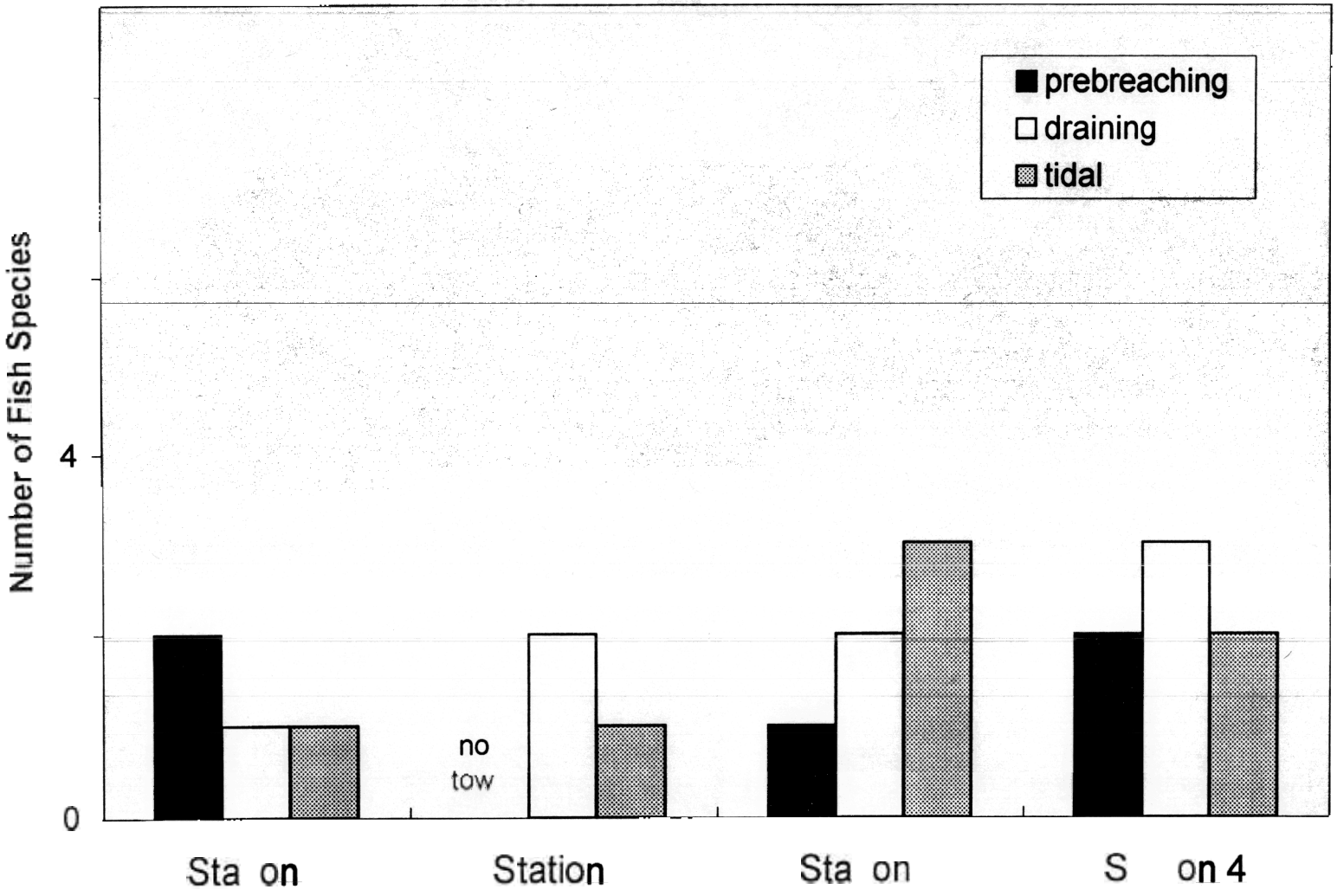
Appendix B-66
Number of Fish Species in Beach Seines
Event V--Breached 19 September 1997



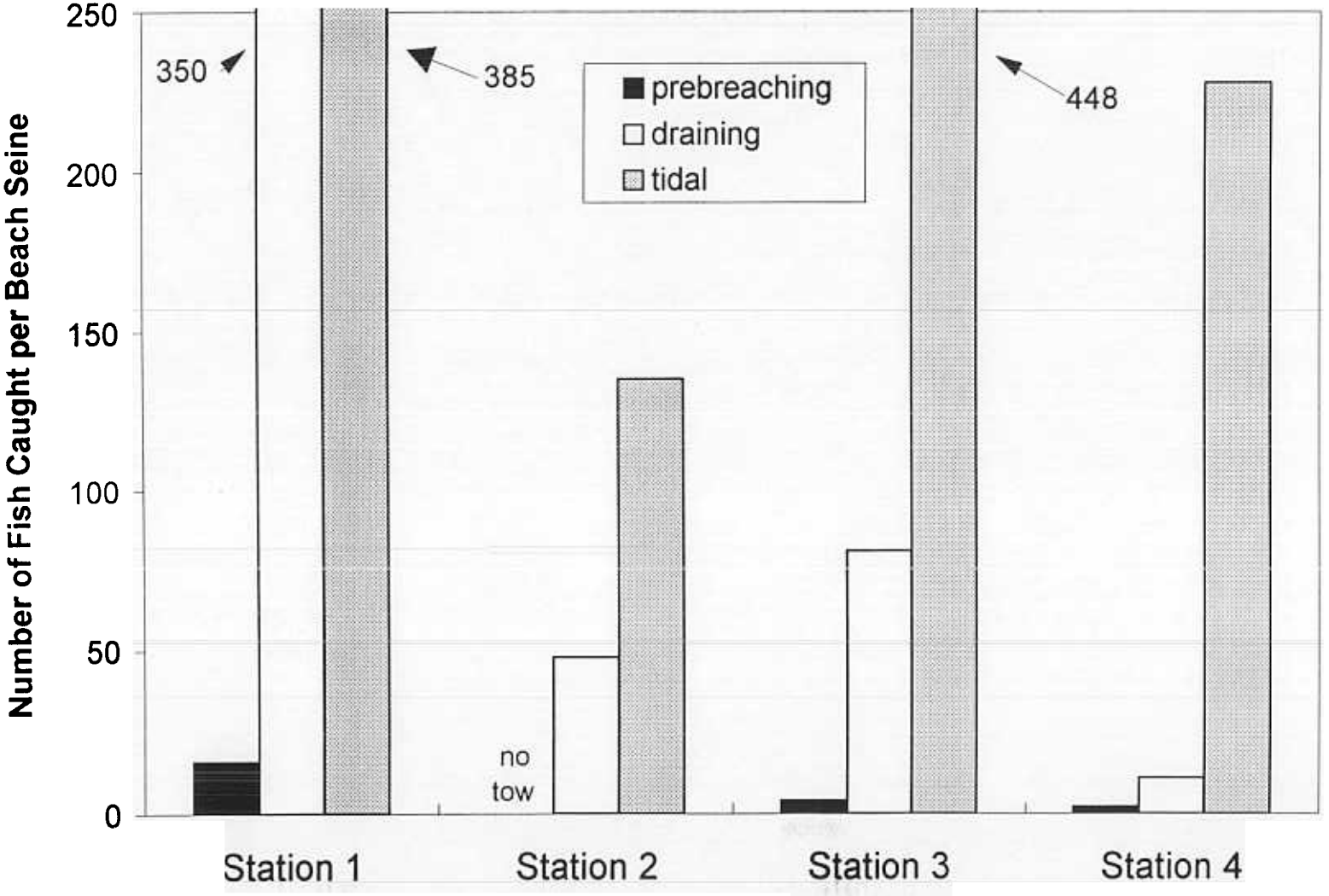
Appendix B-67
Beach Seine Catch
Event V-Breached 19 September 1997



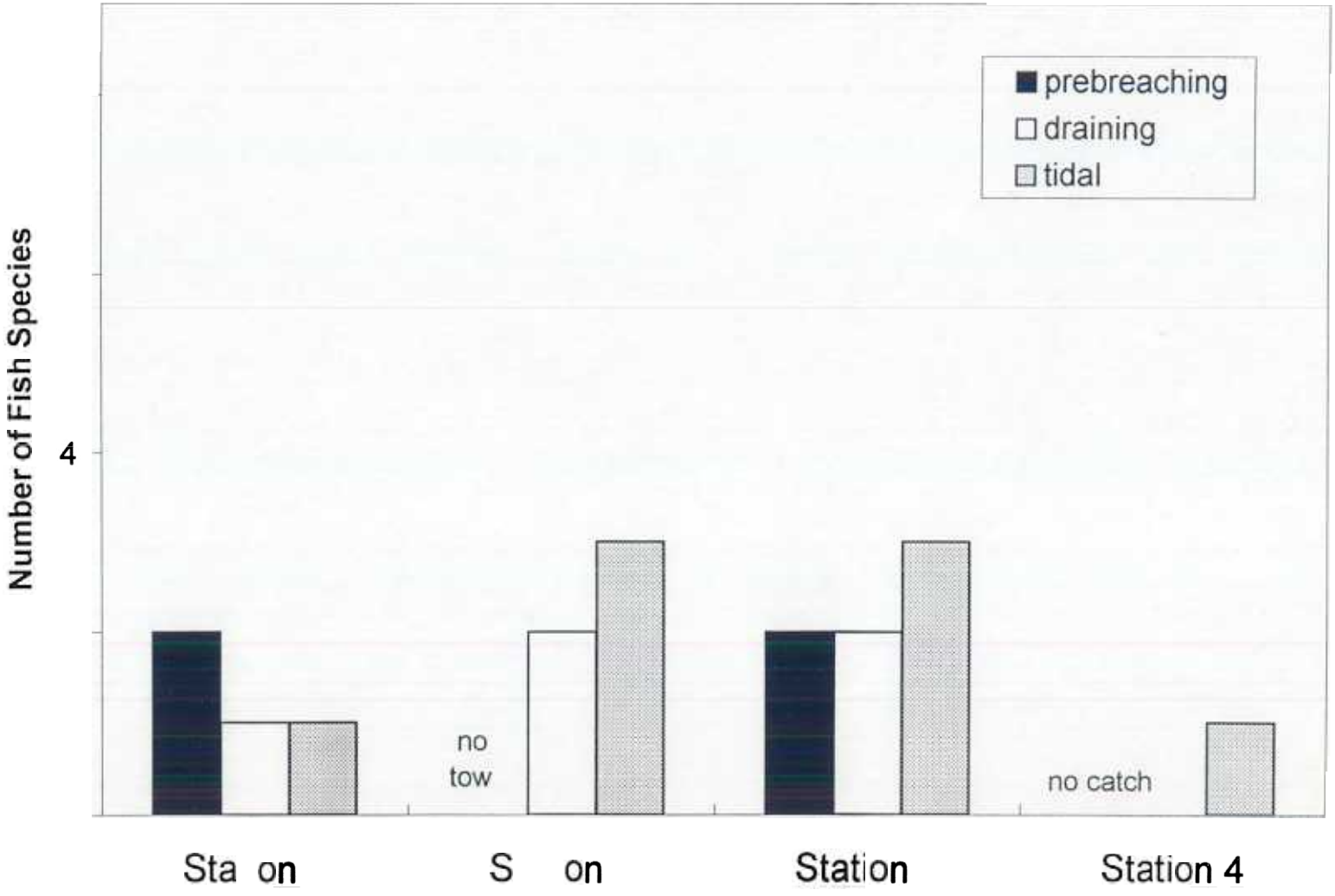
Appendix B-68
Number of F sh Species in Beach Se nes
Event VI Breached October 997



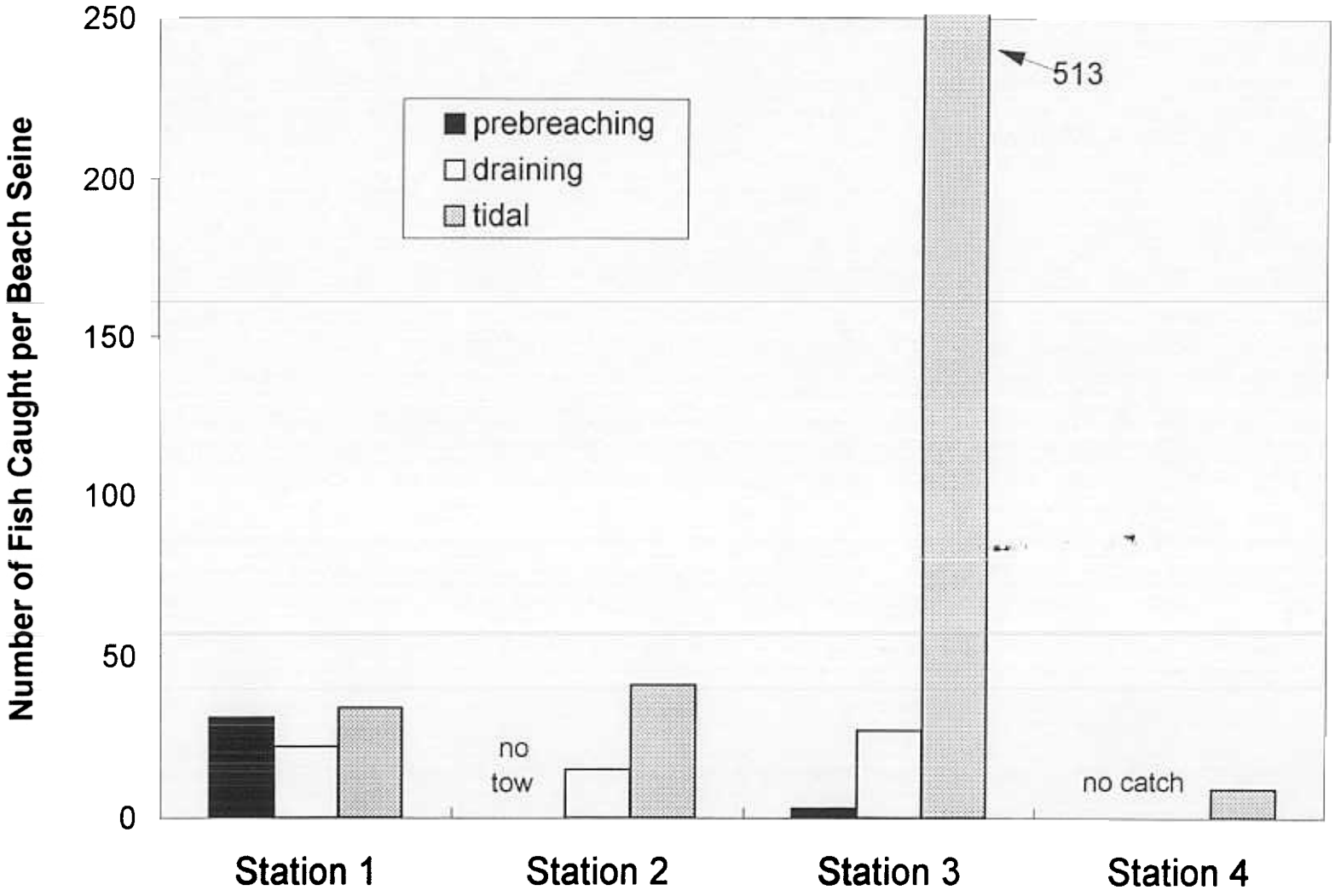
Appendix B-69
Beach Seine Catch
Event VI-Breached 11 October 1997



Appendix B-70
Number of Fish Species in Beach Se nes
Event VII--Breached 3 November 997



Appendix B-71
Beach Seine Catch
Event VII-Breached 3 November 1997



Appendix B-72. Fork Lengths (millimiters) of Steelhead captured in the Russian River Estuary, 1997. *denotes fish caught in otter trawls; all others were caught in beach seines.

		Station Number			
date	Survey Type	stn 1	stn 2	stn 3	stn 4
9-May-97	Tidal			175 164 188	69p
20-May-97	Prebreaching			114	
23-May-97	Draining	168 168			112
10-Jun-97	Draining	160*	75 57		131 68p 63p 63p 51p*
13-Jun-97	Tidal		58p		
22-Jun-97	Prebreaching			76sp* 92sp	71p 62p
28-Jun-97	Draining				82p 63p
1-Jul-97	Tidal			95sp	
20-Sep-97	Draining		410h	171	
10-Oct-97	Prebreaching			150 165 158 172	173
31-Oct-97	Prebreaching			144 141	
4-Nov-97	Draining			235	
7-Nov-97	Tidal			224 179 142	

p = parr marks present
sp = silvery but parr marks still visible
h = half-pounder
all others typical silvery smolts

Appendix B-73. Fork Lengths (millimeters) of coho salmon smolts captured in beach seines in the Russian River Estuary, 1997

		Station Number			
date	Survey Type	stn 1	stn 2	stn 3	stn 4
9-May-97	Tidal				93
23-May-97	Draining	112 106 118 100 114 105	105		
27-May-97	Tidal		93 103 106	102	
10-Jun-97	Draining	105 104 84 98			
28-Jun-97	Draining		115	98	

Appendix C-1. Summary of Organisms Caught in Plankton Tows in the Russian River Near Willow Creek, 1997.
up = upstream of creek mouth
down = downstream of creek mouth

	Event I				Event II				Event III			
	Prebreaching 20-May-97		Draining 23-May-97		Prebreaching 6-Jun-97		Draining 10-Jun-97		Prebreaching 22-Jun-97		Draining 28-Jun-97	
	up	down	up	down	up	down	up	down	up	down	up	down
Mysidacea (mysids)												
Neomysis mercedis	1		87					1			11	2
Isopoda (sowbugs)												
sphaeromatid sp.	4		105	26				20		1	76	8
Amphipoda (scuds)												
Eogammarus confervicoluous*			24	4				20			1	2
Corophium sp.			17				1	278			2	8
Insecta (insects)												
Hemiptera (true bugs)												
corixid sp.		**3**	**185**					**1**			**15**	
Coleoptera (beetles)												
hydrophilid sp.	1											
Diptera (flies)												
chironomid sp.												
Fish												
3-spine stickleback larva			1									
prickly sculpin juvenile			1									
bay pipefish larva			1									
number of taxa	3	1	8	2	0	0	1	5	0	1	5	4
number of individuals	6	3	421	30	0	0	1	320	0	1	105	20
flowmeter initial	759151	762436	765697	775115	-	-	-	-	778446	781916	785225	788155
flowmeter final	762436	765696	769163	778673	-	-	-	-	781916	785252	788153	791743
volume filtered, cubic meters	18.17	18.03	19.17	19.68	18.23**	18.23**	18.23**	18.23**	19.19	18.45	16.19	19.84
total individuals per cubic meter	0.33	0.17	21.96	1.52	0.00	0.00	0.05	17.55	0.00	0.05	6.48	1.01

* =Anisogammarus

**flowmeter not deployed; volume filtered is average of volumes of metered tows.

Appendix C-1. Summary of Organisms Caught in Plankton Tows in the Russian River Near Willow Creek, 1997.
up = upstream of creek mouth
down = downstream of creek mouth

	Event IV				Event V				Event VI			
	Prebreaching 18-Aug-97		Draining 21-Aug-97		Prebreaching 16-Sep-97		Draining 20-Sep-97		Prebreaching 10-Oct-97		Draining 12-Oct-97	
	up	down	up	down	up	down	up	down	up	down	up	down
Mysidacea (mysids)												
Neomysis mercedis							2	9	4		3	
Isopoda (sowbugs)												
sphaeromatid sp.	1	4	9	7	70	2	87	27	185	12	6	
Amphipoda (scuds)												
Eogammarus confervicoluous*	2		14	2	2		2	1				
Corophium sp.			2	17			8	7	1			
Insecta (insects)												
Hemiptera (true bugs)												
corixid sp.												
Coleoptera (beetles)												
hydrophilid sp.												
Diptera (flies)												
chironomid sp.												
Fish												
3-spine stickleback larva												
prickly sculpin juvenile												
bay pipefish larva												
number of taxa	2	1	3	3	2	1	4	4	3	1	2	0
number of individuals	3	4	25	26	72	2	99	44	190	12	9	0
flowmeter initial	792621	796647	799994	804189	811008	808104	814348	817027	820603	822800	825386	831376
flowmeter final	796640	799887	803868	807601	814247	811008	817025	820270	822800	825354	828320	834505
volume filtered, cubic meters	22.23	17.92	21.42	18.87	17.91	16.06	14.80	17.93	12.15	14.12	16.23	17.30
total individuals per cubic meter	0.13	0.22	1.17	1.38	4.02	0.12	6.69	2.45	15.64	0.85	0.55	0.00

* =Anisogammarus

Appendix C-1. Summary of Organisms Caught in Plankton Tows in the Russian River Near Willow Creek, 1997.
up = upstream of creek mouth
down = downstream of creek mouth

	Event VII			
	Prebreaching 31-Oct-97		Draining 4-Nov-97	
	up	down	up	down
Mysidacea (mysids)				
Neomysis mercedis			1	
Isopoda (sowbugs)				
sphaeromatid sp.		1	662	25
Amphipoda (scuds)				
Eogammarus confervicoluous*			12	2
Corophium sp.			24	
Insecta (insects)				
Hemiptera (true bugs)				
corixid sp.				
Coleoptera (beetles)				
hydrophilid sp.				
Diptera (flies)				
chironomid sp.				1
Fish				
3-spine stickleback larva				
prickly sculpin juvenile				
bay pipefish larva				
number of taxa	0	1	4	3
number of individuals	0	1	699	28
flowmeter initial	834017	838292	842063	844841
flowmeter final	838282	841893	844838	849001
volume filtered, cubic meters	23.59	19.91	15.35	23.00
total individuals per cubic meter	0.00	0.05	45.55	1.22

* =Anisogammarus

Breaching of the Russian River and its Effects on Seals in 1997

Joseph Mortenson

Data Collected by Jamie Hall, Kate Fenton,
Joseph Mortenson, and Elinor Twohy

Introduction

This research was the second year of a study examining how the Russian River breaching process affects the behavior of seals. Originally it was expected that the guards would be present during and after breaching, and that guards would keep people back from the breaching area and from the seal colony. In this way guards might both protect people from breaching site hazards and limit disruption of the seal colony. Because Jenner seals are relatively tolerant, it is possible for them to remain at their haulout during the bulldozing of the river bar (Hanson, 1994). However, people attracted by a breaching can later disturb the seals and cause the abandonment of the Jenner haulout, even if the seals have remained during the actual bulldozing.

In the original design of the research, the short-term effects of guarding were to be investigated by comparing seal behavior on the days before, during, and after the breachings. Any disturbances of the colony by people were to be recorded using the standard interference measures developed in earlier studies (Allen, 1984; Allen and King, 1992; Mortenson, 1996). To see if there were any long-term effects of guarded breaching, the Jenner daily seal census was to be analyzed. It was hoped that guarding on breaching day would lower the level of the disturbance at the seal colony, and seals would remain through the breaching. It addition, it was thought possible that the typical increase of seal numbers seen after the river opens might be higher both on breaching day and post breaching day if the breaching site were guarded throughout the day.

In 1996, the first year of this study, most breachings and breaching attempts were not guarded. Some of the breaching attempts were unofficial and out of the control of the Sonoma County Water Agency (SCWA). The time of successful breachings was hard to anticipate. Two of the successful breachings were guarded during bulldozing, but the channel created through the bar was not guarded afterward by SCWA workers. One of these guarded breachings was late in the evening and was not announced, and could not be well documented. All this made it difficult to carry out the original plan to study guarded breachings . In the second year of study all actual breachings observed in detail were guarded during excavation. The SCWA crew withdrew from the beach after each excavation ended. On occasions following the departure of the SCWA crew, State Parks

Lifeguards drove out to the excavation site to guard the seals and warn people away from the breach. Thus although the plan to study guarded breachings was followed more closely in the second year, the amount of guarding on breaching day was inconsistent.

In this report we will first overview overall pattern of seal numbers and river closings in 1997. Then we will review the three individual breachings studied in detail. Lastly, we will draw a series of tentative conclusions on the basis of the 1996 and 1997 studies and previous research.

Method

Harbor seals at the Jenner haulout were counted from the overlook on Highway 1 opposite the colony (see Appendix 1). The time for the daily counts varied intentionally in order to sample the seals at different times of day. However, counts were rarely made soon after sunrise or late in summer evenings. The time that counts were made thus represented the daytime seal population. (In disturbed colonies such as Jenner's, seals sometimes may haul out late in the evening, early in the morning, and/or at night.)

During the prebreaching, breaching, and postbreaching observation days, seals and people were counted at half hourly intervals in order to show daily trends in numbers (Appendix II). Prebreaching observations were made two days prior to breaching day, and postbreaching observations the day following breaching. Human disturbances were logged during intensive observation periods (Appendix III). These disturbances were analyzed using the method previously developed at Jenner (Mortenson, 1996), this method itself being a derivation of the standard interference measures used in studies at the Point Reyes National Seashore (e. g. Allen, 1984; Allen and King, 1992). Because in contrast to Point Reyes disturbances at Jenner are multiple and continuous, the number of minutes when disturbance of different kinds occurs is recorded by the observer. This straightforward procedure generates an hourly interference rate, that is, the number of minutes per hour in which disturbance occurred.

Results

Numbers of Seals and River Closings from January through October 1997

The daily census of the harbor seal population at Jenner from January through October 1997 is presented in Figure 1. As may be seen, numbers were highest in late winter. There was a secondary peak about the time of the summer molt. This is the typical pattern for Jenner (Mortenson and Twohy, 1995).

As is also typical (Twohy, unpublished data) the river was barred most often in the second half of the year. Figure 1 also shows river closures from January through October 1997. Through October 1997, there were ten successful breachings.

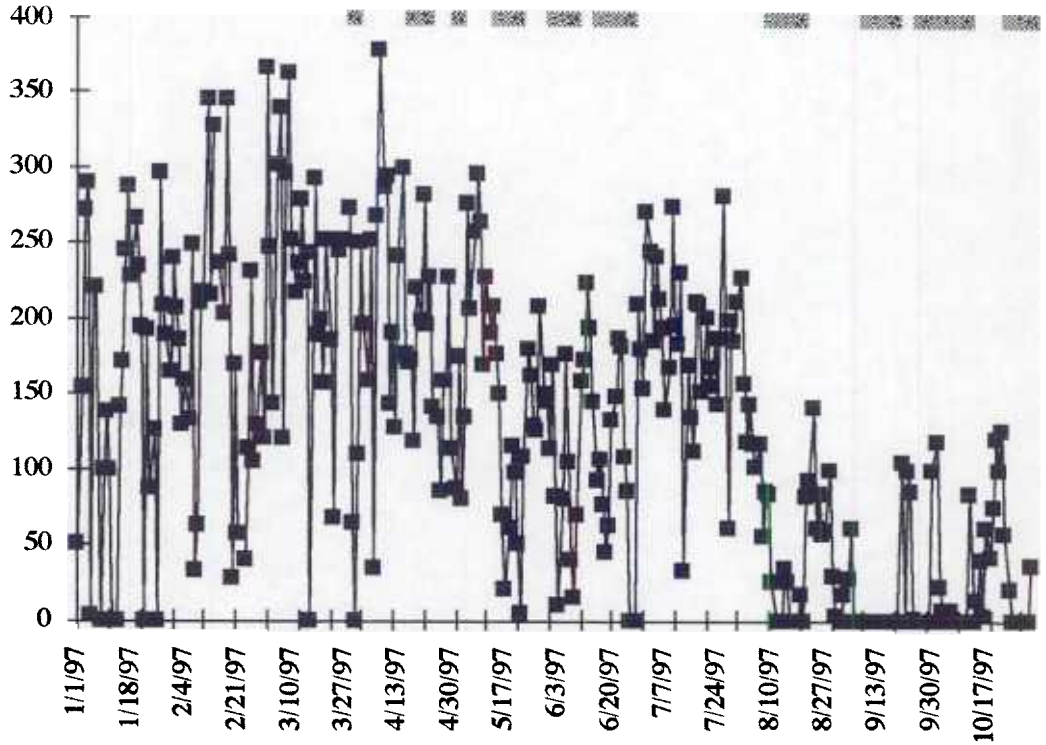


Figure 1. Seal numbers at Jenner from January through October 1997. In this and following figures, a gray bar above indicates when the river was barred.

Seal numbers fell during the closings of the Russian River in 1997 (Figure 2), as has been found in earlier studies (Hanson, 1993, Mortenson, 1994, Mortenson and Twohy, 1995, Mortenson, 1996, Mortenson, 1997). The average figures when open and closed are quite similar to those in the earlier study in this series (1997, closed 48.8, open 153.5; 1996 closed 40.3, open 149.9). It may be that at least some of the Jenner seals haul out on rocks near the end of North Jenner beach when the river is barred. Counts taken at these rocks are inversely related to those at Jenner (Mortenson, unpublished data).

In Figure 3 is shown the mean number of seals present on the day preceding closure, on the day of closure, and on the day after closure. A similar fall in number at closing had also been seen in the earlier study in this series, but the total on the day after closing rose. Numbers rose right after the river was opened (Figure 4). An increase after opening is a typical observation (Mortenson and Twohy, unpublished data).

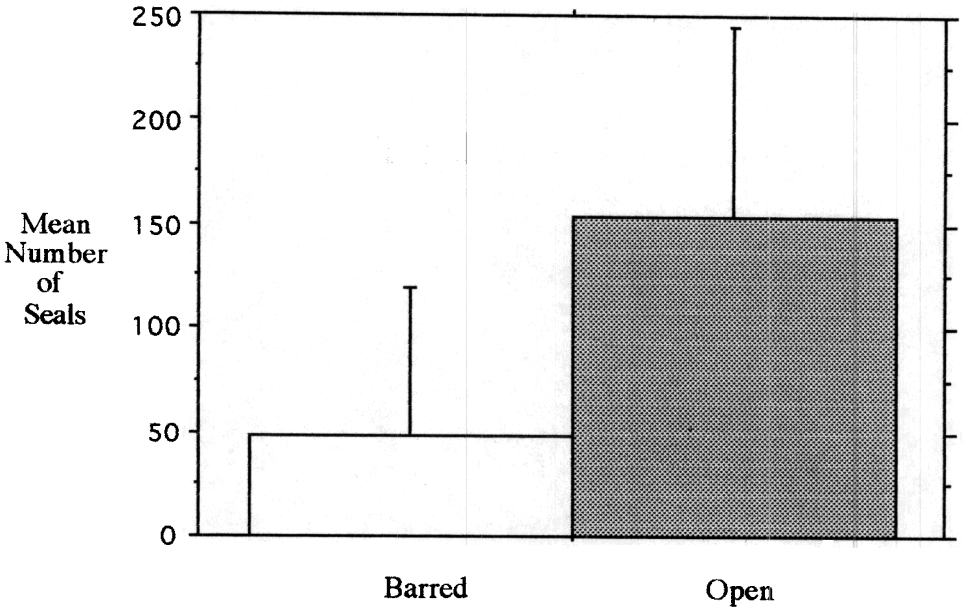


Figure 2. Mean number of seals (+ S. D) hauled out at Jenner when the Russian River was barred or open from January through October 1997.

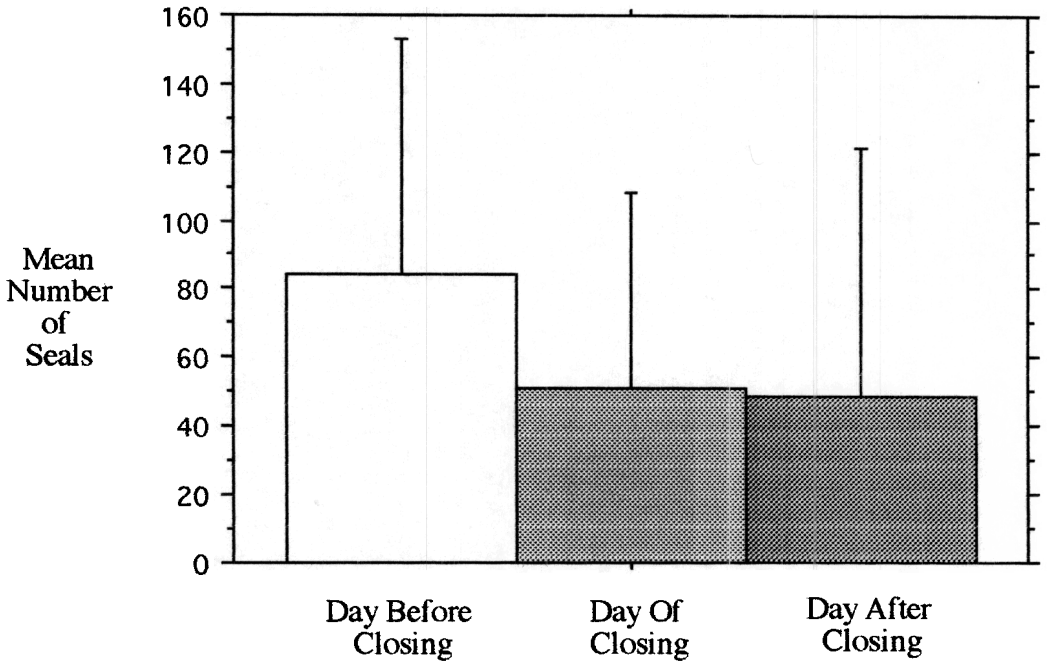


Figure 3. Mean number of seals (+ S. D.) present on the days immediately before, during, and immediately after river closures from January through October 1997.

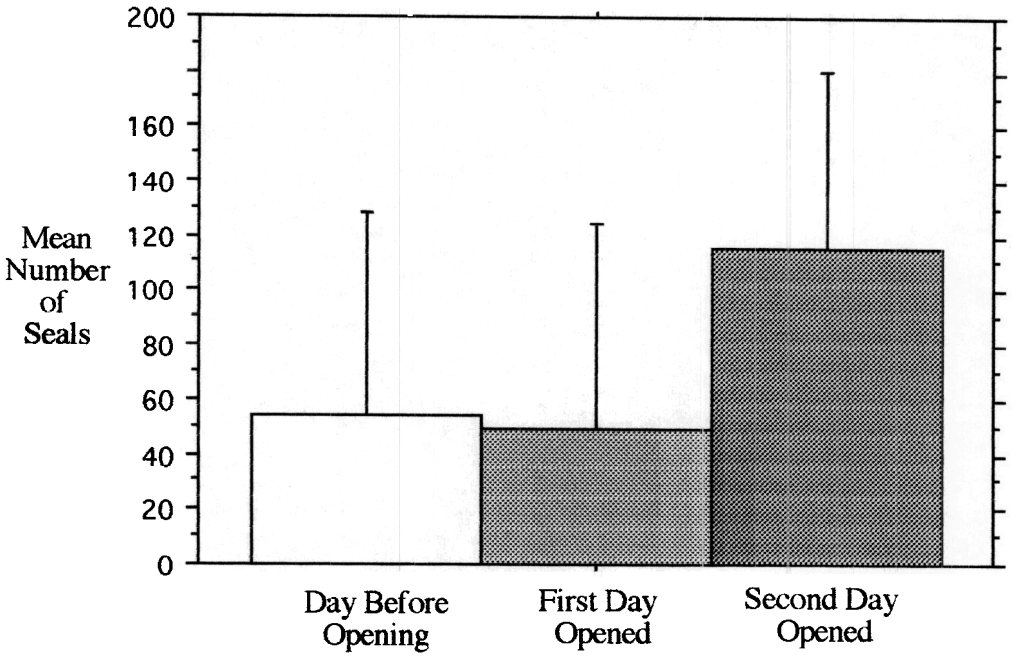


Figure 4. Mean number of seals (+ S. D.) present on the days immediately before, during, and immediately after river openings from January through October 1997.

Individual Breachings

SCWA Breaching of March 31, 1997

The Russian River closed for the first time on March 30, 1997, during the winter period when seal numbers are highest at Jenner (Figure 5). The next day the SCWA breached just as the daily seal census was being made. At the time of the count, 110 seals were present as the bulldozer worked, illustrating that Jenner seals may tolerate the breaching process, with all its noise and vibrations.

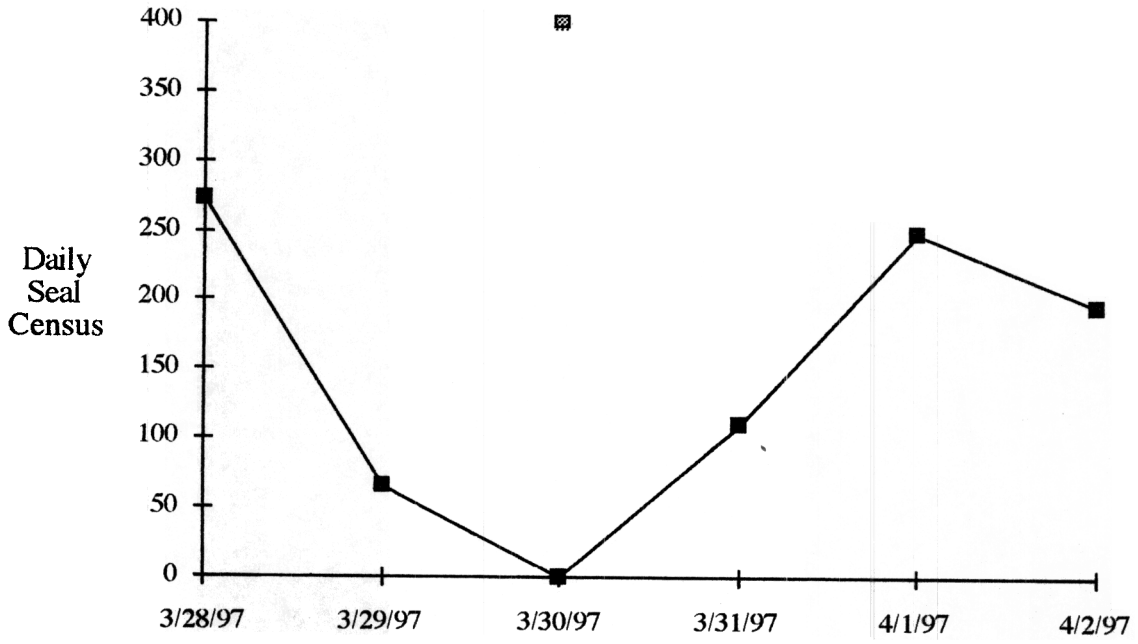


Figure 5. Seal numbers during the river closure beginning March 30, 1997. Gray square indicates the single day of closure.

Natural Breaching of 23 April 1997

Seal counts for the closure of April 18, 1997 were unusual in that more than 200 seals hauled out even though the river was closed. Note that there was no great drop in numbers at the time the river closed or the time when it opened. In fact numbers rose during closing.

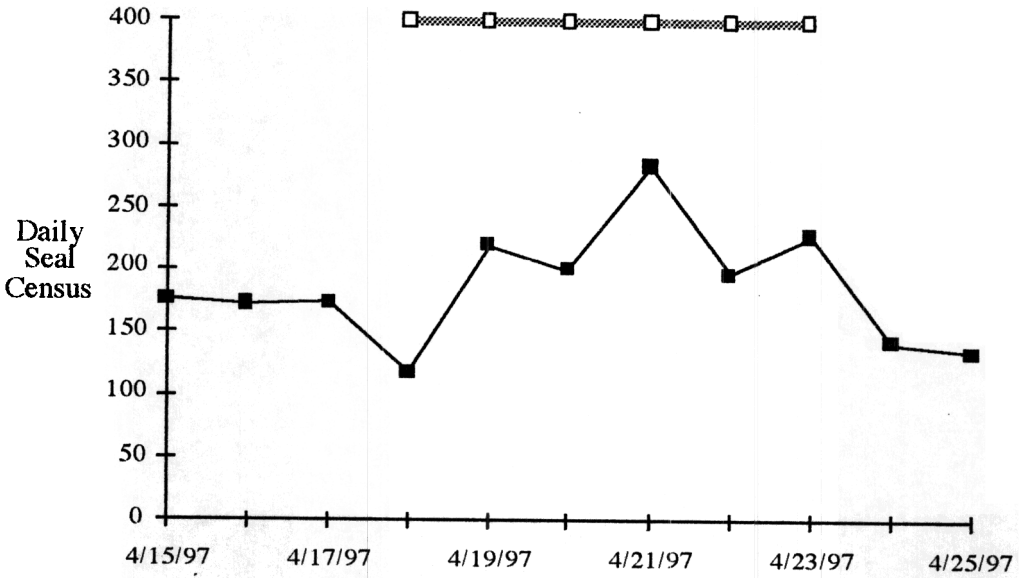


Figure 6. Seal numbers during the river closure beginning April 18, 1997. Gray bar indicates river closure.

Natural Breaching of May 3, 1997

Again, on the brief closure of May 2, 1997, numbers of seals did not fall but instead they increased somewhat. Again, this rise in numbers in the two spring closures contrasted with the overall tendency for numbers of Jenner seals to be lower when the river was closed.

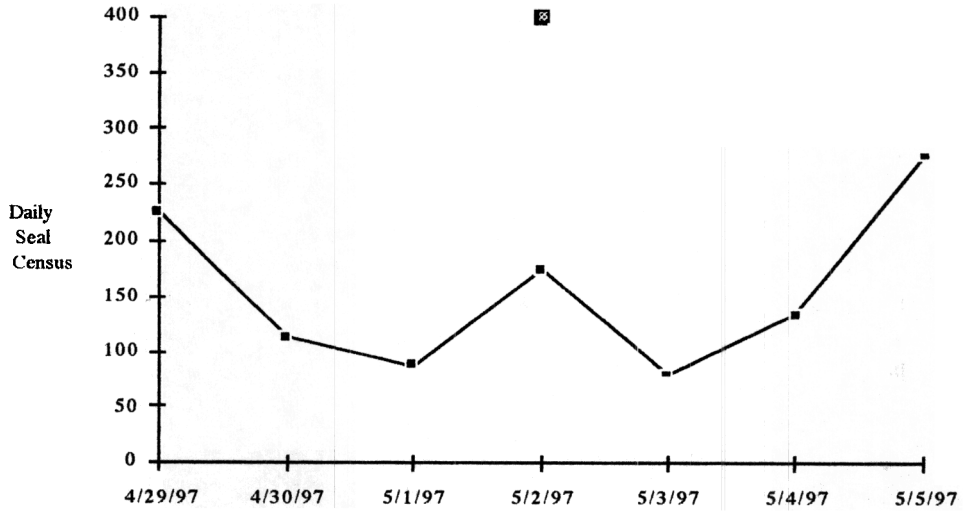


Figure 7. Seal numbers during the closure of May 2, 1997. Gray square indicates the single day of river closure.

SCWA Breaching of May 22, 1997

During the closure which began on May 15, seal numbers dropped, rose, and dropped again (Figure 8).

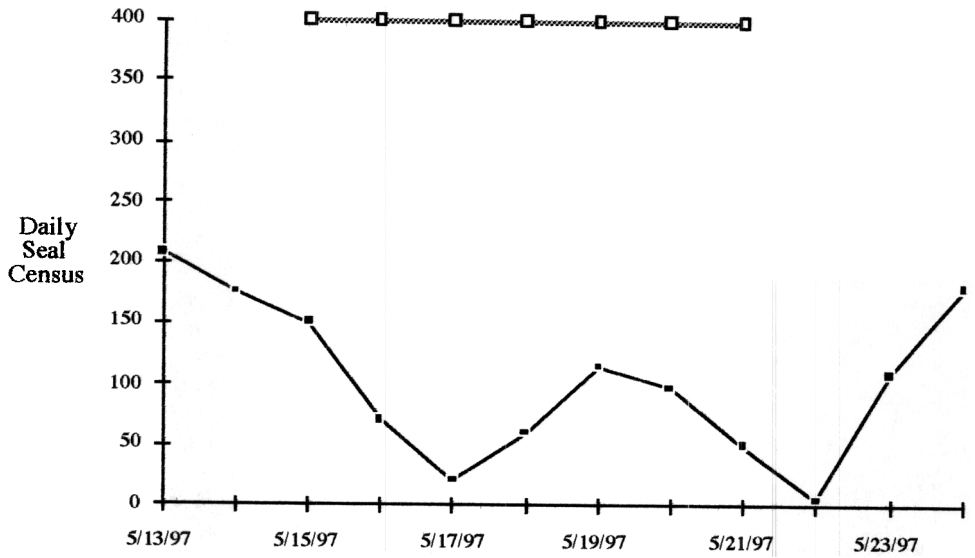


Figure 8. Seal numbers during the river closure beginning 15 May 1997. Gray bar indicates river closure.

Prebreaching observations of May 20, 1997

On May 20, the colony was monitored to provide a baseline for disturbance during breaching (Figure 9). Numbers grew from early morning, reaching a peak at 11:00 AM. Disturbance incidents occurred early in the morning or at lunch time, a not unusual pattern (Figure 9). In the morning incident, the disturbance appeared to be deliberate, since the person walked toward the seals directly, staring at them. Most seal responses evoked by people on prebreaching day consisted of alert postures and movements but not flights.

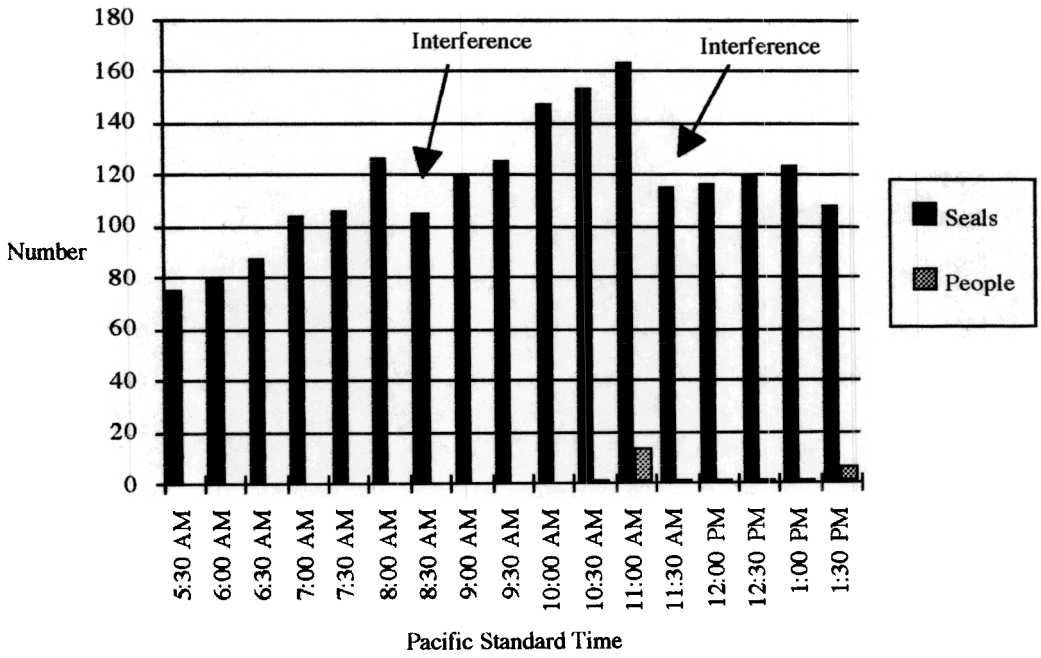


Figure 9. Seal and people counts on May 20, 1997, two days before breaching.

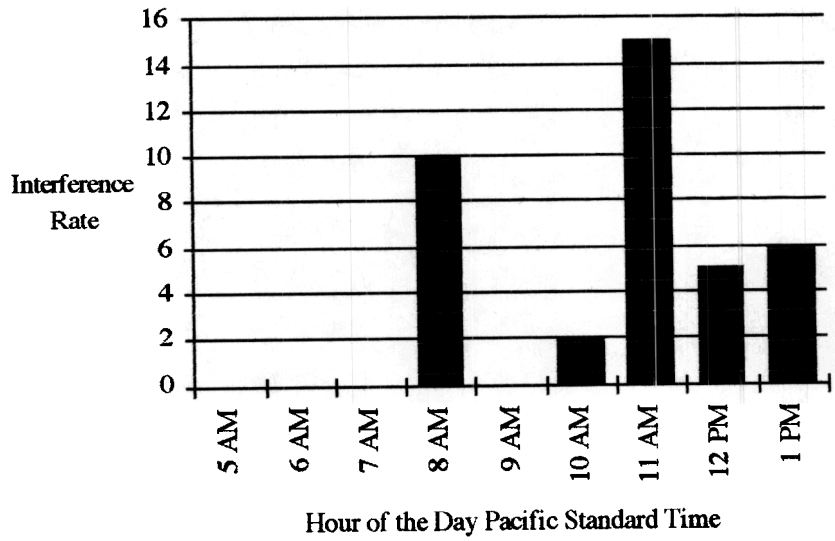


Figure 10. Rates of disturbance during different hours of the day on May 20, 1997.

Breaching Day, May 22, 1997

On breaching day, May 22, 1997, seal numbers increased after dawn, which is characteristic of the undisturbed haulout. The seals were gathered in two groups, one on

the bar, and one on a spit jutting out into the impounded river mouth to the north of the bar group. At 6:45 AM, a SCWA crew of 5 men approached the bar, four on foot, and one in the bulldozer. When the crew arrived at the Seal Watch signs, just south of the Jetty, they commenced to drive t-posts into the sand, and then suspended yellow warning tape between the posts. The seals briefly alerted to the banging noise. The crew then approached the bar, causing some alerts, but began shouting loudly at 7:00 AM, at an estimated distance of 220 m. from the seals. At the sound of the shouts, 29 of the 33 seals on the bar retreated into the water. The last 4 seals on the bar went into the water in the next minute. The bulldozer came forward onto the bar, and then three members of the crew, carrying t-posts, walked north. The seals on the spit retreated into the water when the 3 men approached within 60 m of their haulout, at 7:05 AM. Thus all the seals at the colony had retreated from the SCWA crew and there were none left hauled out at the commencement of excavation.

Two seals rehauled on the bar by 7:13 AM. These seals retreated into the water two minutes later when approached by two members of the SCWA crew returning from the north. Seals again began to rehaul at 7:51 AM. Several times the rehauled seals alerted or retreated to shouts or movements of the SCWA crew or bulldozer. At the end of the excavation, 10-15 seals fled into the water when two SCWA crew members went to retrieve the t-posts and signs on the north side of the bar.

Seal number began to rise after the SCWA crew departed. However, a kayaker landed 160 m from the seals and then walked toward them, causing a series of alerts and retreats. The kayaker came within 10 m of the seals that had not fled, and looked over the bulldozer cut.

A second person approached the cut from the south, as the kayaker went back to his boat on the north. A lifeguard then drove out toward the cut from the south, contacting the person who had approached from south, and this visitor left the area of the cut. The lifeguard parked his vehicle, later stopping five people before they reached the cut. Using his loudspeaker, the lifeguard warned off two people approaching from the north. The lifeguard dragged over a tree trunk to serve as a visual barrier, and had seven visitors stopped at the log. At 10:23 AM. the lifeguard began to leave, but then returned to stop two more people from approaching the cut. The lifeguard cautioned three more people and then finally left at 11:47 AM. At 11:55 AM people began to approach the cut, but they chose to stand away from the eroding cut or on the Jetty.

The kayaker returned, but this time in a small motorized boat. He got out of his boat and at 12:47 PM and started disturbing the seals again. His purpose this time was to dig and bag sand near the cut, which he did, flushing and alerting seals.

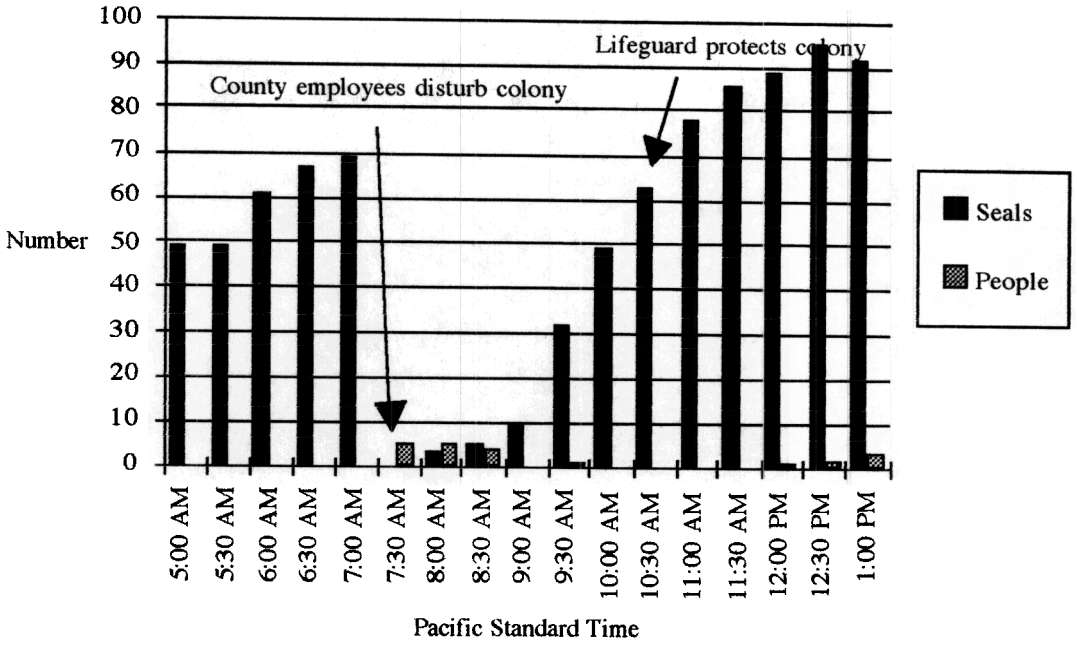


Figure 11. Seal and people counts during the breaching of May 22, 1997.

Interference rates showed a sustained rate of 6 per hour in the morning, caused first by the SCWA crew, and second by the kayaker (Figure 12). While the lifeguard watched over the colony, rates fell to zero, with the exception of one alert that was evoked by his loudspeaker. Once the lifeguard retreated, the kayaker again returned, bring back up the interference rate. Thus it seems clear that a lifeguard can both keep visitors away from the rushing channel and from the seals.

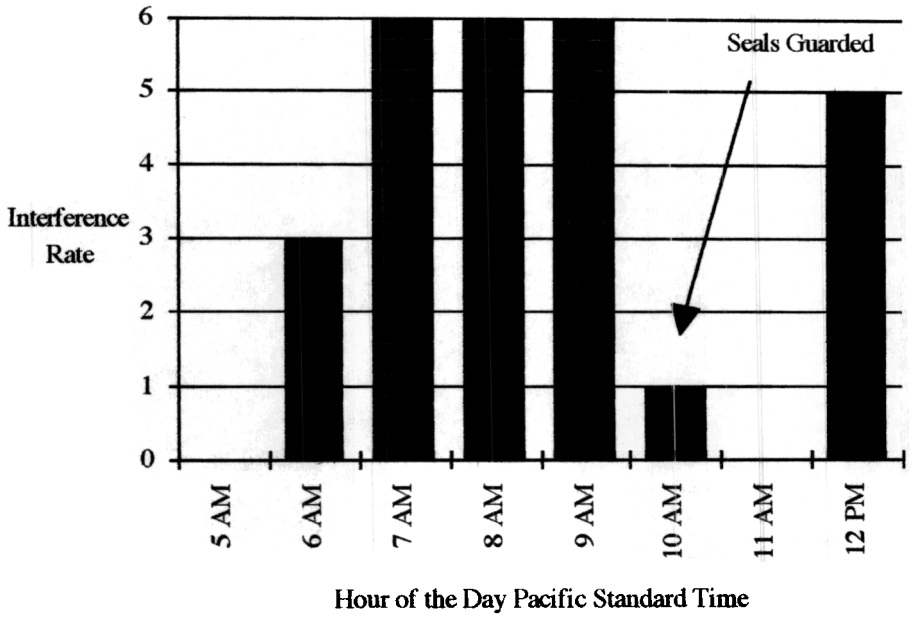


Figure 12. Rates of disturbance during different hours on May 22, 1997, breaching day

Post Breaching Day, May 23, 1996

The day after breaching began with a hard rain, and a drop in seal numbers (Figure 10). Seals often leave haul outs in heavy rain. Disturbance levels were low, initially perhaps because of the weather. After 10:30 AM gray whales appeared close to the mouth, surfacing, diving, and even rolling and spyhopping in plain view of people on the beach and at the overlook. This cetacean display lasted for 1.5 hour. Whales so close to the mouth drew most tourists' attention, probably accounting for the low interference levels with the seals later in the watch. The overall disturbance rate was only .75/h on this day, with three disturbances caused by a helicopter and three others during the time the whales were displaying.

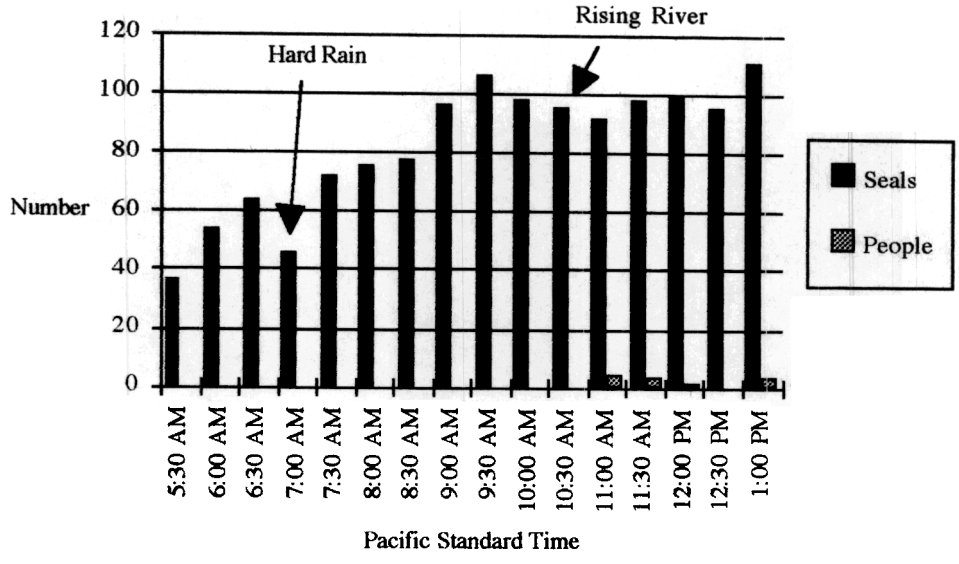


Figure 13. Seal and people counts on May 23, 1997, one day after breaching

SCWA Breaching of June 9, 1997

Seal numbers for the closure of June 2, 1997, followed a somewhat similar pattern to that seen during river closing in May. Numbers fell toward the day of closure, rose, and then fell again when the river was barred (Figure 14). Note that the river was briefly opened during an attempted breach on June 6, 1997.

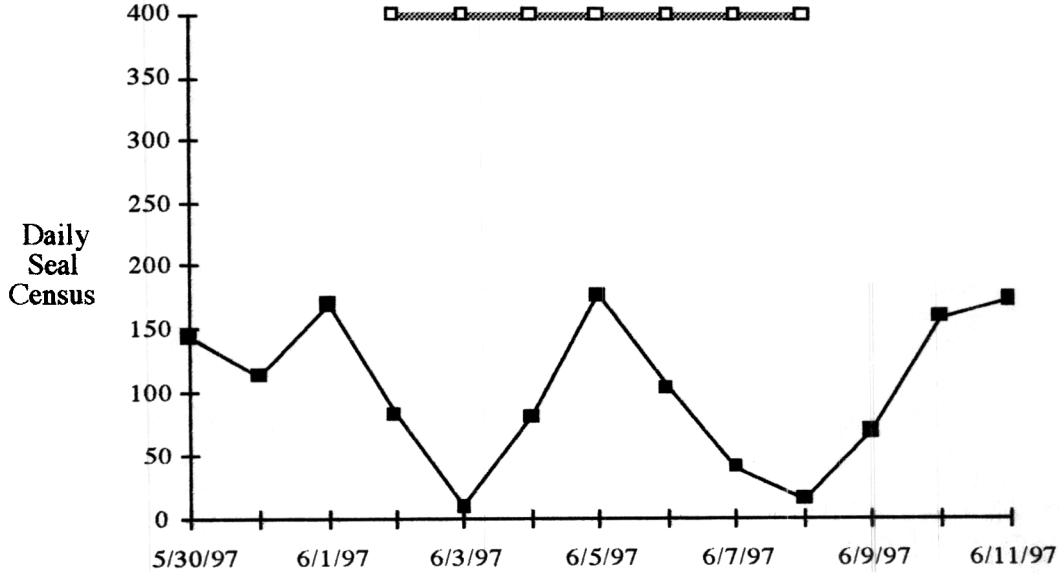


Figure 14. Seal numbers during the closure beginning June 2, 1997. Gray bar indicates river closure.

Attempted Breaching of June 6, 1997

On June 6, 1997 the SCWA attempted to breach the river (Figure 15). The crew started up their equipment at 6:45 AM, causing birds to fly up, and alerted the seals at an estimated distance of 1400 m. Thereafter there was a long series of alerts to the bulldozer, to the banging in of t-posts, and to the guard that had been posted on the north. At 7:00 AM there was a flight of seals to the bulldozer. Thereafter, there were a long series of alerts and three flights caused by the bulldozer or SCWA crew, which lasted until 10:55 AM, shortly after which the crew quit. A rowboat approaching the cut at 8:42 caused six minutes of disturbances and retreats. After the SCWA crew left, only two alerts occurred, one caused by a canoe and the other by a man putting up the bar gulls to flight. The river closed at about 12:14 PM.

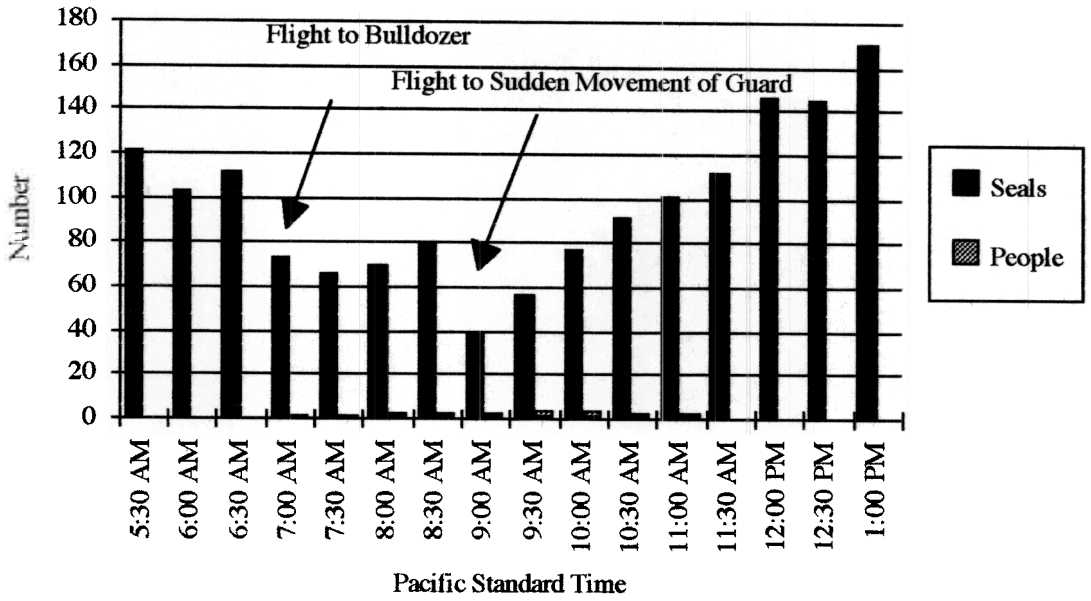


Figure 15. Seal and people counts on June 6, 1997, during an attempted breaching.

The interference rate was high and sustained during the morning breaching attempt (Figure 16). In 83 % of the cases the disturbances were due to the SCWA crew. Yet seals remained present during the entire process, illustrating again that seals can stay during breaching. The most serious drop in numbers was apparently due to a quick movement of the restless north guard. When he suddenly appeared in what seemed to be the seals' field of view and then abruptly looked up, many of the seals left the haul out. If he had not appeared, it is possible that seal numbers might have stayed relatively high through the breaching process.

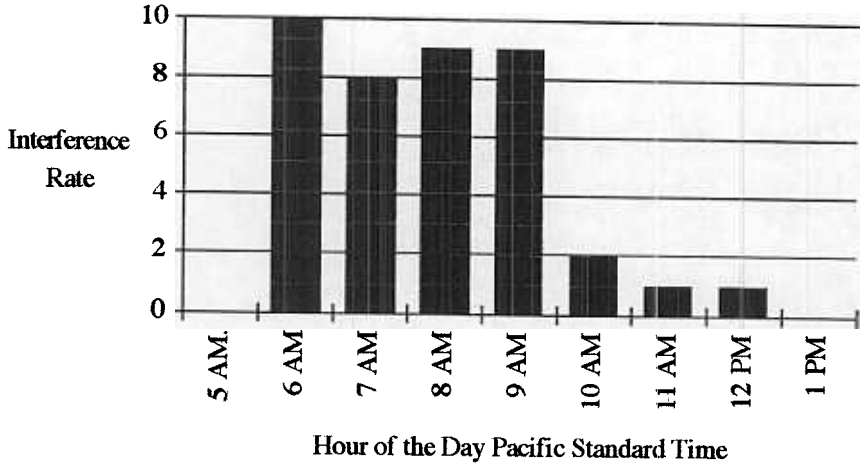


Figure 16. Rates of disturbance during different hours on June 6, 1997, when breaching was attempted.

Breaching Day, June 9, 1997

Breaching day, June 9, 1997, began quietly. Seal numbers climbed during the first hours of the watch (Figure 17). The SCWA crew arrived shortly before 8, started their equipment, then advanced up the beach. They drove t-posts in without using a steel banger and erected their yellow warning tape barrier without alerting the seals.

The seals were in two groups, one on the center of the bar and the other to the north. The seals on the bar first reacted to the approaching bulldozer at 8:14 AM at 400 m by alerting. After two minutes in which alerts occurred, all but two of the seals on the bar fled into the water after the bulldozer operator descended from his machine and walked on the beach, apparently surveying the excavation site. Thereafter, there were many alerts and one major flight of seals as the bulldozer worked in the cut. Most were occasioned by the sudden appearance of the bulldozer or staff atop the berm that the bulldozer had built to the north of the cut. There were also three alerts to a kayak at an estimated distance of 240 m.

The guard toward the north stopped a man from walking south into the excavation area, but two people slipped inside the warning tape and approached the cut from the south. At 9:30 AM, the lifeguard and a Ranger were present at the site. Two people walked around the tape but were stopped by a SCWA crew man, who gestured them away. Two other people stopped at the tape. At 10:36 AM a woman with a child went around the tape but then stood on the Jetty not approaching the cut. She was followed by five other people and two children who advance down the Jetty but did not go to the cut.

At 11:03 AM, the operator shut his engine down and stopped work. At 11:09 the SCWA crew took down their signs and then departed. At 11:23 AM the lifeguard drove down the beach and warned four people standing north of the Jetty away.

For an hour there was a lull in events. Numbers at the seal colony climbed until a man walked through the seals at 12:20 PM provoking three flights of seals. The man, who spoke with me earlier, had expressed hostility at the SCWA workers and life in general, and later the north guard had stopped him from approaching the excavation. Just after this man arrived, a dog wandered into the outflowing water. Two minutes later the dog and his owner started wading in the river just outside the cut. In the next minute, the hostile man waded across the cut, thigh deep in the accelerating water. The dog owner and his dog then repeatedly tried the water of the cut, the man going up to half way across the cut, with the water up to his crotch. His dog was finally swept out the past the cut but was rescued

by a woman who reached out into the water and grabbed the dog. The dog, man and woman then left.. Following 12:45 PM. seals near the cut alerted or retreated from parties of people, and crossing seals were twice blocked by visitors At 12:50 PM three people ran to the cut, and stood, laughing, 20 cm from the edge of the bank being undercut. Several people ran back when the berm was topped with a wave. Two women hesitatingly crossed the channel at 1:15 PM, one thigh deep and one hip deep. The man with the dog then returned and got in the water as the two women recrossed the breach, making a total of three people and a dog in the water. This series of incidents shows again people's reckless behavior after the bar is breached.

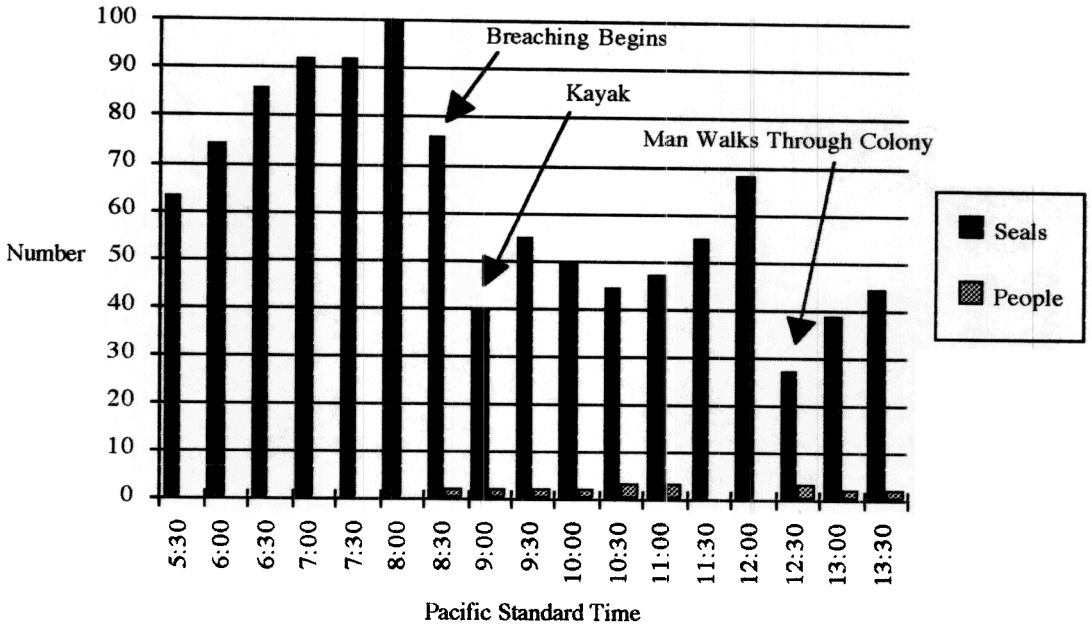


Figure 17. Seal and people counts on June 9, 1997, breaching day.

Disturbance rates were high on breaching day, during breaching itself and later when the visitors were drawn to the accelerating waters in the outflow channel (Figure 18).

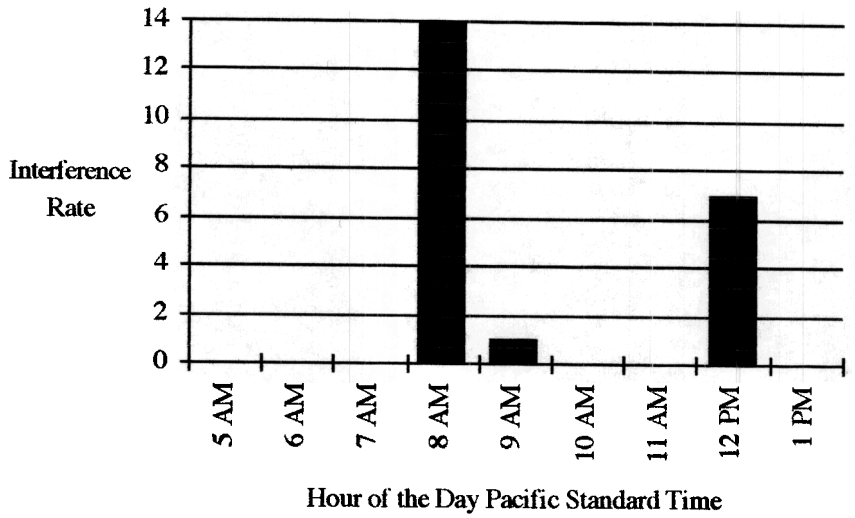


Figure 18. Rates of disturbance during different hours on June 9, 1997, breaching day.

Post Breaching Day, June 10, 1997

At 5: 30 AM, the day after breaching, 187 seals were present on the spits . Their number remained near this value all day (Figure 19), despite flushes of some of the animals. In the beginning of the day, there were only two alerts to trucks across the river (Figure 20). After 9:30 AM, people approaching the seals within 100 m and surfers evoked many alerts, moves, and flights. The rate of disturbance then gradually dropped, reaching zero in the last hour of observation. The odd element in this Saturday morning peak of disturbances was that Seal Watch was present, but stopped neither several parties of people nor the surfers from coming close to the seals. This implies that only a watchful guard can protect the seals; the mere presence of guards in not enough.

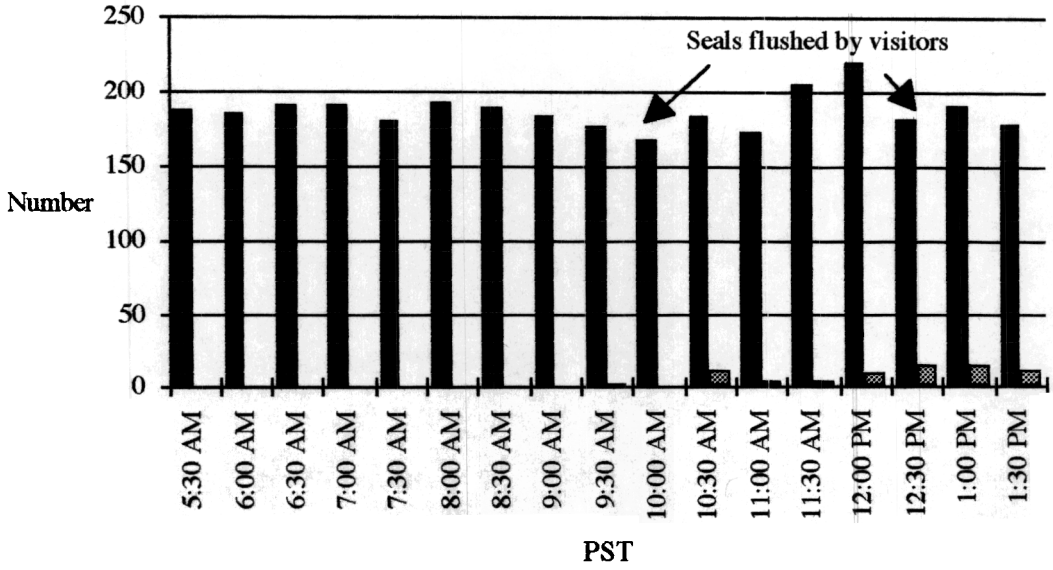


Figure 19. Seal and people counts on June 10, 1997, the day after breaching.

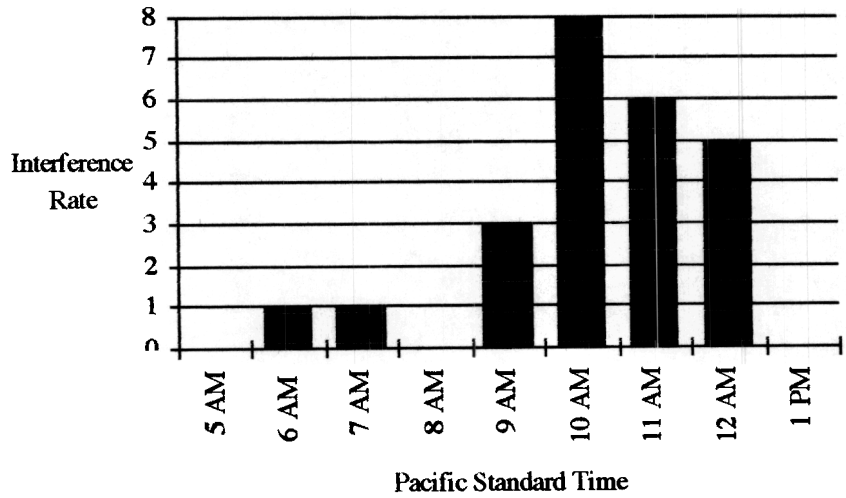


Figure 20. Rates of disturbance during different hours on June 10, 1997, the day after breaching,

SCWA Breaching of June 26, 1997

On June 26, 1997, the SCWA breached the river. Numbers remained up during most of the closure (Figure 21) but fell around breaching day.

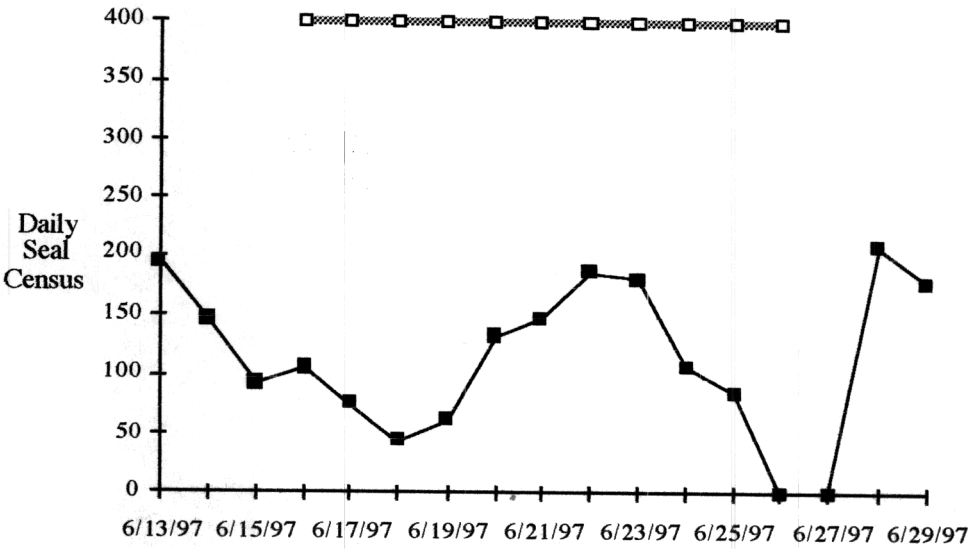


Figure 21. Seal numbers during the river closure beginning June 16, 1977. Gray bar indicates river closure.

SCWA Breaching of August 20, 1997

Seal numbers were low during the daily census count for the closure beginning August 9, 1997 (Figure 22). However, individual day studies to be described indicate that seals were present early in the morning.

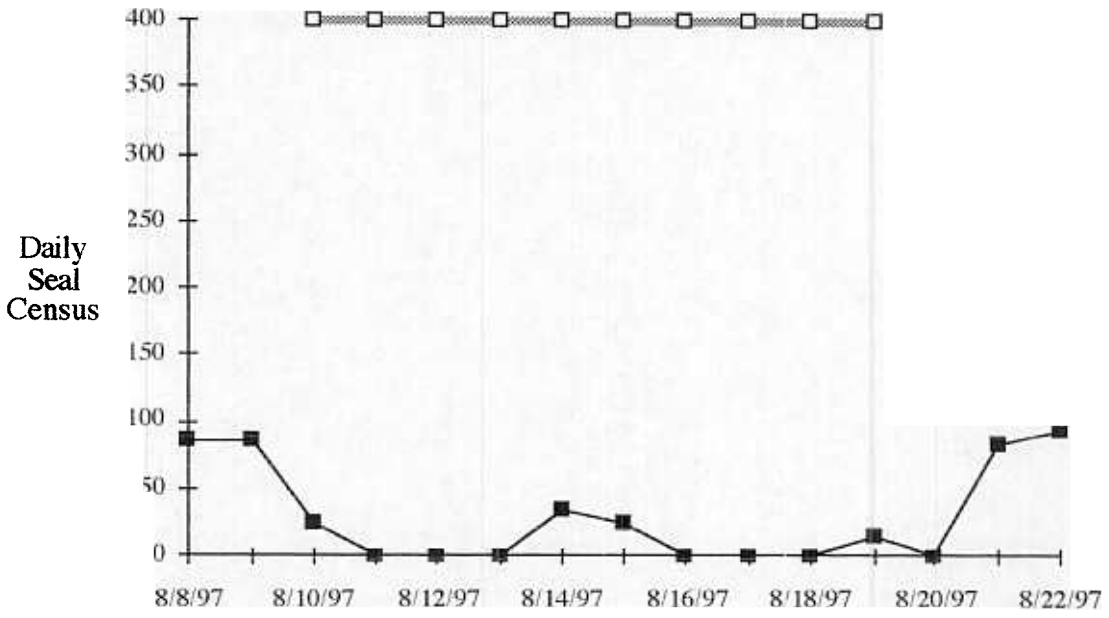


Figure 22. Seal numbers during the river closure beginning August 10, 1977. Gray bar indicates river closure.

Prebreaching Day, August 18, 1997

Visitors arrived early on August 18, 1997, the baseline observation day prior to breaching (Figure 23. A family of four appeared on the bar at 6:14 AM and tried to slowly approach the seals. Instead they caused the pelicans to fly away and alerted the seals. After 7:45 AM a person picking up pebbles started a long series of flights, moves, and alerts, as she walked in an erratic path. She continued to disturb the seals until 8:27 AM A third disturbance episode began at 9:51 AM with a number of people causing alerts and flights. This episode ended when a fisherman casting a net moved through the colony. No seals rehauled following the fisherman's passage.

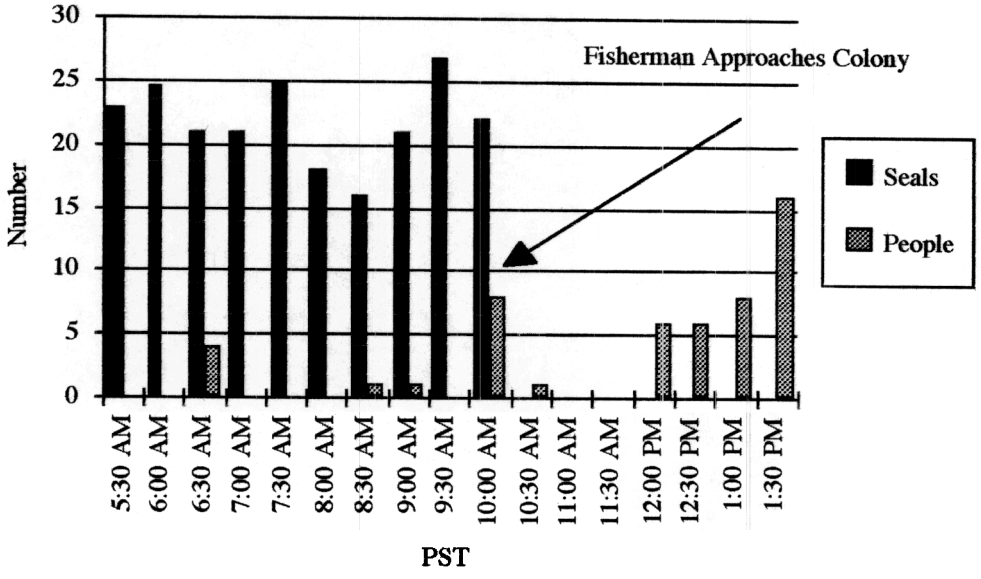


Figure 23. Seal and people counts on August 18, 1997, two days before breaching.

The interference rate rose sharply early on the morning of the prebreaching baseline day (Figure 24, entirely because of the unpredictable movements of the pebble collector. After 10, the rate rose to 15 disturbances per hour.

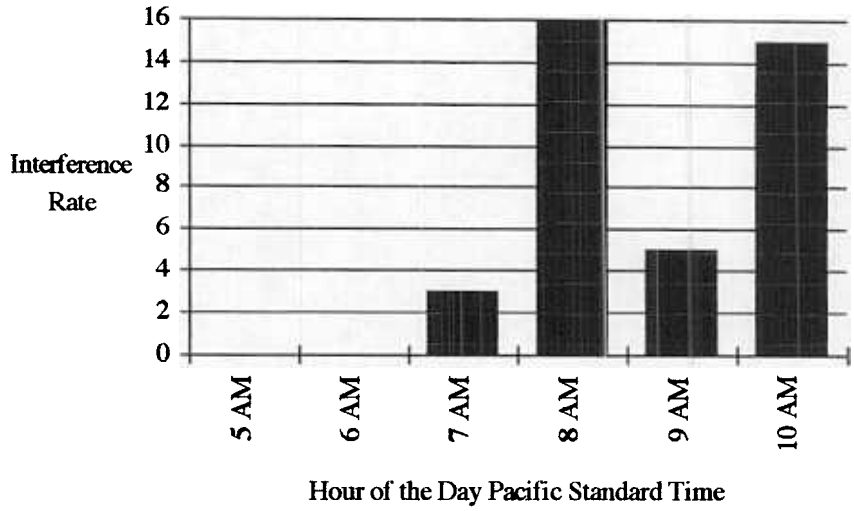


Figure 24. Rates of disturbance during different hours of the day two days before breaching, August 18, 1997

Breaching Day, August 20, 1997

On breaching day, a large number of brown pelicans were present near the bar early in the day--at 7:14 AM 342 were counted. The country crew arrived at 7:44 AM. At 8:11 AM the bulldozer's movement along the beach put the pelicans and many nearby gulls to flight. This mass flight in turn alerted the seals. From 8:12 to 8:14 AM, the seals alerted and moved away from the bulldozer operator, who had dismounted to survey the bar. The seals then ceased responding to the operator. However, the guard posted to the north of the haulout did not stay at the end of the bar as in the previously observed breachings. Instead he walked south toward the bulldozer. He was hidden from the seals during most of his approach, but when he came into view suddenly, carrying t-posts and signs, at an estimated 30 m distance, all the seals went into the water.

During the excavation no seals were hauled out or attempted to haul out (Figure 25). Several seals swam toward the worksite in the sea and oriented to the bulldozer, which is a common response in Jenner seals. People on land also approached the worksite, the SCWA crewman posted to the south stopping two people at 8:58 AM. Three other times people approaching the worksite from the south stopped at the yellow warning line but did not cross.

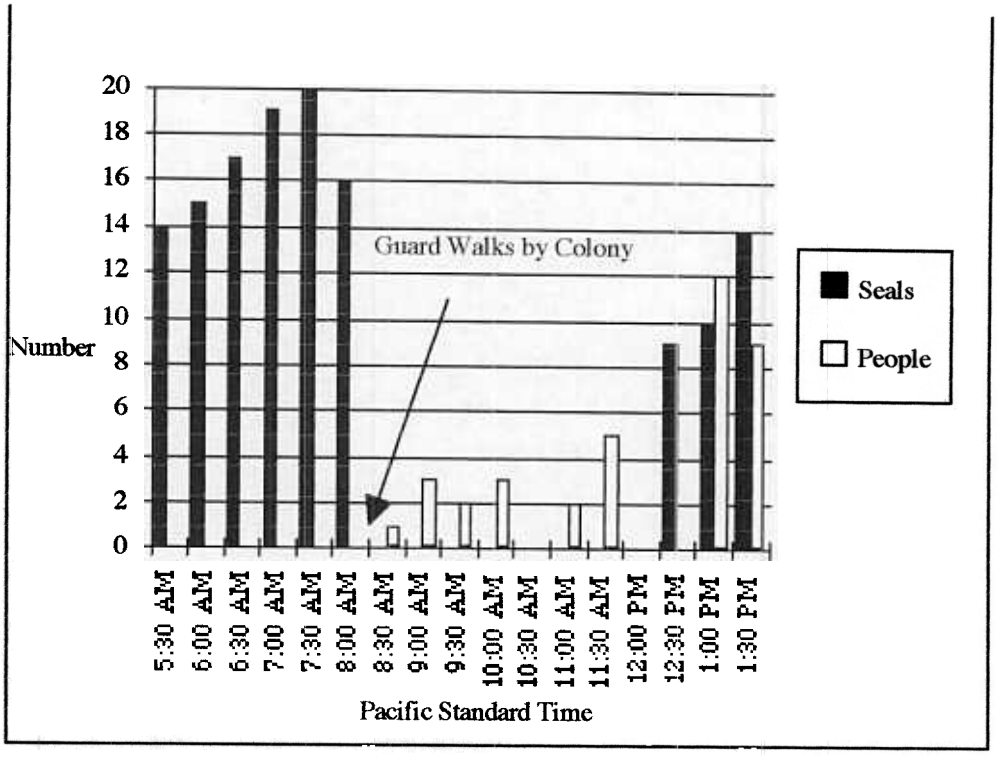


Figure 25. Seal and people counts on August 20, 1997, breaching day.

After the river was breached at 10:22 AM, the bulldozer spent time on the beach extricating the SCWA pickup which had become stuck. When the bulldozer and pickup departed they left up the yellow warning tape, unlike the previous times observed. Three people arriving at the tape stopped there after the crew had left, but later five people proceeded beyond the tape to the Jetty. At 11:55 AM the lifeguard pulled up south of the tape and warned these people back. At 12:12 PM, protected by the lifeguard, a haulout began inside the South Spit. By 12:23 PM the SCWA crew returned and since at this point the breaching seemed successful, started to take down all the signs. The lifeguard drove off and the newly hauled seals alerted to the SCWA crew dismantling their warning line.

I will quote my notes to describe what happened when both the SCWA crew and the guard left, because it illustrates what can happen after bulldozer departs, and also because it is hard to summarize such chaos:

> What follows the withdrawal of the SCWA personnel (who had been at lunch), the lifeguard and the signs at 1244 is pandemonium, if such a word applies to data.
> First a group of five teenagers (looked and acted) rushed toward the gap. The first two were hit by a wave overtopping the berm. They then went back toward the Jetty, causing a flight of ten seals, leaving two seals. By 1247 9 seals were there, a rehaul.
> Two kids advanced to the edge of the cut at first staying back 2 meters but then going to the edge. One kid runs along the edge of the berm that its being undercut. Sand drops into the outlflow.
> 1252 One of the two kids is deliberately kicking sand into the outlflow.
> 1253 The seals alert to the kids, now four of them at the edge of the berm.
> 1255 One kid climbs down to the bit of beach just outside of the berm.
> Then the lifeguards drives up, grabs a float and runs to the kids. He walks all five of them back beyond the Jetty. Then the seals alert to the guard's loudspeaker as he loud hails people away from the cut. Meanwhile a second pair of lifeguards appear in a Zodiac

style boat just off the Jetty in the ocean. Apparently one of the lifeguards jumps in and swims to the spit carrying a short board. This lifeguard, [in what must be a drill for rescues in this situation] swims into the outflow. The seals alert. The Zodiac maneuvers offshore. A third lifeguard then runs half way down toward the cut and claps his hands. All the seals flush except 3.
1308. All the lifeguards are gone. Person goes out onto the spit.
1311 Now 6 seals hauled out. Hard to tell who is reacting to what at this point. Five people are now at the cut, at first not within 3 m.
1314 Now ten people and a dog at the cut. One of the lifeguards in the Zodiac jumps in, swims over to the people, and marches them off the spit.
1315 7 seals at haulout.
1319 12 seals at haulout. These guys must want to haul out.
1328 The seals alert to two people wading 80 m away.
1329 The lifeguard again swims over, this time sounds a whistle to control people, alerts the seals.
1330 An alert of the seals to seven people at 90 m.
Watch over

Needless to say, the disturbance rates were high at two points during this breaching day. The haulout was abandoned in the morning after 5 disturbances, which all occurred within 11 minutes. In the last hour of observation, following the reestablishment of the haulout, 12 disturbances were recorded.

Post breaching day, August 21, 1997

Fog made observation difficult for the first hour and a half of the watch on August 21, 1997, the day after breaching (gap in Figure 26). Despite the gloom, a power boat, two parties of people, and a dog walker emerged from the mist to cause alerts and flights. During the course of these disturbances the seals evacuated the south spit and hauled out on a temporary island that had formed in the center of the river. The rate of disturbance then fell to zero (Figure 27) and with the exception of a small flight from a kayak, the seals remained undisturbed until 9:26 AM. After that time, there were six alerts to visitors or to bird flushes caused by visitors. About 11:00 AM the haulout began to wash out, the last seals departing at 11:16 AM.

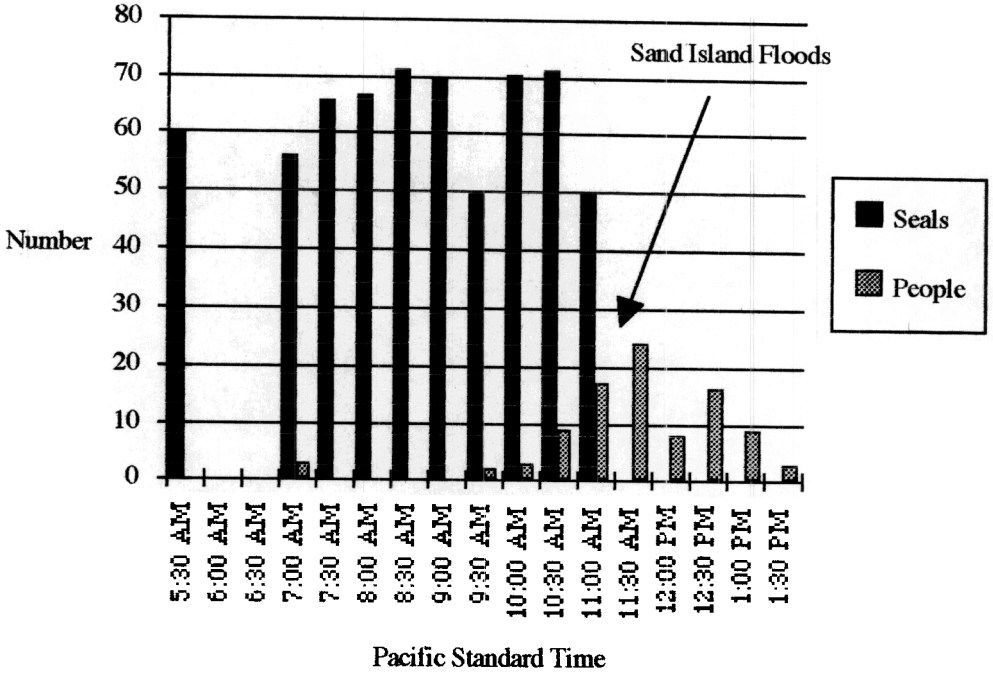


Figure 26. Seal and people counts on August 21, 1997, one day after breaching.

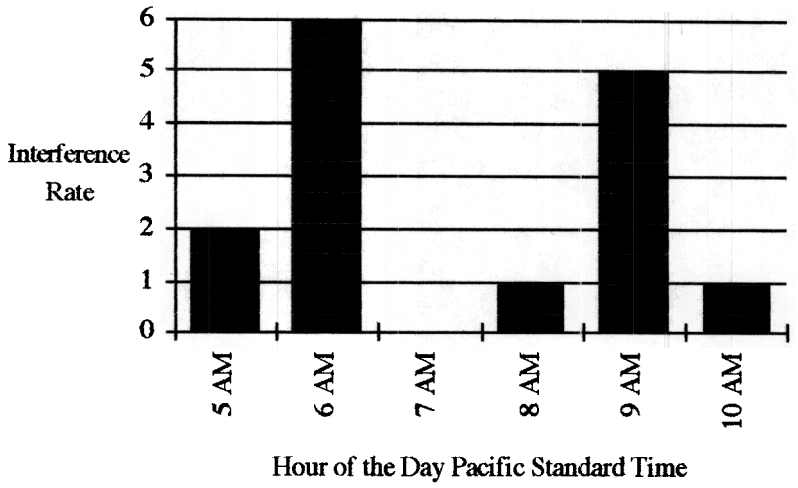


Figure 27. Rates of disturbance during different hours of August 21, 1997, the day after breaching.

SCWA Breaching of September 19, 1997

Seal counts at Jenner often drop to zero in autumn, especially in the middle of day. The breachings of September illustrates this pattern, with no seals being counted before and during the closure of the river. Only on the day after breaching were seals counted, but then numbers fell back. The most extreme case in 1997 was the closing of September 9, when no seals were counted for two weeks, until the bar was breached (Figure 28).

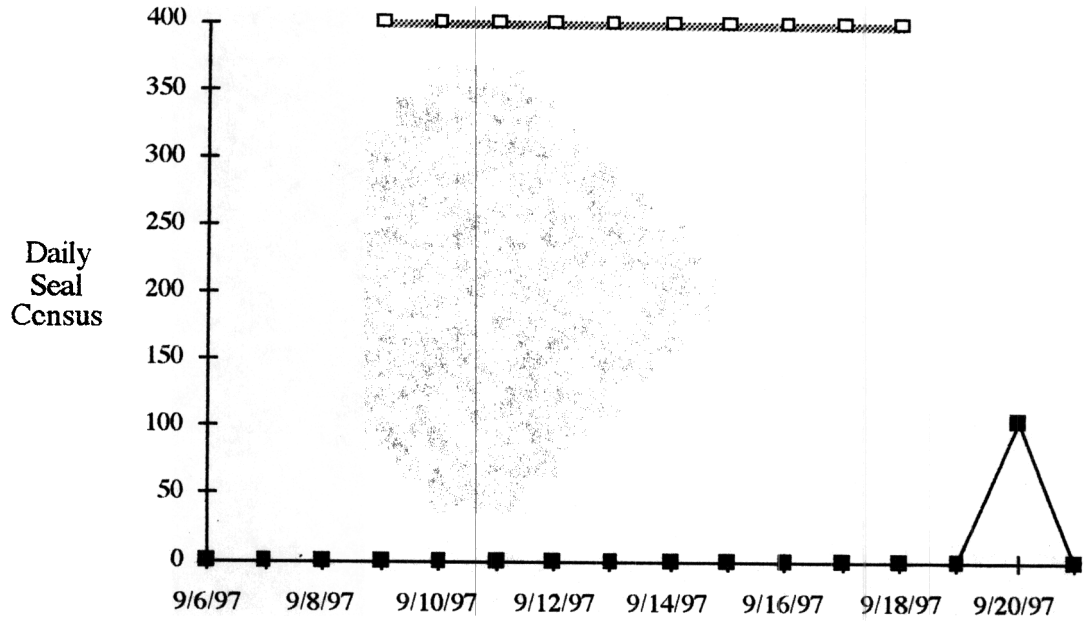


Figure 28. Seal numbers during the river closure beginning September 9, 1997. Gray bar indicates river closure.

SCWA Breaching of September 29, 1997

Seal numbers fell to zero before the closure of the river on September 29, 1997 (Figure 29). On the day after breaching 104 seals were counted, a recovery of numbers common at this time of year.

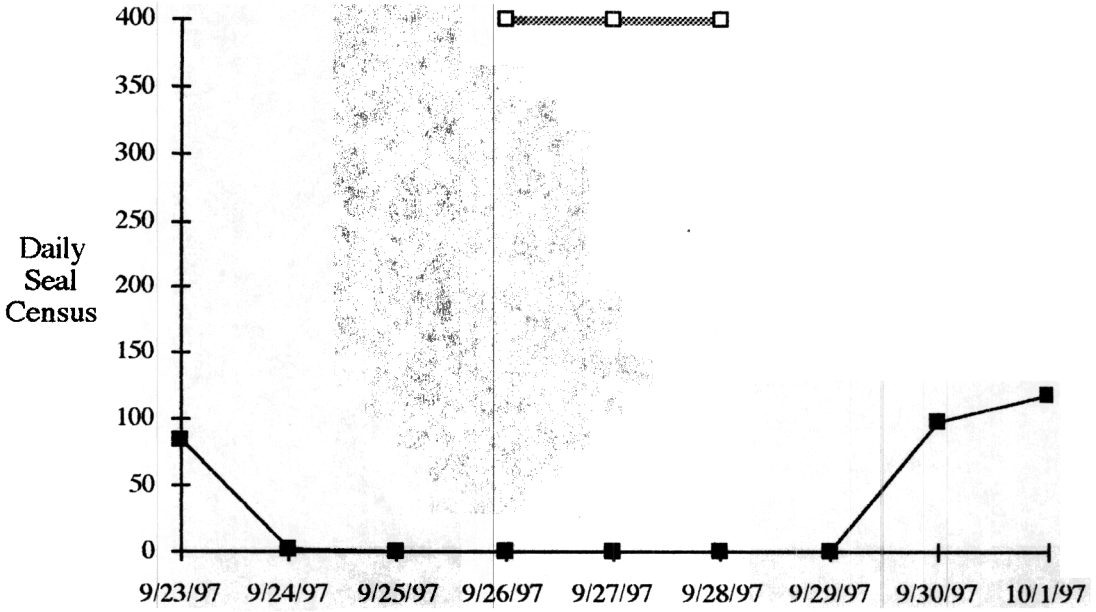


Figure 29. Seal numbers during the river closure beginning September 26, 1997. Gray bar indicates river closure.

SCWA Breaching of October 11.1997

Numbers again fell to near zero during the closing beginning October 3, 1997.

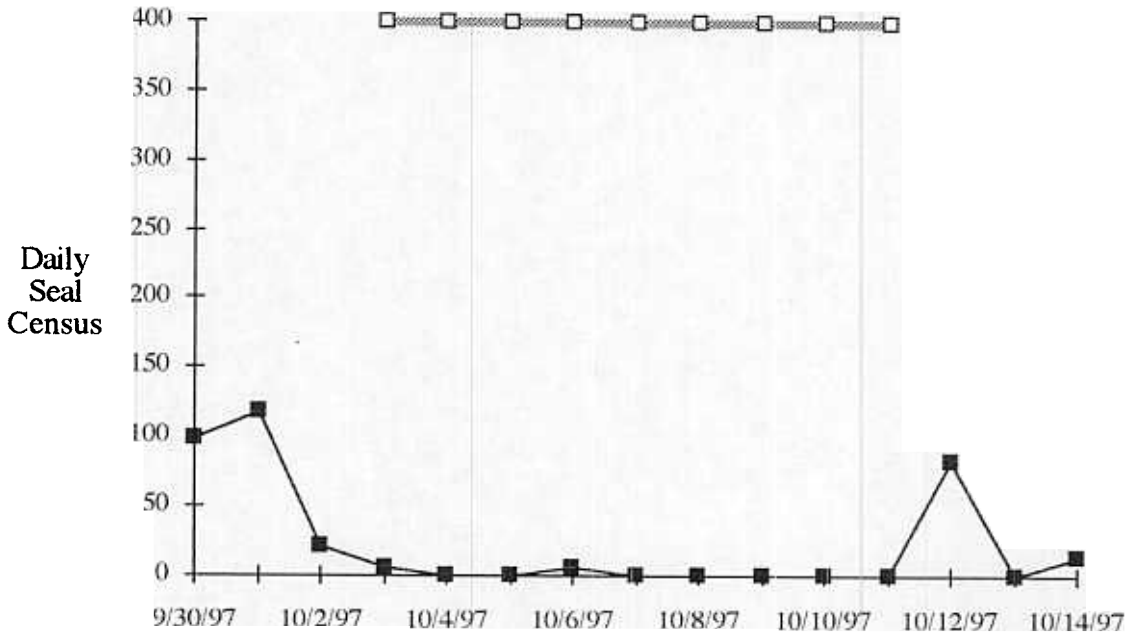


Figure 30. Seal numbers during the river closure beginning October 3, 1997. Gray bar indicates river closure.

Beginning of the closure of October 24, 1997

For the sake of completion, I have added the data for late October, just before the cut off for this paper. Again, numbers fell to zero during the closing (Figure 31).

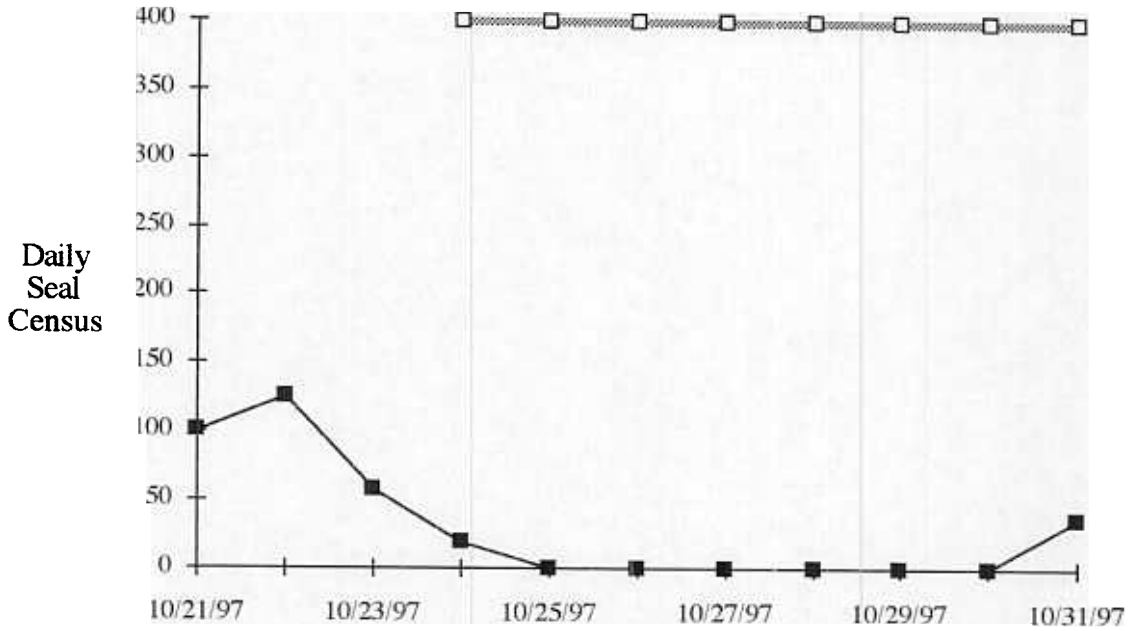


Figure 31. Seal numbers during the river closure beginning October 26, 1997. Gray bar indicates river closure.

Patterns in Seal Behavior during Closures and Breachings

If we combine the results of this year's investigation of partly guarded breaching days with last year's research on mostly unguarded breaching days (Table 1), along with the observations from Hanson's earlier study (1993) we can draw several conclusions by a process of induction.

Table Guarding and breaching during 1996 and 1997

Date	Type of Breaching	Comments
	1996	
July 5, 1996	SCWA	In the evening, 50 seals present, warning tape left
August 3, 1996	Unofficial	
August 27, 1996	Unofficial	
September 8, 1996	Unofficial, seminatural?	
September 26, 1996	SCWA	All seals leave in response to SCWA crew, unguarded
October 15, 1996	SCWA	No seals present, tape up but visitors not stopped

March 31, 1997	SCWA	On the daily census, 110 seals present as the bulldozer digs
April 20, 1997	Natural	Seals present on closure and breaching days
May 3, 1997	Natural	Seals present on closure and breaching days
May 22, 1997	SCWA	Guarded against people, all seals leave in response to SCWA crew
June 9, 1997	SCWA	Guarded against people, one partial flush of the colony to the bulldozer
June 26, 1997	SCWA	
August 20, 1997	SCWA	Guarded against people, all seals leave in response to the SCWA crew
September 19, 1997	SCWA	No seals in daily census
September 29, 1997	SCWA	No seals in daily census
October 11, 1996	SCWA	Few or no seals in the daily census

Table 2. Summary of Hanson's (1993) breachings study.

Date	Type of Breaching	Comments
	1992	
October 7, 1992	SCWA	Unguarded; seals finally flushed 1 1/2 h after bulldozer starts
November 2, 1992	SCWA	Unguarded; some seals flushed but some remain
November 16, 1992	SCWA	Unguarded; seals finally flushed 1 1/2 h after bulldozer starts

First, there may be a seasonality in the response of the seals to closings and breachings. Seals in the winter and early spring are high in number and may actually increase during closures of the river. As spring passes into summer, the number of seals drops, and seals seem to react more to river closure. In fall seals may be absent or only present early in the morning, especially when the river is barred. Seals have not remained during any fall breachings, save for one of the breachings observed by Hanson (1993).

Second, at any time of year it is possible to drive off the seals either intentionally or unintentionally. As an example of the latter, in all of the SCWA breachings observed, some or all seals left the colony in response to the bulldozer or SCWA crew on foot. SCWA employees never showed ill will toward the seals. In a few cases it would be hard to see how they could have avoided disturbing some of the seals; but in others the SCWA workers appeared to drive some or all seals away accidentally by coming too close or too suddenly or by yelling too loudly.

Third, it is possible for guards to control people at the Jenner site, keeping them away from equipment, excavations, or seals. In the second year of this research, for example, the SCWA crew succeeded admirably in keeping almost all people back from the breaching site during excavation. When lifeguards came on the beach after the SCWA crew left, they also kept people away both from the cut in the bar and away from the seals.

Fourth, when guards are not present some people will approach the construction area, the completed cut, or the seals, no matter whether or not signs are posted or ropes raised across the sand. Other people honor signs and warning tapes about the breaching, the breaching site, and the seals.

Fifth, without guards, some people endanger themselves near the breaching site, stamping on the eroding banks, wading in the accelerating outflow, standing with their backs to the sea, being hit by waves, and even ignoring their own children. The same people may drive off the seals from the haulout or block seals from leaving or entering the river. State lifeguards regard the opening of the Russian River as a hazardous process worthy of their attention, but since their mandate is to guard the entire Sonoma State Beach, they cannot remain at the breaching site continuously. Despite this, Rex Grady, a lifeguard interviewed about the breachings, noted that the lifeguards can make between 50 and 80 safety contacts following breaching.

Recommendations

The County Water Agency guarded the excavation site in 1997, keeping people well away from the hazards of machinery or moving water. However, the channel was not guarded after the end of bulldozing, which is when repeated cases of reckless behavior were recorded in this and other studies. I would suggest that the breaching be guarded to reduce the danger to people. The post breaching guard could also protect any seals present at the colony or returning to the colony site from humans that would otherwise be attracked to the site by the breach.

SCWA personnel often unintentionally disturbed the seals at the Jenner colony during the process of breaching. Some disturbance was inevitable but some was certainly avoidable. Impacts could be reduced by not walking through the colony,by not shouting and by having the guard posted to the north of the breaching site out of sight of the seals.

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Appendix I

Jenner Daily Seal Census
January through October 1997

Date	Time-PST	Total Seals	On South Spit	On Bar	On Islands	On North Spit
1/1/97	10:06 AM	50	50	0		0
1/2/97	10:15 AM	154	154	0		0
1/3/97	1:00 PM	271	271	0		0
1/4/97	3:45 PM	289	289	0		0
1/5/97	9:00 AM	3	3	0		0
1/6/97	1:00 PM	220	220	0		0
1/7/97	1:20 PM	220	220	0		0
1/8/97	10:30 AM	0	0	0		0
1/9/97	12:00 PM	100	100	0		0
1/10/97	2:10 PM	138	138	0		0
1/11/97	5:00 PM	100	100	0		0
1/12/97	10:45 AM	0	0	0		0
1/13/97	5:05 PM	0	0	0		0
1/14/97	2:15 PM	141	141	0		0
1/15/97	1:20 PM	172	172	0		0
1/16/97	11:45 AM	246	246	0		0
1/17/97	12:15 PM	287	287	0		0
1/18/97	12:15 PM	228	228	0		0
1/19/97	3:35 PM	266	266	0		0
1/20/97	2:45 PM	234	234	0		0
1/21/97	2:40 PM	195	195	0		0
1/22/97	12:15 PM	0	0	0		0
1/23/97	3:40 PM	193	193	0		0
1/24/97	10:30 AM	87	87	0		0
1/25/97	12:10 PM	125	125	0		0
1/26/97	12:00 PM	0	0	0		0
1/27/97	10:00 AM	296	296	0		0
1/28/97	12:15 PM	208	208	0		0
1/29/97	9:15 AM	189	189	0		0
1/30/97	9:30 AM	165	165	0		0
1/31/97	4:10 PM	240	240	0		0
2/1/97	9:45 AM	206	206			0
2/2/97	12:45 PM	186	186			0
2/3/97	9:45 AM	130	130			0
2/4/97	10:20 AM	160	160			0
2/5/97	10:00 AM	132	132			0
2/6/97	12:10 PM	249	249			0
2/7/97	10:00 AM	32	32			0
2/8/97	9:31 AM	63	63			0
2/9/97	5:00 PM	211	211			0
2/10/97	11:50 AM	217	217			0
2/11/97	11:45 AM	345	345			0
2/12/97	10:45 AM	215	215			0
2/13/97	11:30 AM	328	328			0

2/14/97						
2/15/97	1:15 PM	236	236			0
2/16/97	4:50 PM	204	204			0
2/17/97	5:45 PM	346	346			0
2/18/97	11:45 AM	242	242			0
2/19/97	10:35 AM	28	28			0
2/20/97	10:10 AM	170	170			0
2/21/97	9:15 AM	58	58			0
2/22/97	12:15 PM					
2/23/97	5:25 PM	40	40			0
2/24/97	12:10 PM	113	113			0
2/25/97	10:15 AM	231	231			0
2/26/97	10:00 AM	104	104			0
2/27/97	9:35 AM	129	129			0
2/28/97	10:45 AM	176	176			0
3/1/97	10:20 AM	120	120			0
3/2/97	4:45 PM	367	367			0
3/3/97	10:00 AM	247	247			0
3/4/97	12:00 PM	143	143			0
3/5/97	11:15 AM	301	301			0
3/6/97	12:15 PM	341	341			0
3/7/97	10:30 AM	120	120			0
3/8/97	5:30 PM	297	297			0
3/9/97	5:45 PM	363	363			0
3/10/97	10:45 AM	252	252			0
3/11/97	2:45 PM	217	217			0
3/12/97	10:10 AM	237	237			0
3/13/97	11:30 AM	279	279			0
3/14/97	1:45 PM	224	81			143
3/15/97	1:30 PM	243	81			162
3/16/97	4:00 PM	0	0			0
3/17/97	12:15 PM	292	192			100
3/18/97	10:00 AM	189	189			0
3/19/97	10:05 AM	200	200			0
3/20/97	9:10 AM	157	157			0
3/21/97	3:40 PM	252	122			130
3/22/97	3:00 PM	185	15			170
3/23/97	5:35 PM	67	0			67
3/24/97	10:30 AM	252	0			252
3/25/97	12:00 PM	245	245			0
3/26/97	1:45 PM	253	253			0
3/27/97						
3/28/97	4:00 PM	273	0			273
3/29/97	6:30 PM	65	65	0		0
3/30/97	3:00 PM	0	0	0		
3/31/97	2:15 PM	110	0			110
4/1/97	1:45 PM	250	0			250
4/2/97	5:30 PM	197	11		16	170
4/3/97	5:30 PM	160	0		0	160
4/4/97	2:45 PM	253	0		145	108
4/5/97	8:30 AM	35	0			35
4/6/97	4:00 PM	269	0		0	269
4/7/97	5:35 PM	379	16		0	363
4/8/97	6:00 PM	288	38			250

4/9/97	5:47 PM	294	130			164
4/10/97	8:03 PM	143	38			105
4/11/97	12:00 PM	190	90			100
4/12/97	10:14 AM	128	60			68
4/13/97	6:00 PM	241	115			126
4/14/97	5:00 PM	300	170			130
4/15/97	12:30 PM	176	76			100
4/16/97	4:15 PM	171	88			83
4/17/97	10:45 AM	174	63			111
4/18/97	12:50 PM	118		118		
4/19/97	10:30 AM	220	57			163
4/20/97	5:30 PM	200	136			64
4/21/97	8:43 PM	283		283		
4/22/97	4:30 PM	197	197			
4/23/97	3:30 PM	228	165			63
4/24/97	10:45 AM	142	126			16
4/25/97	1:45 PM	135	95			40
4/26/97	3:30 PM	86	66			20
4/27/97	2:15 PM	159	124			35
4/28/97	2:45 PM	159	60			99
4/29/97	1:55 PM	227	65			162
4/30/97	11:30 AM	114	6			108
5/1/97	7:20 AM	87	24			63
5/2/97	5:30 PM	175	0	0		175
5/3/97	5:00 PM	80	0			80
5/4/97	10:26 AM	134	67			67
5/5/97	4:30 PM	277	0			277
5/6/97	4:30 PM	206	0			206
5/7/97	5:45 PM	258	0			258
5/8/97	4:00 PM	297	22			275
5/9/97	3:45 PM	264	0			264
5/10/97	4:45 PM	169	25			144
5/11/97	1:50 PM	227	29			198
5/12/97	5:45 PM	190	4			186
5/13/97	10:00 AM	208	103			105
5/14/97	5:00 PM	176	63			113
5/15/97	3:15 PM	150	0	150		0
5/16/97	3:15 PM	70	0	30	40	0
5/17/97	7:00 PM	21	0	21		0
5/18/97	5:15 PM	60	0	60		0
5/19/97	6:45 PM	115	0	115		0
5/20/97	3:00 PM	97	0	97		0
5/21/97	11:15 AM	50	0	50		0
5/22/97	9:40 AM	5	0			5
5/23/97	5:00 PM	109	0			109
5/24/97	1:45 PM	181	0			181
5/25/97	4:15 PM	163	0			163
5/26/97	2:00 PM	130	0			130
5/27/97	4:00 PM	125	0			125
5/28/97	2:00 PM	209	62			147
5/29/97	11:00 AM	151	54			97
5/30/97	4:15 PM	145	26			119
5/31/97	3:50 PM	113	7			106
6/1/97	3:30 PM	170	0			170

6/2/97	1:30 PM	82		82	
6/3/97	5:15 PM	9		9	
6/4/97	10:30 AM	81		81	
6/5/97	12:00 PM	177		177	
6/6/97	11:30 AM	104		104	
6/7/97	10:30 AM	40		40	
6/8/97	9:00 AM	15		15	
6/9/97	1:30 PM	70	0		70
6/10/97	12:30 PM	160	11		149
6/11/97	10:00 AM	174	0		174
6/12/97	12:00 PM	225	0		225
6/13/97	10:30 AM	195	0		195
6/14/97	2:45 PM	146	0		146
6/15/97	6:00 PM	92	0		92
6/16/97	2:45 PM	107		107	
6/17/97	1:45 PM	76		76	
6/18/97	9:50 AM	45		45	
6/19/97	12:30 PM	62		62	
6/20/97	7:15 PM	133		133	
6/21/97	1:00 PM	149		149	
6/22/97	4:00 PM	187		187	
6/23/97	6:00 PM	182		182	
6/24/97	4:15 PM	108		108	
6/25/97	2:30 PM	85		85	
6/26/97	2:30 PM	0		0	
6/27/97	10:00 AM	0	0		0
6/28/97	4:30 PM	210	0		210
6/29/97	2:20 PM	180	0		180
6/30/97	4:45 PM	154	0		154
7/1/97	5:25 PM	272	0		272
7/2/97	1:30 PM	245	0		245
7/3/97	12:10 PM	185	0		185
7/4/97	6:45 PM	241	0		241
7/5/97	1:15 PM	213	0		213
7/6/97	1:00 PM	195	0		195
7/7/97	11:00 AM	140	0		140
7/8/97	11:15 AM	168	0		168
7/9/97	11:45 AM	276	0		276
7/10/97	1:30 PM	197	0		197
7/11/97	1:30 PM	183	0		183
7/12/97	10:30 AM	231	0		231
7/13/97	10:15 AM	33	0		33
7/14/97	6:45 PM	170	0		170
7/15/97	11:15 AM	134	0		134
7/16/97	11:10 AM	112	0		112
7/17/97	7:00 PM	212	0		212
7/18/97	10:30 AM	211	0		211
7/19/97	10:35 AM	152	0		152
7/20/97	1:35 PM	201	0		201
7/21/97	11:05 AM	156	0		156
7/22/97	10:45 AM	168	0		168
7/23/97	11:30 AM	187	0		187
7/24/97	11:15 AM	143	0		143
7/25/97	3:50 PM	282	0		282

7/26/97	4:00 PM	188	0			188
7/27/97	7:30 PM	60	0			60
7/28/97	10:45 AM	199	0			199
7/29/97	11:00 AM	185	0			185
7/30/97	11:00 AM	212	0			212
7/31/97	11:45 AM	228	0			228
8/1/97	11:40 AM	157	0			157
8/2/97	9:50 AM	119	0			119
8/3/97	5:20 PM	143	0			143
8/4/97	12:00 PM	117	0			117
8/5/97	10:45 AM	102	0			102
8/6/97	10:45 AM	117	0			117
8/7/97	11:00 AM	55	0			55
8/8/97	12:00 PM	85	85			0
8/9/97	10:55 AM	84	84			0
8/10/97	12:00 PM	25		25		
8/11/97	12:15 PM	0		0		
8/12/97	10:30 AM	0		0		
8/13/97	10:45 AM	0		0		
8/14/97	9:50 AM	35		35		
8/15/97	11:30 AM	25		25		
8/16/97	10:00 AM	0		0		
8/17/97	2:20 PM	0		0		
8/18/97	2:45 PM	0		0		
8/19/97	12:10 PM	16		16		
8/20/97	11:45 AM	0	0			0
8/21/97	10:00 AM	82	0		82	0
8/22/97	11:00 AM	93	0		5	88
8/23/97	10:00 AM	141	0		3	138
8/24/97	9:50 AM	61	0		61	0
8/25/97	1:30 PM	83	0			83
8/26/97	11:00 AM	58	58			0
8/27/97	11:30 AM	59	0			59
8/28/97	12:50 PM	100	0			100
8/29/97	10:00 AM	29	0			29
8/30/97	10:40 AM	3	0		3	0
8/31/97		0				
9/1/97	7:45 PM	0	0			0
9/2/97	12:45 PM	16	16			0
9/3/97	10:20 AM	27	27			0
9/4/97	8:45 AM	60	60			0
9/5/97	4:00 PM	0	0			0
9/6/97	4:50 PM	0	0			0
9/7/97	7:00 PM	0	0			0
9/8/97	10:30 AM	0	0			0
9/9/97	10:15 AM	0	0			0
9/10/97	10:30 AM	0	0			0
9/11/97	11:40 AM	0	0			0
9/12/97	5:00 PM	0	0			0
9/13/97	1:15 PM	0	0			0
9/14/97	3:45 PM	0	0			0
9/15/97	3:45 PM	0	0			0
9/16/97	12:00 PM	0	0			0
9/17/97	2:45 PM	0	0			0

9/18/97	11:45 AM	0	0		0
9/19/97	10:30 AM	0	0		0
9/20/97	8:15 AM	104	0		104
9/21/97	5:00 PM	0	0		0
9/22/97	10:50 AM	100	0		100
9/23/97	9:45 AM	85	0		85
9/24/97	10:30 AM		0		1
9/25/97	6:00 PM	0	0		0
9/26/97	1:15 PM	0		0	
9/27/97	9:30 AM	0		0	
9/28/97	4:30 PM	0		0	
9/29/97	10:45 AM	0	0		0
9/30/97	10:15 AM	99	0		99
10/1/97	5:00 PM	118	0		118
10/2/97	10:30 AM	22	0		22
10/3/97	10:00 AM	6		6	
10/4/97	10:15 AM	0		0	
10/5/97	6:15 PM	0		0	
10/6/97	9:30 AM	6		6	
10/7/97	5:10 PM	0		0	
10/8/97	11:45 AM	0		0	
10/9/97	12:15 PM	0		0	
10/10/97	9:30 AM	0		0	
10/11/97	10:00 AM	0		0	
10/12/97	12:45 PM	83	0		83
10/13/97	3:30 PM	0	0		0
10/14/97	4:35 PM	14	0		14
10/15/97	9:30 AM	39	0		39
10/16/97	1:45 PM	2	0		2
10/17/97	5:10 PM	60	0		60
10/18/97	6:00 PM	41	0		41
10/19/97	3:45 PM	75	0		75
10/20/97	11:00 AM	120	0		120
10/21/97	11:00 AM	100	0		100
10/22/97	12:10 PM	126	0		126
10/23/97	9:45 AM	58	0		58
10/24/97	11:40 AM	20	0		20
10/25/97	11:30 AM	0		0	
10/26/97	2:45 PM	0		0	
10/27/97	11:30 AM	0		0	
10/28/97	12:30 PM	0		0	
10/29/97	8:30 AM	0		0	
10/30/97	9:30 AM	0		0	
10/31/97	10:40 AM	36		36	

Appendix II

Seal and People Counts for Breaching Observation Days

Pre Breaching 5/20/97

	Seals	People
5:30 AM	76	0
6:00 AM	80	0
6:30 AM	88	0
7:00 AM	104	0
7:30 AM	107	0
8:00 AM	127	0
8:30 AM	105	0
9:00 AM	119	0
9:30 AM	126	0
10:00 AM	148	1
10:30 AM	153	2
11:00 AM	164	14
11:30 AM	115	2
12:00 PM	116	2
12:30 PM	120	2
1:00 PM	124	2
1:30 PM	108	7

Breaching 5/22/97

	Seals	People
5:00 AM	49	0
5:30 AM	49	0
6:00 AM	61	0
6:30 AM	67	0
7:00 AM	69	0
7:30 AM	0	5
8:00 AM	3	5
8:30 AM	5	4
9:00 AM	10	0
9:30 AM	32	1
10:00 AM	49	0
10:30 AM	63	0
11:00 AM	79	0
11:30 AM	86	0
12:00 PM	89	1
12:30 PM	95	2

1:00 PM	92	3

Post Breaching 5/23/97

	Seals	People
5:30 AM	37	0
6:00 AM	54	0
6:30 AM	64	0
7:00 AM	46	0
7:30 AM	72	0
8:00 AM	76	0
8:30 AM	78	0
9:00 AM	96	0
9:30 AM	106	0
10:00 AM	98	0
10:30 AM	95	0
11:00 AM	92	4
11:30 AM	98	3
12:00 PM	99	2
12:30 PM	96	0
1:00 PM	111	3

Breaching Attempt 6/6/97

	Seals	People
5:30 AM	121	0
6:00 AM	103	0
6:30 AM	111	0
7:00 AM	73	2
7:30 AM	66	2
8:00 AM	70	3
8:30 AM	81	3
9:00 AM	40	3
9:30 AM	56	4
10:00 AM	77	4
10:30 AM	92	3
11:00 AM	101	3
11:30 AM	112	0
12:00 PM	146	0
12:30 PM	144	0
1:00 PM	170	0

Breaching 6/9/97

	Seals	People
5:30	63	0
6:00	74	0
6:30	86	0
7:00	92	0

	7:30	192	0
	8:00	100	0
	8:30	76	2
	9:00	40	2
	9:30	55	2
	10:00	50	2
	10:30	44	3
	11:00	47	3
	11:30	55	0
	12:00	68	0
	12:30	27	3
	13:00	39	2
	13:30	44	2

Post Breaching 6/10/97

PST	Seals	People
5:30 AM	187	0
6:00 AM	186	0
6:30 AM	191	0
7:00 AM	192	0
7:30 AM	181	0
8:00 AM	193	0
8:30 AM	189	0
9:00 AM	185	0
9:30 AM	177	2
10:00 AM	168	0
10:30 AM	185	12
11:00 AM	173	5
11:30 AM	205	4
12:00 PM	220	10
12:30 PM	183	16
1:00 PM	192	16
1:30 PM	179	12

Pre Breaching 8/18/97

Time	Seals	People
5:30 AM	23	0
6:00 AM	25	0
6:30 AM	21	4
7:00 AM	21	0
7:30 AM	25	0
8:00 AM	18	0
8:30 AM	16	
9:00 AM	21	
9:30 AM	27	0
10:00 AM	22	8

10:30 AM	0	
11:00 AM	0	0
11:30 AM	0	0
12:00 PM	0	6
12:30 PM	0	6
1:00 PM	0	8
1:30 PM	0	16

Breaching 8/20/97

	Seals	People
5:30 AM	14	0
6:00 AM	15	0
6:30 AM	17	0
7:00 AM	19	0
7:30 AM	20	0
8:00 AM	0	0
8:30 AM	0	1
9:00 AM	0	3
9:30 AM	0	2
10:00 AM	0	3
10:30 AM	0	0
11:00 AM	0	2
11:30 AM	0	5
12:00 PM	0	0
12:30 PM	9	0
1:00 PM	10	12
1:30 PM	14	9

Post Breaching 8/21/97

	Seals	People
5:30 AM	60	0
6:00 AM	Fog	Fog
6:30 AM	Fog	Fog
7:00 AM	56	3
7:30 AM	66	0
8:00 AM	67	0
8:30 AM	71	0
9:00 AM	70	0
9:30 AM	50	2
10:00 AM	71	3
10:30 AM	72	9
11:00 AM	50	17
11:30 AM	0	24
12:00 PM	0	8
12:30 PM	0	16
1:00 PM	0	9
1:30 PM	0	3

Appendix III

Seal Disturbances for Breaching Observation Days

Incident Time	Response Class	Other Responses	Fled	Source	Other Sources	So #	d in meters	Comment
PreBreaching	5/20/97							
7:45 AM {1}		Mass		?				
8:05 AM	3	Indirect Gulls	6	People and Dog		3	200	
8:06 AM	3		25	People			100	Deliberate
8:07 AM	3		9	People		1	60	
8:08 AM	2			People and Dog		3	100	
8:09 AM	2			People and Dog		3	100	
8:10 AM	1			People and Dog		3	100	
8:11 AM	2			People		1	80	
8:12 AM	2			People		1	80	
8:13 AM	2			People			80	
8:14 AM				People and Dog		3	100	
8:15 AM				People and Dog		3	140	
10:43 AM	1			Photographer			100	
10:46 AM	1			Photographer		1	100	Retreat
11:01 AM	2			Photographer		4	60	
11:02 AM	2			Photographer		4	40	
11:03 AM	2			Photographer		4	30	
11:04 AM	3		4	Photographer		4	30	Moving, shouting
11:06 AM	1		4	Photographer		4	30	Turns
11:15 AM	1	Indirect by birds		People		2	100	
11:16 AM	3		2	People		2	100	
11:17 AM	1			People		3	80	
11:18 AM	2			People		3	70	
11:20 AM	3		36	People		3	40	
11:21 AM	1			People		3	40	
11:22 AM	1			People		3	40	
11:43 AM	1			People		2	60	
11:44 AM	1			People		2	60	
11:45 AM	1			People		2	80	
12:00 PM	1			Automobile		1	300	Horn
12:20 PM	3		7	People		4	80	
12:22 PM	2			People		4	70	
12:24 PM	1			People		4	70	

12:34 PM	2		People	5	70	
12:42 PM {3}	By		?			
1:01 PM {3}	Birds Indirect? By Gull?		Opsrey			
1:02 PM	1		People	2	50	
1:19 PM	1		People	2	50	
1:35 PM	3	8	People	2	50	Running

Breaching 5/22/97

6:49 AM	1		Banging T-posts		300	
6:58 AM	1		County Crew	5	240	
6:59 AM	1		County Crew	5	240	
7:00 AM	3	29	County Crew	5	220	Shouts
7:01 AM	3	4	County Crew	5	220	
7:03 AM			Bulldozer		200	
7:05 AM	3		County Crew	3	60	Carrying T-posts
7:14 AM	3	2	County Crew	2	50	
7:55 AM	1		County Crew		100	Shouts
8:17 AM	1		County Crew		100	Shouts
8:18 AM	1		County Crew		100	Shouts
8:31 AM	1		Bulldozer		220	Withdrawing
8:43 AM	3	12	County Crew	2	30	
8:44 AM	3	2	County Crew	2	40	
8:45 AM	3	2	County Crew			
9:14 AM	1		Kayaker on foot	1	160	
9:15 AM	3	4	Kayaker on foot	1	40	
9:16 AM	3	5	Kayaker on foot	1	30	
9:17 AM	3	1	Kayaker on foot	1	10	
9:18 AM	Block		Kayaker on foot	1	10	
9:29 AM	Mass		Kayaker on foot	1	10	
10:04 AM	1		Lifeguard Loudhailer	1	300	
12:41 PM	2		Kayaker on Foot	1	40	
12:42 PM	3	1	Kayaker on Foot	1	80	
12:43 PM	3	16	Kayaker on Foot		20	
12:44 PM	1		Kayaker on Foot	1	30	
12:55 PM	3		Kayaker on Foot	1	40	

Post Breaching 5/23/97

8:27 AM	Mass		Helicopeter	1	300	
11:15 AM	2		People	2	20	Sitting at sight of a whale
11:39 AM	3		Photographer	1	10	
11:46 AM	1	Mass	Helicopter		300	N125NP
11:47 AM			Photographer	1	12	

11:52 AM	1		People	120	Loudspeaker from Ranger
Prebreaching	6/6/97				
6:45 AM	Indirect by birds		Bulldozer	1200	
6:48 AM	1		Bulldozer	600	
6:49 AM	1		Bulldozer	600	
6:50 AM	1		Banging t-posts		
6:52 AM	1		North Guard	160	
6:53 AM			North Guard	160	
6:54 AM	1		North Guard	160	
6:55 AM			North Guard	160	
6:56 AM	1		Bulldozer at Jetty	300	
6:59 AM			Bulldozer on bar	260	
7:00 AM	3	9	Bulldozer on bar	240	Probably more seals go
7:02 AM	1		Bulldozer on bar	240	
7:03 AM	1		Bulldozer on bar	240	
7:04 AM			Bulldozer on bar	240	
7:06 AM	1		Bulldozer on bar	240	
7:24 AM	3	5	Bulldozer on bar	220	
7:49 AM	1		Bulldozer on bar	220	Crossers
7:50 AM	1		Bulldozer on bar	220	Crossers
8:20 AM			Bulldozer on bar	200	Crossers
8:30 AM	1		South Guard		
8:35 AM	3		Sudden appearance of pacing North Guard		
8:42 AM	1		Rowboat approaching but		
8:44 AM	3	4	Rowboat	20	
8:45 AM	3	29	Rowboat	20	
8:46 AM			Rowboat	20	
8:47 AM	1		Rowboat	24	
8:57 AM	1		Bulldozer clanks	220	
9:03 AM	1		Shouts	220	
9:05 AM	1		Noise	220	
9:10 AM	1		Bulldozer pushing sand over mound	220	
9:11 AM	1		Bulldozer sounds	220	
9:14 AM	1		Bulldozer sounds	220	
9:16 AM	1		Bulldozer sounds	220	
9:34 AM			Bulldozer pushing sand over mound	220	
9:37 AM			Bulldozer pushing sand over mound		
9:41 AM	1		Bulldozer pushing sand over mound	220	
10:23 AM			Bulldozer noise	220	
10:55 AM	1		Bulldozer	220	
11:16 AM	3	1	Canoe		
12:37 PM	2 Indirect		Man spooks gulls		

10:50 AM	1		People	2	30.5	
10:56 AM	2		People on east shore, gull fight			
11:00 AM	1		Truck			
11:06 AM	1		People		30.5	
11:08 AM	1		Door slamming on overlook			
11:09 AM	1		People on eastrn shore			
11:30 AM	2		People		30.5	
11:44 AM	2		People	2	15.2	
12:05 PM	3		People		15.2	
12:10 PM	1		Surfer		30.5	
12:19 PM	3		Surfer	1	5	
12:23 PM	1		Surfer		30.5	
12:51 PM	1		Surfer		45.7	

Breaching 6/9/97

8:14	of 3		Bulldozer	1	400	
8:16	1		Bulldozer	1	300	
8:17			Bulldozer	1	200	
8:18	3		21 Person	1	200	
8:27	1		Person		200	
8:28			Person	1	200	
8:29	1		Person		200	
8:33	3	59	Bulldozer		200	First sight of bulldozer atop berm
8:38	1		Bulldozer	1	200	Sight of bulldozer atop berm
8:39	1		Bulldozer		200	Sight of bulldozer atop berm
8:41			Bulldozer	1	200	Sight of bulldozer atop berm
8:52			Kayak		240	
8:53	1		Kayak		240	
8:54	1		Kayak	1	300	
9:10	1		Bulldozer		200	Sight of bulldozer atop berm
12:19	1 Mass		Dog Bark		240	
12:20	3 below		Person		50	
12:21	3	44.8	Person		40	
12:45	1		Person		120	
12:46	3		7 Person	1	100	
12:47	2		Person	1	80	Sits
12:48	1		Person	1	80	Reads book

Post Breaching 6/10/97

6:36 AM	1		Jake Brake	1		
7:53 AM	1		Truck on Road	1		
9:22 AM			People on East Shore			
9:38 AM	3		People at Rope Barrier North		30.5	
9:44 AM	1		Ranger on beach			
10:02 AM	1	25%	Cars at lookout			
10:09 AM	1		People	2	30.5	
10:13 AM			People at Jetty			
10:16 AM	1		People at South Rocks			
10:31 AM	1		Car alarm at lookoff			
10:37 AM	1		Yelling on south side			
10:50 AM	1		People	2	30.5	
10:56 AM	2		People on east shore, gull fight			
11:00 AM	1		Truck			
11:06 AM			People		30.5	
11:08 AM	1		Door slamming on overlook			
11:09 AM	1		People on eastrn shore			
11:30 AM	2		People		30.5	
11:44 AM	2		People	2	15.2	
12:05 PM	3		People		15.2	
12:10 PM	1		Surfer		30.5	
12:19 PM	3		Surfer	1	5	
12:23 PM	1		Surfer		30.5	
12:51 PM	1		Surfer		45.7	
Prebreaching	8/18/97					
6:14 AM	1		People	3	300	
6:19 AM	1 several		People	3	200	
6:20 AM	1 of 2		People	3	180 Creeping	
6:27 AM	1		People	4	180 Talking	
6:32 AM	1 of 4		People	4	130	
6:33 AM	1 of 3		People	4	130 Stop	
6:34 AM	1 of 1		People	4	130 People Retreat	
7:45 AM	3	2	People	1	360 Rock picker	
7:46 AM	1 of some		People		360 Rock picker	
7:47 AM	1 of 4		People	1	200 Rock picker	
7:48 AM	2 of 1, mass alert		People	1	160 Rock picker	
7:49 AM	1 mass		People	1	160 Rock picker	
7:50 AM	1 of 2		People		180 Rock picker	
7:51 AM	1 of 3		People	1	180 Rock picker	
8:12 AM	3	1	People		170 Rock picker	
8:13 AM	1 of several		People	1	130 Rock picker	
8:14 AM	1		People	1	110 Rock picker	
8:15 AM	1 of several		People		100 Rock picker	
8:16 AM	1		People	1	100 Rock picker	
8:17 AM	1		People	1	70 Rock picker	
8:18 AM	1		People		60 Rock picker	
8:21 AM	1		People		50 Rock picker, gulls walk	
8:22 AM	2 Mass		People		20 Rock picker	

8:23 AM	2		People	1	20 Rock picker
8:24 AM			People	1	20 Rock picker
8:25 AM	2		People		20 Rock picker
8:26 AM	2		People	1	20 Rock picker
8:27 AM	1		People	1	30 Rock Picker
8:33 AM	1		People	1	20 Rock Picker
8:24 AM			People		20 Rock Picker
9:51 AM	1		People		150 Kid
9:56 AM	1		People	3	80 Gulls walk
9:57 AM	3	3	People	3	80 Miss some flight?
9:58 AM			People	4	80
9:59 AM	3	1	People	5	80 Turnaway
10:04 AM	1		People	8	80
10:07 AM	1		People	8	80 W/ wave
10:09 AM	3	2	People	8	80
10:11 AM	1		People	2	80
10:12 AM			People & Dog	1	20
10:13 AM			People & Dog		160 Turn dog loose
10:14 AM	1		People		60 Rock picker
10:15 AM	1		People	2	60
10:19 AM	1		People	2	30
10:21 AM	1		People	1	24
10:22 AM			People	1	40 Running
10:23 AM	3	5	People	1	20 wave hit too?
10:27 AM	2		Fisherman	1	130 Casting
10:28 AM	3	1	Fisherman	1	100 Casting
10:30 AM	3	9	Fisherman		80 Casting

Breaching 8/20/97

8:11 AM	2 move, mass alert. indirect		bulldozer		240 600+ birds
8:12 AM	2 move		operator	1	200 Operator walks
8:13 AM	2 move of 1, alert of many		operator	1	180 Operator walks
8:14 AM	1		operator	1	200 Operator walks
8:22 AM	3	16	north guard	1	30 All flushed
12:34 PM	1		People	1	80 Signs down
12:35 PM	1		People	1	80 Signs down
12:39 PM	1		People	2	200 Signs down
12:45 PM	3	12	People	2	20
12:46 PM	3	1	People	2	20
12:53 PM	1	1	People	4	20
1:04 PM	1	1	People	1	80 Short board
1:05 PM	1	1	People	1	40 Short board
1:06 PM	3	8	People	1	40 Guard claps
1:28 PM	1		People	2	80 Waders
1:29 PM	1		People	1	40 Guard whistle

1:30 PM	1		People	7	90
Post Breaching	8/21/97				
5:49 AM	1	Maybe more, fog	Power boat		
6:26 AM	1	Maybe more, fog	People	4	120
6:27 AM	3		48 People	4	60
6:56 AM	3	Indirect by Pelicans	1 People and Dog	2	120
6:58 AM	1		People	3	
6:59 AM	1		People	3	
6:58 AM	1	Indirect	People by pelicans		120
8:21 AM	3		3 Kayak	1	180
9:26 AM	1	Indirect	People by pelicans	2	180
9:27 AM	3	Indirect	7 People by pelicans	2	
9:39 AM	1 of 2		People	2	100
9:55 AM	1 of 3-4		People	1	120
9:56 AM	1 of 2		People		60 Wading
10:12 AM	1 of 3-4		Dogs on leash		100