AD-A151 117 BEHAVIOR OF THE WHITE SHARK CARCHARODON CARCHARIAS AND SCALLOPED HAMMERHE..(U) SCRIPPS INSTITUTION OF OCEANOGRAPHY LA JOLLA CA MARINE BIOLOG.. A P KLIMLEY

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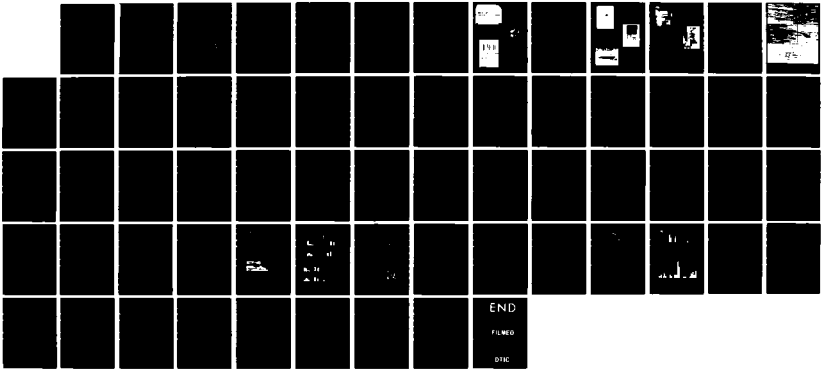

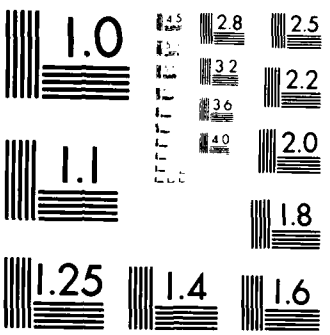

MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS 1963-A

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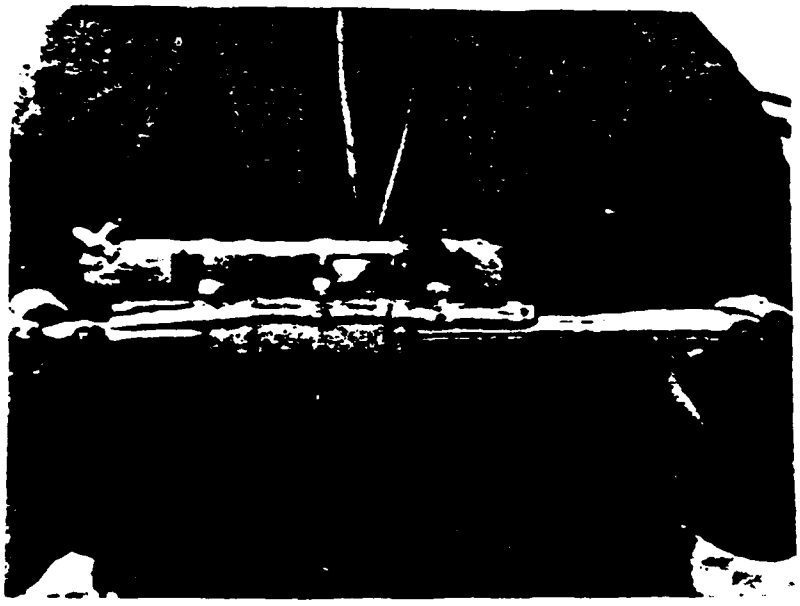


Fig. 1. Prototype multi-sensor telemetry transmitter (minus compass sensor) intended for use in monitoring predation by the white shark on pinnipeds in the Point Reyes/Farallon Island National Marine Sanctuary.

Fig. 2. Sensor to record shark swimming speed. The sensor consists of a paddle wheel with transversely embedded magnets and an inductive pickup (core and coil) potted within the transmitter's end cap.

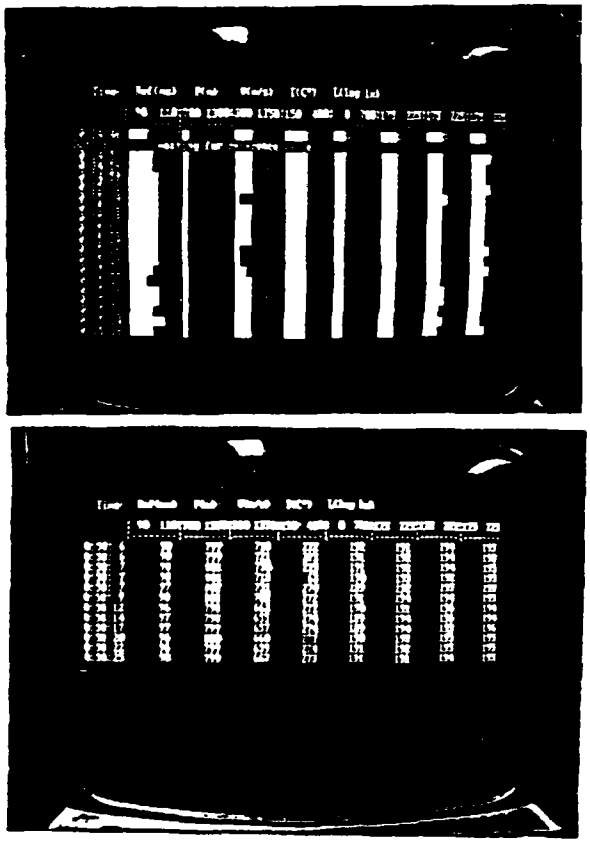


Fig. 3. Computer monitor to display multiplexed sensor data from 8 channels of the transmitter either graphically or numerically before storing the data on floppy disk. The data may either be from a tracked shark or a sonde used to obtain oceanographic measurements.

Fig. 7. The decoder can be comfortably operated from the aft seat of the research vessel. Note the dark blue seat built into the floor of the vessel for keeping the decoder secure during operation.

Fig. 8. APK calibrating temperature sensor of transmitter in refrigerated water bath (lower left). Telemetry receiver on top of computerized decoder housing.

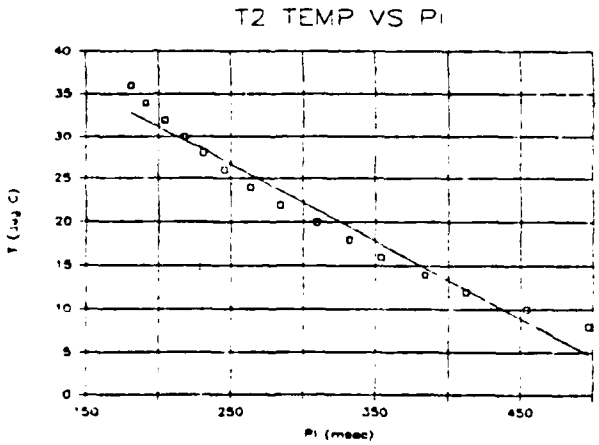


Fig. 9. Plot of temperature as a function of pulse interval. Note observed values (squares) lie in a curve, deviating slightly from regression line based on same values. The computer will convert a PI to a temperature using the straight rather than the curved line. Although the maximum descrepancy is only $\pm$0.75 deg C, increased accuracy may be achieved by programming the computer to interpolate temperature from a file of calibration values.

differences in the design and mesh sizes of different bottom gill nets were ignored in this comparison. White sharks in the 3.1-4.5 m size class were caught most often with bottom gill nets and set lines (see Table 1). Since effort with the former gear type was so similar for both areas and with the latter type was greater south of Point Conception (see Fig. 2), it is unlikely that the higher percentage of sharks caught in this size class south than north of Point Conception was due to a difference ir fishing effort. Finally, white sharks in the 4.6-6.0 m size class were caught most frequently by gill net and harpoon. It is possible that the greater harpoon fishing effort in southern California (12.5 % of the records) compared to that in northern California (6.7 %) might explain in part the larger numbers of large females captured off southern California.

Both male and female white sharks were caught more frequently during the summer and fall seasons (lower righthand histograms for south and north of Point Conception in Fig. 2). Seasons in the histograms consist of three month periods with summer from June to August and fall from September to November. Again the catch records for different seasons are presented as percentages of the total number of males and females captured. Does this summer-fall peak truly reflect a greater abundance of white sharks, or does it only reflect greater fishing effort at this time? Although the peak north of Point Conception is paralleled by large landings of fishes in the San Francisco and Monterey Areas (lower lefthand histogram in the upper half of Fig. 2), the peak south of Point Conception is not paralleled by high seasonal landings in the Los Angeles and San Diego Areas during the summer but is during fall (see lower lefthand histogram in bottom half of Fig. 2). The landings were compiled by Pinkas (1974) from landings during 1972. There appears to be a real increase in abundance of both male and females in the summer. Since the males and females caught at this time are mostly in the 0-1.5 m size class, this peak may be due

For instance, the landing of fishes in the San Francisco Area was the smallest, constituting only 4.2 % of the total of landings along the California coast; however, the 17 catch reports in this area was the second largest total, constituting 26.6 % of the total number of white sharks reported captured along the California coastline. On the other hand, the largest landing, 47.3 % of the total catch, was in the Los Angeles Area where only five catch reports, or 7.8 % of the total, were recorded. In the four remaining zones the capture percentages were: 1) 3.1 % for the Eureka Area, 2) 7.8 % for the Monterey Area, 3) 28.1 % for the Santa Barbara Area, and 4) 26.6 % for the San Diego Area. These were also not correlated with fishing effort. Although the numbers of captures in the different zones can not be attributed to differences in effort, it is possible that the high numbers of captures reported, in particular in the San Francisco Area, could be due to the presence there of investigators interested in documenting such captures. Those sources providing eight or more percent of the reports are presented in Fig. 1 to the right of the locations of their institutions. William Follett of the California Academy of Science and Leonard Compagno, at one time at Stanford University and later at the Tiburon Center for Environmental Studies were both at locations near San Francisco, and they accounted for 25 % of the total number of reports. Cam Swift of the Natural History Museum of Los Angeles County took records of the small white sharks captured by Bruce Henke near Santa Barbara prior to 1977, and Seaworld has done this since 1977. In recent years Seaworld has probably increased fishing effort for smaller white sharks in Southern California by offering substantial monetary rewards for captured white sharks to be placed in the Seaworld shark exhibit.

Size Segregation

Do juvenile and adult white sharks occupy different geographical areas as do

cartilaginous fishes (addit., brown smoothhound-Mustelus henlei, soupfin shark-Galeorhinus zygopterus, and bat ray-Myliobatis californica), a pinniped (harbor seal-Phoca vitulina), and a crustacean. Large sharks greater than 4000 mm in length fed on pinnipeds (northern elephant seal-Mirounga angustirostris and California sea lion-Zalophus californiensis, bony fishes (Pacific hake-Merluccius productus), cartilaginous fishes (basking shark-Cetorhinus maximus), and crustaceans (market crab-Cancer magister). The increasing importance of pinnipeds over fishes in the diets of larger white sharks probably affects their distribution. Since pinnipeds haul out both inshore and offshore north of Point Conception, white sharks may move into both of these areas to capture prey. Since pinnipeds haul out only offshore on islands south of Point Conception, white sharks probably remain offshore there where prey is available.

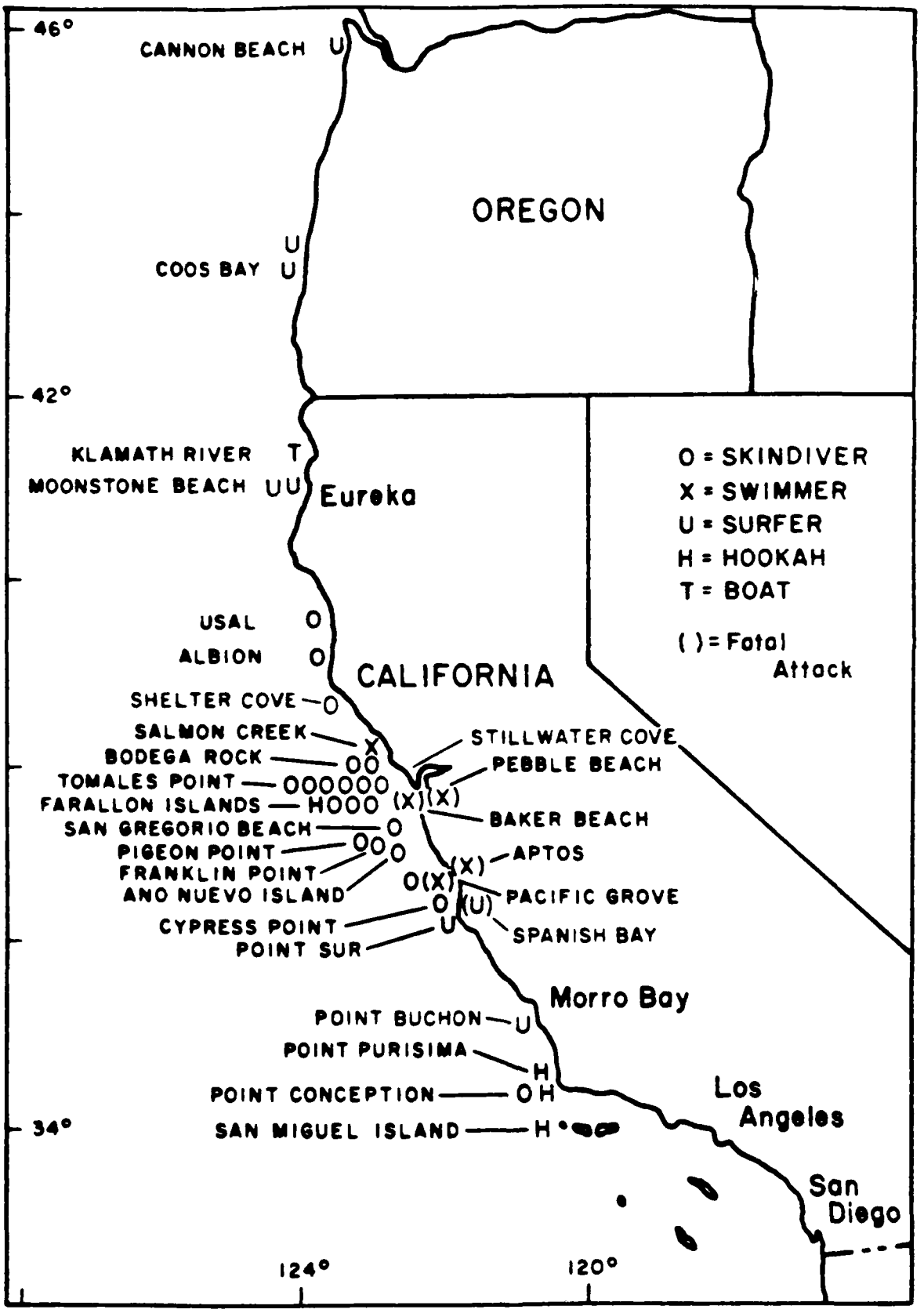
Finally, the frequency with which white shark captures are being reported is increasing. The numbers of white sharks captured during two-year periods from 1934 to 1983 are presented in figure 8. Although there is considerable variability in records on both the annual and biennial scales, the numbers of captures appear to be increasing, in particular, since 1974. There are biennial frequency peaks, 1958-1959 and 1976-1977. The reports in the former peak were primarily from northern California, and this prevalence was probably due to the interest of William Follett in recording capture events at that time. The reports comprising the latter peak were primarily from southern California, probably due to the public interest aroused from the motion picture "Jaws" in 1975. Furthermore, since then Seaworld has offered a reward for small white sharks for exhibition; this has probably increased fishing effort. It would be difficult to attribute increases in the capture rate of white sharks to other factors such as the recent increases in pinniped populations along the California coastline without eliminating the effect of other confounding variables.

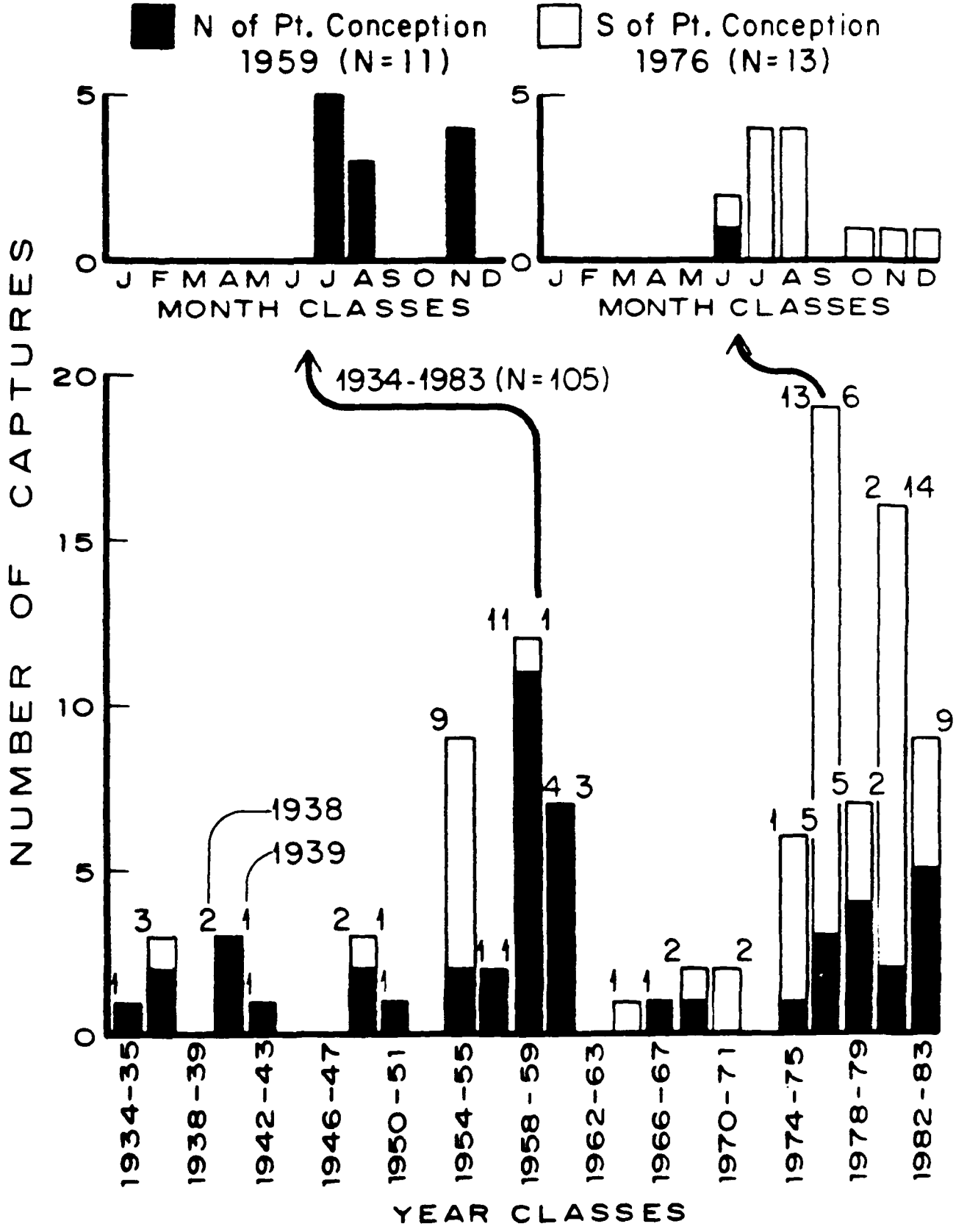
If the years with the maximum numbers of captures are broken down by month (see upper inserts in Fig. 8), it can be seen that most captures occurred during the summer both in northern (see 1959) and southern California (see 1976). In addition, during 1959 there was an additional peak in November.

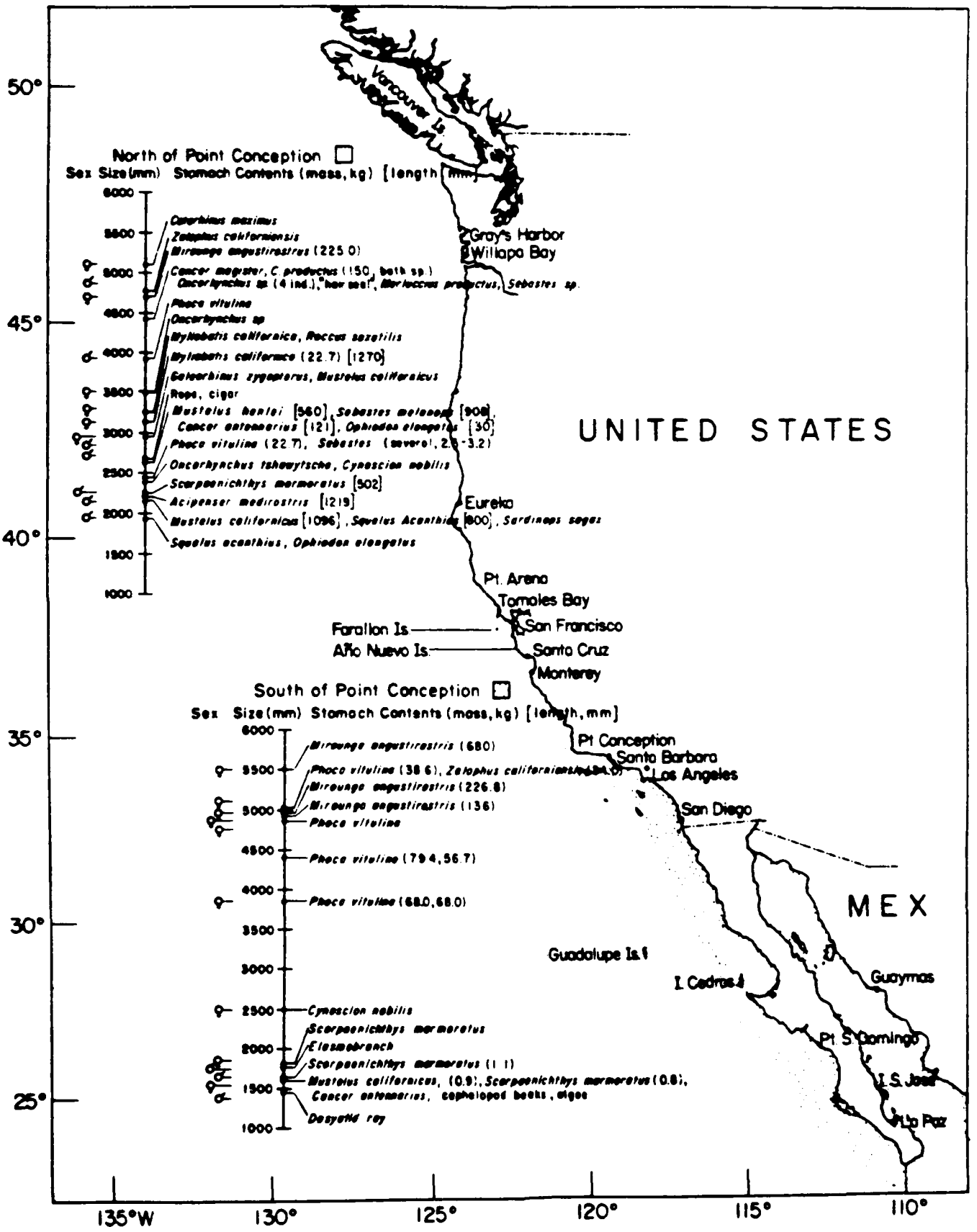
Discussion

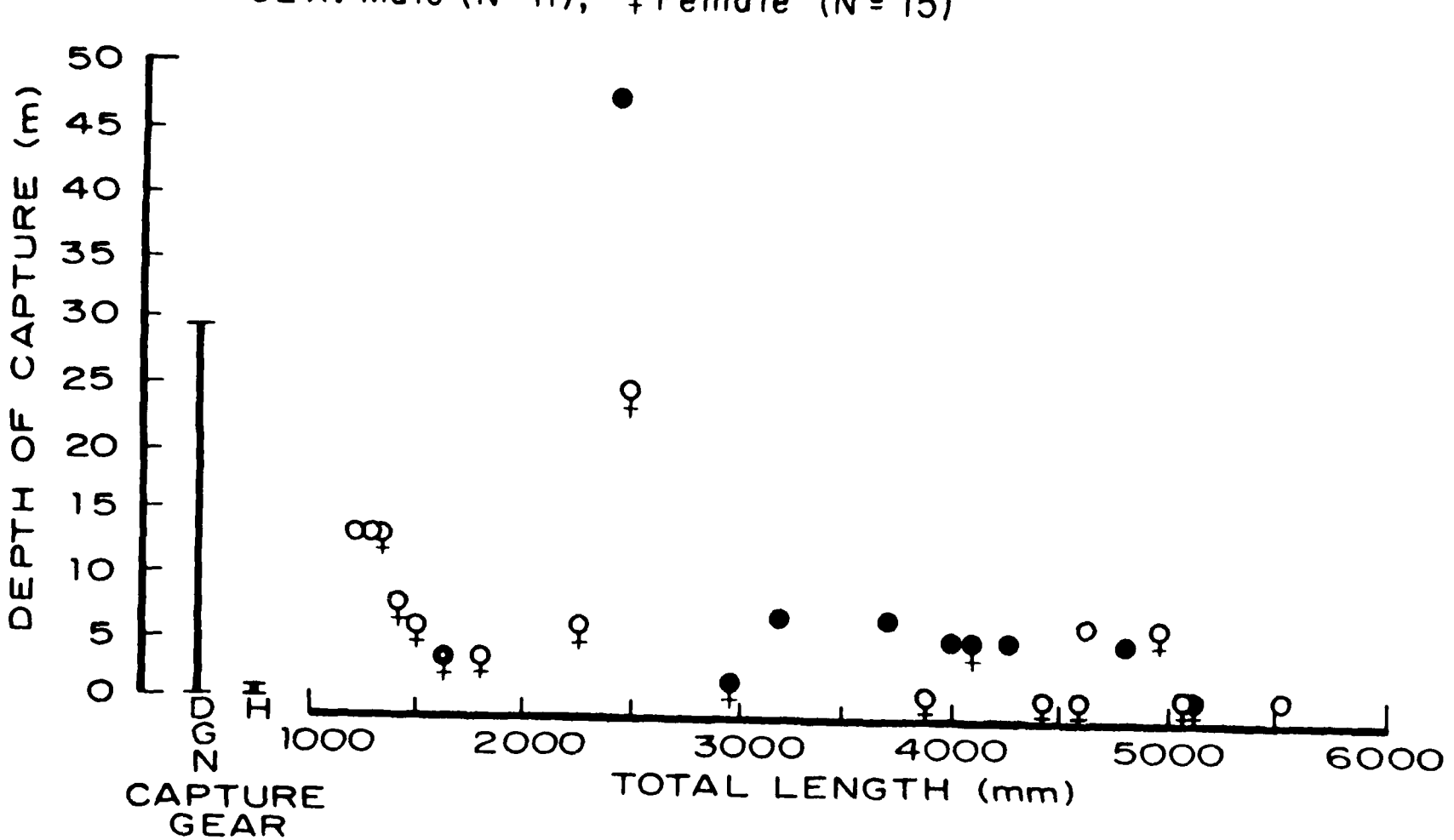
Areal Distribution

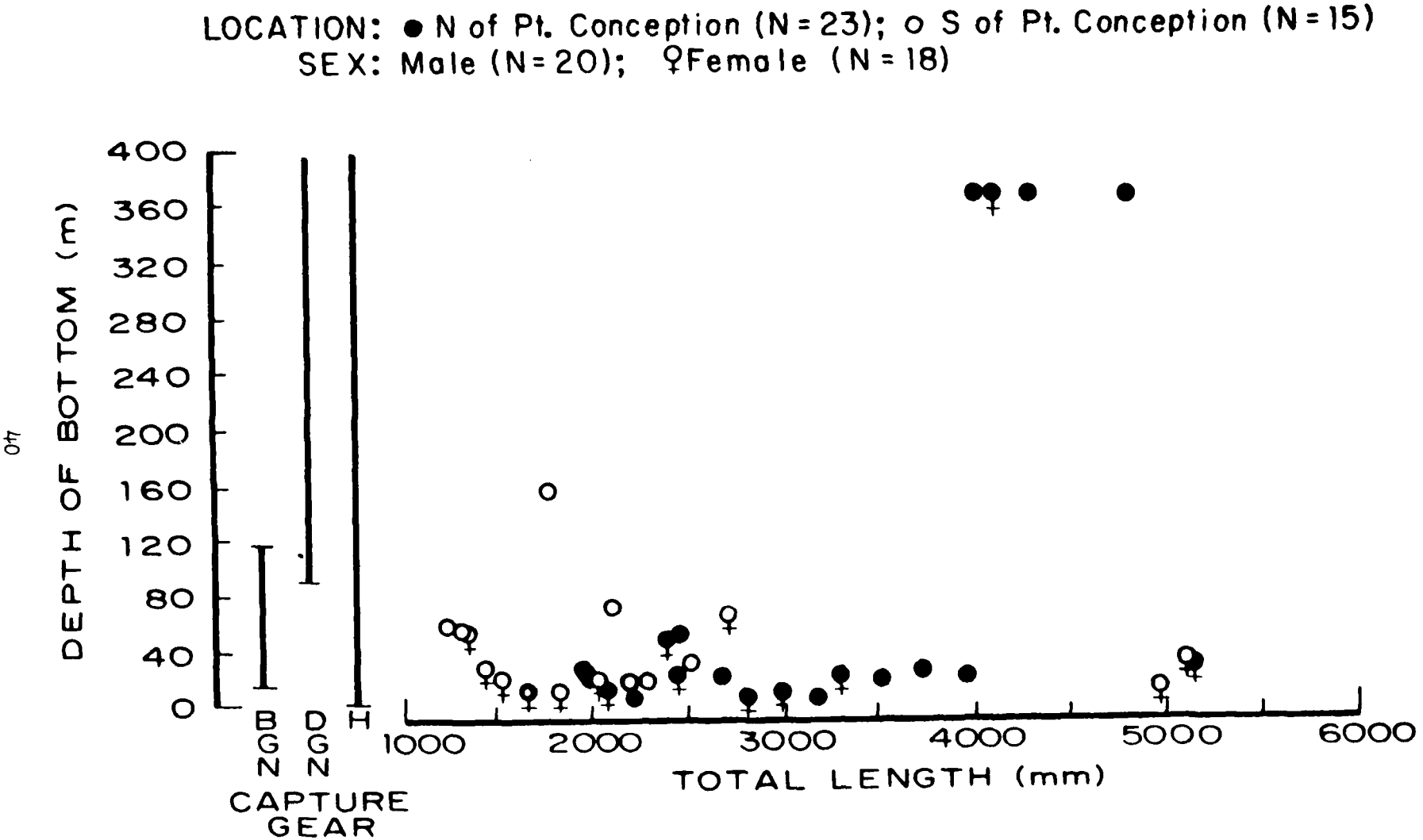
If the relative frequency with which white sharks have been caught reflects their relative abundance (despite the confounding variability from interested investigators in the larger cities), the frequencies of white sharks captures at different locations should be correlated with other indicators of relative abundance. Two such indicators are attacks of white sharks on man and the sea otter, Enhydra lutris. Attacks on man by the white shark have in all cases but one (at San Miguel Island) occurred north of Point Conception (Fig. 9). The attacks shown on the map were obtained from Miller and Collier (1980) and Lea (pers. com.); these occurred between 1926 and 1982. The shark in all of these attacks was identified as the white shark either from the victim's description of the attacking shark or the presence of identifiable tooth fragments in the victim's wounds (see annotations in Miller and Collier, 1980). This areal distribution to attacks is what one would expect from the inshore-offshore capture of large white sharks north of Point Conception and offshore capture of sharks south of Point Conception. Furthermore, this attack pattern is also correlated with the distribution of pinnipeds along the coast of California. The greatest numbers of attacks occurred near San Francisco at Tomales Point (six attacks), the Farallon Islands (four attacks), and Bodega Rock (two attacks). Fourteen large white sharks were captured in the same area with eight at Tomales Bay, four from the Farallon Islands, and two from Bodega Bay. This number of catches is the largest for a comparable distance of coastline along


46°
CANNON BEACH U
OREGON
U
COOS BAY U
42°
KLAMATH RIVER T
MOONSTONE BEACH UU
Eureka
O = SKINDIVER
X = SWIMMER
U = SURFER
H = HOOKAH
T = BOAT
( ) = Fatal Attack
USAL O
ALBION O
CALIFORNIA
SHELTER COVE O
SALMON CREEK X
BODEGA ROCK OO
TOMALES POINT OOOOOO
FARALLON ISLANDS HOOO
SAN GREGORIO BEACH O
PIGEON POINT OOO
FRANKLIN POINT
ANO NUEVO ISLAND
CYPRESS POINT O
POINT SUR U
STILLWATER COVE
PEBBLE BEACH
(X)(X)
BAKER BEACH
(X) APTOS
O(X)
PACIFIC GROVE
(U)
SPANISH BAY
Morro Bay
POINT BUCHON U
POINT PURISIMA H
POINT CONCEPTION OH
SAN MIGUEL ISLAND H
Los Angeles
34°
San Diego
124°
120°

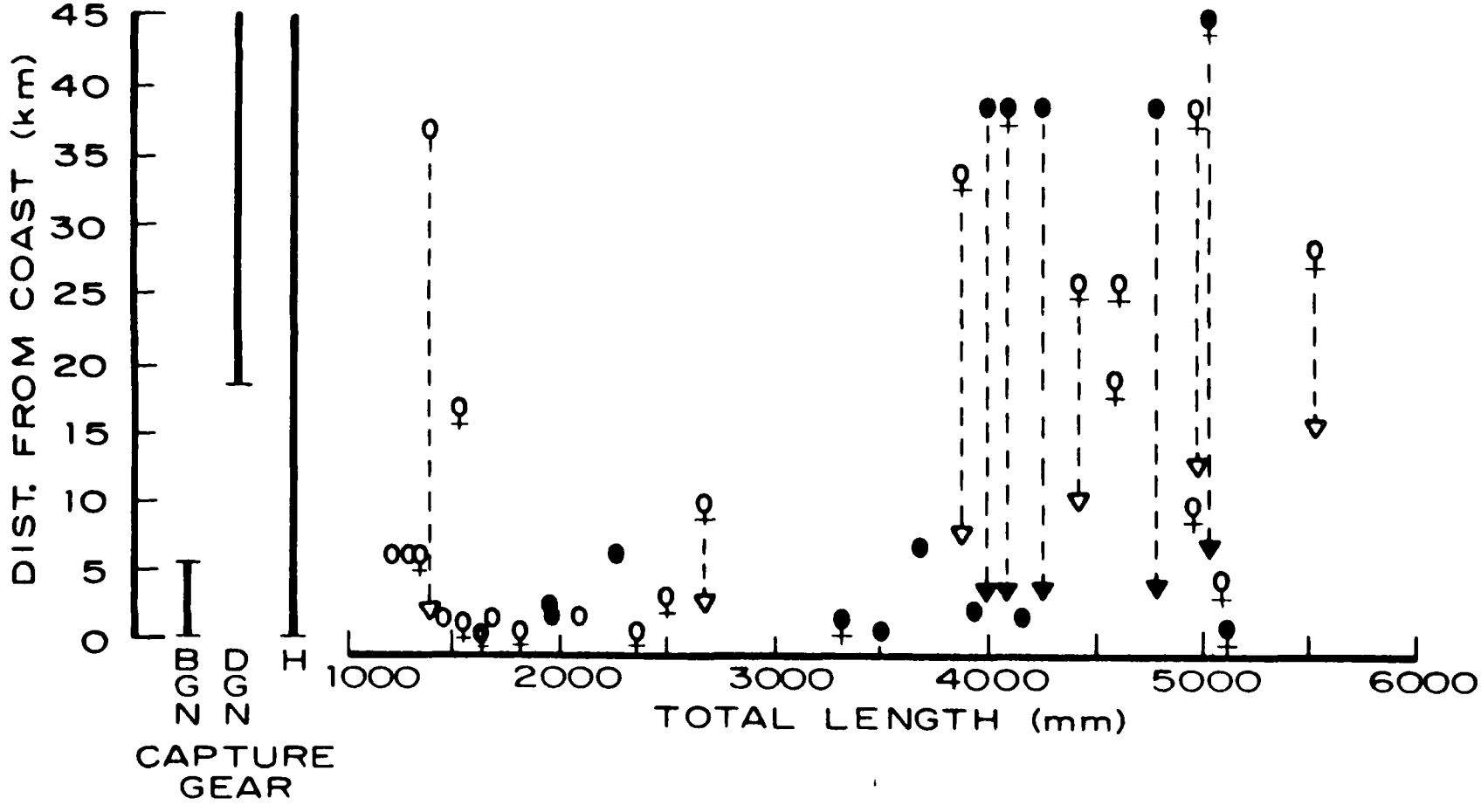

N of Pt. Conception
1959 (N=11)
S of Pt. Conception
1976 (N=13)
5
0
J F M A M J J A S O N D
MONTH CLASSES
1934-1983 (N=105)
NUMBER OF CAPTURES
20
15
10
5
0
1938
1939
1934-35
1938-39
1942-43
1946-47
1950-51
1954-55
1958-59
1962-63
1966-67
1970-71
1974-75
1978-79
1982-83
YEAR CLASSES

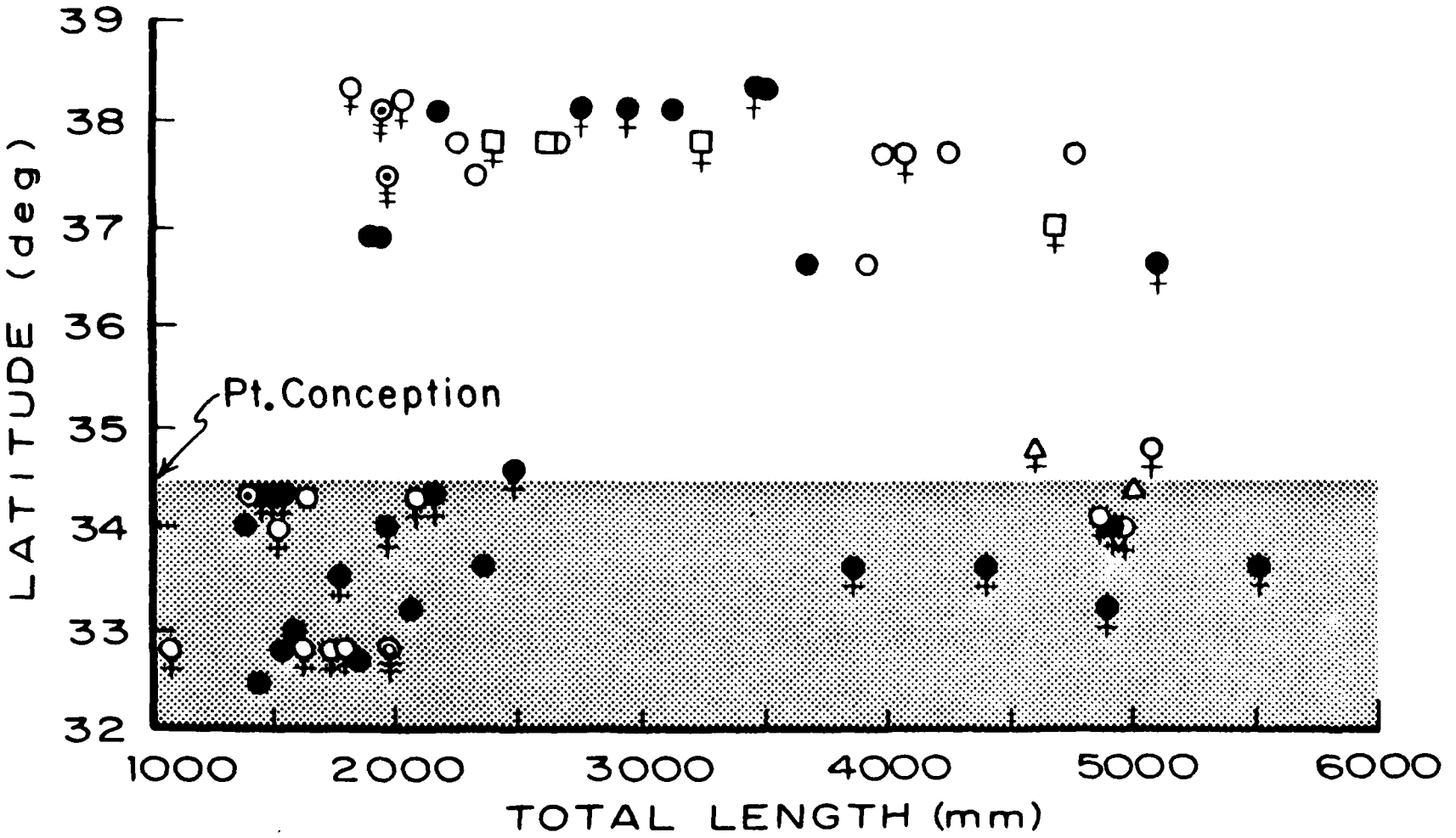

North of Point Conception
Sex Size(mm) Stomach Contents (mass, kg) [length, mm]
Caprhinus mexilus
Zalophus californiensis
Mirounga angustirostris (225.0)
Cancer magister, C. productus (150, both sp.)
Oncorhynchus sp. (4 ind.), "harbor seal", Merluccius productus, Sebastes sp.
Phoca vitulina
Oncorhynchus sp.
Myliobatis californica, Raccus sazatilis
Myliobatis californica (22.7) [1270]
Galeorhinus zyopterus, Mustelus californicus
Rope, cigar
Mustelus henlei [560], Sebastes melanops [908],
Cancer antennarius [121], Ophiodon elongatus [30]
Phoca vitulina (22.7), Sebastes (several, 2.5-3.2)
Oncorhynchus tshawytscha, Cynoscion nobilis
Scorpaenichthys marmoratus [502]
Acipenser medirostris [1219]
Mustelus californicus [1096], Squalus Acanthias [800], Sardinops sagax
Squalus acanthias, Ophiodon elongatus
South of Point Conception
Sex Size(mm) Stomach Contents (mass, kg) [length, mm]
Mirounga angustirostris (680)
Phoca vitulina (38.6), Zalophus californianus (84.0)
Mirounga angustirostris (226.8)
Mirounga angustirostris (136)
Phoca vitulina
Phoca vitulina (79.4, 56.7)
Phoca vitulina (68.0, 68.0)
Cynoscion nobilis
Scorpaenichthys marmoratus
Elasmobranch
Scorpaenichthys marmoratus (1.1)
Mustelus californicus, (0.9), Scorpaenichthys marmoratus (0.8),
Cancer antennarius, cephalopod beaks, algae
Dasyatid ray
Vancouver Is.
Gray's Harbor
Willapa Bay
Eureka
Pt. Arena
Tomales Bay
San Francisco
Farallon Is.
Año Nuevo Is.
Santa Cruz
Monterey
Pt Conception
Santa Barbara
Los Angeles
San Diego
UNITED STATES
MEX
Guadalupe Is.
I. Cedros
Guaymas
Pt. S. Domingo
La Paz
50°
45°
40°
35°
30°
25°
135°W
130°
125°
120°
115°
110°

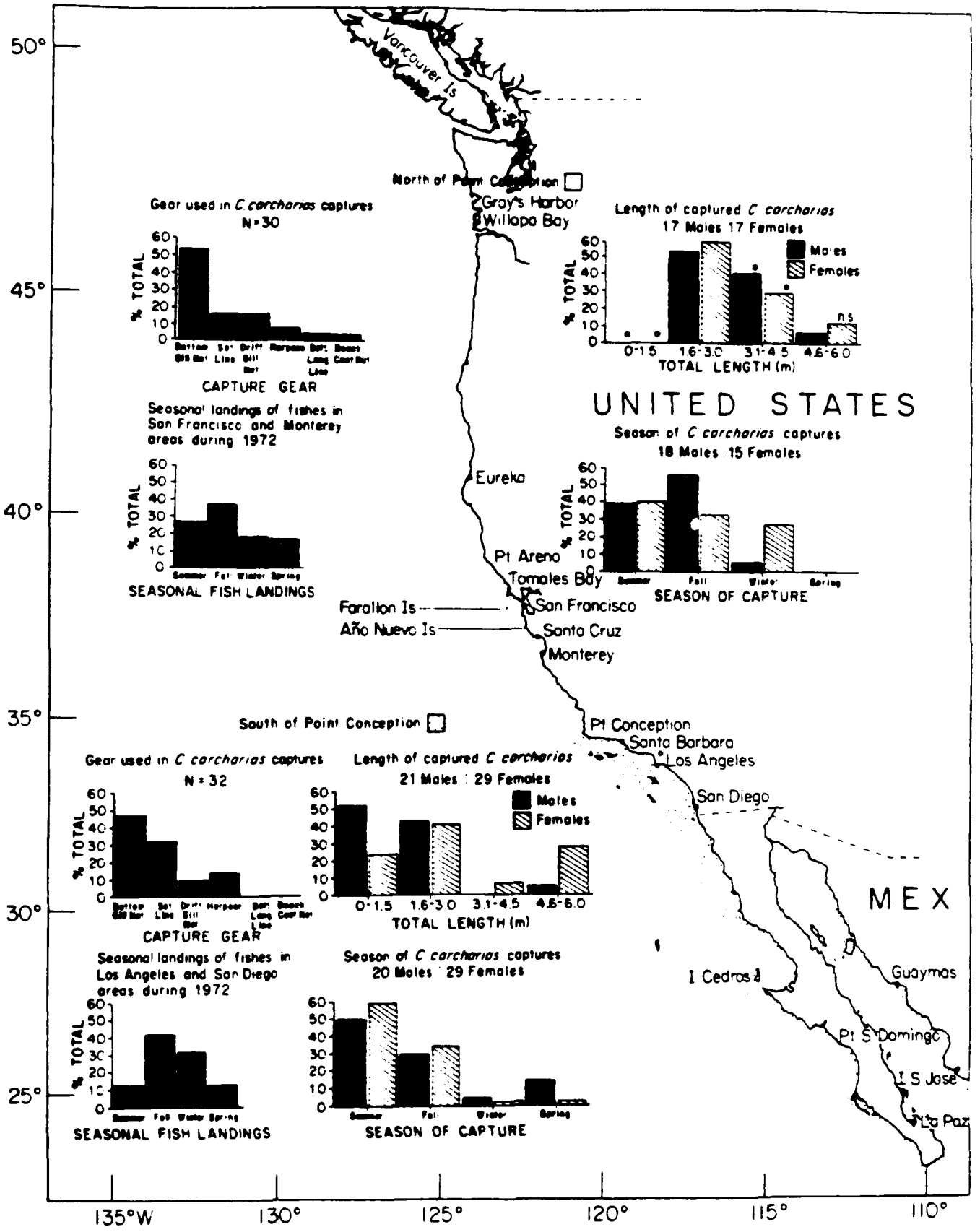

LOCATION: ● N of Pt. Conception (N = 10); o S of Pt. Conception (N = 16)
SEX: Male (N = 11); ♀ Female (N = 15)
DEPTH OF CAPTURE (m)
50
45
40
35
30
25
20
15
10
5
0
DGN
H
1000
2000
3000
4000
5000
6000
TOTAL LENGTH (mm)
CAPTURE GEAR

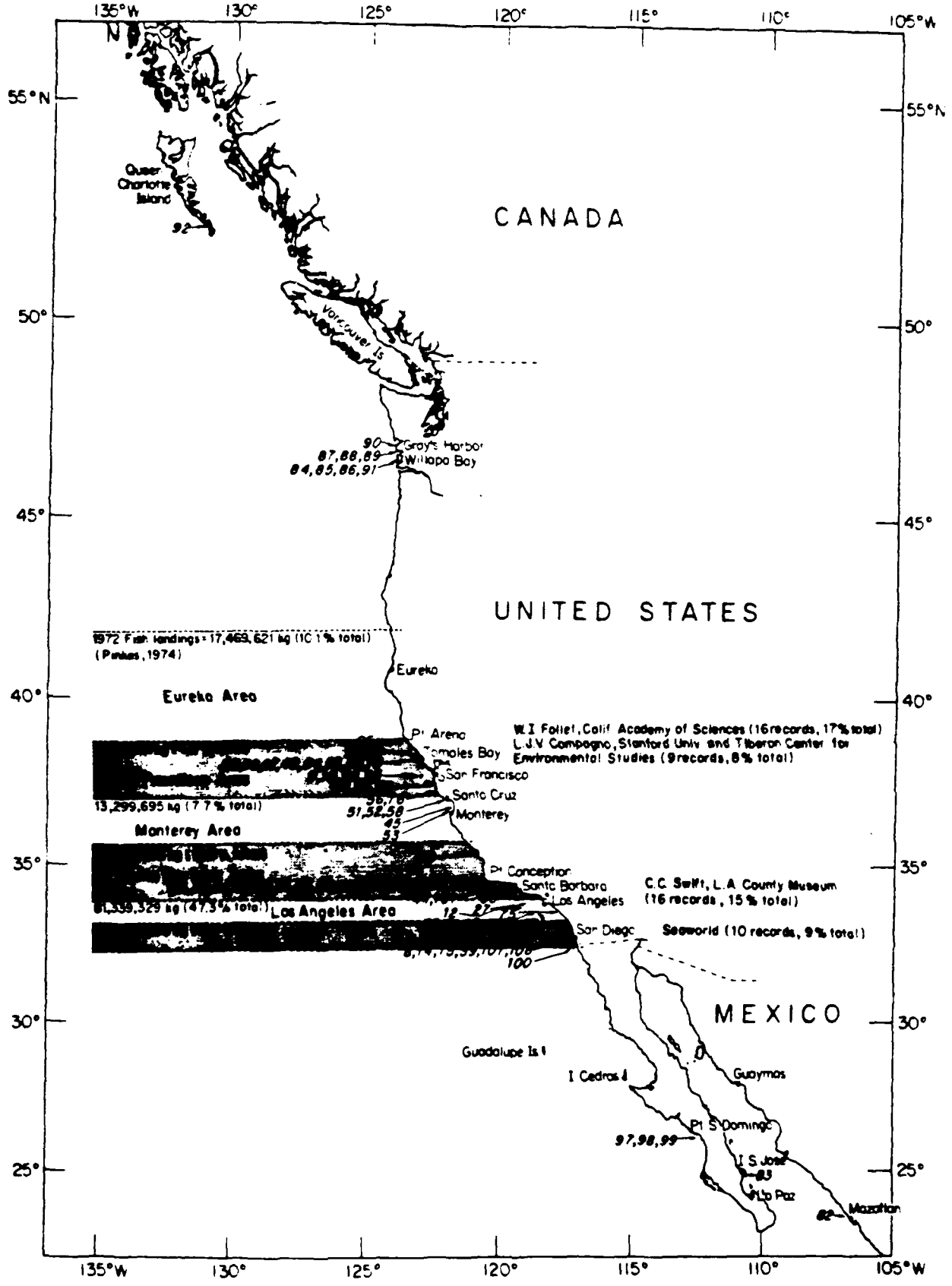

LOCATION: ● N of Pt. Conception (N = 23); o S of Pt. Conception (N = 15)
SEX: Male (N = 20); ♀Female (N = 18)
DEPTH OF BOTTOM (m)
400
360
320
280
240
200
160
120
80
40
0
B GN
D GN
H
CAPTURE GEAR
1000
2000
3000
4000
5000
6000
TOTAL LENGTH (mm)

LOCATION: ● N of Pt. Conception (N = 14); o S of Pt. Conception (N=22);
SEX: Male (N= 20); ♀ Female (N= 16). Circle on dashed line indicates distance from coast, arrow distance from shore.




SEASON: ● Summer (N = 40); ○ Fall (N = 28); □ Winter (N = 5);
△ Spring (N = 2)
SEX: Male (N = 38); ♀ Female (N = 37)
LATITUDE (deg)
39
38
37
36
35
34
33
32
Pt. Conception
1000
2000
3000
4000
5000
6000
TOTAL LENGTH (mm)


Vancouver Is
North of Point Conception
Gray's Harbor
Willapa Bay
Gear used in C. carcharias captures
N = 30
% TOTAL
CAPTURE GEAR
Length of captured C. carcharias
17 Males 17 Females
Males
Females
n.s
TOTAL LENGTH (m)
UNITED STATES
Seasonal landings of fishes in San Francisco and Monterey areas during 1972
SEASONAL FISH LANDINGS
Season of C. carcharias captures
18 Males 15 Females
SEASON OF CAPTURE
Eureka
Pt Arena
Tomales Bay
Farallon Is
San Francisco
Año Nuevo Is
Santa Cruz
Monterey
South of Point Conception
Pt Conception
Santa Barbara
Los Angeles
San Diego
Gear used in C. carcharias captures
N = 32
Length of captured C. carcharias
21 Males 29 Females
MEX
I Cedros
Guaymas
Pt S Domingo
I S Jose
La Paz
Seasonal landings of fishes in Los Angeles and San Diego areas during 1972
Season of C. carcharias captures
20 Males 29 Females
50°
45°
40°
35°
30°
25°
135°W
130°
125°
120°
115°
110°


135°W
130°
125°
120°
115°
110°
105°W
55°N
50°
45°
40°
35°
30°
25°
CANADA
Queen Charlotte Island
92
Vancouver Is
90
87,88,89
84,85,86,91
Gray's Harbor
Willapa Bay
UNITED STATES
1972 Fish landings = 17,469,621 kg (10 1% total)
(Pinkas, 1974)
Eureka
Eureka Area
Pt Arena
Tomales Bay
San Francisco
Santa Cruz
Monterey
13,299,695 kg (7 7% total)
51,52,58
Monterey Area
Pt Conception
Santa Barbara
Los Angeles
Los Angeles Area
San Diego
W.I Follet, Calif Academy of Sciences (16 records, 17% total)
L.J.V Compagno, Stanford Univ and Tiberon Center for Environmental Studies (9 records, 8% total)
C.C Swift, L.A County Museum (16 records, 15% total)
Seaworld (10 records, 9% total)
100
MEXICO
Guadalupe Is
I Cedros
Guaymas
Pt S Domingo
97,98,99
I S Jose
83
Pt Lo Paz
Mazatlan
82

pers. com., 2) population censuses and kills of pinnipeds from Ainley et al., 1981, 3) bite scars on northern elephant seals from LeBoeuf et al. 1982, and 4) mortality of sea otters from Ames and Morejohn 1980.

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Marine Biology Research Division, A-002. Scripps Institution of Oceanography, University of California, San Diego, La Jolla, California, 92093.

Running Head: Autoecology of White Shark off West Coast

Fig. 7. Stomach contents of white sharks caught north and south (stippled) of Point Conception. The mass (parenthesis) and length (brackets) given after identities of dietary items to right of shark length scale; the sex of the shark given to the left of the scale.

Fig. 8. Numbers of white sharks captured biennially from 1934 to 1983 (below) and monthly (above) during 1959 (lefthand) and 1976 (righthand) along the western coast of North America. Solid part of histogram bar indicates the number of captures north of Point Conception, the clear part south of Point Conception. Number at top of bar to left gives captures during first year; number to right captures during the second year of biennial class.

Fig. 9. Attacks by white sharks on humans along the western coast of North America. Records prior to 1979 taken from Miller and Collier (1979); those from 1980 to 1983 obtained from Lea (pers. com.).

Table Captions

Table 1. Capture information for white sharks caught along the western coast of North America. DFS: distance from shore; DFC: distance from the coastline; BD: bottom depth; SD: shark depth; S: sex; X: missing date; NIA: not included in analysis.

Table 2. Indicators of seasonal abundance of the white shark off the western coast of North America: 1) aerial survey from Squire, 1967, 2) attack data from Miller and Collier, 1980, and Lea, pers. com., 3) population censuses and kills of pinnipeds from Ainley et al., 1981, and mortality of sea otters from Ames and Morejohn, 1980.

Table 3. Indicators of annual abundance of the white shark off the western coast of North America: 1) attack data from Miller and Collier 1980, and Lea

3) male and female white sharks during four seasons, and 4) fish landings during 1972 for four seasons. Landings for north of Point Conception pooled from the San Francisco and Monterey Areas; landings for south of Point Conception pooled from the Los Angeles and San Diego Areas. The asterisks above bars in length histograms indicate statistically significant differences between the relative number of sharks in that size class north and south of Point Conception. A non-significent difference indicated by n.s.

Fig. 3. White sharks of different sizes are plotted as a function of latitude. The season during which the shark was captured indicated by the color and shape of the symbol. The sex of the shark designated by the presence or absence of an attached cross. The number of captures in parenthesis. Multiple captures of similarly sized sharks at the same location indicated by concentric symbols. Note that small males and females were caught south of Point Conception (stippling) during summer (solid circles) and fall (clear circles).

Fig. 4. The distance from coastline and shore at which white sharks of different sizes are captured. Note distinction between the distance from the coastline (circle) and distance from the shore (triangle connected by dashed line). These two distances only included when the former was greater than the latter. Also included to the right of the ordinate are the ranges of distance over which fishing with bottom gill nets (BGN), drift gill nets (DGN), and harpoons (H) occurs. If the range exceeds that of the ordinate, the upper horizontal bar excluded.

Fig. 5. Bottom depths over which white sharks of different sizes captured.

Fig. 6. Depths at which white sharks of different sizes captured.

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Walford, L.A. 1931. The sharks and rays of California. Fish. Bull., Division of Fish and Game of California, 45:1-66.

Figure Captions

Fig. 1. Locations of white shark captures along the western of North America. Captures identified by numbers given in Table 1. As an index of fishing effort, commercial fish landings included for six areas (alternately stippled or clear) along the coast of California. In the upper lefthand corner of each area, catch mass and its percent of the total catch is given in parenthesis. As an index of investigator interest, names of investigators (and their institutions) providing 8 % or more of the record total are added to right of coastline. The record number and its percent of the total number of records shown in parenthesis.

Fig. 2. Sets of four histograms given for north (upper) and south (lower) of Point Conception. Beginning with the upper lefthand histogram and moving in a clockwise manner, percentages of the total catch given for: 1) six gear types, 2) male (solid) and female (cross-hatched) white sharks in four size classes,

Table 3. Indicators of annual abundance of the white shark off the western coast of North America: 1) attack data from Miller and Collier, 1980, and Lea, pers. com., 2) population censuses and kills of pinnipeds from Ainley et al., 1981, 3) bite scars on northern elephant seals from LeBoeuf et al., 1982, and 4) mortality of sea otters from Ames and Morejohn, 1980.

Indic.	1	2			3	4
Years	Attacks on Man	Pinn. Kills*	Pinn. Cens.*	Kills / Pinn.Cens.	Seal Bites	Sea Otter Kills
1982	3					
1981	0					
1980	1				17	
1979	2				7	5
1978	0	12	1507	0.008	9	6
1977	1	7	1140	0.006	8	7
1976	3	4	965	0.004	3	3
1975	4	6	665	0.009		5
1974	5	3	610	0.005		6
1973	0	2	356	0.006		6
1972	3	1	278	0.004		9
1971	0	0	170	0		7
1970	0	1	95	0.011		2
1969	2					3
1968	1					1
1967	0					
1966	1					
1965	0					
1964	1					
1963	0					
1962	1					
1961	2					
1960	2					
1959	2					
1958	0					
1957	0					
1956	0					
1955	1					
1954	0					
1953	0					
1952	1					

*taken from Table 1 in Ainley et al., 1981 with winter (late Dec.-Feb.), summer (late March-early July), and fall (late Aug.-mid Dec.)

Table 1. Capture information for white sharks, *Carcharodon carcharias*, caught along the western coast of North America. DFS: distance from shore; DFC: distance from coast; BD: bottom depth; and SD: shark depth; S: sex; X: missing date; NIA: not included in analysis.

No.	Date	Time hrs	DF km	SDFC km	BD m	SD m	Cap. Meth.	Fisherman	Len. mm	Wt. kg	S	Stomach Contents	Source
1	10-30-55	1530		0.4	6.1	3.1	set line	Flechsig	1806		F	*Scorpaenichthys marmoratus*	Flechsig
2	10-31-55	1530		0.4	6.1	3.1	set line	Flechsig	1632		M	*S. marmoratus*, *Cancer antennarius*, *Mustelus californicus*, algae, squid beaks	Flechsig
3	10-31-55	2100		0.4	6.1	3.1	set line	Flechsig	1629		F	*S. marmoratus*	Flechsig
4	11-3-55	1300		0.4	6.1	3.1	set line	Arebalo			F	not examined	Flechsig
5	11-6-55	1100		0.4	6.1	3.1	set line	Tuthill	1626		M	none	Flechsig
6	11-9-55							anon.					Flechsig
7	11-12-55	1000		0.4	6.1	3.1	set line	Limbaugh				none	Flechsig
8	11-4-55				15.2		set line	Tomlinson	2000		F	not examined	Flechsig
9	10-5-82	1500	2.9	38.0	366.0	4.5	set line	Pemperton	4089	684.9	F	not examined	Metzger
10	10-5-82	2200	2.9	38.0	366.0	4.5	set line	Pemperton	4775		M	*Zalophus californicnsis*	Metzger
11	9-24-81			16.7				Desherow	1524	22.7	F	not examined	Zumwalt
12	6-28-76	1330		3.7	31.1	0	harpoon	Weeren	5080	2152.3		stomach everted	Swift
13	7-23-75		9.3	25.7		0	harpoon	Hawthorne	4409	612.3	F	*Phoca vitulina*	LeBoeuf
14	5-X-68								1854	54.9	M	not examined	Seaworld
15	10-X-71							Tomlinson	1981		F	not examined	Seaworld
16	9-7-75		11.3	37.8					4966	1560.4	F	*Mirounga angustirostris*	LeBoeuf
17	9-X-X								4877	1428.8	F	*P. vitulina*	Seaworld
18	8-21-76		18.5			0	harpoon	Langham	4572			not examined	Nelson
19	6-13-76		14.8	27.8		0	harpoon	Weeren	5525	2041	F	*M. angustirostris*	LeBoeuf
20	7-29-X							Fromhold	2946	385.6		not examined	Nelson
21	6-24-75		7.4	33.3		0	harpoon	Mansur	3861	635.0		*P. vitulina*	LeBoeuf
22	10-5-79						gill net	Bertelli	1829	90.7		not examined	Nelson
23	8-3-81		1.9	1.9			gill net		1676	45.4		not examined	Nelson
24	10-24-81								1473	25.9	M	not examined	Cailliet
25								Wilson	2133	136.1	F	not examined	Nelson
26	4-16-80		5.6	44.5			gill net	Barker	5029	1587.6	F	*Z. californiensis*, *P. vitulina*	Johnson
27	4-30-82		9.2	9.2	9.2	5.5	gill net	Williams	4942	907.3	F	*M. angustirostris*	Seigel
28	5-20-82		25.9	25.9		6.1	gill net	Peters	4609	1224.7	M	not examined	Swift
29	10-15-76						gill net		1650		M	not known	Huddleston
30	9-3-77						gill net	Henke	1408		M	not known	Swift
31	9-3-77						set line	Henke	1414			not known	Swift
32	9-18-77						gill net	Henke	2099	73.5	F	not known	Swift
33	7-15-76				14.6	5.8	gill net	Henke	1500	29.5	F	not known	Swift
34	7-15-76				14.6	5.8	gill net	Henke	2258			not known	Swift
35	8-16-78						gill net	Henke		36.3		not known	Swift
36	7-3-78		7.4	0.7	22.0		gill net	Henke		25.0		not known	Swift
37	11-X-76						gill net	Henke		45.4	F	not known	Swift
38	8-18-76							Langham	4900		F	not known	Swift

39	11-4-71					gill net	Tomlinson	1085		F	not known	Swift
40	12-17-76		0.7	9.2		gill net	Caywood		48.5	F	not known	Swift
41	8-9-76			14.6		gill net	Henke	2170		F	unident.	Swift
42	8-17-77					gill net	Henke	1514		M	not known	Swift
43	7-27-76			25.6	7.3	gill net	Henke	1410	23.5	F	not known	Swift
44	7-12-59		2.8	27.5	24.5	gill net	Castagnola	2492	145.2	F	Cynoscion nobilis	Follett
45	1-23-59	1400	0.5	27.5	0	harpoon	Tomlinson	5105	1279.1	F	Cetorhinus maximus	Follett
46	7-25-59	0730		5.5	5.5	drift net	Konatich	3143	283.5	M	Myliobatis californica	Follett
47	7-25-59	0730		5.8		drift net	Konatich	2775	109.3	F	none	Follett
48	7-2-60	1900		5.8	1.2	set line	Spenger	2960	190.1	F	Galeorhinus zygopterus, Mustelus californicus	Follett
49	11-13-59						Vella	2673	171.1	M	S. marmoratus	Follett
50	11-9-59		5.6			gill net	Vella	2254	101.6	M	rope, cigar	
51	8-10-59	0300	2.3	22.9		drift net	Carniglia	1943	61.7	M	not examined	Follett
52	8-7-59	0530	24.8			drift net	Cardinalli	1924	65.6	M	Squalus acanthias, Ophiodon elongatus	Follett
53	7-31-59	0530	6.5	23.8	6.4	drift net	Olivieri	3683	380.1	M	none	Follett
54	7-30-59	1620		5.8		drift net	Konatich	2184	98.9	M	Mustelus californicus, S. acanthias, Sardinops sagax	Follett
55	8-21-79					gill net	Bertelli	1956	88.7	F	none	Follett
56	2-X-77					beach cast	Helm					Follett
57	10-25-78		1.8	20.0		tram. net	Salter	3930	544.3	M	P. vitulina	Morejohn
58	8-28-59	0300	1.8	18.3		gill net	Carniglia	1959	54.4	M	none	Follett
59	10-7-60						Konatich	1965	69.9	F	none	Follett
60	12-27-60			20.1		gill net	Crivello	2419		F	Onchorhynchus tshawytscha, C. nobilis	Follett
61	1-2-61			20.1		gill net	Crivello				Mustelus californicus, Roccus saxatilis	Follett
62	12-28-60			20.1		gill net	Crivello	2651	180.5	M	Mustelus henlei, Cancer antennarius, O. elongatus, Sebastes melanops	Follett
63	6-X-81						Mueller	1290	16.1	M	not examined	Cailliet
64	11-8-81						Renardez	2340	86.2	M	not examined	Compagno
65	11-8-81							1990	78.0	F	not examined	Compagno
66	8-27-81	1600				set line	Follett	1976	42.2	F	not examined	Follett
67	9-24-81							1590	37.6	M	not examined	Cailliet
68	10-16-66			9.2		gill net	Spenger	2044	68.0	F	none	Compagno
69	8-25-56							3505	408.2	F	Oncorhynchus sp.	Compagno
70	11-1-68					gill net		2340	72.6	M	not examined	Compagno
71	8-22-75					gill net	Johnson	1990	78.0	F	none	Compagno
72	X-X-35						Strobbeca	1981			not examined	Compagno
73	11-13-59						Vella		183.7	M	not examined	Compagno
74	11-9-59						Vecca		101.6		not examined	Compagno
75	8-1-75		0.1	45.5		gill net	Seaworld	2362	138.8	F	pinniped	LeBoeuf
76	2-3-77							4700		F	M. angustirostris	LeBoeuf
77	9-25-78		1.6					4150			P. vitulina	LeBoeuf
78	X-X-55							3048		M	not examined	Miller, 1981
79	11-29-48			47.6	47.6	gill net	Thomas	2438	181.4		P. vitulina, Sebas-	Fitch, 1949

											es sp.	
80	8-21-48		0.9			set line	Ramsower	1543		F	not examined	Fitch, 1949
81	X-X-36					set line	Follett	1676	42.2	M	not examined	Follett, 1966
82	1-25-64							1960		M	not examined	Kato, 1965
83	8-2-81	1.8	9.2	62.2		long line	Cuevas	2685		F	not examined	Michael
84	4-28-36					gill net	Pederson	2235	155.1		Acipenser medirostris	Bonham, 1942
85	9-1-36					gill net	Moore		362.9		P. vitulina	Bonham, 1942
86	9-5-40					gill net	Moore	3962	997.2	M	not known	Bonham, 1942
87	8-X-41					gill net	Ogren		226.8		not known	Bonham, 1942
88	8-X-41					gill net	Oblad		453.6		not known	Bonham, 1942
89	8-X-41							3658	408.3		not known	Bonham, 1942
90	8-16-49	0.9	0.9			gill net	Fuller	3302	317.5	F	not known	LeMier, 1951
91	9-1-50						Nelson	4420	907.2		Cancer magister, Cancer productus, Oncorhynchus sp., "hair" seal, Merluccius productus, Sebastes sp.	LeMier, 1951
92	10-24-61							3429	453.6		not known	Pike, 1962
93	10-24-61							4674			not known	Royce, 1963
94	10-5-82	2.9	38.0	366.0	4.5	set line	Pemperton	4267	601.0	M	not examined	Metzger
95	10-5-82	2.9	38.0	366.0	4.5	set line	Pemperton	3988	567.0	M	not examined	Metzger
96	8-X-82		0.3	16.8		gill net		3480		M	not examined	Metzger
97	7-4-80		5.6	54.9	11.9	drift net	West	1295		M	not examined	Johnson
98	7-17-81		5.6	54.9	11.9	drift net	West	1219		M	not examined	Johnson
99	7-17-81		5.6	54.9	11.9	drift net	West	1321		F	not examined	Johnson
100	8-12-76		1.4			gill net		1448	25.9	M	none	Seaworld
101	7-3-78	0.9	37.0			gill net	Henke	1397	17.2	M	none	Seaworld
102	8-16-78					gill net	Henke	1473	25.8	M	fish head, dasyatid ray	Seaworld
103	7-25-81					gill net	Henke	1422	23.1	M	none	Seaworld
104	7-29-81					gill net	Henke	1549		F	not known	Seaworld
105	8-3-81							1600	36.3	M	not known	Seaworld
106	6-17-82					gill net	Quinn	1778	52.6	M	elasmobranch	Seaworld
107	X-X-74			152.4			Mechado	1473	25.9			Seaworld
108	11-3-76			152.4		gill net	Nichols	1750	372.9	F	not examined	Seaworld
109	8-13-76		1.8	73.2		gill net	Miller	2083		M	not examined	Seaworld
NIA	6-5-83	18.5	27.8			gill net	Tibbles	4420				Ica
NIA	6-27-83		0.2			tram. net			90.7			Ainley

APPENDIX B : AUTHORIZATION TO USE PINNIPED CARCASSES IN BAITING

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE

Southwest Region
300 South Ferry Street
Terminal Island, California 90731

February 3, 1984 F/SWR31:DJS
1514-01

Dr. A. Peter Klimley
Marine Biology Research Division (A-002)
Scripps Institution of Oceanography
University of California, San Diego
La Jolla, CA 92093

Dear Dr. Klimley:

I have reviewed your request to utilize the carcasses of beach stranded pinnipeds in your studies of white shark swimming and feeding behavior off the Farallon Islands, California. I hereby authorize you to obtain a total of five carcasses of either northern elephant seals (Mirounga angustirostris), California sea lions (Zalophus californianus), or harbor seals (Phoca vitulina) from either a scientific institution or a rehabilitation center authorized as participants in the California Marine Mammal Stranding Network. In this regard, I suggest you contact Ms. Harriet Huber, Point Reyes Bird Observatory; Ms. Jacqueline Schoenwald, California Academy of Sciences, or Ms. Peigin Barrett, California Marine Mammal Center.

All specimens obtained are to be collected either as dead beach stranded individuals or as animals that died in the rehabilitation process. Please indicate the final disposition of individuals transferred to you in the appropriate space on the stranding report form provided by the participant, and submit this form to this office. All specimens obtained must be utilized immediatley as described in your November 29, 1983, letter. Any individuals not utilized should be disposed at sea or returned to the participant for final disposition; you may not retain carcasses indefinitely.

If you have any further questions please contact Mr. Dana J. Seagars, the Network Coordinator, at (213) 548-2518.

Sincerely yours,

J. Gary Smith
Acting Regional Director

cc:
PRBO, H. Huber
CAS, J. Schoenwald
CMMC, P. Barrett

Publications

Klimley, A.P. 1974. An inquiry into the causes of shark attacks. Sea Frontiers, 20(2):66-75 (discussion of stimuli releasing attack under hunger and aggressive motivational states).

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Myrberg, Jr., A.A., C.R. Gordon, and A.P. Klimley. 1975. Rapid withdrawal from a sound source by sharks under open ocean and captive conditions. Technical Report, University of Miami, 24 pp (effectiveness of different sounds bringing about withdrawal in sharks).

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Myrberg, Jr., A.A., C.R. Gordon, and A.P. Klimley. 1976. Attraction of free-ranging sharks by acoustic signals in the near-subsonic range with comments on biological significance. Pp. 205-239 in A. Schuijf and A.D. Hawkins (Eds.), Sound Reception in Fishes. Elsevier Press, New York (effectiveness of different bandwidths of sound in attracting sharks).

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Klimley, A.P. 1981. Schooling of scalloped hammerhead, Sphyrna lewini, in the Gulf of California. Fishery Bulletin, 79(2):356-360 (preliminary description of hammerhead schools including sizes and sex of sharks, group sizes, and locations

where groups are found).

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Klimley, A.P. and S.T. Brown. 1982. A stereophotographic technique for the determination of the lengths of free-swimming sharks. CIBCASIO Transactions, 11:110-134 (photogrammetric technique for measuring sizes of free-swimming sharks for joint U.S.-Mexican publication by Scripps Institution of Oceanography).

Klimley, A.P. and S.T. Brown. 1983. Stereophotography for the field biologist: measurement of lengths and three-dimensional positions of free-swimming sharks. Marine Biology, 74(2):175-183 (photogrammetric technique for determining the three-dimensional positions, interindividual distances, and sizes of free-swimming sharks).

Klimley, A.P. 1982. Social organization of schools of scalloped hammerhead shark, Sphyrna lewini (Griffith and Smith), in the Gulf of California. Dissertation, University of California, 341 pp.

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Klimley, A.P. in press. Composition, structure, and dynamics of schools of the scalloped hammerhead shark (Sphyrna lewini) in the Gulf of California. Fishery Bulletin (social organization of shark populations).

Klimley, A.P. in press. Reproductive maturity and ripeness in the scalloped hammerhead, Sphyrna lewini. Copeia. (Size range at maturity based on indices such as c. asper length, testes width, epididymis length, presence of spermatazoa, and size of ova).

Klimley, A.P. in prep. Schooling in the large predator, Sphyrna lewini: a non-egalatarian state. Z. fur Tierpschology (comparison composition, structure, levels of aggression of predation-free hammerhead schools to predation-influenced schools of small fishes)

Klimley, A.P. and J. Cigas. in prep. Computer interface for decoding of multisensor telemetry data. Behavioral Instrumentation.

Klimley, A.P. and P. Sikkel. in prep. Differences in stereotypy between communicatory and non-communicatory behaviors in the scalloped hammerhead, Sphyrna

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