

**AN ASSESSMENT OF THE ACCIDENTAL
TAKE OF SEA OTTERS, ENHYDRA LUTRIS,
IN GILL AND TRAMMEL NETS**



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ABSTRACT

The sea otter, Enhydra lutris, is fully protected in California by both state and federal law. Despite this protection the population has not grown appreciably since at least 1976. Research efforts directed at identifying the reasons for the lack of population growth have concentrated on sources of mortality and their contribution to total mortality.

The accidental drowning of sea otters in gill and trammel nets used to take California halibut, Paralichthys californicus, was identified as a source of mortality which has probably increased as the sea otter population expanded into areas of intense fishing. As a result, an existing gill and trammel net fishery observation program in Monterey Bay was expanded to assess the extent and significance of the accidental drownings of sea otters in the areas near Morro Bay and Port San Luis.

Three different estimates of the number of sea otters drowned annually in gill and trammel nets were generated using comparable data bases. The average of these estimates was approximately 80 sea otters per year for the level of fishing effort expended during the June 1982 through June 1984 study period.

Back calculations of the annual take of sea otters by the gill and trammel net fishery for California halibut were made for each year from 1973 through 1983. These calculations suggest that the level of accidental take of sea otters during the last decade may have been high enough to be a significant factor in the lack of sea otter population growth.

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INTRODUCTION

The sea otter, Enhydra lutris, has been fully protected by state and federal law in California since the early 1900's. Under this protection the sea otter population expanded from a small remnant group to an estimated population of 1,789 animals in 1976 (Geibel and Miller 1984). Passage of the federal Marine Mammal Protection Act (MMPA) in 1972, and the designation of the population as threatened under the Endangered Species Act (ESA) in January 1977, provided an additional umbrella of protection for sea otters. Under the auspices of the MMPA and ESA, both state and federal regulatory and research activities on sea otters in California were directed toward the protection and recovery of the population. Justification for the 1977 determination that the California sea otter population was threatened was based on the potential impact of a major oil spill. This potential was considered significant because of the relatively small size of the population and its reduced range. Recent census results suggest that population growth has not occurred since at least 1976 (Wendell, Hardy, and Ames 1986). Research efforts directed toward identifying the reasons for the apparent lack of sea otter population growth in California have concentrated on sources of mortality and their contribution to total mortality.

Rumors of the accidental take of sea otters in commercial gill and trammel nets (set nets) were fairly persistent in recent years. Net drowning, if it was occurring, probably increased with sea otter range expansion into areas of intense set net activity. Unfortunately, drowning is virtually impossible to detect with any certainty during necropsy. However, there was a high correlation between seasonal changes in set net fishing effort and the recovery of sea otter carcasses in certain areas near the range periphery (Ames et al. 1983). This correlation suggested that the accidental drowning of sea otters in set nets could be a significant source of mortality.

The first observation of a sea otter entangled in a commercial set net occurred in Monterey in June 1982. This observation led to the expansion of an existing set net observation program in Monterey Bay to include all areas fished within the sea otter's range, particularly the Morro Bay and Port San Luis areas.

The primary objective of the observation program was to determine the extent and significance of set net related mortality throughout the sea otter's range (Point Ano Nuevo to the Santa Maria River). The results of the observation program from its inception (June 1980) through August 1984 are discussed in this report. The main body of data was

collected from June 1982 through June 1984.

METHODS

There are three set net fisheries active within the sea otter's range. Two of these fisheries, because of the mesh size used or the areas where fishing occurred, do not appear to be involved in the accidental take of sea otters. These fisheries, which target on white croaker, Genyonemus lineatus, and rockfish, Sebastes spp., respectively, are not considered in this report. The third fishery targets on California halibut, Paralichthys californicus.

The set net fishery for California halibut is most active in water depths less than 30 fm (1fm = 6ft = 1.9m). Nets, both gill and trammel, are set (anchored) in sandy areas, and left to capture fish by entanglement. Weights (along the bottom line) and floats (along the top line) hold the panels of webbing in a vertical position, to form a curtain-like wall of mesh. Typically, nets were soaked (fished) overnight but on occasion were left for longer periods of time. Trammel nets were, with few exceptions, made of multifilament nylon twine. Gill nets were constructed of either multifilament nylon twine or monofilament line. The minimum mesh size of both types of nets used in this fishery was generally eight to eight and one half inches. Trammel nets have two additional outer panels of much larger size mesh.

The California Department of Fish and Game (CDFG) at-sea observations of the set net fishery for California halibut were initiated in Monterey Bay in June 1980. Subsequent observations in that area were supported by a combination of resource agencies and conservation groups. The observation program was extended into the southern portion of the sea otter's range in August 1982. Initially, observations were made from boats; but shore based observations using high resolution telescopes became an established part of the program in January 1984.

Observers usually recorded net characteristics; including net type, length, mesh size, and material. Date, location, depth, and length of time the net fished were also noted. In addition, each species of fish, seabird, and marine mammal observed entangled was identified and tallied. When possible, sea otters observed accidentally drowned in set nets were tagged and returned to the ocean to assess subsequent recovery rates on the beach.

Where no indication of the length of net observed was

available an estimate was made based on the fisherman's log book information submitted in compliance with general set net permit requirements. If log book data were not available, an average net length used by other vessels in the boat's home port was substituted.

An estimate of the annual sea otter mortality from accidental drowning was based on an expansion of the average rate at which drowned sea otters were observed in set nets. This rate was calculated from data collected during the period June 1982 through June 1984. Data collected during 1983 were considered separately to provide, for comparative purposes, an estimate of the rate for a calendar year. These rates were expanded using estimates of the total set net fishing effort for California halibut within the sea otter's range.

The estimate of total set net fishing effort was generated by integrating three data bases: 1) an entry in the fisherman's log book indicating fishing activity (the only indicator of spatial and temporal distribution of fishing activity), 2) a landing receipt for fish sold, and 3) a direct observation of fishing activity. Criteria were developed, based on known fishing industry practices, that eliminated possible duplications in the recording of fishing activity. For instance, if a day of fishing was indicated in a fisherman's log book and a landing receipt was available dated for the next day, two possible days of fishing activity were recorded as one day of activity. Landings are frequently made the day following the actual fishing activity.

The unit of effort for set net fishing activity used in the assessment of accidental take of sea otters was the length of net fished rather than the number of days fished. Conversion from days fished to the length of net fished was readily made if the fishing activity was entered into the log book. However, if the log book information was missing or not complete, then a typical length of net fished in a day by that boat was used based on other log book entries. As with observation data, if log book data were not available, an average net length used by other vessels in the boat's home port was substituted. The estimate of the length of net fished by each boat was summed to develop a measure of total fishing effort by month and area. The monthly measures were used to estimate the annual total fishing effort.

Since fishing practices may differ between ports, and observations were initiated at different times in geographically distinct areas, data were analysed for three separate areas. The areas were: 1) Monterey (Ano Nuevo Island to Point Sur), 2) Morro Bay (Point Sur to Point San

Luis), and 3) Port San Luis (Point San Luis to the Santa Maria River).

To identify commercial fishing areas coastal waters are separated by CDFG into block units (measuring ten minutes of longitude by ten minutes of latitude). Each unit in this block system measures approximately eight by ten nautical miles. The location of set net fishing activity was summarized using this block system. Commercial fishing blocks included in the Monterey area are blocks 502, 501, 509, 508, 507, 516, 517, 526, and 532 (Figure 1). Commercial fishing blocks within the Morro Bay area are 539, 538, 548, 547, 554, 553, 561, 560, 602, 601, 608, 607, 615, and 614. The two fishing blocks within the Port San Luis area are 623 and 622.

The Port San Luis area is considered to be at the southern periphery of the sea otter's range. Marked seasonal changes in sea otter densities occur in this male dominated area; most males disperse north into the more established sea otter range (Point Estero to Monterey Bay) in early summer. The data used in the analysis for this area were only collected during times of high sea otter densities: January through July in 1983 and January through June in 1984.

RESULTS

Monterey Area

The number of boats active in the set net fishery within this area varied considerably between June 1982 and June 1984 (Table 1). Forty-nine boats submitted log book information indicating some activity within the Monterey area during this 25 month period. Thirty-three of these boats (68%), however, fished set nets on fewer than ten days. Only four boats active in 1982 were still active in 1984; only three of the fifteen boats that entered the set net fishery in 1983 were still active in 1984. Those seven boats accounted for slightly over 30% of the total days of set net fishing effort within the Monterey area.

Approximately 195 km (107,000 fm) of net was reported set during the 362 days of fishing activity entered into log books (Table 2). An additional 330 km (181,000 fm) of net was estimated to have been set in the Monterey area from June 1982 to June 1984 based on landing receipts and direct observation. Approximately 458 km of the total fishing effort was estimated to have occurred in depths shallower than 15 fm.

A total of 26.4 km (14,445 fm) of set net was observed,

representing approximately 5% of the estimated total fishing effort expended in the area (Table 3).

In general, the distribution of observed effort reflects the distribution of fishing effort reported in log books for depth and season (Tables 1-3). Log book fishing effort provides the only indication of how these parameters are distributed for the total fishing effort. The distribution of observation effort did not correspond as well with the distribution of log book fishing effort by area. In 1982, all of the observed fishing effort occurred within fishing blocks 516 and 526, in the southern portion of Monterey Bay. In contrast, fishing blocks 508 and 509, both in the northern portion of the bay, received most of the fishing effort as reported in log books (Figure 1). The discrepancy between the distribution of observed and logged fishing effort continued, to some extent, throughout the study period.

Several changes in gear used in the Monterey set net fishery occurred between June 1982 and June 1984. In 1982, monofilament gill nets were the most frequently sampled net, accounting for over 90%, by length, of set nets observed (Table 4). In 1983, multifilament gill nets predominated (48%), with the remaining observations comprised of monofilament gill nets (32%) and multifilament trammel nets (20%). The occurrence of more multifilament gear continued in 1984; however, most of the nets were trammel nets.

All sea otters were observed entangled in nets set in water shallower than 15 fm. Since this was the case for all sea otters observed accidentally taken throughout the range, the data were stratified by depth into two components (< 15 fm and > 15 fm) for the assessment of the number of sea otters taken annually by area. Seven sea otters were observed entangled in nets set within the Monterey area during the 25 month period from June 1982 through June 1984 (Table 5). The rate of sea otter entanglement inside the 15 fm contour based on this data was 0.3088 sea otters/km of net. The rate for just 1983 data was 0.1992 sea otters/km of net. The mortality estimate based on data collected during the entire 25 month period was 68 sea otters accidentally taken per year. The set net related annual sea otter mortality estimate for 1983 in the Monterey area was 27.

Morro Bay Area

The same general activity pattern observed in the Monterey area fishery was also apparent in this area (Table 6). A smaller percentage (41% vs 68%) of the boats submitting log book information (29 boats) fished on fewer than 10 days. Seven boats active in 1982 remained active through June 1984. One of the three boats that entered the set net

fishery in the Morro Bay area remained active in 1984. Those eight boats accounted for slightly over 74% of the total days of set net fishing effort within this area.

The level of activity was considerably greater among the most active boats when compared with boats from the Monterey area. Four boats were active more often than the most active boat in the Monterey area.

Approximately 742 km (406,000 fm) of net was reported set during the 766 days of fishing activity entered into log books (Table 2). An additional 295 km (161,000 fm) of net was estimated to have been set in the Morro Bay area from August 1982 through June 1984 based on landing receipts and direct observation. Approximately 837 km of the total fishing effort was estimated to have occurred in depths shallower than 15 fm. The total fishing effort expended in the Morro Bay fishery in 23 months was about twice that expended in Monterey for the 25 month period.

The distribution of observed fishing effort varied somewhat from that reported in log books for the Morro Bay area. Almost 46% of the fishing effort reported in log books occurred before July in 1983, while only 7% of the observed fishing effort occurred in that same period. Observation effort prior to July in 1983 was concentrated in the Port San Luis area. Another disparity between observed fishing effort and fishing effort reported in log books also developed in 1983 when more fishing activity shifted to the north of Point Estero (Figure 1). Very little of the activity north of Salmon Creek was observed due to constraints of at-sea sampling from a small vessel. The observation of fishing effort in this area increased substantially in 1984 with increased utilization of shore based observers.

In contrast to the change from monofilament to multifilament gear in the Monterey area, the Morro Bay area fishermen switched from predominantly multifilament gear to monofilament gear (Table 4). In 1982, over 90% of the gear observed was multifilament trammel net. In 1984, only 23% of the gear observed was multifilament trammel net and over 75% was monofilament gill net. Monofilament gill net was first observed being fished in August 1983 so the transition from one gear type to the other was relatively rapid.

Five sea otters were observed entangled in set nets in the Morro Bay area from August 1982 through June 1984 (Table 5). All sea otters were observed entangled in nets set in water shallower than 15 fm. The rate of entanglement inside the 15 fm contour (0.0442 sea otters/km of net) was considerably lower than that calculated for the Monterey area (0.3088 sea otters/km of net). The rate using just 1983 data was also

considerably lower (0.0624 vs 0.1992 sea otters/km of net). The mortality estimate based on data collected during the entire 23 month period was 19 sea otters accidentally taken per year. The set net related annual sea otter mortality estimate for 1983 in the Morro Bay area was 23.

Port San Luis Area

This set net fishery operates within the southern peripheral portion of the sea otter's range. Nine boats submitted log book information indicating some fishing activity within the area from June 1982 through June 1984. Three of these boats fished on fewer than 10 days. Most of the boats active in 1982 remained active through June 1984 (83%). None of the boats that entered the set net fishery in 1983 remained active in 1984 (Table 8). Those five boats active through the entire period accounted for over 90% of the total days of set net fishing effort within this area. Four of these boats fished more often than the most active boat from the Monterey area.

Approximately 250 km (137,000 fm) of net was reported set during the 447 days of logged fishing activity when sea otters were present. An additional 37 km (20,000 fm) of net was estimated to have been set during that period based on landing receipts and direct observation. An estimated 241 km (132,000 fm) of the total fishing effort occurred in depths shallower than 15 fm.

A total of 30.1 km (16,459 fm) of set net was observed, representing approximately 12% of the estimated total fishing effort expended in the Port San Luis area when sea otters were present (Table 9). In general, the distribution of observed fishing reflects the distribution of fishing as reported in log books by season. A higher percentage of the fishing occurring in depths shallower than 15 fm was observed (14% vs 6%).

A change from multifilament trammel to monofilament gill net occurred during the period when sea otters were absent from the area in 1983. This change coincided with a comparable change in gear observed in the Morro Bay fishery.

Five sea otters were observed entangled in set nets during the thirteen month observation period (January through July in 1983 and January through June in 1984) (Table 5). Again, all otters were observed entangled in nets set in water shallower than 15 fm. The rate of entanglement was 0.1661 sea otters/km of net for the entire period. The rate using just 1983 data (7 months) was considerably higher (0.2317 s.o./km of net). The mortality estimate based on data collected during the entire 13 months was 18 sea otters accidentally taken per year. The net related annual

mortality estimate for 1983 in the Port San Luis area was 23 sea otters.

Rangewide Estimate of Accidental Take

The 1983 rangewide estimate of sea otters accidentally taken in set nets was 73 animals. Another annual estimate based on data collected from June 1982 through June 1984 was 105 animals. The two estimates vary because of the difference in the estimates from the Monterey area. The annual mortality estimate in the Monterey area was 27 sea otters based on 1983 data; and 68 sea otters based on cumulative data (June 1982 through June 1984).

Set net observation data collected from the Monterey area prior to June 1982 (June 1980 through May 1982), with no accidental drownings observed, suggest that the estimate based on cumulative data may be high. Incorporating this observation data yields a rate of entanglement (0.0865 s.o./km of net) for the Monterey area which is comparable to that observed in the other two areas.

Assuming that there are no significant changes through time or between areas in the rate of entanglement, the rangewide rate, based on all available observation data (June 1980 through August 1984) was 0.0844 sea otters/km of net. Using this rate of entanglement and expanding by the total fishing effort estimated for the June 1982 through June 1984 period yields an estimate of 66 sea otters accidentally taken per year.

However, there was at least one change in fishing practice through time which could affect the validity of the above assumption. There was a marked change from multifilament to monofilament gear in each of the areas. Stratifying the observation data by gear type yielded a rate of entanglement of 0.0452 sea otters/km of net for monofilament gear and 0.1049 sea otters/km of net for multifilament gear. The lower rate of entanglement for monofilament set nets did not result in a lower accidental take because considerably more net was fished.

DISCUSSION

The accuracy of the annual estimate of accidental take of sea otters in set nets is dependent on how accurately total fishing effort is reflected by the sampling effort. It is likely that the rate of accidental take varies to some extent by area, depth, time, fishing practices (e.g. net type and construction, proximity to sea otter rafting sites) and by sea otter behavior. Sampling design was structured

in an attempt to make observed and actual fishing effort proportional, and thereby minimize bias in several of the above variables. However, various sampling constraints led to disproportionate sampling.

Lack of cooperation from some fishermen created a situation where some fishing activity could either not be observed or could not be observed in proportion to its contribution to the total fishing effort. Fishing activity occurring long distances from port created the same sampling problem. If differences in fishing practices exist among fishermen which influence the rate of accidental take, disproportionate sampling of fishing activity could result in bias which affects the accuracy of the accidental take estimates.

Recognized differences in the distribution of observed fishing effort and the fishing effort reported in log books existed. For example, the Morro Bay area received no observation effort during the first six months of 1983 because of the difficulty of anticipating fishing activity. Fishing effort in the area from Point Piedras Blancas to Point Sur was also not sampled proportionally through 1983 because of the distance from port. Later in the sampling program, with shore based effort, the latter area was actually sampled disproportionately higher. Assuming that the fishing effort reported in log books accurately depicts the distribution of total fishing effort, these differences could also influence the accuracy of the estimates.

Sample size obviously can influence how well observed fishing effort reflects total fishing effort. For example, the highest estimate of the rate of accidental take (0.3088 s.o./km of net) occurred in the Monterey area, which also had the smallest proportion (5%) of the estimated total fishing effort sampled. The small sample size may be responsible for the relatively high rate and influences our confidence in the estimate of sea otters taken accidentally in set nets in the Monterey area.

Despite the above limitations, we have confidence that the estimated number of sea otters accidentally taken rangewide in set nets during this study is representative of the actual take. Based on the three estimates of annual accidental take generated in this report (105 sea otters based on cumulative data, 68 based on all available observation data, and 73 based on 1983 data) an estimate of 80 sea otters accidentally taken each year is suggested for the sampling period.

What impact would the estimated annual accidental take of sea otters in set nets have on sea otter population growth? Two factors need to be addressed to assess this impact: 1) the level of set net fishing activity within the sea otter's

range through time and 2) sea otter population numbers through time.

Fishermen's logs of activity, observations of fishing activity, and landing receipts for fish sold were integrated to estimate total fishing activity in this report. However, landing receipts provide the only indication of how prior fishing effort within the sea otter's range has changed through time. The relationship between the number of landings in 1983 and the estimated 1983 accidental take was 73 sea otters per 696 landings or 0.1049 sea otters entangled/landing. Using this relationship, an approximation of the accidental take by set nets was generated by year for the period 1973 through 1982, and ranged from 48 to 166 animals (Table 10).

It is generally accepted that the sea otter population in California has increased at an average rate of 5% per year (Geibel and Miller 1984). Sea otter range expansion into areas of intense set net fishing activity occurred in 1973 on both ends of the range. The 1973 sea otter population estimate was 1,720 animals. If the population increased by 5% per year, the sea otter population would have contained approximately 2,800 animals by 1983 (Figure 2). The estimate from a 1984 census, however, was 1,372 animals. If the number of sea otters estimated to have been accidentally taken annually by set nets (Table 10) is subtracted each year after the assumed 5% annual increase from 1973 through 1983, the resulting population projection is 1,550 sea otters.

It appears, using the relationship between the rate of sea otter entanglement and landing receipts in 1983, that the accidental take of sea otters in set nets could have been high enough to contribute significantly to the lack of sea otter population growth. However, other factors may have contributed to the indicated lack of population growth. For instance, mortality of new recruits may have increased with the range expansion if food were a limiting factor in the central portion of the range. If this were the case, population growth may have been higher early in the recovery phase and then slowed as the range expanded and the potential for growth in recent years may not have approached the accepted long term average rate of increase.

The accidental take of sea otters in set nets can be mitigated. Development of electronic devices to repel marine mammals is being pursued by several agencies, including CDFG. However, no devices have yet been developed capable of repelling sea otters. Until other methods are developed, regulations restricting the use of nets within the sea otter's range appears to be the most effective option for reducing the accidental take. The substantial

number of observations made since June 1980 indicates that the incidence of sea otters accidentally drowning in set nets fished deeper than 15 fathoms is very low. A closure of the entire sea otter range out to the 15 fathom contour should essentially eliminate all accidental take. However, such a closure could also eliminate the commercial set net fishery for California halibut within the sea otter's range.

Other considerations have been suggested that could influence the level of accidental take, including: 1) setting a limit on soak time, 2) limiting the length of net fished, 3) ensuring nets are set parallel to shore and, 4) restricting utilization of multifilament net material. Of these, the most promising appears to be setting a ceiling on fishing effort by limiting the length of net fished.

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FIGURE 1. Distribution of total estimated fishing effort and observation effort in fathoms of net within two depth strata by fishing block for selected time periods (Monterey area (horizontal lines) from June 1982 through June 1984; Morro Bay area (clear blocks) from August 1982 through June 1984; Port San Luis area (vertical lines) from January through July 1983 and January through June 1984).

BLOCK #	ESTIMATED TOTAL EFFORT			OBSERVED EFFORT			SEA OTTER
	<15	≥15	TOTAL	<15	≥15	TOTAL	
502	0	0	0	0	0	0	-
501	0	0	0	0	0	0	-
509	95177	6292	101469	75	0	75	0
508	70824	9182	80006	305	0	305	0
507	0	0	0	625	0	625	0
516	26489	5221	31710	1745	0	1745	0
517	13909	250	14159	0	0	0	0
526	44053	16124	60177	9645	2050	11695	6
532	0	0	0	0	0	0	-
539	1125	0	1225	0	0	0	-
538	6684	0	6684	0	0	0	-
548	316	0	316	0	0	0	-
547	32035	2457	34492	1825	0	1825	0
554	19687	4111	23798	400	0	400	0
553	18176	2405	20581	2282	925	3207	0
561	40283	4761	45044	1025	0	1025	0
560	10343	2205	12548	3155	625	3780	0
602	63183	8454	71637	11658	1100	12758	2
601	62061	5912	67973	10715	600	11315	0
608	3427	1003	4430	350	300	650	0
607	199436	69968	269404	27593	16790	44383	3
615	904	8134	9038	2875	2735	5610	0
614	228	0	228	0	0	0	-
622	19581	582	20163	4747	0	4747	0
623	112191	24592	136783	11712	660	12372	5

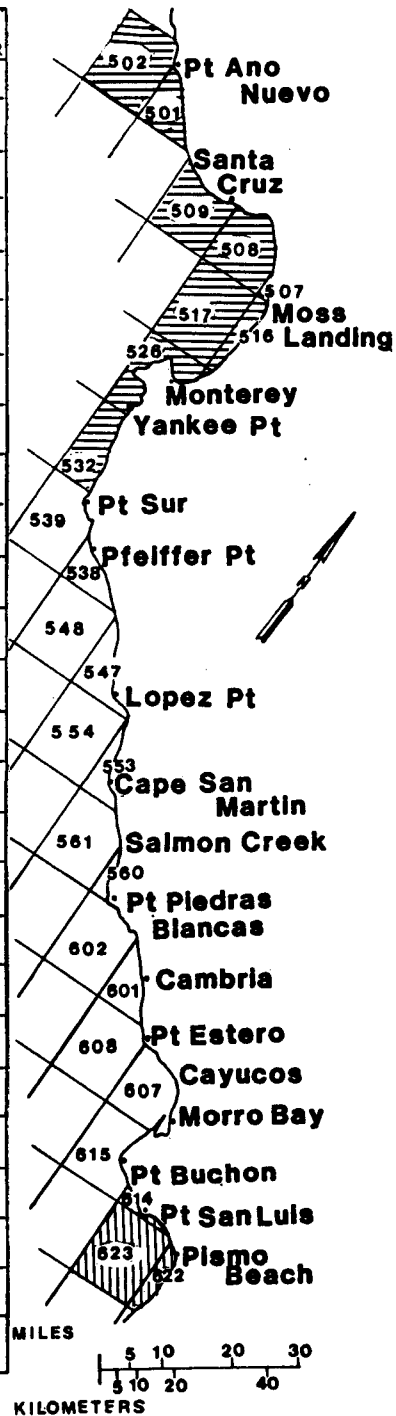


Figure 2. Comparison of estimated and theoretical sea otter population growth patterns. Line 1 indicates a theoretical growth of 5% per year using a 1973 population census estimate as a base reference point. Line 2 indicates a theoretical growth of 5% per year minus the estimated accidental take in set nets. Line 3 indicates sea otter population estimates from censuses.

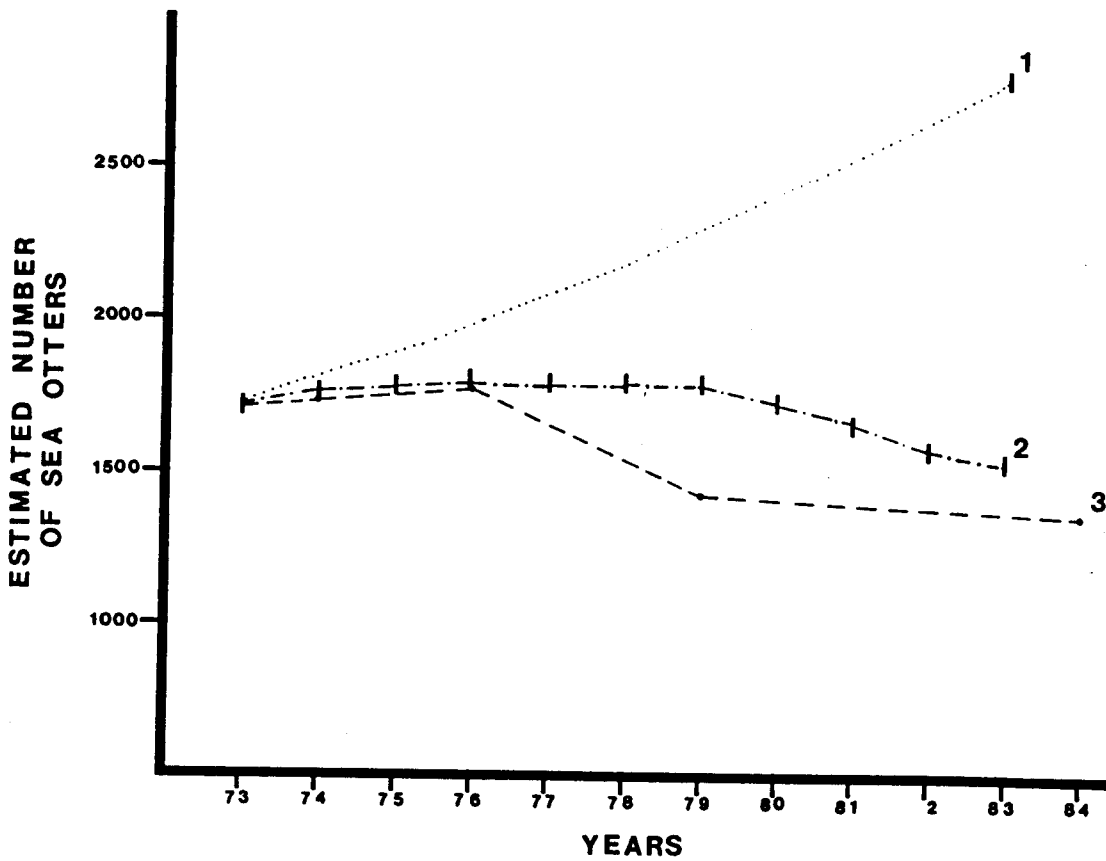


TABLE 1. Distribution of Fishing and Observation Days (#/#) by Boat and Month for the California Halibut Set Net Fishery Within the Monterey Area.

Year/Month	Boat Number										
	1	2	3	4	5	6	7	8	9	10	11
1982 Jun			2/0		1/0				1/0		
Jul	1/0		4/0	1/0		10/0					
Aug							2/0	3/0			1/0
Sep											
Oct											1/0
Nov											
Dec		1/0									
1983 Jan											
Feb											
Mar						1/0					
Apr		4/0				10/0					
May						4/0					
Jun									3/2		
Jul				1/0		10/1			4/1		
Aug			1/0			15/0					
Sep						8/0					
Oct						6/0					
Nov											
Dec											2/0
1984 Jan*											
Feb						4/0					6/0
Mar						3/0	5/0				
Apr							12/0				
May							1/0				
Jun											
Total	1/0	5/0	7/0	2/0	1/0	71/1	20/0	3/0	8/3	0/0	10/0

TABLE 1. Continued

Year/Month	Boat Number											
	12	13	14	15	16	17	18	19	20	21	22	
1982	Jun	12/2	15/0	2/0		1/0	1/0			4/2		22/2
	Jul	5/0	13/0	1/0			1/0	4/1	2/0	1/0		22/4
	Aug	4/0	13/0								11/1	17/1
	Sep		4/0	2/0							3/0	
	Oct		10/1									
	Nov		3/0									
	Dec		6/0									
1983	Jan											
	Feb											
	Mar											
	Apr											
	May			1/0							3/0	
	Jun								3/0	1/0		
	Jul								12/2	1/0	3/0	
	Aug	1/0		5/0					3/0	6/0	2/0	
	Sep									8/0		
	Oct			1/0						1/0		
	Nov											
	Dec											
1984	Jan*											
	Feb											
	Mar								5/3			
	Apr											
	May								9/5			
	Jun								4/4			
	Total	22/2	64/1	12/0	0/0	1/0	2/0	4/1	2/0	41/16	34/1	66/7

TABLE 1. Continued

Year/Month	Boat Number										
	23	24	25	26	27	28	29	30	31	32	33
1982 Jun	22/0										
Jul	10/0										
Aug											
Sep	10/0										
Oct	16/0										
Nov	12/0										
Dec	4/0										
1983 Jan	9/0										
Feb											
Mar											
Apr		1/0									
May						2/0				3/0	
Jun						8/1					
Jul					1/0	3/1					3/0
Aug				1/0	2/0		1/0				
Sep							2/0				
Oct			2/0							2/0	
Nov									5/1		
Dec											
1984 Jan*											
Feb											
Mar											
Apr											
May											
Jun											20/10
Total	83/0	1/0	2/0	1/0	3/0	13/2	3/0	5/1	2/0	3/0	23/10

TABLE 1. Continued

Year/Month	Boat Number											
	34	35	36	37	38	39	40	41	42	43	44	
1982	Jun											
	Jul											
	Aug											
	Sep											
	Oct											
	Nov											
	Dec											
1983	Jan											
	Feb											
	Mar											
	Apr											
	May											
	Jun			1/0								
	Jul		2/0									
	Aug											
	Sep											
	Oct	1/0			9/0	1/0						
	Nov											
	Dec											
1984	Jan*										3/0	
	Feb		2/0					1/0				
	Mar				15/3	2/0	1/0					
	Apr						5/0					8/2
	May				6/5		8/0	11/0	6/0			3/0
	Jun				4/2							
	Total	1/0	4/0	1/0	9/0	26/10	2/0	15/0	11/0	6/0	3/0	11/2

TABLE 1. Continued

Year/Month	Boat Number					Total
	45	46	47	48	49	
1982 Jun						83/6
Jul						75/5
Aug						51/2
Sep						19/0
Oct						27/1
Nov						15/0
Dec						11/0
1983 Jan						9/0
Feb						0/0
Mar						1/0
Apr						15/0
May						13/0
Jun						16/3
Jul						40/5
Aug						37/0
Sep						18/0
Oct						23/0
Nov						5/1
Dec						2/0
1984 Jan*						3/0
Feb						13/0
Mar		1/1	1/1			33/8
Apr				1/1		26/3
May	4/2			2/2		50/14
Jun	1/1			1/1	4/4	34/22
Total	5/3	1/1	1/1	4/4	4/4	

* The 1984 summary of activity only includes log and observation data. Landing receipt data increased the 1983 estimate of fishing days by 82 (85% added).

TABLE 2. Summary of Total Estimated Effort, Total Logged Effort and Total Observed Effort in Fathoms of Net by Month and Area.

YEAR/MONTH	Monterey			Morro Bay			Port San Luis		
	Tot. Est.	Tot. Log.	Tot. Ob.	Tot. Est.	Tot. Log.	Tot. Ob.	Tot. Est.	Tot. Log.	Tot. Ob.
1982 JUN	25854	9270	825	-	-	-	-	-	-
JUL	26221	2680	2275	-	-	-	-	-	-
AUG	18992	5975	250	25760	600	1000	-	-	-
SEP	5853	825	0	29285	8660	1500	-	-	-
OCT	7300	6350	75	41095	31600	4270	-	-	-
NOV	4650	4650	0	32335	27400	3385	-	-	-
DEC	2539	600	0	14676	10866	900	-	-	-
TOTAL	91409	30350	3425	143151	79126	11055	-	-	-
1983 JAN	3150	0	0	11400	6050	1500	2820	800	700
FEB	0	0	0	3150	3150	0	4020	4020	0
MAR	180	0	0	6820	6300	0	3150	3150	855
APR	4495	0	0	16000	15400	550	6440	6440	480
MAY	5791	2960	0	22892	20700	0	12770	12194	2987
JUN	8739	6350	990	30215	26350	11	18284	17210	2162
JUL	18900	8980	1195	20120	14300	1280	21356	20410	560
AUG	13861	7210	0	25874	19248	5802	-	-	-
SEP	5078	4000	0	47600	29700	10500	-	-	-
OCT	10525	2440	0	31397	17947	4750	-	-	-
NOV	3450	0	560	11961	5550	0	-	-	-
DEC	500	500	0	11245	5850	4215	-	-	-
TOTAL	74669	32440	2745	238674	170545	28608	68840	64224	7744

TABLE 2. Continued

YEAR/MONTH	Monterey			Morro Bay			Port San Luis		
	Tot. Est.	Tot. Log.	Tot. Ob.	Tot. Est.	Tot. Log.	Tot. Ob.	Tot. Est.	Tot. Log.	Tot. Ob.
1984 JAN	1675	0	0	31889	27734	9720	1162	0	0
FEB	11864	4605	0	20629	18100	6200	2779	2600	785
MAR	20620	6102	780	12456	10650	8065	8988	7200	0
APR	20950	6990	305	1742	1200	5530	3094	2200	680
MAY	44806	19120	2955	48294	40075	7300	38795	32180	6280
JUN	21528	7010	4235	70563	58550	8475	33288	28550	1630
TOTAL	121443	43827	8275	185573	156309	45290	88106	72730	9375

TABLE 3. Distribution of Logged Effort and Observed Effort in Fathoms of Net by Depth of Set and Month Within the Monterey Area. Ten Fathom Closure Within Monterey Bay Effective 28 June 1982. * Depth of set noted as <15 fathoms

Year/Month		Depth of Set (fm)							
		< 10		10-14		15-19		> 19	
		Log	Obs	Log	Obs	Log	Obs	Log	Obs
1982	Jun	950	725	8320	100	0	0	0	0
	Jul	0	1025	2680	1250	0	0	0	0
	Aug	0	150	5975	100	0	0	0	0
	Sep	0	0	825	0	0	0	0	0
	Oct	0	0	6350	75	0	0	0	0
	Nov	0	0	4500	0	150	0	0	0
	Dec	0	0	450	0	150	0	0	0
	Total	950	1900	29100	1525	300	0	0	0
1983	Jan	0	0	0	0	0	0	0	0
	Feb	0	0	0	0	0	0	0	0
	Mar	0	0	0	0	0	0	0	0
	Apr	0	0	0	0	0	0	0	0
	May	0	0	2960	0	0	0	0	0
	Jun	0	250	6350	740	0	0	0	0
	Jul	0	0	8980	1195	0	0	0	0
	Aug	0	0	7210	0	0	0	0	0
	Sep	0	0	4000	0	0	0	0	0
	Oct	0	0	2440	0	0	0	0	0
	Nov	0	0	0	560	0	0	0	0
	Dec	0	0	250	0	0	0	250	0
Total	0	250	32190	2495	0	0	250	0	
1984	Jan	0	0	0	0	0	0	0	0
	Feb	0	0	2300	0	1735	0	570	0
	Mar	0	0	4382	330	720	450	1000	0
	Apr	0	*	6540	305*	450	0	0	0
	May	850	580	15720	2375	2550	0	0	0
	Jun	0	*	1760	2275 ^{360*}	5250	1600	0	0
	Total	850	580+*	30702	4980 ^{665*}	10705	2050	1570	0

TABLE 5. Data on all Sea Otters Observed Entangled in Large Mesh Set Nets from June 1982 Through August 1984.

DATE	LOCATION	DEPTH (fathoms)	NET TYPE	SEX	LENGTH (cm)	WEIGHT (kg)	RELATIVE AGE	REMARKS*
6-22-82	Monterey	11	9" multi-gill	M	126cm	26.8	adult	not released
6-22-82	Monterey	11	9" multi-gill	M	124cm	26.8	adult	not released
6-24-82	Monterey	2	8" mono-gill	-	-	-	-	not tagged
10-18-82	Morro Spit	10	trammel	M	-	23	adult	tagged
10-20-82	Villa Creek	6	trammel	F	109cm	14.5	sub adult	11-8-82
4-26-83	Shell Beach	11	trammel	M	102cm	15.0	sub adult	tagged
4-26-83	Shell Beach	11	trammel	M	121cm	23	adult	tagged
6-20-83	Shell Beach	10	trammel	M	116cm	23	adult	tagged
8-10-83	Pt. San Simeon	12	mono-gill	M	92cm	11.8	immature	tagged
10- 9-83	Villa Creek	7	mono-gill	F	112cm	19.1	adult	10-22-83
11-18-83	Monterey	11	trammel	M	121cm	21.3	sub adult	11-28-83
1-21-84	Piedras Blancas	11	mono-gill	-	-	-	sub adult	shore ob. not tagged
2-28-84	Shell Beach	6	trammel	-	-	-	adult	shore ob. not tagged
5-22-84	Avila Beach	4	mono-gill	-	-	-	adult	shore ob. not tagged
6- 4-84	Monterey	11	mono-gill	F	101cm	13.5	sub adult	tagged
6- 9-84	Monterey	10	trammel	F	102cm	13.3	sub adult	tagged
6-11-84	Monterey	10	trammel	M	107cm	19.1	sub adult	7-8-84

TABLE 5. Continued

DATE	LOCATION	DEPTH (fathoms)	NET TYPE	SEX	LENGTH (cm)	WEIGHT (kg)	RELATIVE AGE	REMARKS*
7-12-84	Villa Ck Cayucos	10	mono-gill	M	98cm	13.6	Imm.	tagged
7-25-84	San Simeon	9	mono-gill	-	-	-	adult	shore ob. not tagged
7-30-84	Villa Ck Cayucos	4	mono-gill	-	-	-	sub adult	shore ob. not tagged
7-30-84	Villa Ck Cayucos	3	mono-gill	-	-	-	sub adult	shore ob. not tagged
8-21-84	Cayucos Point	6	trammel	-	-	-	adult	shore ob. not tagged

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*When possible carcasses were tagged and released on site to help assess relative recovery rates in the salvage program. When a tagged carcass was recovered on shore a recovery date is shown.

TABLE 6. Distribution of Fishing and Observation Days (#/#) by Boat and Month for the California Halibut Set Net Fishery Within the Morro Bay Area.

Year/Month	Boat Number										
	1	2	3	4	5	6	7	8	9	10	11
1982 Jun	17/0		8/0		5/0	2/0					1/0
Jul	13/0	2/0	1/0		4/0		4/0				
Aug	7/0		7/0	2/0	4/0						
Sep				4/0	4/0			17/0			
Oct				2/0	2/0	4/0		12/1	2/1		
Nov					3/0	6/0			9/2		
Dec				2/0	2/0	7/0			2/0		
1983 Jan					8/0	4/0			3/0		
Feb					3/0	3/0					
Mar					8/0	4/0					
Apr					12/1	10/0			1/0		
May	15/0				13/0	1/0					
Jun	9/1				18/0						
Jul	12/0			9/0	19/0	14/0					
Aug	6/1			8/0	22/4	5/0					
Sep				11/0	20/5	14/2					
Oct				1/0	7/0	15/4					
Nov					3/0	12/0					
Dec					8/1	6/1					
1984 Jan *				7/0	17/5	13/8					
Feb					11/5	11/4					
Mar					16/7	4/2					
Apr					3/3	7/6					
May					19/5	17/0				9/1	
Jun					9/0	16/5				6/0	
Total	79/2	2/0	16/0	46/0	240/36	175/32	4/0	29/1	17/3	15/1	1/0

TABLE 6. Continued

Year/Month	Boat Number										
	12	13	14	15	16	17	18	19	20	21	22
1982 Jun		1/0			2/0	6/0					
Jul	1/0	6/0	1/0		20/0						
Aug	1/0	3/0	8/0		15/2	2/0					
Sep	1/0	6/0	12/2	1/0	6/1	1/0					
Oct		7/0	18/3		15/5	6/1					
Nov		2/0	12/3		9/3	7/0			1/0		
Dec					8/2						
1983 Jan					6/3						
Feb											
Mar											1/0
Apr											
May						3/0					
Jun		2/0	8/1			15/0					
Jul	1/0	2/0	7/3			4/0					
Aug	1/0	2/1			8/7	1/0		3/0			
Sep		12/7			10/6		1/0	5/0			
Oct		8/5	2/0			9/0	1/0				
Nov		4/0				4/0					
Dec		2/2			3/3			3/0			
1984 Jan*		3/3						6/0		3/0	
Feb					3/2			3/0			
Mar					3/3			2/0			
Apr					2/2						
May		11/3	2/2		3/1	2/1					
Jun		17/5			16/1	4/1					
Total	5/1	88/26	70/14	1/0	129/41	64/3	2/0	22/0	1/0	3/0	1/0

TABLE 6. Continued

Year/Month	Boat Number							Total
	23	24	25	26	27	28	29	
1982 Jun								42/0
Jul								53/0
Aug								49/2
Sep								52/3
Oct								68/11
Nov								49/8
Dec								21/2
1983 Jan								21/3
Feb								6/0
Mar								13/0
Apr								23/1
May								32/0
Jun								52/2
Jul								68/4
Aug								56/13
Sep								73/20
Oct								43/9
Nov								23/0
Dec								22/7
1984 Jan*								49/16
Feb	2/0							30/11
Mar								25/12
Apr		2/0	3/0					17/11
May			15/0	2/0	3/0	6/1	4/0	93/14
Jun			22/1	6/1	13/0	14/1	19/0	142/15
Total	2/0	2/0	40/1	8/1	16/0	20/2	23/0	

* 1984 Summary of activity only include log and observation data. Landing receipt data would increase estimate of total days active.

TABLE 7. Distribution of Logged Effort and Observed Effort in Fathoms of Net by Depth of Set and Month Within the Morro Bay Area.

Year/Month		Depth of Set (fm)							
		< 10		10-14		15-19		> 19	
		Log	Obs	Log	Obs	Log	Obs	Log	Obs
1982	Jun	-	-	-	-	-	-	-	-
	Jul	-	-	-	-	-	-	-	-
	Aug	400	800	200	200	0	0	0	0
	Sep	900	800	7510	700	250	0	0	0
	Oct	4150	750	14775	1250	9000	2000	3675	270
	Nov	8750	1885	11225	1400	5125	100	2300	0
	Dec	2473	0	4643	0	3750	900	0	0
	Total	16673	4235	38353	3550	18125	3000	5975	270
1983	Jan	825	0	3300	200	1925	1300	0	0
	Feb	0	0	3150	0	0	0	0	0
	Mar	0	0	4750	0	1100	0	450	0
	Apr	3025	550	11275	0	1100	0	0	0
	May	17275	0	3425	0	0	0	0	0
	Jun	11075	11	10725	0	3950	0	600	0
	Jul	4400	150	5350	830	3500	0	1050	300
	Aug	8024	1852	8824	2675	2400	1275	0	0
	Sep	9300	3300	16475	3325	3650	2325	275	1550
	Oct*	6986	1325	9776	1075	1051	200	134	2000
	Nov	825	0	4225	0	0	0	500	0
	Dec	875	600	3375	1690	1400	1525	200	400
	Total	62610	7788	84650	9795	20076	6625	3209	4250
1984	Jan**	5573	2945	12708	1680	6748	600	2705	1160
	Feb**	6275	1380	8749	3325	600	1100	2476	305
	Mar	1075	1489	3248	4866	5727	810	600	900
	Apr	0	1300	600	3350	600	705	0	175
	May	13909	3525	15156	2525	10260	1050	750	200
	Jun	26333	5975	30117	775	4475	1525	0	200
	Total	53165	16614	70578	16521	28410	5790	6531	2940

* 150 fms of net observed where depth of set not recorded

** Plus 3335 fathoms of net observed in Jan in <15 fathoms
90 fathoms of net observed in Feb in <15 fathoms

TABLE 8. Distribution of Fishing and Observation Days (#/#) by Boat and Month for the California Halibut Set Net Fishery from the Port San Luis Area Within the Sea Otter's Range.

Year/Month	Boat Number									Total
	1	2	3	4	5	6	7	8	9	
1982 Jun	1/0	3/0		4/0						8/0
Jul		9/0	3/0	4/0		1/0				17/0
Aug	10/0	2/0				1/0				13/1
Sep	12/0	3/0								15/0
Oct	9/0	6/0	15/0							30/0
Nov	13/0	5/0	15/0							33/0
Dec					4/0					4/0
1983 Jan	4/0		5/0		11/3					20/3
Feb			8/0		10/0					18/0
Mar		3/3			6/3					9/6
Apr	2/0	10/2			1/0					13/2
May	11/4	18/8			16/2		4/2			49/16
Jun	6/1	20/6	3/0		10/1	2/0	9/2			50/10
Jul	6/0	20/0	8/1		7/0	9/0	16/1			66/2
Aug	8/0	13/0	14/0		21/0	1/0	14/0			71/0
Sep	7/0	5/0	1/0		1/0		1/0			15/0
Oct	6/0	6/0	10/0		4/0			9/0	4/0	39/0
Nov	4/0	7/0	3/0		6/1					20/1
Dec	2/0	1/0	3/0		3/0					9/0
1984 Jan*		8/0			5/0					13/0
Feb			1/0		1/0					2/0
Mar	6/0	8/0			6/0					20/0
Apr	10/1						1/0			11/1
May		17/6	16/4		25/8	16/5				74/23
Jun		5/0	25/3		7/2	16/0				53/5
Total	117/7	169/25	130/8	8/0	144/20	47/5	44/5	9/0	4/0	

* 1984 Summary of activity only includes log and observation data. Landing receipt data would increase estimate of total days active.

TABLE 9. Distribution of Logged Effort and Observed Effort in Fathoms of Net by Depth of Set and Month Within the Port San Luis Area.

Year/Month		Depth of Set (fm)							
		<10		10-14		15-19		>19	
		Log	Obs	Log	Obs	Log	Obs	Log	Obs
1982	Jun	-	-	-	-	-	-	-	-
	Jul	-	-	-	-	-	-	-	-
	Aug	200	120	1100	0	0	0	0	0
	Sep	200	0	2800	0	0	0	0	0
	Oct	1500	0	7070	0	400	0	760	0
	Nov	0	0	1000	0	400	0	10040	0
	Dec	0	0	0	0	0	0	1200	0
	Total	1900	120	11970	0	800	0	12000	0
1983	Jan	0	0	0	300	0	250	800	150
	Feb	0	0	0	0	650	0	3370	0
	Mar	0	0	2400	855	0	0	750	0
	Apr	0	0	6240	480	200	0	0	0
	May	3414	690	6080	2037	2700	260	0	0
	Jun	7100	1072	7230	1090	1620	0	1260	0
	Jul	7890	360	9280	200	3240	0	0	0
	Aug	-	-	-	-	-	-	-	0
	Sep	-	-	-	-	-	-	-	0
	Oct	-	-	-	-	-	-	-	0
	Nov	-	-	-	-	-	-	-	170
	Dec	-	-	-	-	-	-	-	0
	Total	18404	2122	31230	4962	8410	510	6180	320
1984	Jan	0	0	0	0	0	0	0	0
	Feb	500	785	2100	0	0	0	0	0
	Mar	0	0	3400	0	3800	0	0	0
	Apr	0	250	2200	430	0	0	0	0
	May	9130	6150	22050	130	300	0	700	0
	Jun	7675	1630	19525	0	1350	0	0	0
	Total	17305	8815	49275	560	5450	0	700	0

TABLE 10. Estimates of Accidental Take of Sea Otters in Set Nets Calculated from Estimates of Set Net Effort 1973-1983.*

Year	Number of Landings	Estimated Mortality
1973	457	48
1974	645	68
1975	no data	-
1976	980	103
1977	663	70
1978	874	92
1979	1449	152
1980	1407	148
1981	1578	166
1982	1057	111
1983	696	73

*Estimate of effort is based on the number of landings of set net boats within the sea otter's range. Estimated take is based on the rate of take observed in 1983.