BIOLOGY OF SEA TURTLES IN SAN DIEGO BAY, CALIFORNIA, AND IN THE NORTHEASTERN PACIFIC OCEAN

A Thesis

Presented to the

Faculty of

San Diego State University

---

by

Margery L. Stinson

Fall 1984

Approved by:

Richard Etheridge 18 Dec. 1984

Thomas H. Fritts 18 Dec. 1984

Gregory K. Pregill 18 Dec. 1984

Richard H. Miller 12/18/84

BIOLOGY OF SEA TURTLES IN SAN DIEGO BAY, CALIFORNIA, AND IN THE NORTHEASTERN PACIFIC OCEAN

A Thesis

Presented to the

Faculty of

San Diego State University

In Partial Fulfillment

of the Requirements for the Degree

Master of Science

in

Biological Sciences

by

Margery L. Stinson

Fall 1984

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

PART I

BIOLOGY OF SEA TURTLES IN SAN DIEGO BAY

CHAPTER I

INTRODUCTION

In 1976, during a discussion among a number of San Diego's fishermen... one of those talks that recount the many oddities of their lives at sea—a fish or catch of great size, a sighting of a whale or unusual bird, a species well out of range or season—Ed McEwen (Pacific Queen) one of San Diego's most respected fishing captains told me what seemed amazing—that sea turtles exist in San Diego Bay, California, far north of their known range, in a bay subject to tremendous boat traffic and surrounded by the city of San Diego. Later that year during one very rainy, windswept December afternoon, crouched with binoculars along the bay's most southeastern shore, I saw for myself. Sea turtles did exist in the bay. As wind whipped across the water, binoculars could not be focused fast enough to catch more than a glimpse of these giants surfacing for air. Surfacing with each rising turtle were questions concerning their biology in this bay, their existence in these northern waters. Thus began this study of the biology of sea turtles in San Diego Bay.

Eventually photographs were taken and enlarged, identifying these as green sea turtles (*Chelonia mydas*). Many authors have described *Chelonia* as an occasional visitor to southern California. Their inclusion of this species in southern California's herpetofauna apparently was based solely upon Stephens' (1922) report that several greens "have been seen in San Diego Bay and in Mission Bay. One was caught in National City [San Diego Bay] several years ago."

Immediately to the south of San Diego lies Baja California, Mexico. During the early part of this century green sea turtles were abundant in the lagoons and bays along the peninsula's southern and central coast. Townsend (1916), Averett (1920) and Nelson (1921) described catches of green sea turtles from these lagoons in quanities so great that they supplied ships with meat for months and made profitable the business of canning turtles at a station within Magdalena Bay or sending such live cargos north via steamship to be canned in San Diego. Green sea turtles still exist in southern Baja California—in Magdalena and Turtle (San Bartolome) Bays and in Scammon's and San Ignacio Lagoons but apparently in numbers greatly reduced (personal observations and interviews with Mexican turtle hunters in these lagoons). Caldwell (1962) reports that green sea turtles are known to occur on a regular basis on the outer coast of Baja California as far north as Bahia San Quintin (155 nautical miles south of San Diego). Sr. Yruretagoyena, biologist for Mexico's Direccion de Pesca office in Ensenada, reports that, as of 1979, a few turtles were still seen in the very small bays and coastal waters of northern Baja California (personal communication).

North of San Diego, individual green turtles have been recorded as far north as the Gulf of Alaska—in California within Los Angeles Harbor, on the Davidson Seamount (Radovich, 1961) and in the mouth of Redwood Creek in Humboldt County (Smith and Houck, 1984); in

Oregon in Coos Bay (Forbes and McKey-Fender, 1968); in Washington in Grays Harbor and Willapa Bay (Slater, 1963); in Canada off Vancouver Island, British Columbia (Logier and Toner, 1961; Radovich, 1961) and in the Gulf of Alaska at Kupreanof and Admiralty Islands (Hodge, 1981). Reports of greens in any of these areas were rare enough to warrant publication.

This study has established that, for at least the last two decades, green sea turtles have seasonally migrated to San Diego Bay. Through these years, during the months of November through April, green sea turtles have occupied the southern part of the bay spending most of their time in a long, narrow channnel that carries water discharged from the San Diego Gas and Electric Company's power generating facility. This water, previously used to cool the facility, is 10-15°C warmer than temperatures normal for the rest of the bay. The channel flanks the southeastern shore of the bay and ultimately opens to the bay's southern shallows; consequently turtles have free access to enter and to exit the channel. Despite this uninhibited passage turtles rarely are sighted beyond the southern shallows of the bay.

In 1960, when the SDG & E Company began discharging warm water into this channel, they created an artificially "tropical" microhabitat in an otherwise cool, temperate bay. In the decades preceeding the construction of this facility and its use of bay water to cool its equipment, in fact since the turn of the century, there were no reports of sea turtles having occupied San Diego Bay. But with the advent of the facility discharging warm water into the channel, SDG & E employees report the seasonal occurrence of turtles each year. I question whether sea turtles historically have always used San Diego Bay as they do today or if their annual migration to this northern bay during cooler months has begun only after 1960, when this artificially "tropical" microhabitat came into existence.

As a species, the green sea turtle has been afforded protection by the U.S. Endangered Species Act of 1978. Certain breeding colonies of greens along Florida's coast and along the Pacific coast of Mexico have been designated as "endangered species", defined by the act as any species which is in danger of extinction through all or a significant portion of its range. Throughout the rest of its global distribution, including the west coast of the United States and Canada, greens are considered only "threatened", designating any species which is likely to become "endangered" within the forseeable future through all or a significant part of its range (U.S. Fish & Wildl. Serv., U.S. Dept. Int., 1977; U.S. Fed. Register, 1978). The designation of threatened status for greens in the eastern Pacific north of Mexico does not reflect their biological status--that is unknown--but rather our ignorance of their existence. A strong argument could be made that greens found in the northern Pacific originate from the west coast of Mexico and consequently should be afforded the same legal and more stringent protection awarded greens in Mexican waters. In the case of turtles utilizing habitats (such as San Diego Bay and its warm water channel) presumably made favorable by man's actions--do these same questions apply? If it could be established that sea turtles now migrate to

San Diego Bay because of the existence of the tropical microhabitat of the turtle channel, under Section 7 of this Act could the channel's creator the San Diego Gas and Electric Company legally cease pumping warm water into the channel or change the channel in some way making it a less acceptable habitat for the turtles? Would such action be considered an adverse act jeopardizing the survival and continued propagation of the species? baloney

There were several purposes to the study:

1) To determine if sea turtles, particularly greens, occupied San Diego Bay historically, before the construction of the SDG & E warm-water channel or whether turtles began migrating to this bay only after the construction of this tropicana in the mid-1960's. If turtles were, historically, part of the bay's life were they year-round residents or seasonal migrants? Throughout the world nesting beaches used by various populations of turtles are devastated by encroaching man, oil spills, hurricane destruction, etc. and biologists puzzle whether turtles robbed of their nesting goals will be able to alter their migratory pathways and accept new beaches as their destinies. Answering this question could offer insight on the speed at which a sea turtle can alter its migration route, extend its margins of distribution and its ability to recognize and utilize new habitats.

2) To determine what environmental differences exist in San Diego Bay between areas used by the turtles and areas of the bay not used. Are those environmental conditions that are present in the turtle channel, required in order for the turtles to survive life in

San Diego Bay?

3) To determine how environmental conditions of these "turtle areas" change seasonally from November through April, when the turtles are seen daily, and the rest of the year when turtles are conspicuously absent from the bay.

4) To determine which environmental variables are strongly correlated with the turtles' seasonal presence and selective geographic distribution in San Diego Bay in order to determine which factors might have the strongest control or effect on their biology in San Diego. Describing and comparing the "turtle" and "nonturtle" environments of the Bay will provide information on their habitat requirements and tolerances, particularly in northern waters. The Pacific Ocean north of Mexico has been overlooked as habitat for sea turtles, understandably so, in view of so few published accounts of their occurrence so far north. The fact that green sea turtles exist in San Diego affords a rare opportunity to study their seasonal use of the northern part of their range. Why are they in San Diego during the year's coolest months and absent during summer when bay temperatures finally approach or equal those of the tropics? Are they in California's waters all year entering the bay only for relief from winter temperatures outside? If they are on a long-shore coastal migration from Mexico, why would it be timed so they spend the coolest part of the year at the route's most northern end?

5) To determine if local or extraneous environmental factors trigger or cause the turtles' seasonal migration.

6) To study the thermal biology of these green turtles in the bay, to investigate the effect that changes in ambient temperatures have on their body temperatures and behavior. Because water temperature was the most immediately obvious difference between areas of the bay where turtles occurred and areas they did not, and because the global centers for green sea turtles are tropical, monitoring the relation between the turtles' body and ambient bay temperatures offered a logical place to begin studying clues to their existence in this bay and northern waters.

7) To examine the individual and group behavior of green sea turtles on a daily and seasonal basis and to relate these behaviors to water temperature, tidal phase and time of day. Individual and groups of turtles were tracked using ultrasonic telemetry and their travel patterns within the bay studied.

8) To study respiration rates and the breathing behavior of free-swimming green sea turtles and to study their group (synchronous) breathing behavior relating this to their social behavior.

Such an opportunity to study so many facets in the daily and seasonal biology of any species of sea turtle, and that it can involve turtles swimming freely in an environment of their own selection is indeed unique—a rich opportunity impossible to ignore. This study has generated and uncovered a tremendous amount of data, answering some questions, giving birth to a great many more and will provide a stepping stone or a platform for future generations of questions, research and hopefully answers concerning the biology of sea turtles in the northeastern Pacific. With man's accelerating use of coastal waters and beaches, it is imperative that we know what comprises a day, a year in the life of a sea turtle and how man impacts its environment and ability to survive.

CHAPTER II

METHODS AND MATERIALS

History of Sea Turtles in San Diego Bay

Historical records were extracted from local Californian newspapers as early as the 1850's. Microfilms of the original articles were examined for any mention of sea turtles. Archives of the San Diego Historical Society, San Diego Maritime Museum Association, Hotel Del Coronado historical collection (housed at San Diego State University's library), U.S. Department of Commerce Library at the National Marine Fisheries Service Southwest Fisheries Center and collection records for the San Diego Museum of Natural History, San Diego Zoo, Sea World and Scripps Institute of Oceanography were researched. Dr. Carl Hubbs (SIO) contributed his valuable files as well as those maintained during the early 1900's by Dr. Ritter, founder of the Marine Biological Association of San Diego (later to be known as Scripps). Photographs were obtained from Dr. Hubbs and from the San Diego Title Insurance and Trust Company's extensive historical collection.

Through the San Diego Maritime Museum Association, San Diego's early fishermen, boatwrights, cannery employees, turtle hunters, historians and families were located and interviewed. Employees of the SDG & E and Western Salt Companies, who maintain the turtle channel, as well as employees of Lockheed Corporation, San

Diego Unified Port District, U.S. Navy and the captains and crews from vessels at Fisherman's Landing offered information on turtle sightings—or the lack of them—in San Diego Bay.

Description of Study Area

San Diego Bay

? Turtles migrate annually to San Diego Bay, but restrict their daily travel to the bay's most southern area. Shaped like a long narrow crescent, San Diego Bay is 24 kilometers (15 miles) in length, 0.4 to 4.0 kilometers (¼ to 2½ miles) in width and has only one entrance, at its north end. Most turtle activity and travel is confined to a channel located in the southern most part of the bay. This channel, constructed in 1960, serves the San Diego Gas and Electric Company as an area for cooling their discharge water before it flows again into the open bay. Turtles spend most of their time within this discharge channel, leaving only on wanderings and on what I believe to be feeding sojurns through a small area of south bay (7.2 sq. km) extending from the channel across to the bay's southern and western shores (1.8 km distance) and as far north along the Coronado Peninsula as 4 km (Figures 1 and 2).

With the exception of a few slightly deeper spots, all of south bay and much of the channel (especially the outer and middle areas) are very shallow, generally less than one meter in depth at low tide (0.3 to 1.0 m). But these water depths change drastically, about 30% of the bay's volume is exchanged with the open ocean during

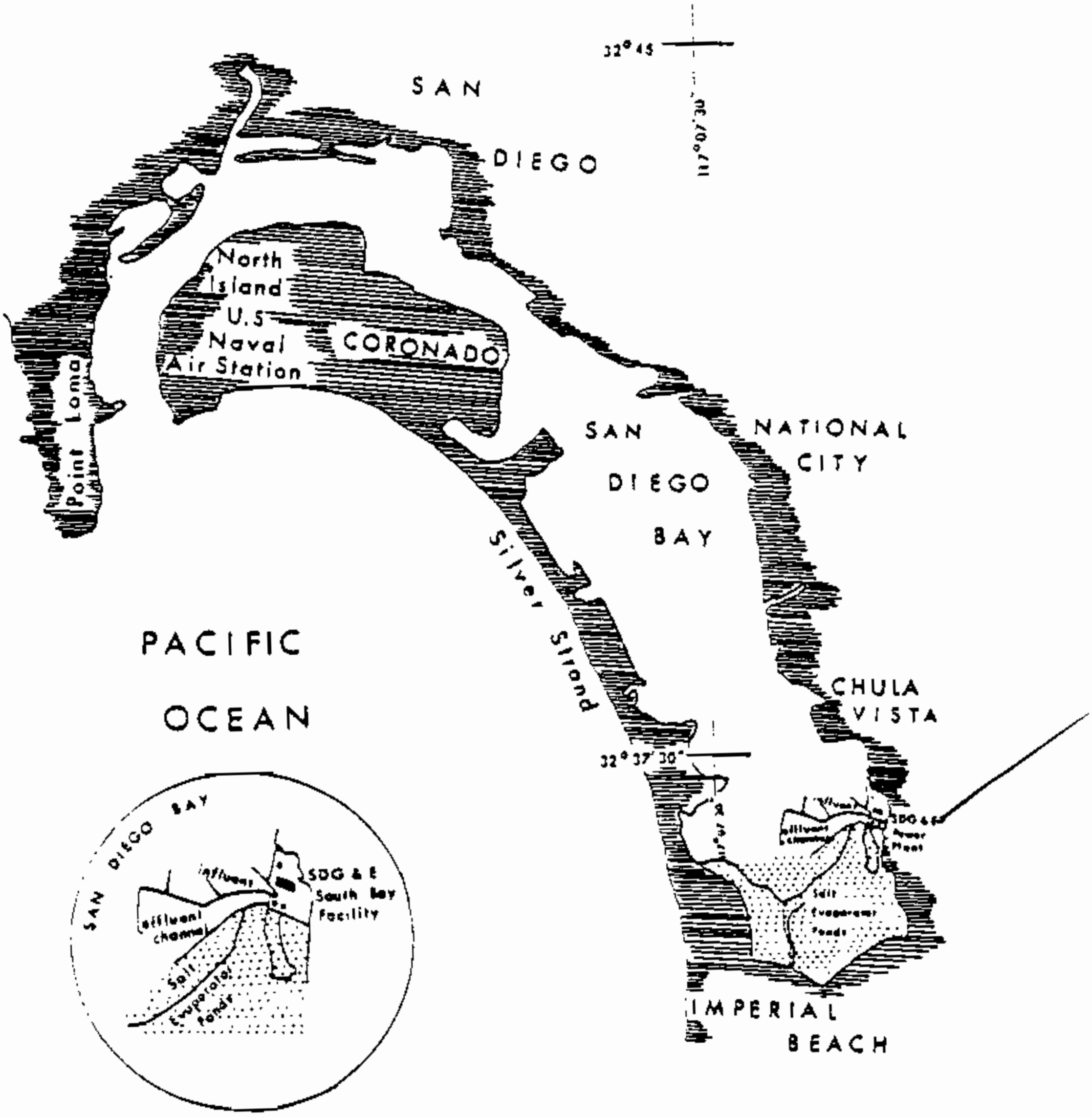


Figure 1. Map of San Diego Bay, California showing the San Diego Gas and Electric Company's effluent channel where green sea turtles are known to occur seasonally.

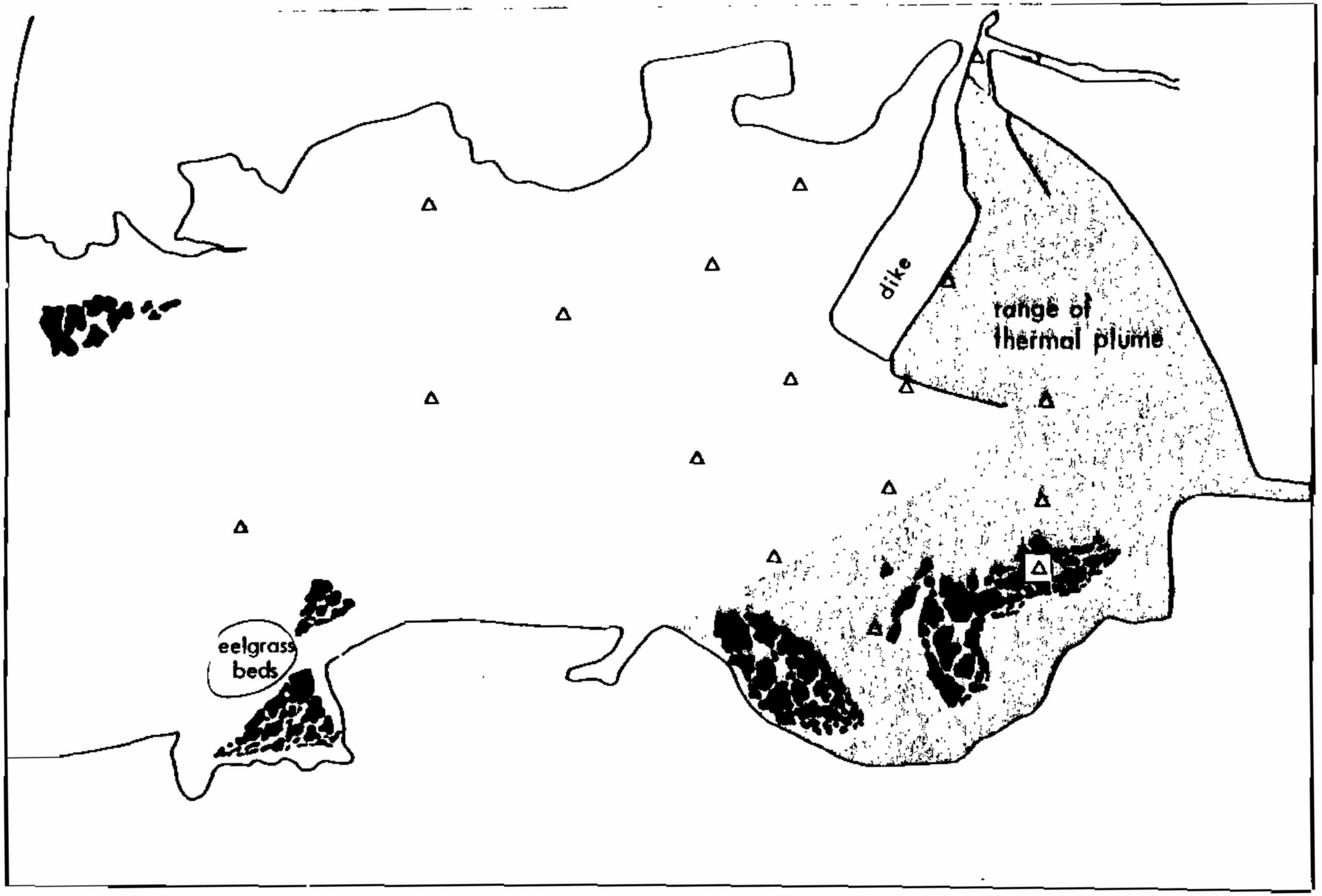


Figure 2. Map of the southern third of San Diego Bay showing the "L" shaped channel where green sea turtles occur, the range of the thermal plume of warm water discharged into the channel by the SDG & E Company (plume coincides with turtle distribution), the location of eelgrass beds and environmental monitoring stations.

each tidal cycle (San Diego Unified Port District, 1980). The height of water in San Diego Bay varies an average of 5.3 feet (1.6 m) and an extreme of 10 feet (3 m) between high and low tides; and this difference is greatest in the southern areas of the bay (Ford, 1973). During high tides, water depths throughout south bay increase from the low tide level, of less than one meter, to high tide levels of two to three meters.

While tidal currents in south bay are reported to be greatly reduced from those experienced in the northern areas of the bay (2.9 knots during ebb tides and 2.2 knots during flood tides), the southern area is unprotected from winds and these winds have a very strong effect on water conditions (Ford, 1973; Peeling, 1975). During winter and spring months (turtle season), persistent local winds create steep 1-3 foot (0.3 - 1.0 m) surface chop across south bay and the channel. This wind chop, together with the normal tidal current and the force of discharge water surging from the SDG & E Company result in strong and turbid local currents.

Turtle Channel

was this demonstrated?

The channel, to which green sea turtles annually migrate, is 1.8 kilometers in length and extends out from the bay's most southeastern corner (Figures 1,2,3). It is bordered on the north by a narrow L-shaped dike of land, on the south by the bay's southern shore and the dike of the Western Salt Company's evaporative salt ponds and opens to the bay at its western end. The channel varies in width from 75m at its eastern end, where water is discharged into the

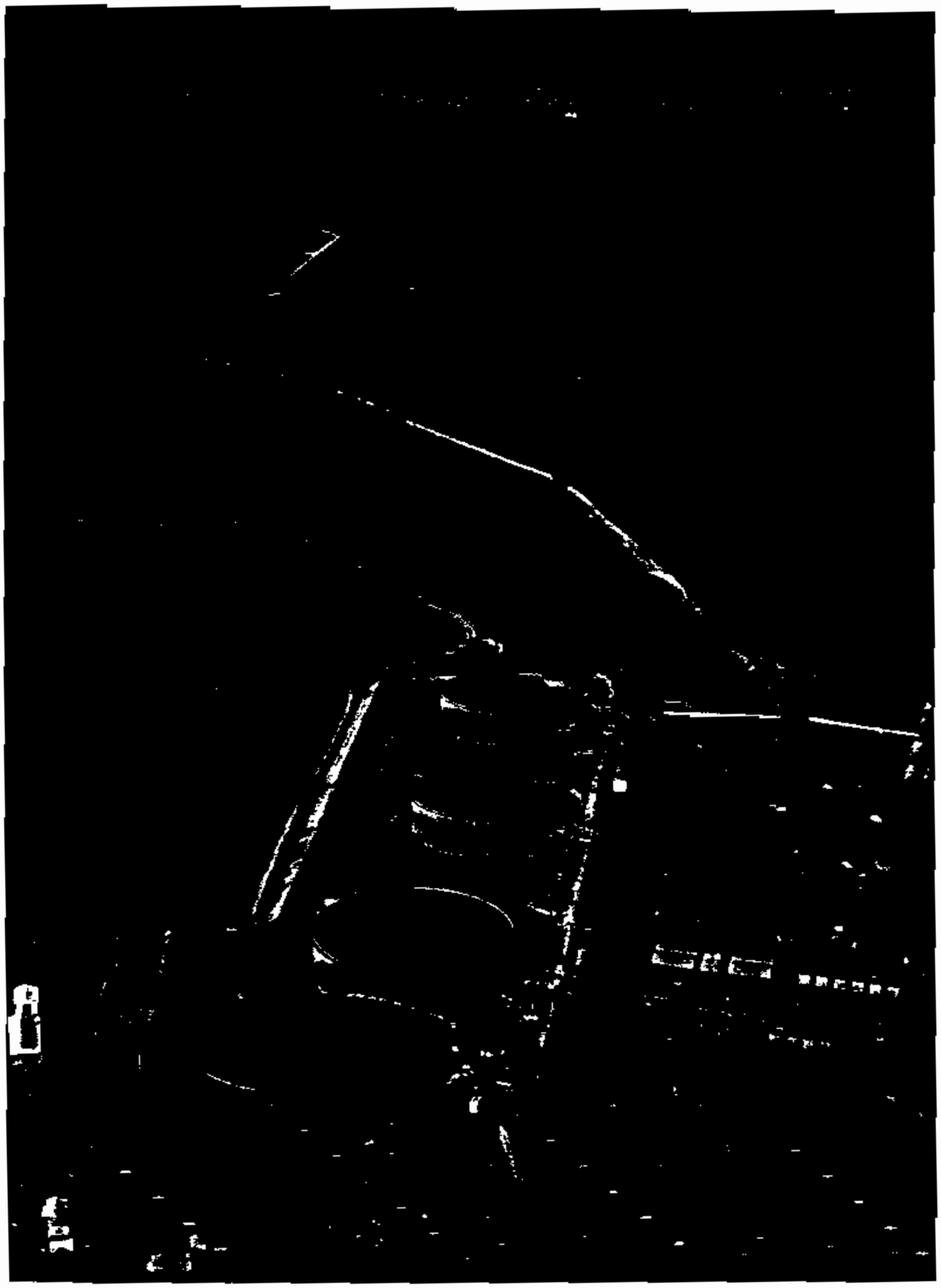


Figure 3. Aerial view of the San Diego Gas and Electric Company's effluent channel, that is used by green sea turtles during winter and spring months. The channel is separated from the rest of the bay by a "L" shaped dike.

channel from the power plant (bridge area); 100-200m for the next 700m section of channel, which is considered for turtle activity to be the main or inner channel; 250-300m through the middle section of the channel (Big Flipper Point); 0.9 to 1.2 km across the bight formed by the western L-bend in the dike; and 350-600m at the channel's entrance.

The channel is essentially very shallow. It is deepest at its eastern end, where discharge water enters the channel (10-13m), and then becomes increasingly shallow toward its western entrance with the bay. Water depths are 2-5m in the inner channel, 1-3 m in the middle area and $\frac{1}{2}$ to $1\frac{1}{2}$m in the outer channel and entrance areas. Water depth throughout the channel (except at its eastern end) is drastically effected by changes in tides. During low tides great expanses of mud are exposed along both shorelines, water depths are decreased by one-third to one-half of high tide levels and the width of the channel narrows considerably. With the exception of a thread-like path of 1 - $1\frac{1}{4}$m water running from Big Flipper Point up into the inner channel, all areas of middle and outer channel are covered during low tide with less than one meter of water ($\frac{1}{4}$ - 1m). Figure 3 shows the great difference in the channel's width between high and low tides.

The SDG & E Company uses bay water to cool their equipment. When discharged from the power plant into the channel, this water averages 10 to 15°C warmer than bay temperatures. The effect of this warm discharge extends about three kilometers beyond the channel out into south bay. During November through April, months when green sea turtles occupy the channel and south San Diego Bay, temperatures range from 21-37.5°C within the channel and 14-24°C throughout the rest of the southern part of the bay. Water temperatures in the central and northern parts of the bay (14-18°C) are considerably cooler than in the turtle area and are only slightly warmer than those along San Diego's open coastline (12.5 - 17.2°C, see Table 19).

Temperatures within the turtle channel vary greatly--from its floor to surface and along its length. Temperatures along the floor are generally 5-8°C cooler than at the surface and the warmest part of the channel is at its east end, where effluent water is discharged into the channel, and coolest at the entrance. During February and March, 1979, the period when turtles were monitored with telemetric tracking equipment, channel temperatures were 20-31°C in February and 23-37.5°C in March.

Correlation of Environmental Variables with the Seasonal and Geographic Distribution of Sea Turtles in San Diego Bay

Table 1 lists the 47 variables used to measure and compare environmental differences between "turtle areas" and "nonturtle areas" in San Diego Bay and between "turtle season" and "nonseason" months. Each variable was analyzed to determine to what extent it correlated with the turtles' seasonal appearance and restricted distribution within the bay.

Nonparametric Mann Whitney U rank sum and parametric t-tests were used to detect significant differences between the means of data sampled in turtle and nonturtle areas and between season and nonseason months. Spearman rank correlation coefficients were calculated to measure the correlation between each environmental variable and the presence or absence of green sea turtles in San Diego Bay (i.e., the correlation between surface water temperature and the seasonal presence or absence of turtles and the correlation of this variable with the presence or absence of sea turtles in different areas of the bay).

This nonparametric test for correlation was elected for use because, for too many of the 47 environmental variables there was no evidence that the data were normally distributed. The locations of the mean and median, skew, kurtosis and analysis of frequencies were calculated and examined for each variable in order to determine the data's statistical distribution. The significance of the correlation coefficients were determined using a t-table (Biomedical Computer Program P3S).

Data measuring these 47 environmental variables were not collected during this study but came from a series of indepth monitoring surveys completed during the months of January, April, July, August, September and October from 1968 to 1979 (Chambers and Chambers, 1973; Ford and Chambers, 1973a, 1973b, 1974; Ford, Chambers and Merino, 1970, 1971, 1972; Lockheed, 1977, 1978, 1979). Figure 1 shows the location of 13 stations monitored in San Diego Bay during these studies.

Table 1. List of environmental variables for which Spearman rank correlation coefficients were calculated to determine each variable's degree of association with the distribution of green sea turtles in San Diego Bay, California.

Variable 1	Mean Surface Water Temperature
Variable 2	Mean Bottom Water Temperature
Variable 3	Mean Sediment Temperature
Variable 4	Mean Surface Water Dissolved Oxygen Content
Variable 5	Mean Bottom Water Dissolved Oxygen Content
Variable 6	Mean Surface Water Salinity
Variable 7	Mean Bottom Water Salinity
Variable 8	Mean Chemical Oxygen Demand (COD) of Sediment
Variable 9	Mean Total Kjeldahl Nitrogen Content of Sediment
Variable 10	Seechi Measurement of Water Turbidity
Variable 11	Total Number of Plant and Invertebrate Species
Variable 12	Total Number of Plant Species
Variable 13	Total Number of Invertebrate Species
Variable 14	Total Number of Coelenterate Species
Variable 15	Total Number of Polychaete Species
Variable 16	Total Number of Crustacean Species
Variable 17	Total Number of Mollusc Species
Variable 18	Shannon-Wiener Diversity Index for all Benthic Inveretbrates

Table 1. (continued).

Variable 19	Shannon-Wiener Diversity Index for all Polychaete Species
Variable 20	Shannon-Wiener Diversity Index for all Crustacean Species
Variable 21	Shannon-Wiener Diversity Index for all Mollusc Species
Variable 22	Total Plant and Invertebrate Biomass
Variable 23	Total Plant Biomass
Variable 24	Total Invertebrate Biomass
Variable 25	Total Coelenterate Biomass
Variable 26	Total Nemertinea Biomass
Variable 27	Total Polychaete Biomass
Variable 28	Total Oligochaete Biomass
Variable 29	Total Phoronid Biomass
Variable 30	Total Amphipod Biomass
Variable 31	Total Isopod Biomass
Variable 32	Total Ostracod Biomass
Variable 33	Total Bivalve Biomass
Variable 34	Total Gastropod Biomass
Variable 35	Total Echinoderm Biomass
Variable 36	Total Invertebrate Density
Variable 37	Total Coelenterate Density
Variable 38	Total Nemertinea Density

Table 1. (continued).

Variable 39	Total Polychaete Density
Variable 40	Total Oligochaete Density
Variable 41	Total Phoronid Density
Variable 42	Total Amphipod Density
Variable 43	Total Isopod Density
Variable 44	Total Ostracod Density
Variable 45	Total Bivalve Density
Variable 46	Total Gastropod Density
Variable 47	Total Echinoderm Density
Variable 48	Distribution of Green Sea Turtles

Thermal Biology of Green Sea Turtles in San Diego Bay

One juvenile (sex undetermined) and three adult male green sea turtles were captured in the San Diego Gas and Electric Company's effluent channel in southern San Diego Bay on 27-28 January 1979 and two adult females were captured on 10 March 1979 (Figures 4-9). The turtles were transferred for several days to the Hubbs Sea World Research Institute in San Diego for attachment of telemetric tracking devices and then returned to the channel and released (Figures 10-12).

Because green sea turtles are legally designated a threatened species, permits were required in order to capture and track these animals. Consequently all work was done under the auspices of the National Fish and Wildlife Laboratory, U.S. Fish and Wildlife Service (Washington, D.C.).

The turtles were monitored using telemetric devices designed to measure temperature and to transmit this information as a sonic signal underwater (allowing us to locate and track the turtles while they swam, even, below the surface). A large transmitter was attached to each adults' carapace; it measured ambient temperature and its signal could be heard for a maximum of 2½ miles under excellent conditions (Figure 13-17). Instead of the large transmitter, a miniature device (intended to be swallowed for monitoring internal body temperature) was attached to the carapace of the juvenile turtle (Figure 18). All but one of the turtles were fed one of these tiny transmitters, that until defecated, measured body

An underwater, unidirectional hydrophone and receiver were used to locate and monitor the transmitters. Each turtle was identified sonically by its transmitters' distinct frequencies. Each transmitter had a distinct pulse rate that changed speed to reflect changes in temperature. Every time a transmitter was monitored, its pulse rate signal was recorded onto a cassette tape recorder for 60 seconds and later the pulses/second were counted for comparison with a pulse rate/temperature curve that accompanied each transmitter.

The telemetric equipment (transmitters, hydrophone [SR-70-H] and receiver [TA-25]) were designed and manufactured by the Smith-Root Company of Vancouver, Washington. The carapace transmitter was customed designed (8.5cm dia., 20cm length, 1.8kg weight, with a battery life of 1½ years) and the internal transmitter (14mm dia., 5.7cm length, 9.1 g weight in water, with a battery life of 20 days) was their standard model SR-69-T. A 13 foot Boston Whaler skiff powered by a 20hp Mercury outboard motor was used for tracking.

Body and ambient temperatures were monitored for the single juvenile and three adult males during the period of February 1-10. From March 14-22, the body and ambient temperatures were recorded for one adult female and the ambient temperatures, alone, for a second adult female.

For more information on the techniques used to capture the turtles and for a more detailed description of the telemetry system (method of attachment of transmitters and problems in tracking and monitoring temperature data using this system) see Appendix A.

Behavior of Green Sea Turtles in San Diego Bay

During November through April, of each year from 1976-1981, green sea turtles were observed from the banks of the SDG & E Company's channel. In 1979, in addition to shoreline observation, turtles were tracked telemetrically throughout the channel and southern San Diego Bay using a skiff. Body measurements of those turtles captured and tracked are presented in Table 2.

The data presented here were all collected during 1979. In order to determine the distribution and activity of turtles during different tides and times of day, transects of the entire channel were completed during various tidal phases (high, outgoing, low, incoming) and during morning, afternoon and night periods. During transects, whether made by boat of from shore, equal time was spent at each of eight locations along the channel.

During the telemetry phase of 1979, I alternated between periods when I elected to follow one turtle exclusively (for as long as 24 hour periods) and other times when my efforts were to track and re-locate all of the tagged turtles as often as possible in order to simultaneously compare all of their activity and travel patterns.

For each sighting, the following information was recorded: exact position of turtle, its swimming direction, time, and if possible, a description of the animal. Bearings were taken on three landmarks using a hand-held sighting compass, to obtain map position by triangulation.

Table 2. Identification tag numbers and measurement data for 6 *Chelonia mydas* captured, released and tracked using ultrasonic telemetry in San Diego Bay, California.

No.	Capture Date Release Date	Tag No. Mexico Univ. Fla.	Sex	Weight	Carapace Length Curved/ Straight	Carapace Width Curved/ Straight	Plastron Length	Plastron Width	Head Width
#1	27 January 1979 2 February 1979	C-06031 D-3006	?	30.5 lbs 13.84 kg	47.5 cm 45.5 cm	44.0 cm 38.2 cm	40.0 cm	42.0 cm	7.8 cm
#2	27-28 January 1979 1 February 1979	C-06026 D-3002	Male	184 lbs 83.46 kg	89.0 cm 86.3 cm	83.5 cm 64.5 cm	69.0 cm	66.0 cm	12.5 cm
#3	27-28 January 1979 2 February 1979	C-06027 D-3004	Male	190 lbs 86.18 kg	90.5 cm 86.5 cm	79.5 cm 65.0 cm	70.0 cm	69.0 cm	12.6 cm
#4	27-28 January 1979 1 February 1979	C-06029 D-3005	Male	220 lbs 99.79 kg	98.0 cm 94.0 cm	88.0 cm 70.0 cm	73.5 cm	71.0 cm	13.3 cm
#5	10 March 1979 13 March 1979	C-06016 No Fla. Tag	Female	380 lbs 172.37 kg	——	——	——	——	16.0 cm
#6	10 March 1979 13 March 1979	C-06015	Female	312 lbs 141.52 kg	106.5 cm 94.8 cm	93.5 cm 74.8 cm	——	——	14.5 cm

Mexico's Departmento de Pesca tag was attached to left foreflipper, Univ. of Florida's tag to right.

A Boston Whaler skiff and Mercury outboard motor were used for all water transects. Although the engine noise only occasionally interfered with reception of telemetric devices, it became standard practice to turn off the engine at recording stops and to use oars when near turtles. Turtles frequently surfaced within several meters of the skiff and slowly following a turtle did not seem to cause it to travel any faster than turtles not being followed.

Breathing Patterns of Green Sea Turtles in San Diego Bay

Collection of Data

Green sea turtles spend considerable amounts of time in the SDG & E Company's effluent channel in San Diego Bay and can easily be observed from a foot bridge crossing above the channel (Figure 19). From this vantage point the swimming and breathing patterns of the turtles were observed and recorded during 17 sessions (for a total of 31 hours and 45 minutes).

Each time a turtle surfaced the exact time was recorded. The direction the turtle was facing noted and the animal's exact location mapped relative to surrounding landmarks. The turtle was either visually recognized and identified, or described (body size, shape, coloration, barnacle pattern, etc.). Any confusion in the identification or observation of a surfaced animal was noted. Recognizing different individuals and mapping swimming patterns and ranges sometimes clarified problems of unverified identifications which were inevitable due to the very nature of the study conditions and area.

The portion of the channel used to study the turtles' respiration rates was roughly square in shape and about 50 meters on each side. The shore was steeply banked, with sides reaching about 8 meters above the water and was covered with boulders, jagged blocks of concrete and pipes. A foot bridge crossing above the channel formed one side of the study area.

Observations were made from various elevated points on shore or from the bridge depending on sun-glare. During each session observations were made randomly from different points in order to evenly cover the area and to view the turtles from different angles.

The presence of the observer on shore would have no effect on the turtles because the top of the shoreline and bridge were well above the level of the water; turtles lifted their heads clear of the surface for only seconds at a time and probably could not locate and discriminate or recognize a human against the confused appearance of the shore and surrounding buildings, tanks and machinery. Also the presence of people walking in the area or fishing from shore is commonplace as are passing trucks and other vehicles.

Differences in Breathing Rates in Green Sea Turtles of Different Sizes

Length of dives (breathing rates) were analyzed using the F-distribution of variance ratios and the Kruskal-Wallis sum of ranks test for nonparametric analysis to determine if statistically significant differences existed in the length of dives (or breathing rate) in green sea turtles of different body sizes.

Measurement of Synchrony

In order to test whether or not the surfacing behavior of the turtles was synchronized as a group behavior, the surfacing data were recorded on time scale graphs. The time records were divided into 2 minute intervals and the number of surfacings (breaths) occurring in each interval counted. For such analysis it is not necessary to recognize individual turtles from one interval to the next but it is critical to accurately count the number of different individuals surfacing within the interval.

The Poisson distribution, which is a discrete frequency distribution of the number of times a rare event occurs (Sokal and Rohlf, 1969) was used to calculate the statistically expected frequency of intervals during an observation period in which a specified number of surfacings would occur together [n intervals with 0 surfacings, n intervals with 1 turtle surfacing ... n intervals with 7 turtles surfacing].

In order to attempt to fit data to a Poisson distribution, three conditions must be met:

1. the number of times that an event (surfacing) does not occur must be infinitely large as to make the event rare;
2. that the mean number of surfacings/observation period must be small relative to the maximum possible number of events which could occur in that period;
3. and that the occurrence of the event must be independent of prior occurrences of the event.

The mean number of surfacing events occurring during an observation period were found to be sufficiently rare as to be distributed in a Poisson (random) fashion. There is considerable variation in the breathing pattern of green sea turtles and physiologically, Chelonia mydas can remain submerged at the bridge location for long periods (at least 120 minutes, which might be longer than the actual observation period). An individual turtle's breathing pattern can continually change and there is considerable variation between the breathing patterns of conspecifics at any given time. Thus there is no reason to assume that the act of one turtle breathing enhances the probability of a conspecific breathing in response to another turtle's prior surfacing act.

The data from this study comply with prerequisite conditions and can be applied to a Poisson distribution to test for randomness and to determine whether the surfacing events occur independently with respect to each other. If the occurrence of one event were to enhance the probability of a second such event occurring, a clumped distribution would occur and not fit a Poisson distribution.

The expected frequencies generated by the test for a Poisson distribution were applied to a Chi Square test of Goodness of Fit to determine if there is any statistically significant differences between the observed frequencies and expected frequencies, calculated to fit a Poisson distribution in a random fashion, and to determine whether the surfacing or breathing events occur independently of each other.

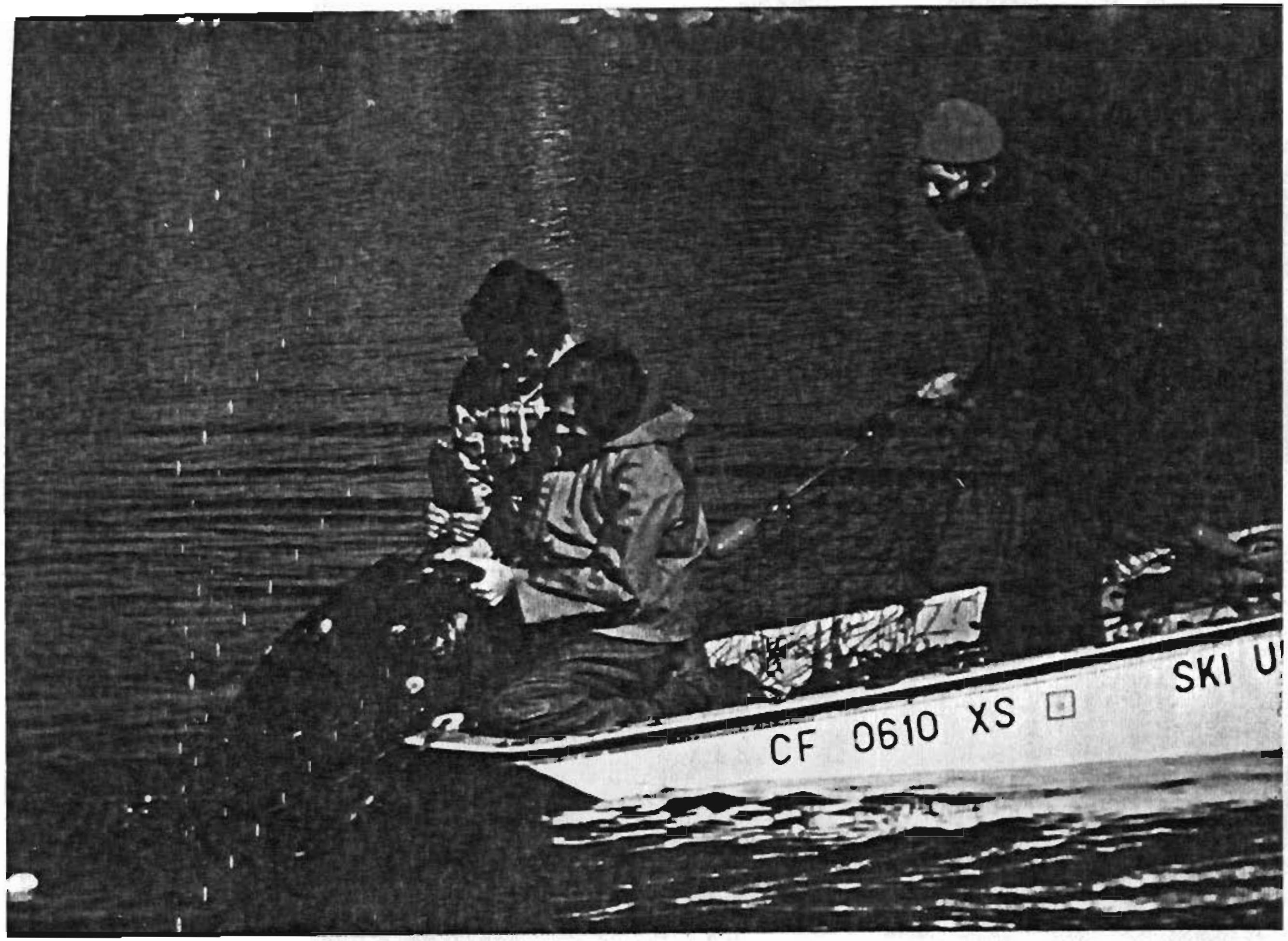


Figure 4. Removing an adult male green sea turtle from a drift-net set across the San Diego Gas and Electric Company's effluent channel in south San Diego Bay.

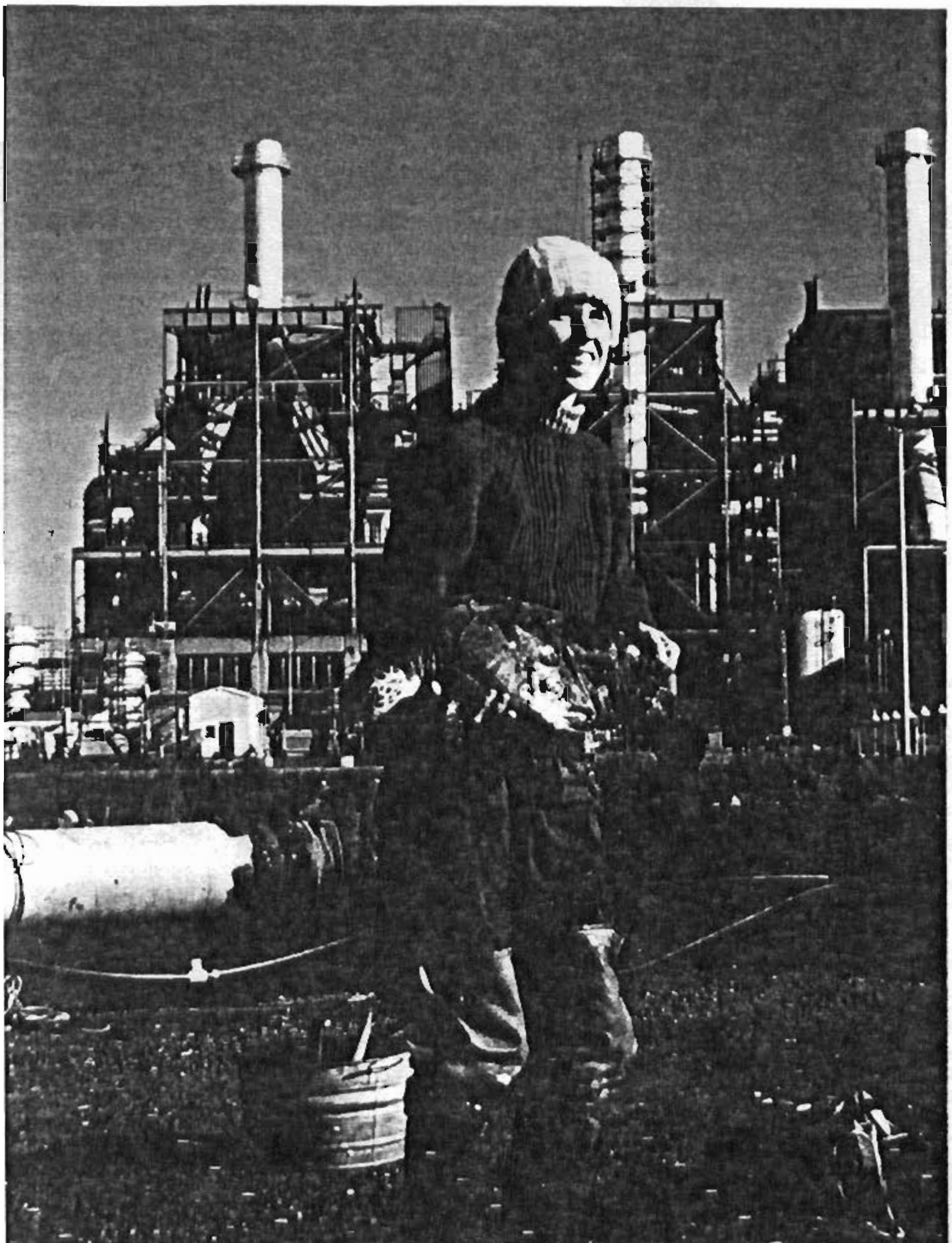


Figure 5. Margie Stinson holding the single juvenile green sea turtle captured and tracked in San Diego Bay (Turtle #1).

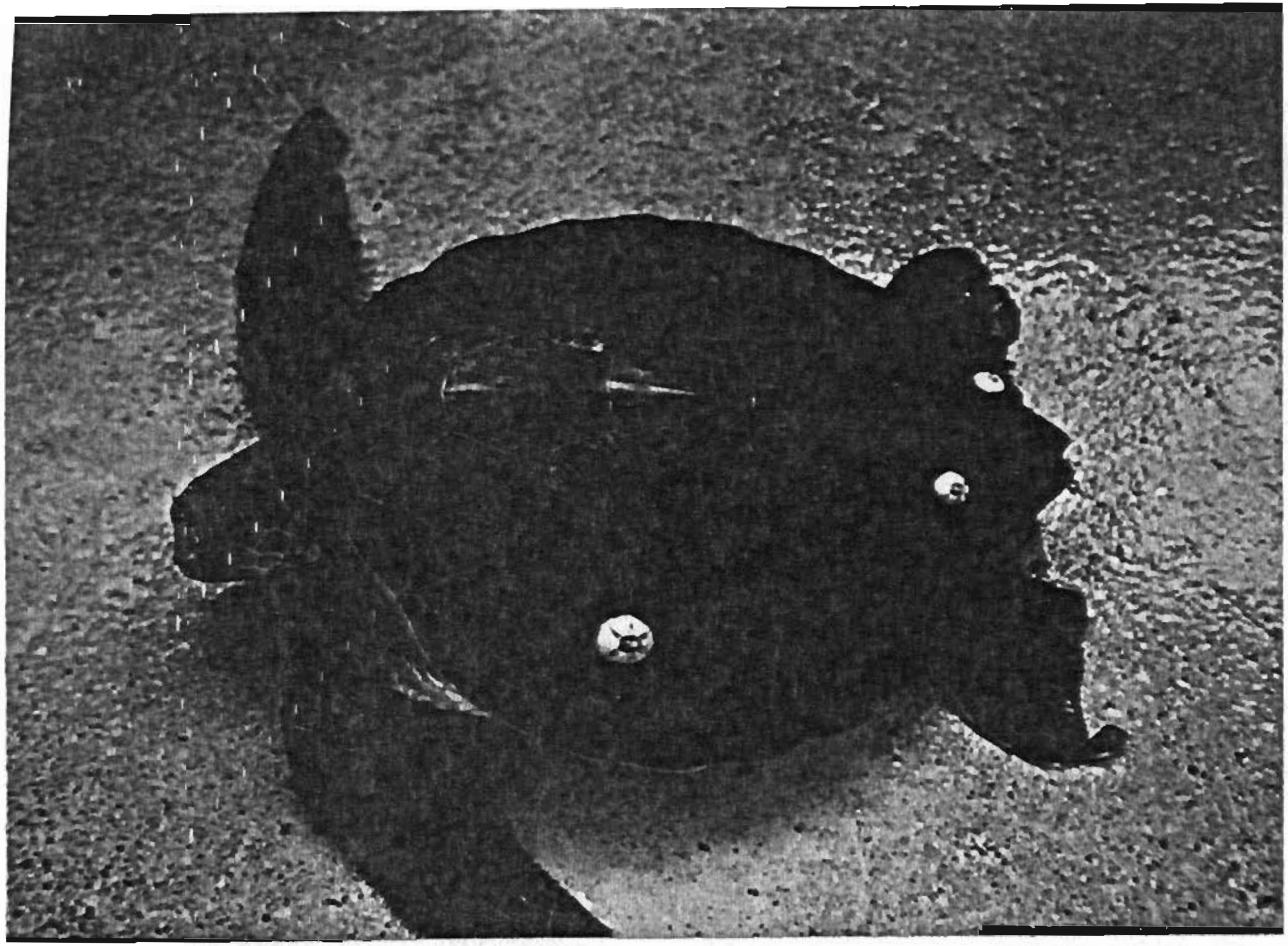


Figure 6. Juvenile green sea turtle captured and later tracked, using ultrasonic telemetry, in southern San Diego Bay.

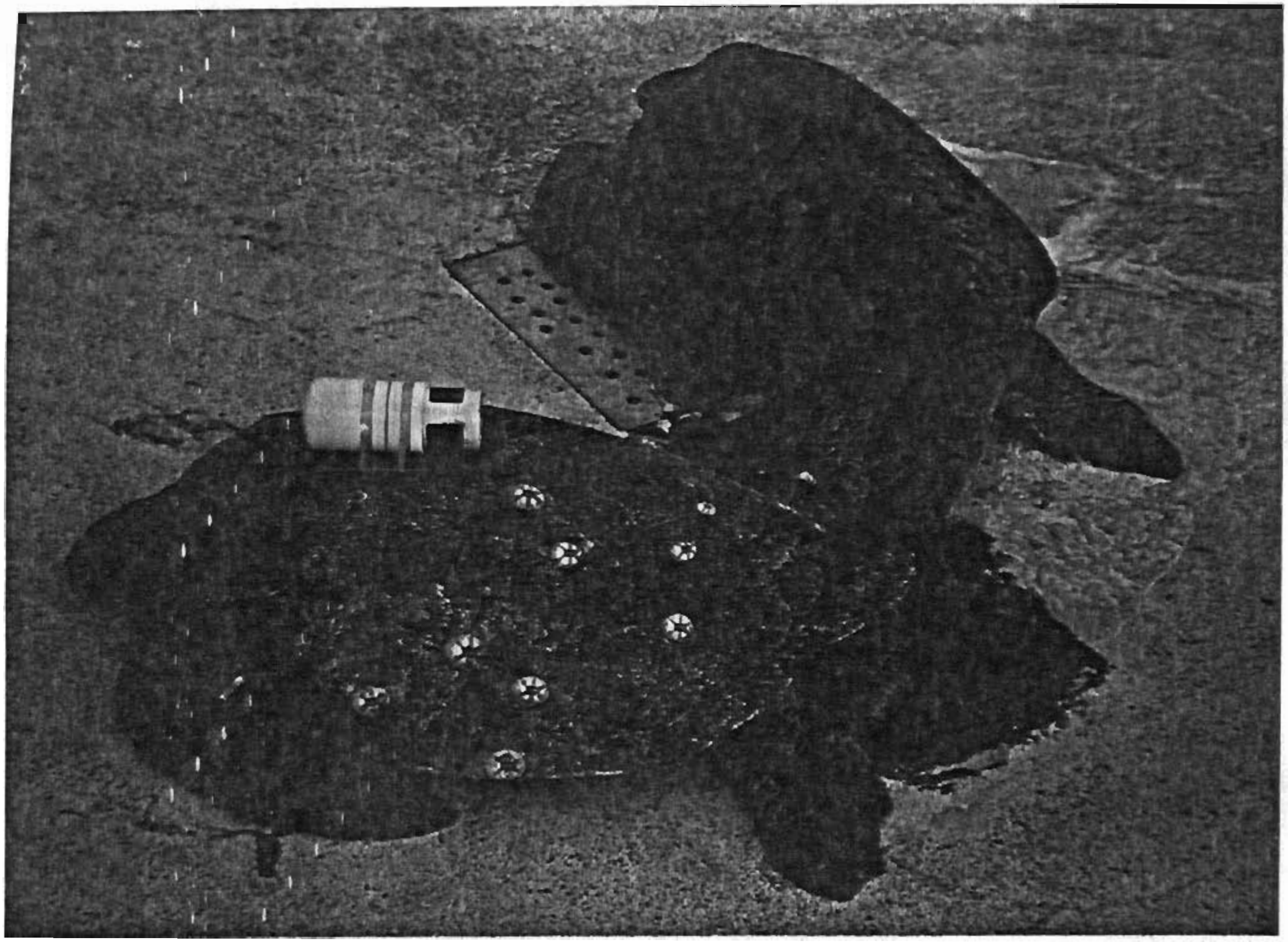


Figure 7. Two adult male green sea turtles captured in southern San Diego Bay, photographed while in captivity at the Hubbs Sea World Research Institute. These turtles were released back into San Diego Bay and tracked, using ultrasonic telemetry during February 1979.

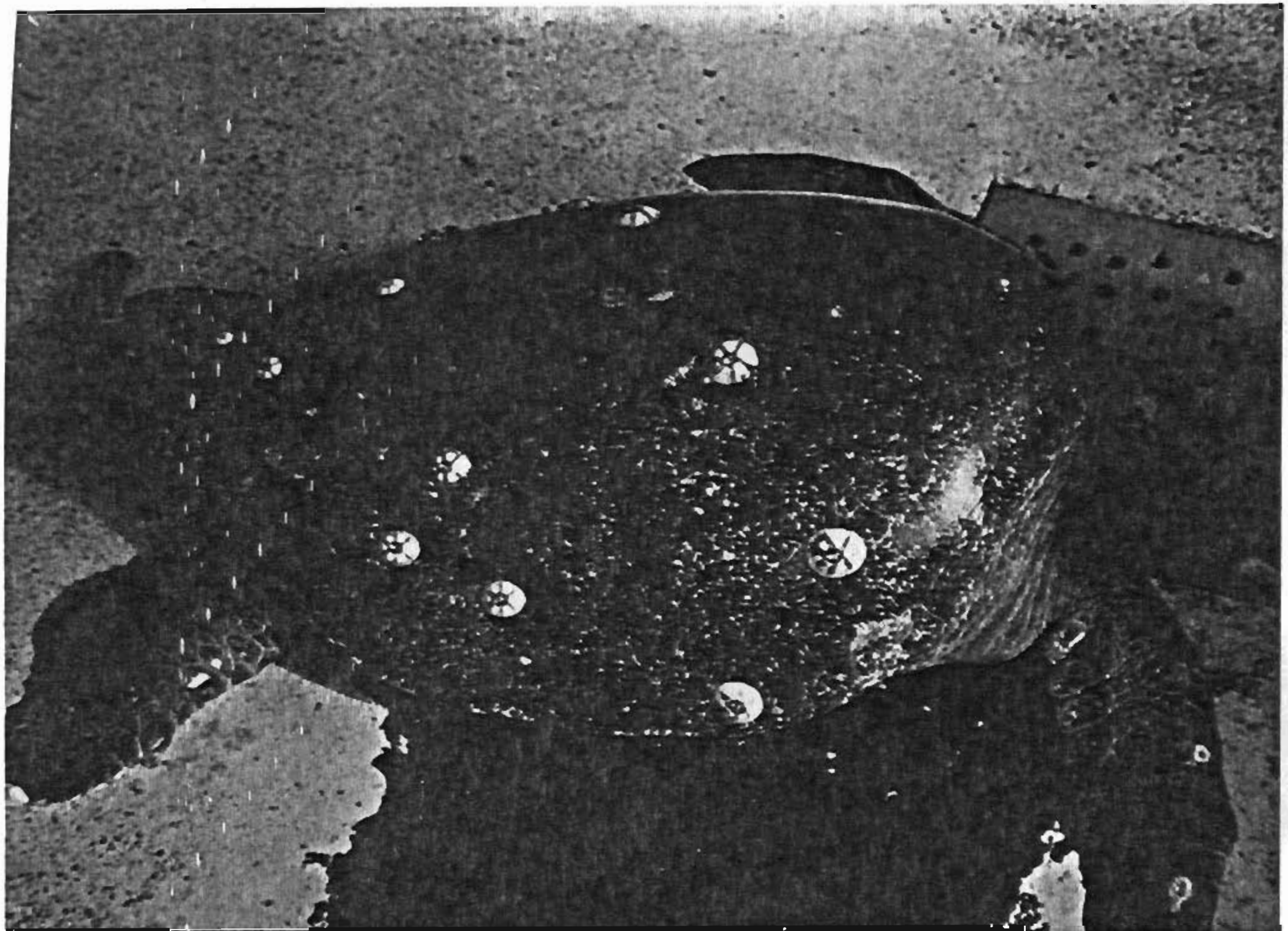


Figure 8. Adult male green sea turtle captured and tracked using ultrasonic telemetry in San Diego Bay during February 1979.

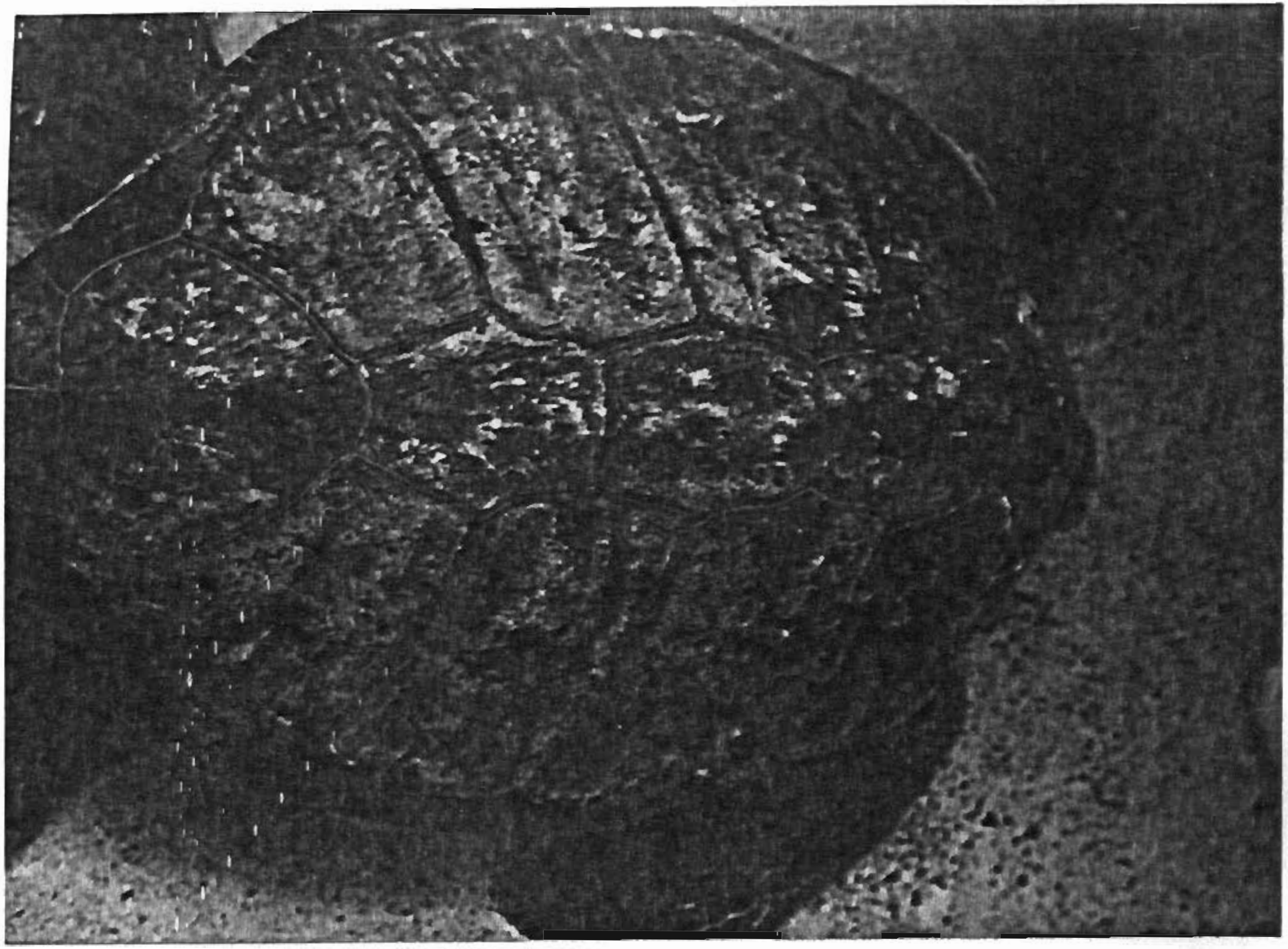


Figure 9. Adult male green sea turtle captured in southern San Diego Bay. This turtle was tracked during February 1979 using temperature-sensing ultrasonic telemetry.

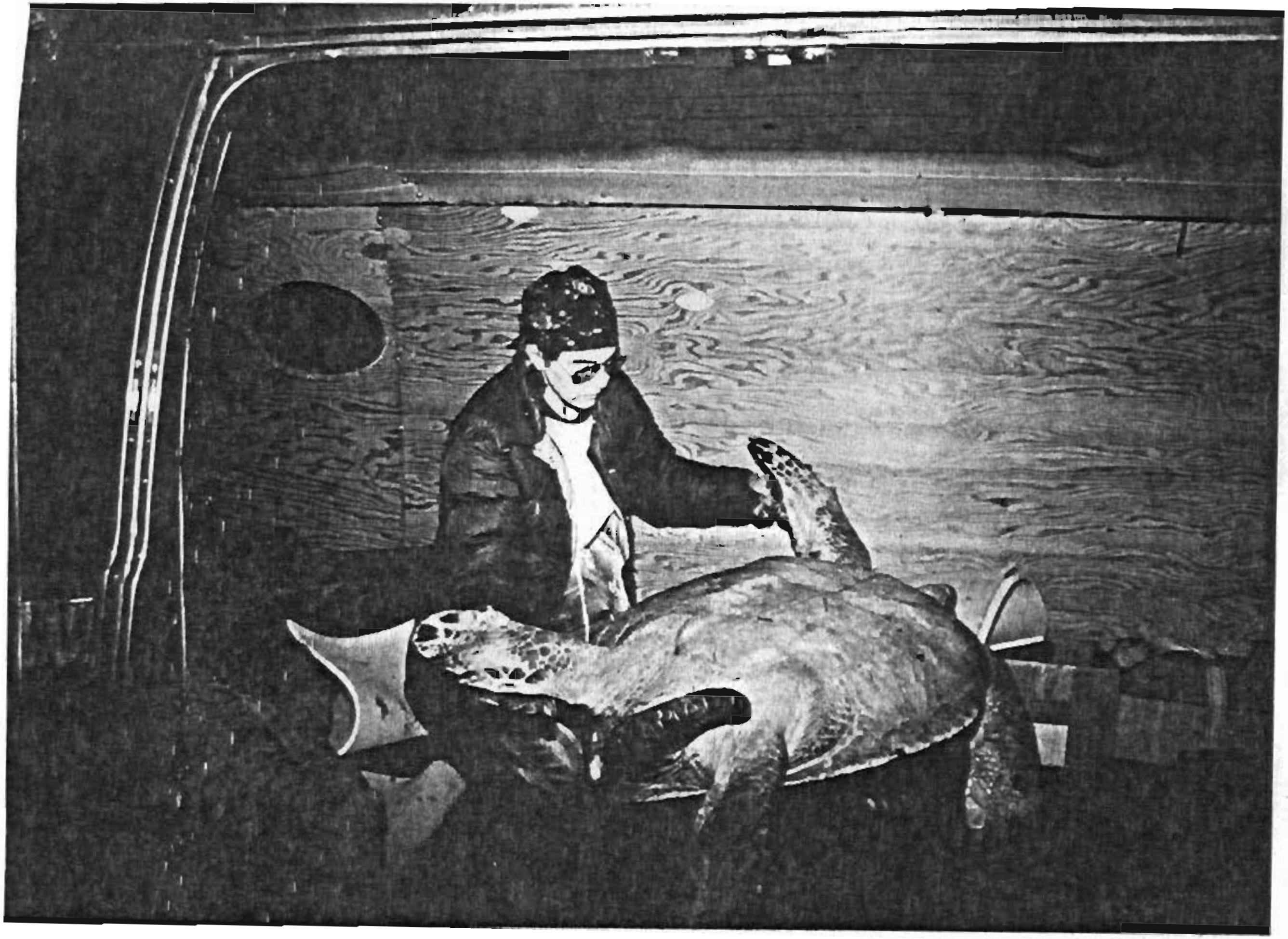


Figure 10. Method used to transport green sea turtles from San Diego Bay to the Hubbs Sea World Research Institute.

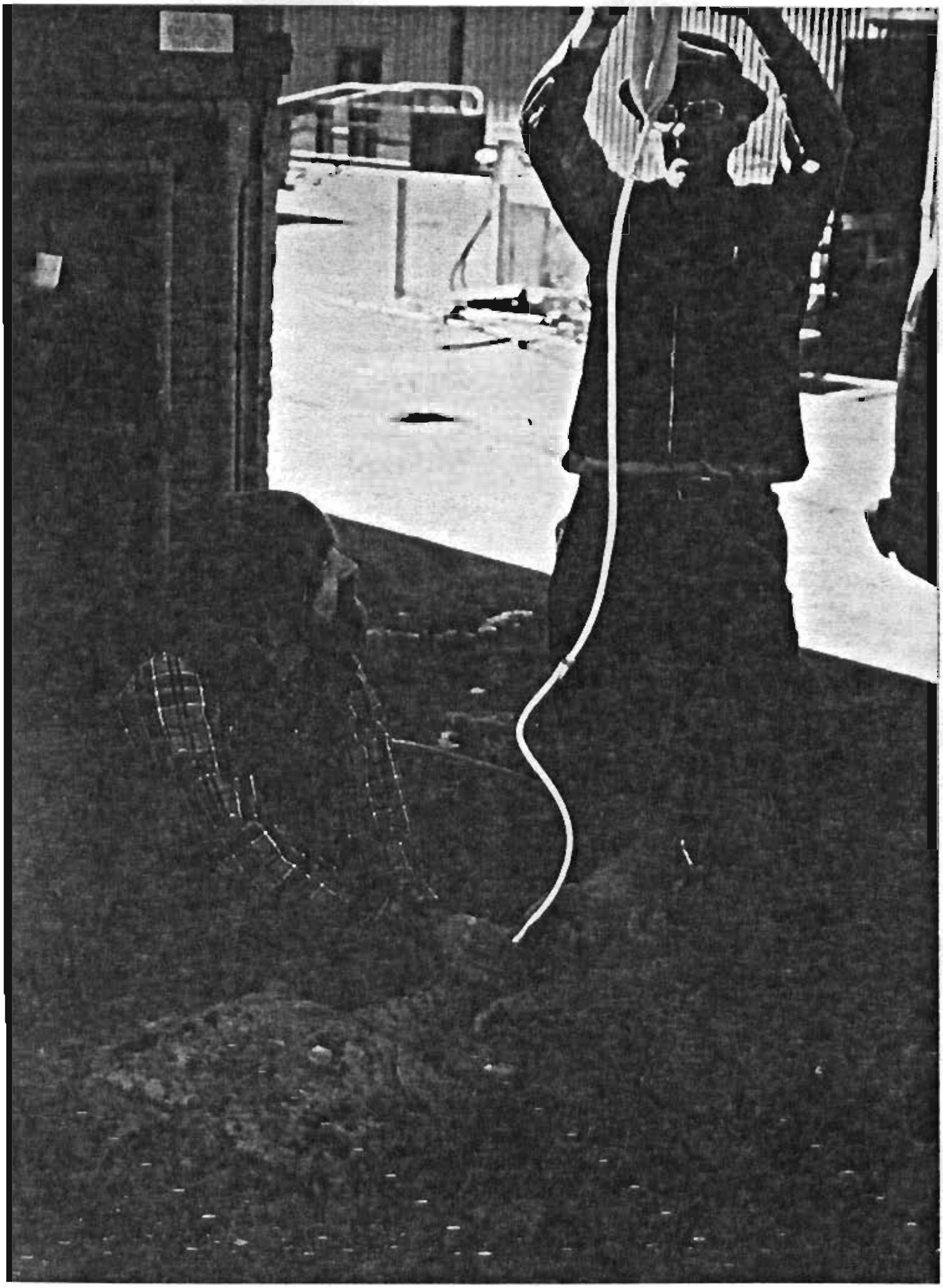


Figure 11. Attempting to give an enema to a male green sea turtle captured in San Diego Bay and transferred to the Hubbs Sea World Research Institute for attachment of tracking device.

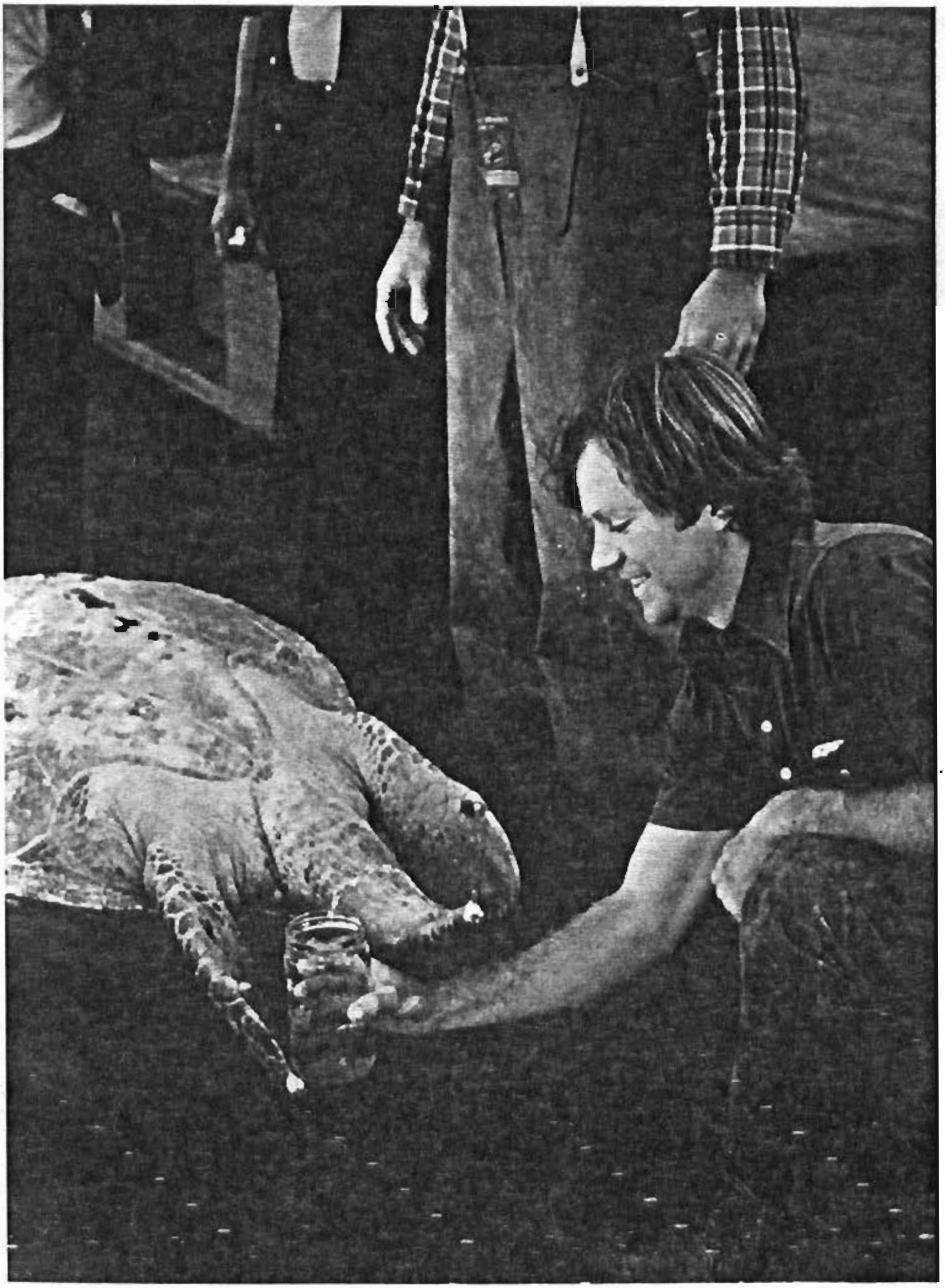


Figure 12. Results of an enema given to an adult male green sea turtle captured in San Diego Bay (see Figure 11).

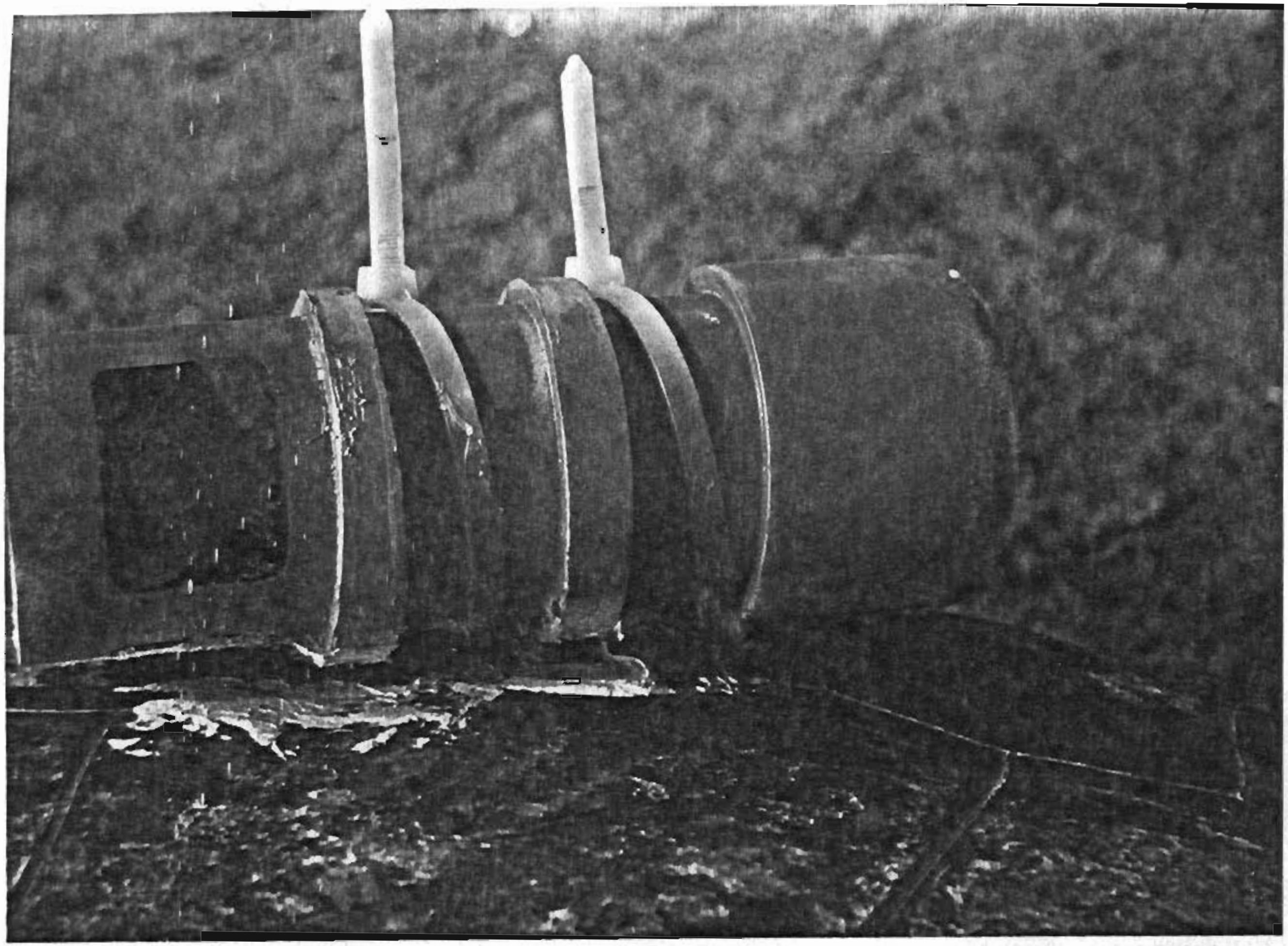


Figure 13. Ultrasonic temperature-sensing tracking device attached to the carapace of green sea turtles captured and tracked in south San Diego Bay.

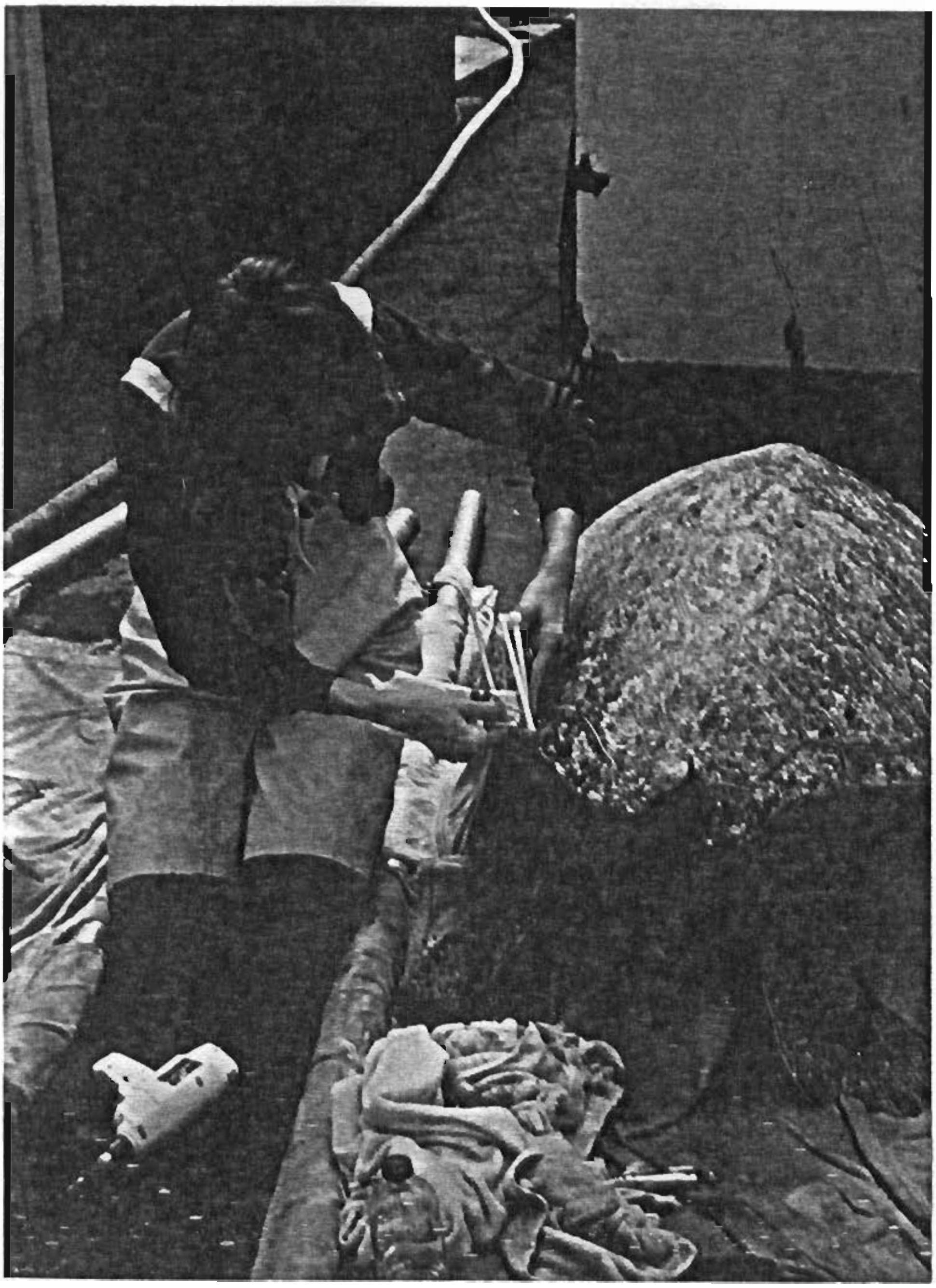


Figure 14. Preparing to attach an ultrasonic tracking device to the carapace of Turtle #6.

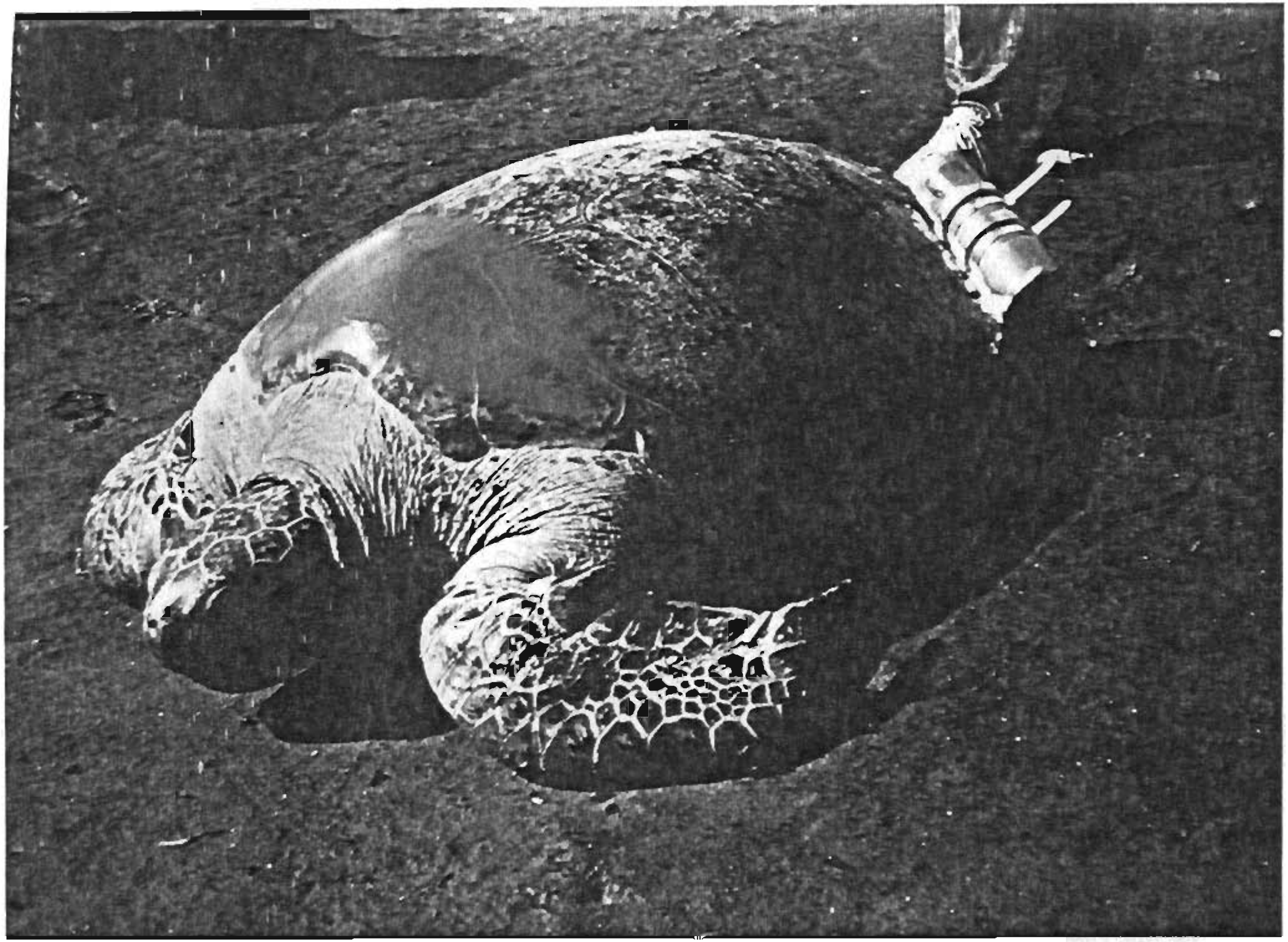


Figure 15. Turtle #6 (adult, female green sea turtle) ready for release into the San Diego Gas and Electric Company's effluent channel in southern San Diego Bay.

Figure 16. Attaching transmitter to carapace of Turtle #5. The deformed posterior portion of this female's carapace served as a cradle for the transmitter.

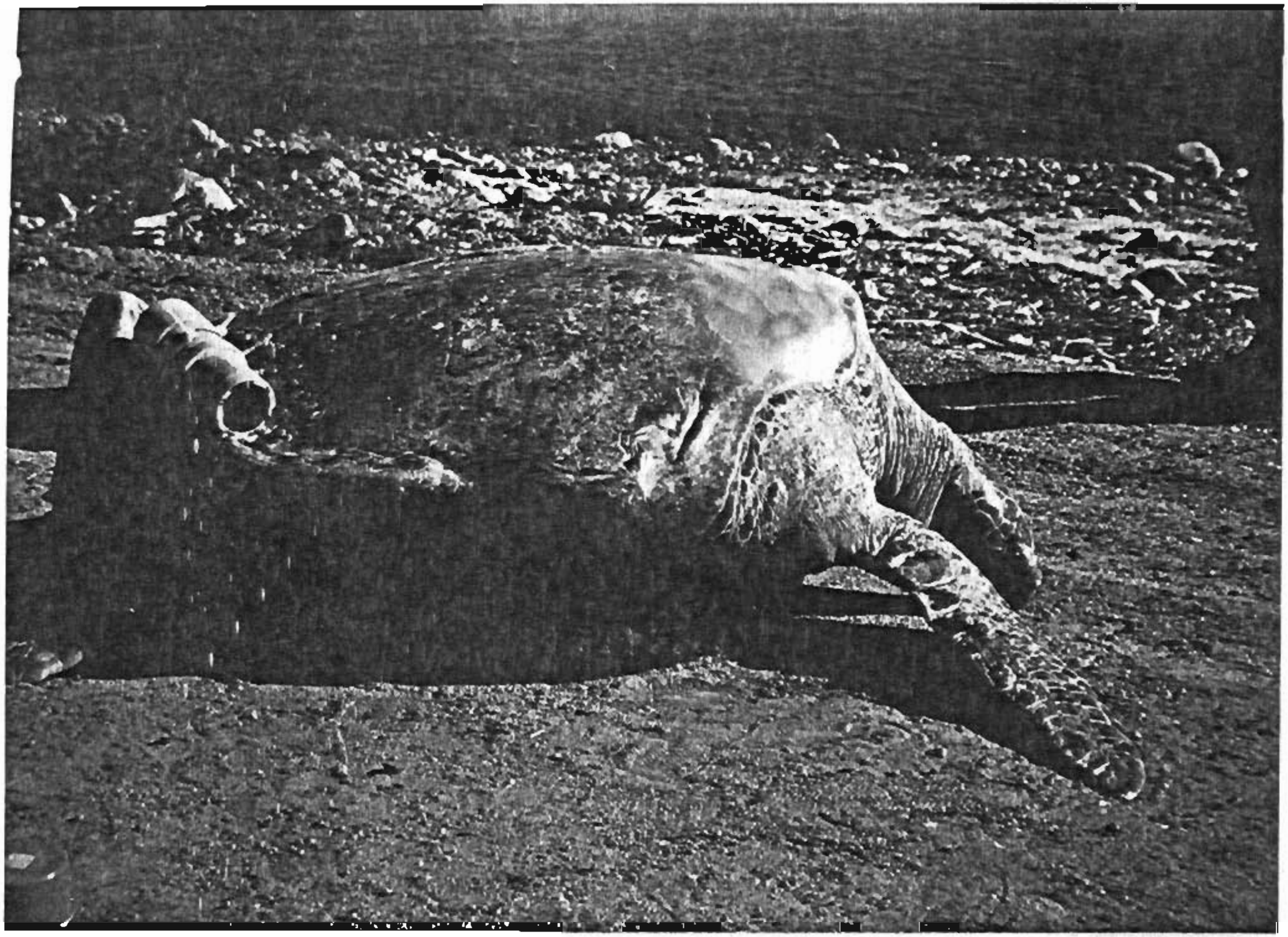


Figure 17. Turtle #5 with carapace transmitter attached and animal ready to be released back into the San Diego Gas and Electric Company's effluent channel in southern San Diego Bay.

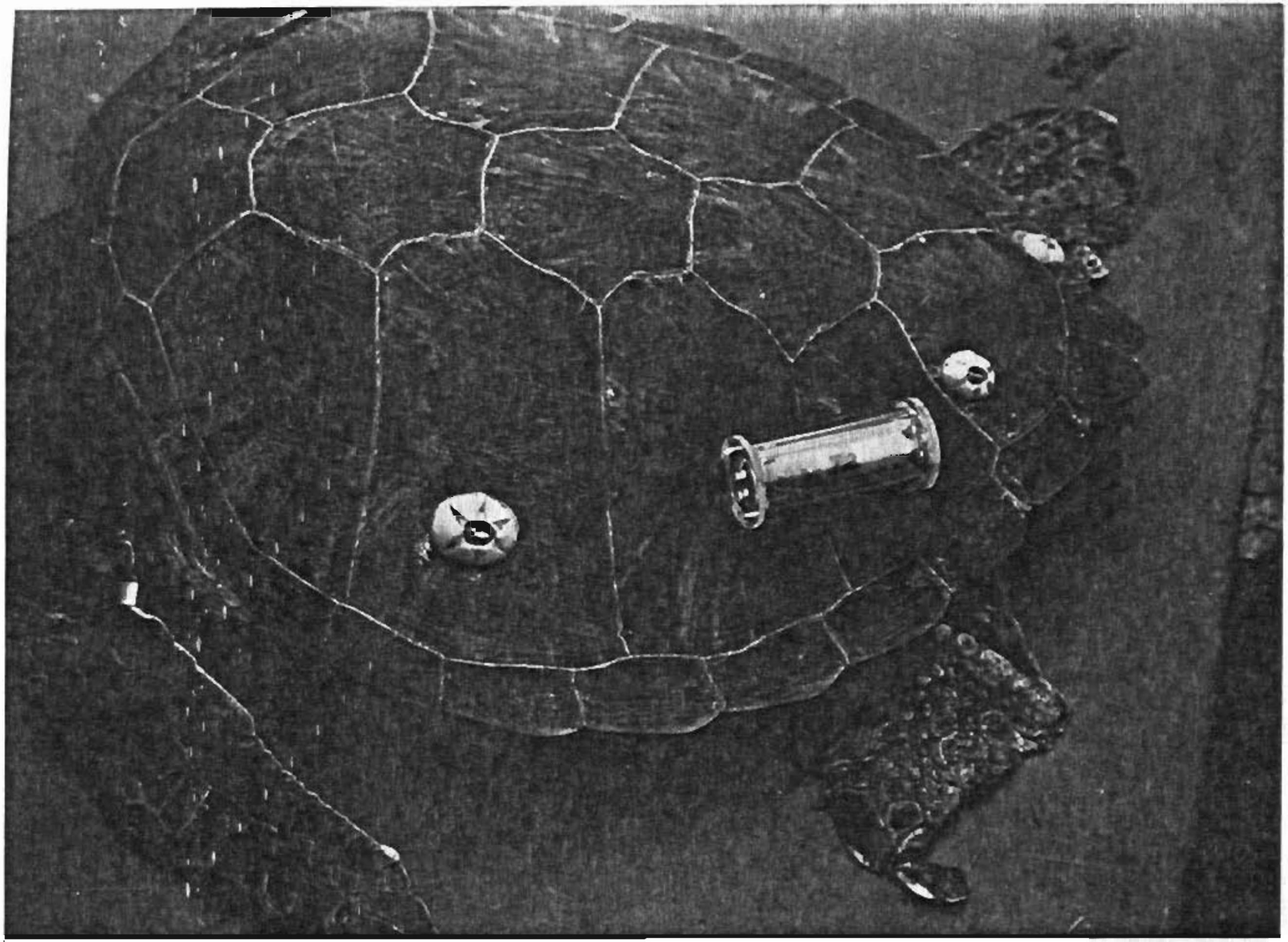


Figure 18. Juvenile green sea turtle (#1) with ultrasonic temperature-sensing tracking device attached to carapace. A miniature device, intended to be swallowed for monitoring body temperature, was encased in a plastic tube and used as this turtle's carapace transmitter.

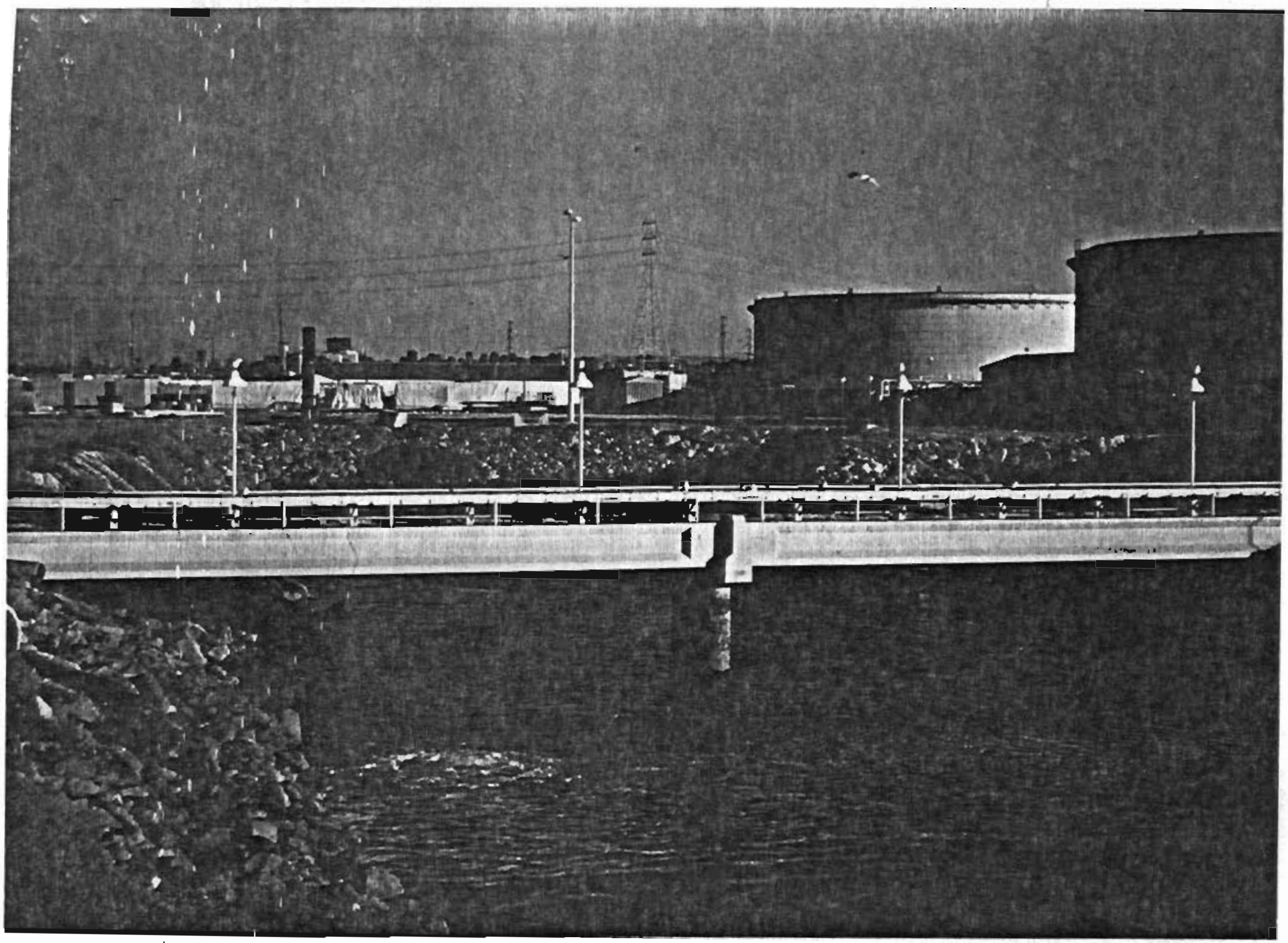


Figure 19. Bridge crossing over the eastern end of the San Diego Gas and Electric Company's effluent channel. Observations of green sea turtles were easily made from this bridge and the surrounding shore.

CHAPTER III

RESULTS

History of Sea Turtles in San Diego Bay

A survey of newspaper articles, reporting sea turtles sightings in San Diego Bay, indicates that turtles preceeded the construction of the San Diego Gas and Electric Company's facility and channel by at least a century. Sea turtles were first mentioned in San Diego's newspapers on 26 August 1857 when the whaling Captain Bogart arrived in San Diego with 40 turtles from 350 miles south along the coast of Lower California. He built a turtle pen on Aspinwall's Island [what is now North Island on the Coronado Peninsula of San Diego Bay], and planned to make a good business by sending them to San Francisco by steamer (Hayes, 1929). But Captain Bogart met with quite a loss ...

> 12 September 1857: "...Our harbor is at this season full of the most excellent fish, of a hundred varieties, including the forty fine turtles that made their escape from the pen of Captain Bogart, a short time ago, and yet there is nobody who has enterprize enough to go down and take them out. The tide being very high they broke through the pen and made tracks for deep water." (San Diego Herald, p 2:4; and Phillips, no date).

And on 3 October 1857:

> "...The Schooner Elizabeth Owens, Captain J.C. Bogart, arrived here on Friday, from the lower coast, with 120 fine turtles in good condition. He lost 60 by the breaking of the corral, which with fifty [sic. or 40?] that broke away some weeks ago, here, makes quite a loss.

Wisdom comes with experience, as well as in the construction of turtle pens." (San Diego Herald, p2:1)

The largest of these 110 green and hawksbill turtles (Hayes, 1929) weighed 350 pounds [160 kg]. In the decades following the escapes, newspaper accounts prove that sea turtles were present in large numbers both in San Diego and the adjacent False [Mission] Bay:

> 23 March 1872: "Number in bay increasing; not rare to find one weighing 200 pounds; Chinese have found several lately, sold them to restaurants and hotels." (San Diego Herald, p3:2)
>
> 12 July 1888: "News Notes from National [City] and Coronado ... 'Many turtles in the Bay. Anglers report that many turtles are sighted daily from the wharf, but none have ever been killed or captured. The difficulty lies in the fact that the only way of catching these elusive reptiles is by shooting them, and the discharge of firearms from the wharf is prohibited.'" (San Diego Herald, p5:5)
>
> 6 June 1890: "National [City]. 'Turtles of large dimensions are reported numerous around the wharves, and are quite annoying to anglers.'" (San Diego Union and Daily Bee, p6:2)
>
> 17 June 1890: "At this time of the year there are numerous sea turtles in False Bay, and during last week two men who make a business of catching the monsters were quite successful, clearing $98 for the week's work. The turtles were delivered in the city are worth four cents per pound at the restaurants." (San Diego Union and Daily Bee, p1:6)
>
> 11 July 1890: "Some very large turtles were brought from False Bay yesterday by the Chinamen. One weighed 250 pounds and was all two of them could carry swung by shoulder poles." (San Diego Union and Daily Bee, p8:4)
>
> "... In the summer of 1890 two men were catching huge sea-turtles in False [Mission] Bay. At that time those big fellows, weighing several hundred pounds apiece, sojurned there every summer. (Now apparently, they give it the go-by, but are occasionally brought up by fishermen from the Lower California coast.)" (Hensley, 1952)

The last of such reports appeared on 24 May 1903 (San Diego Union and Daily Bee, p5:2), when "Peter Stanovitch brought in fourteen large turtles which he had caught during the night, the largest one weighing 500 pounds [230 kg]. The turtles were captured in the shallow waters of the mud flats where they breed at this time of the year." We have no evidence that turtles ever nested or even copulated in San Diego Bay. While, on occasion, they might have copulated sea turtles do not nest on mud substrate and consequently it is extremely doubtful that these turtles ever nested on San Diego's mud flats as this newspaper article implies.

Fishermen believed these turtles to be the "children of the children" of the 1857 escapees, but the validity of this assumption is questionable. And unfortunately, it is not known whether sea turtles were present in San Diego before 1857.

> "Speaking of turtles, however, we are indebted to Captain Bogart for the supply our bay now contains. In August 1856 [sic 1857], he returned from about three hundred and fifty miles down the coast with about fifty turtles. They were the kind known as the green turtle and raw-bill. The largest weighed about three hundred and fifty pounds. They were all caught with a seine. Captain Bogart built a turtle pen in the bay, intending to send them to San Francisco, but they escaped from him and their children's children are often seen in our bay." (San Diego Herald, 1983 Sept. 7: 3 (col. 2))

Articles involving sightings of sea turtles in San Diego Bay are conspicuously absent from local newspapers after 1903. Several men, who have lived in San Diego since the turn of the century, and grew up as a part of San Diego's whaling community and subsequent tuna fishery, recall (personally or from their fathers) that sea turtles were common in the bay until about 1910. One of these men, Edwin Bertin, now a historian for the San Diego Maritime Museum Association, attests that "in those early years, one could go anyplace along the bay front and on the Dutch Flats (delta of the San Diego River upon which the San Diego Lindberg Airport now stands) and "turn" turtles, hauling the giant reptiles ashore and flipping them onto their carapace to await hauling them to market or home. This apparent report of turtles coming so close to shore in an area where they are not known to nest is noteworthy since green turtles are known to bask on shore in other areas (for a review of this behavior see Snell and Fritts, 1984). Mr. Donald Dittenhaver, of the Western Salt Company whose salt ponds border the southern bank of the turtle channel, recalls that his father used to catch turtles in the bay at the turn of the century. "He would go out on quiet nights, listen for turtles to blow and then encircle them with nets" (Figures 20-22). He attributed their subsequent absence from the bay to increased ship activity and pollution.

None of these gentlemen remember ever seeing or hearing of sea turtles swimming freely in San Diego or Mission (False) Bays after the beginning of World War I. Mr. Clifford Reid, who worked for Blackman's Turtle Cannery in National City during the 1920's, says that he never saw any turtles swimming out in the bay either during the time the cannery was in operation (1919-1930) or since then. The Blackman turtles, awaiting slaughter, were kept in canals and ponds which were barricaded from the bay and Mr. Reid knew of no escapees (Figures 23,24).

Dr. Robert Wisner (SIO) reports seeing a turtle in Mission Bay in March 1945 (see Appendix H). An old fisherman, also seeing the turtle, "was not too surprized to see it because he saw one every once in a while". This is the only indication that we have that sea turtles might have been present in either San Diego or Mission Bays between the early 1900's and the mid-1960's, when the SDG & E Company constructed their power facility on the southeastern shore of San Diego Bay and began discharging warm water into the bay. The factors that might have caused any disappearance of sea turtles from the bays are unknown; but following the turn of the century San Diego underwent significant growth and the bay became an increasingly important port for maritime traffic.

Historic and Economic Importance of Sea Turtles to San Diego

Sea turtles, particularly *Chelonia*, were important to early whaling vessels, providing them a "sea-stock of fresh meat" (Scammon, 1874, 1970; Mulford, 1865, 1889; and Henderson, 1972; Figures 25,26). During the latter half of the nineteenth century, these vessels and those of the Pacific Mail Steamship Company frequently entered San Diego Bay with shipments of sea turtles from the lagoons of southern Baja California. These turtles were intended for the local market and for future transport to the San Francisco and London wharves (Smith, 1894; Nelson, 1921; Parsons, 1962). Shipments, during this period, were frequent and involved so many turtles that fishermen, market owners and captains of vessels plying the southern coast repeatedly tried to establish a steady market for sea turtle products. The San Diego Herald (23 February 1871, p3:1) announced that a new business, "Gordon, Stewart and Company shipped to San Francisco by the last steamer sixty soft shell turtles from Lower California [would have to be sea turtles]. Several men are engaged in the business on the lower coast, and regular shipments will be made hereafter." The following appeared in the San Diego Herald on 15 June 1871:

> "A firm in this city is in receipt of a letter from a large house in San Francisco making inquiries in relation to the possibility of receiving a steady supply of turtle through this port. The San Diego firm has replied offering to contract to supply any stated quantity, from one up to ten thousand pounds, by each steamer, or even more if desired. Turtles are found in abundance at Turtle Bay...or at Scammon's Lagoon...and can be supplied to the San Francisco dealers very cheaply." (p4:1)
>
> 4 January 1872: "In giving the shipments of merchandise by the steamer Orizaba on Tuesday we neglected to make a note of a small lot of green turtle which went up. The shipment in point of numbers was light, but in pounds it looks well. One of the last lot shipped, weighed 103 pounds. During the remainder of the winter, we are told, regular shipments of the green turtle will be made to San Francisco." (San Diego Herald, p4:1)
>
> "San Diego, February 10th. —Arrived, schooner Cygnet, from Scammon's Lagoon, with 100 turtle; forty of them will be shipped direct to Chicago." (Alta California. 1871 Feb. 11: 1)
>
> 3 March 1887: "Two big sea turtles, one weighing 360 pounds, were brought up on the Pacheco yesterday, from Ensenada, and are now to be seen at Connor's market." [classified ad]: "Turtle soup for the whole county at Connor's Market. Go and see the big sea turtles." (San Diego Herald, p5:3,4)
>
> 4 March 1887: "San Diego will hereafter be supplied three times a week with fresh turtle. At each trip the Carlos Pacheco will bring them from the lagoon near Todos Santos [Ensenada], where they congregate in the millions." (San Diego Herald, p5:1)

It is noteworthy that the articles dated 3 March and 4 March and 2 September 1887 specifically mention turtles brought from the vicinity of Ensenada only 60 nautical miles south of San Diego.

When the Albatross visited San Bartolome (Turtle) Bay in Lower California on 11 April 1889, a very remarkable catch of green turtle was made (Townsend, 1916). The U.S.S. Ranger was there at the same time and together a seining party was organized. "In a single haul of a seine 600 feet long we brought to shore 162 green turtles, many of them of large size. Probably half as many more escaped. ...The great bulk of this catch was, of course, liberated, although both vessels took on board all that could be used. There are doubtless other bays around the Peninsula (Baja California) which are frequented by turtles at the egg laying season and where large numbers might be obtained by seining. ...Turtles are sometimes shipped to San Francisco by steamer from Magdalena Bay." (Townsend, 1916).

> 9 May 1889: "Wharf and Waves. A Large Catch of Turtles. Executive Officer Harris, of the United States Survey Steamer Ranger, states that while off the Lower California coast, and bound for San Diego, they caught 177 turtles in one haul, the smallest weighing 50 pounds and the twenty largest weighing over 300 pounds." (San Diego Union and Daily Bee, p2:2)

> 15 June 1891: "Extract of Turtle. A New Use for the Monsters of Magdalena-Ensenada. The crop of monster turtles in Magdalena Bay, Lower California, has induced a company to experiment with canning the extract for exportation. The first lot has gone to England through La Paz. The Lower Californian of Ensenada reports also that fishing for hair seals is a growing industry at the head of the Gulf of California, miners buying the output at 50 cents a gallon." (San Diego Union and Daily Bee, p5:2)

> 20 July 1902: "Shipping Big Turtles. A 300 pound turtle was shipped to Los Angeles yesterday through Wells Fargo Express by the San Diego Fish Company. A number of these turtles have been sent out of San Diego during the past week or two." (San Diego Union and Daily Bee, p6:2)

The Hotel del Coronado and Horton House restaurants occasionally displayed these "curious monsters of the sea" and gratefully added them to their menus.

> 16 March 1871: "Big Turtle--The Largest turtle we ever saw was purchased by the Horton House yesterday. The creature weighed 335 pounds [152 kg]. Four gentlemen from China were required to carry the monster into the house. We had turtle steak for dinner and it was good."

> 3 June 1887: "Mr. W.F. Cabral of Roseville [an early whaling and fishing community of San Diego Bay] caught a turtle weighing 1,200 pounds while fishing off the kelpbeds beyond Point Loma [entrance to Bay] on 1 June 1887. It was caught on an ordinary-sized fishing hook and in endeavoring to pull the turtle into the boat the fisherman was almost drawn overboard. The monster fish was exhibited for several days at Jorre's Wharf before going the way of all sea turtles--toward the tureen." (San Diego Herald; Hensley, 1952).

> 2 September 1887: "A 600 pound turtle will form a novel feature of the St. Louis Grand Army Encampment. It will be in the San Diego exhibit, having been caught in the bay of Ensenada de Todos Santos, in Lower California." (San Diego Herald, p3:1)

> 1 September 1888: "The Turtle Case. The case of Mr. Herman, proprietor of the Saddle Rock restaurant, who was arrested by Officer Cook of the 17th inst., on the charge of obstructing the sidewalk by exposing a turtle in front of his place of business came up before Police Judge Monroe, yesterday. Much interest has been displayed in the matter ever since the arrest was made, and the courtroom was crowded. Much humor was displayed in the progress of the trial, and the evidence tended to show that the grounds of the charges were trivial. It took the jury only about two minutes to bring in a verdict of not guilty." (San Diego Herald)

But in practice, the California turtle industry did not flourish as was anticipated with each large catch of turtles. Unlike the London connoisseurs, Californians never acquired a taste for sea turtle and according to Captain Bogart, "a dozen would glut the market".

> 13 June 1873: "It is a singular fact that turtle is appreciated in California neither as an article of food nor an element of commerce. Californians can hardly be persuaded to eat turtle. In New York, and the East generally, and over the whole world, turtle is regarded as a great delicacy. [Captain Bogart] informed me that turtle exist in wonderful quantities on the Lower California coast. It may be impossible to make a market for the dainty in California, but the meat can be packed and exported. Captain Bogart informs us that Scammon's Lagoon, several lagoons to the north of it, and the bay at Cerros [Cedros] Island are crammed with turtle. Many sloughs open into the lagoons, and the practice of the turtle is to float up them at flood-tide and feed. Captain Bogart, by stretching a seine over the mouth of these sloughs, has captured eight tons at a single haul. He could have taken more but had no room for them." (The Daily World Newspaper, San Diego)
>
> 26 March 1887: "Chicago Tribune; San Diego, California should have the portliest aldermen in the world. Fresh sea turtles exist in millions in the great lagoon near by [Scammon's] and turtle soup is as abundant as bread and butter. What a place for testing vest buttons. (San Diego Herald, p5:2)

A more elaborate turtle enterprise began when several Americans, involved with a Mexican family in a dispute concerning land in New York City, were traded a strip of coastal desert in Baja California (personal communication with the San Diego family of one of the men involved, John Blackman). This concession included Scammon's Lagoon and stretched south to also include San Ignacio Lagoon, Turtle Bay and Magdalena Bay. The new owners, "The Chartered Company of Lower California", built a turtle cannery on Santa Margarita Island in Magdalena Bay in about 1900 (Nelson, 1921). Live turtles and canned products were exported from these lagoons to San

Diego until the mid-1930's. According to Nelson (1921), about 1,000 turtles were exported just from Scammon's Lagoon each month.

According to Mr. S.L. Potter of Alpine, California, turtles were also transported to San Diego on large stake-bed trucks. He vividly recalls that his brother brought a truckload of turtles from the Yucatan beaches to San Diego in about 1918. While coming down the "Torrey Pine" grade of Del Mar, along the open coast of San Diego, the truck swerved to miss a car and rolled onto its side, dumping its cargo of turtles. According to Mr. Potter, a few of the turtles escaped into the Pacific despite efforts by the San Diego Zoo to capture them all. It seems highly unlikely that turtles were shipped overland from the Yucatan coast. If such shipments occurred they probably came from San Felipe, at the head of the Gulf of California (Craig, 1926).

John Blackman, one of the original owners of the Chartered Company of Lower California, built a turtle cannery in San Diego in 1919 (McGrew, 1922). This cannery processed turtles imported from San Felipe, in the Gulf of California (Craig, 1926), as well as those from lagoons along the west coast of Baja California (Averett, 1920). Blackman sold a variety of soups, stews, plain meats and oil under the tradesname "Juanada" (formed by the combination of his name Juan and that of his wife, Ada; personal communication with the Donald Blackman family). In 1919, 15,000 cases of sea turtle were processed at his San Diego cannery (Bell and MacKenzie, 1923).

In 1908, 38,000 [17,237 kg] of sea turtles were listed in the commercial fisheries statistics of the United States for the Pacific coast states; most of these were imported from Mexico. According to California statistics, the largest deliveries of turtles to California were made in 1919 and 1920 (Karmelich, 1937). Records show that 255,000 pounds [115,670 kg] of sea turtle were imported into California in 1919; 77,000 pounds [34,925 kg] in 1920; and only 2,571 pounds [1,166 kg] in 1921. These records differ considerably from those collected by the Mexican Fisheries Agency Offices of San Diego and San Pedro, which report only 42,211 pounds [19,147 kg] of turtle imported in 1920 and 6,384 pounds [2,896 kg] in 1921 (Bell and MacKenzie, 1923).

In March 1922, the Mexican government issued an edict regulating the fishing of sea turtles in Mexican waters (Bell and MacKenzie, 1923). With turtle imports decreasing drastically after 1921, the Blackman cannery was successful for only a short time. In about 1924, the cannery was sold to the Naylor Brothers of San Diego, who continued to bring small shipments of sea turtles into San Diego from the southern coast of Baja California on turtle schooners (Figures 27-30; personal communication with the Blackman Family, Naylor Sea Shells and H&M Sportfishing of San Diego).

Deliveries were so spasmodic that a dependable market could not be maintained, with the result that the fishermen found it difficult to dispose of their catches whether large or small (Karmelich, 1937). According to an article in the San Diego Union in 1932, a market could not be found for a cargo of 60 turtles from Mexico:

> 25 August 1932: "On her second visit here with a similar cargo in the last few months, the vessel Mexico, Peter Koralish, skipper, was in port yesterday with a quantity of live turtles for the local market.
>
> Weighing anywhere from 85-150 pounds each, the turtles numbering about 60, will bring if sold here, about six or seven cents per pound "on the hoof" according to reports along the waterfront. The heavy shell, it was said, causes a loss of between 60 and 70 percent in the net value of the turtles to the buyer.
>
> No market for the turtles had been found here yesterday, according to an official of one of the large fish companies, and in the event that the turtles cannot be disposed of either here or in San Pedro, the opinion was expressed that the cargo may be taken south and dried." (San Diego Union, Sect. II, p4:4)

By the mid-1930's, San Diego's three turtle schooners were converted to commercial albacore and sportfishing boats, two of which are still in service (one is the Mascot III of H&M Sportfishing), and San Diego's turtle industry ended.

Figure 20. Team of fishermen hauling in a catch of sea turtles from San Diego Bay (circa 1920). Photograph courtesy of the San Diego Historical Society-Ticor Collection.

Figure 21. Fishermen removing sea turtles from a net in San Diego Bay (circa 1920). Photograph courtesy of the San Diego Historical Society-Ticor Collection.

Figure 22. Fishermen removing sea turtles from a net in San Diego Bay. According to the San Diego Historical Society's collection records this photograph was taken in about 1920. This series of photographs gives us our only indication that sea turtles existed in the bay after about 1910. Photograph courtesy of the San Diego Historical Society-Ticor Collection.

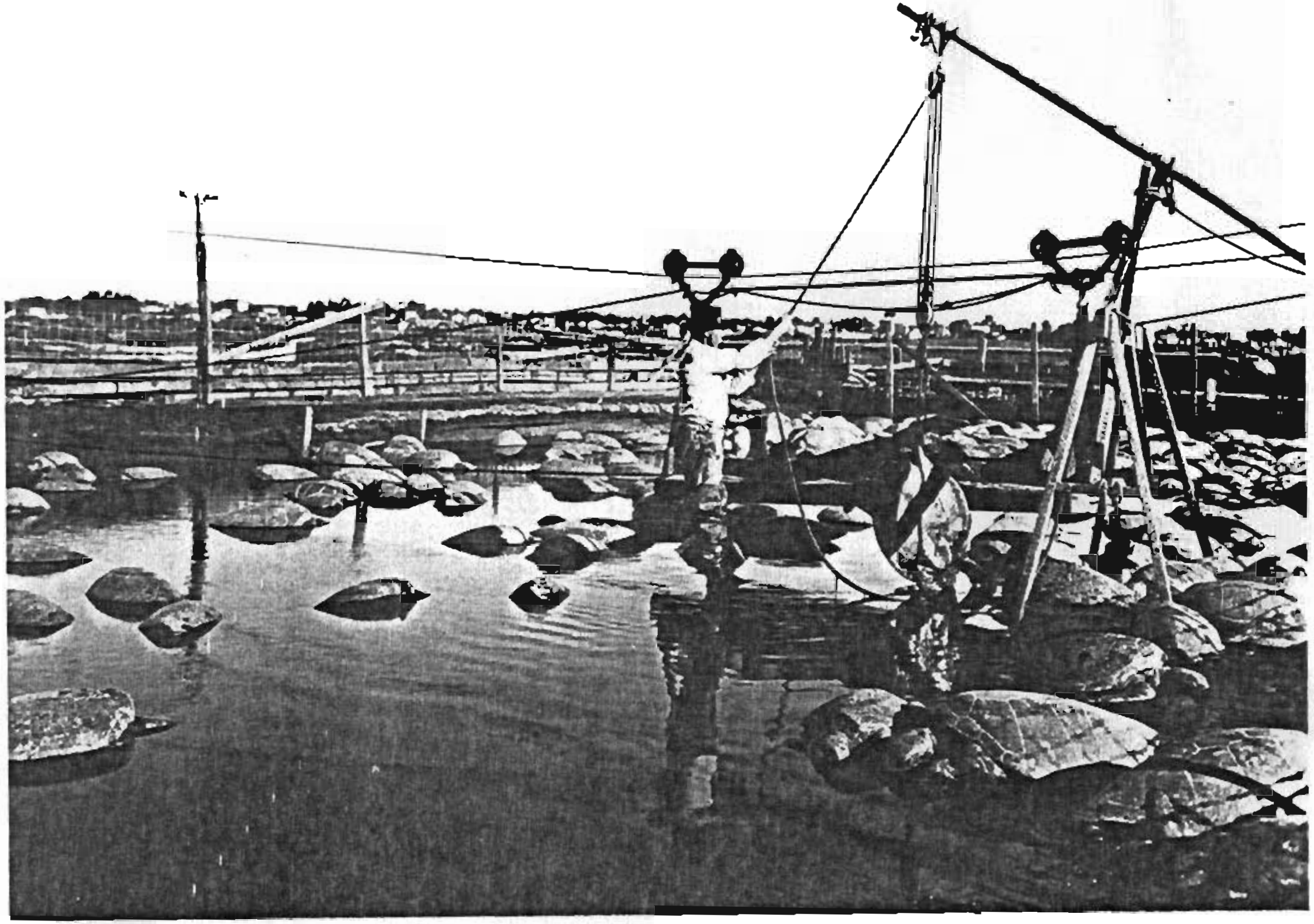


Figure 23. Holding pond for sea turtles at the Blackman Cannery in San Diego Bay (circa 1920). Photograph courtesy of the San Diego Historical Society-Ticor Collection.

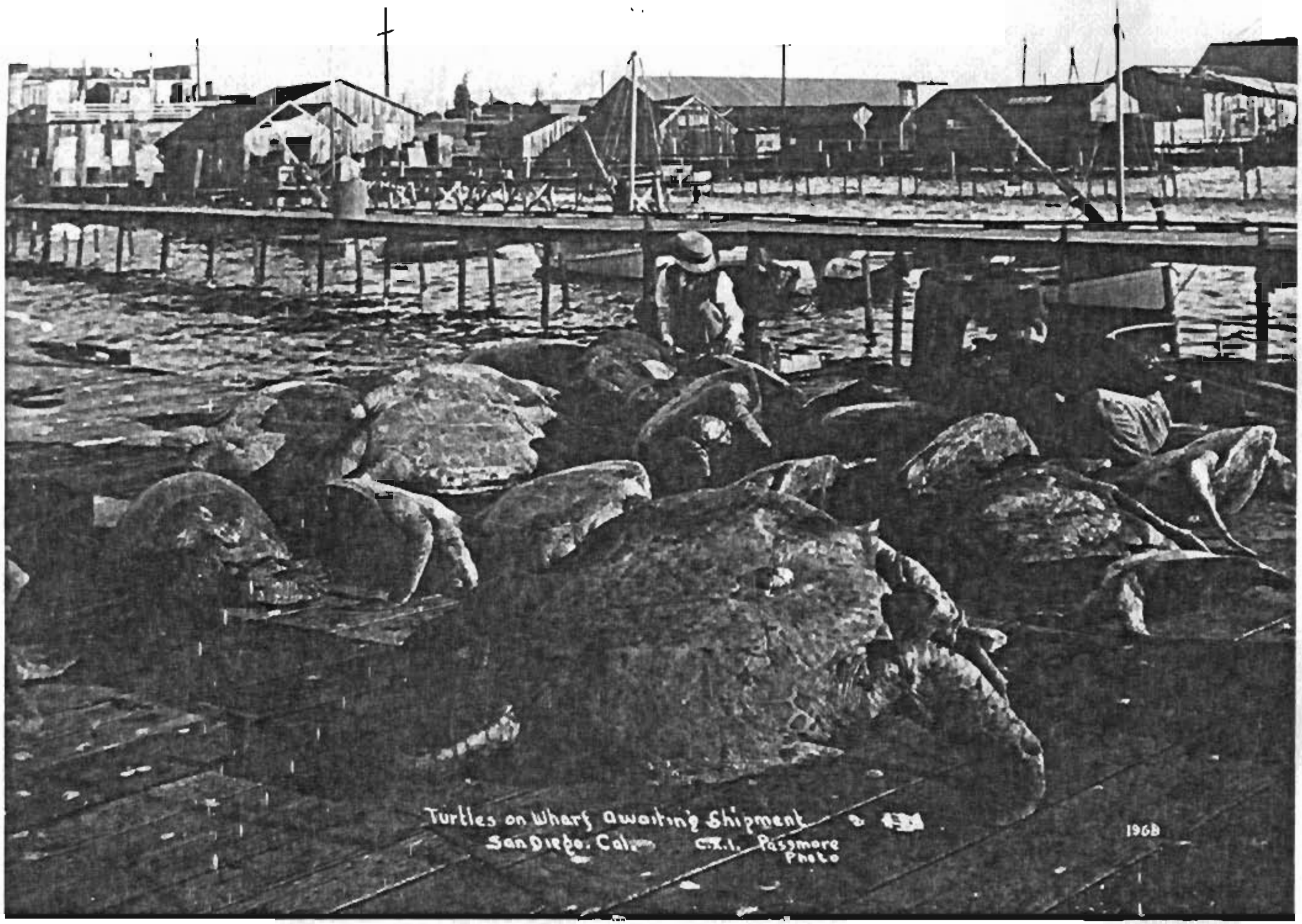


Figure 24. Sea turtles on wharf in San Diego awaiting shipment (circa 1910). Photograph courtesy of the San Diego Historical Society-Ticor Collection (Passmore Photograph).

Figure 25. Remnants of a turtle camp on Cholla Island in Laguna Ojo de Liebre (Scammon's Lagoon), Baja California del Sur, Mexico. Photographed by Raymond Gilmore (San Diego Museum of Natural History) in February 1956.

Figure 26. Turtle camp on Stony Island in Laguna Ojo de Liebre (Scammon's Lagoon), Baja California del Sur, Mexico. Photographed by Raymond Gilmore (San Diego Museum of Natural History) in February 1956.

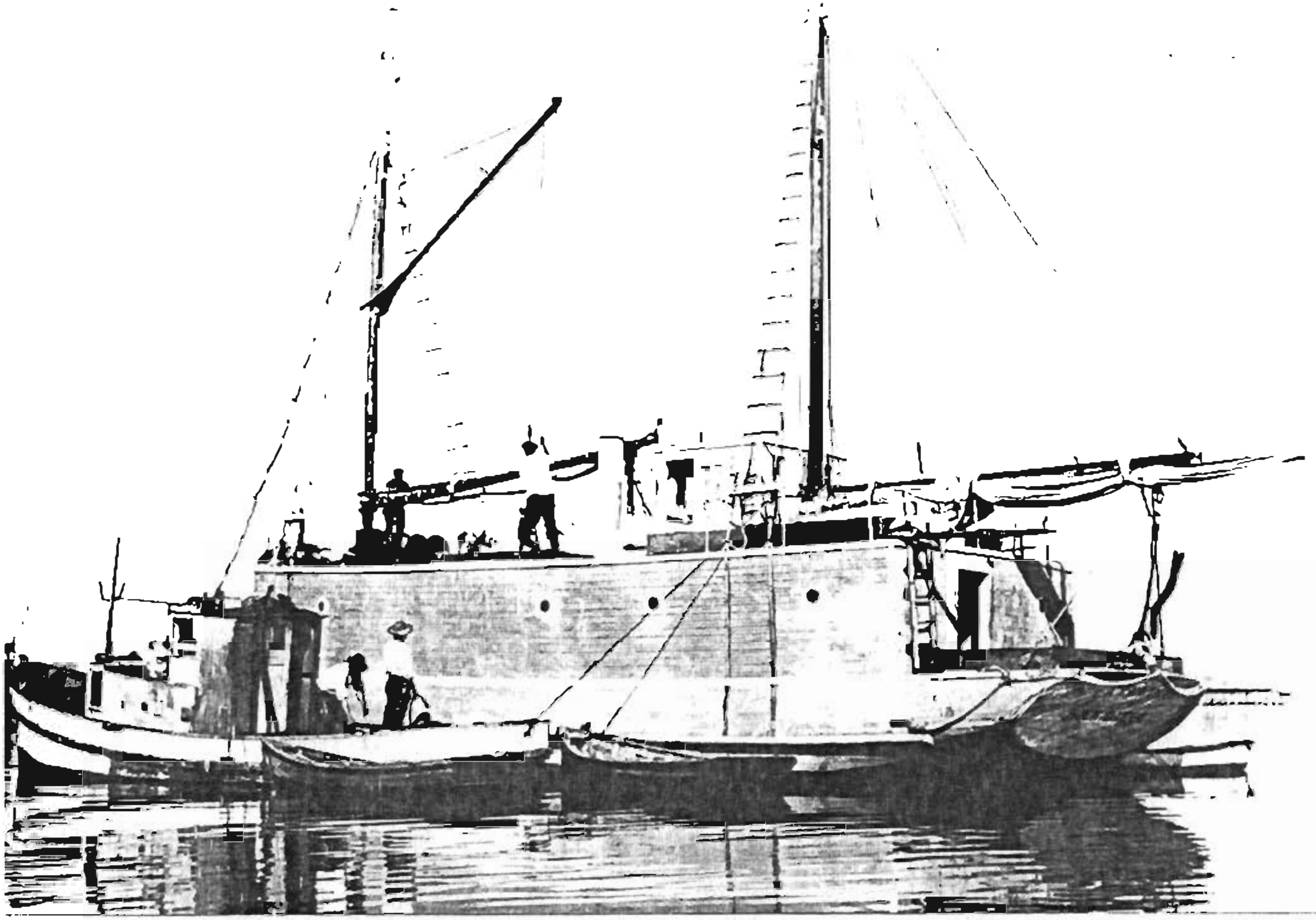


Figure 27. Vessel Catarina (circa 1920) previously used to bring shipments of sea turtles to San Diego from the lagoons of southern Baja California, Mexico. Courtesy of the San Diego Historical Society-Ticor Collection.

Figure 28. Bringing in a load of sea turtles netted in San Diego Bay (circa 1920). Photograph courtesy of the San Diego Historical Society-Ticor Collection.

Figure 29. Shipment of sea turtles arriving in San Diego from Baja California, Mexico (circa 1915). Photograph courtesy of the San Diego Historical Society-Ticor Collection.

Figure 30. San Diego Bay in 1908. Photograph courtesy of the San Diego Historical Society-Ticor Collection.

Geographic Distribution of Green Sea Turtles Within San Diego Bay

Figure 2 shows the distribution of green sea turtles within San Diego Bay during months—November through April--when they are present. Of the 47 environmental variables analyzed, 17 had mean population values significantly different for areas of San Diego Bay used by green sea turtles and areas not used (Table 1). A significant correlation was found for each of these 17 variables and the distribution of sea turtles within the bay. Table 3 shows the positive or negative correlation of each of these variables with the presence of sea turtles and also indicates the positive or negative correlation of each variable with water and sediment temperatures and with salinity.

Positive correlations indicate that those environmental variables increase in value (i.e., surface temperatures) in areas of the bay used by turtles. Negative correlations signify a decrease in value (i.e., number of invertebrate species) in turtle areas (Figure 31). The Spearman correlation coefficient indicates the degree or strength of correlation, those correlations having values closest to 1.0 are the strongest or possibly most important to sea turtle distribution within the bay.

Table 3. Environmental variables for which a significant correlation exists between the variable and the distribution of green sea turtles in San Diego Bay and between water and sediment temperatures and salinities. Significance of Spearman rank correlation coefficients were determined using T-tables.

Variable	Spearman Correlation Coefficient	t-test for Significance	α 0.05	+/- Correlation With turtle area	surface temp.	bottom temp.	sediment temp.	surface sal.	bottom sal.
Surface Water Temp.	0.525	4.698	2.00	+	=	+	+	+	+
Bottom Water Temp.	0.515	4.580	2.00	+	+	=	+	+	+
Bottom Water Salinity	0.435	3.774	2.00	+	+	+	=	+	+
Sediment Temperature	0.413	3.544	2.00	+	+	+	=	+	+
Surface Salinity	0.343	2.503	2.01	+	+	+	+	=	+
Total Oligochaete Biomass	0.327	2.701	2.00	+	0	0	0	0	0
SWI Crustacean Diversity	-0.594	-4.547	2.02	-	-	-	-	-	-
Total Number Crustacean Species	-0.584	-5.143	2.01	-	-	-	-	-	-
Total Number Invertebrate Species	-0.501	-4.298	2.001	-	0	-	-	-	-
Total Number Plant and Invertebrate Species	-0.470	-3.945	2.01	-	-	-	-	-	-
Total Ostracod Biomass	-0.427	-3.628	2.00	-	-	-	-	-	-

Table 3. (continued).

Variable	Spearman Correlation Coefficient	t-test for Significance	0.05	+/- Correlation With: turtle area	surface temp.	bottom temp.	sediment temp.	surface sal.	bottom sal.
SWI Invertebrate Diversity	-0.423	-3.429	2.01	-	-	-	-	-	-
Total Number Coelenterate Species	-0.394	-3.060	2.01	-	-	-	-	0	0
Density Ostracods	-0.340	-2.819	2.00	-	-	-	-	-	-
COD	-0.331	-2.741	2.00	-	0	0	-	0	0
SWI Mollusc Diversity	-0.316	-2.055	2.02	-	-	-	-	0	0
Seechi (Turbidity)	-0.314	-2.500	2.00	-	+	+	+	+	+

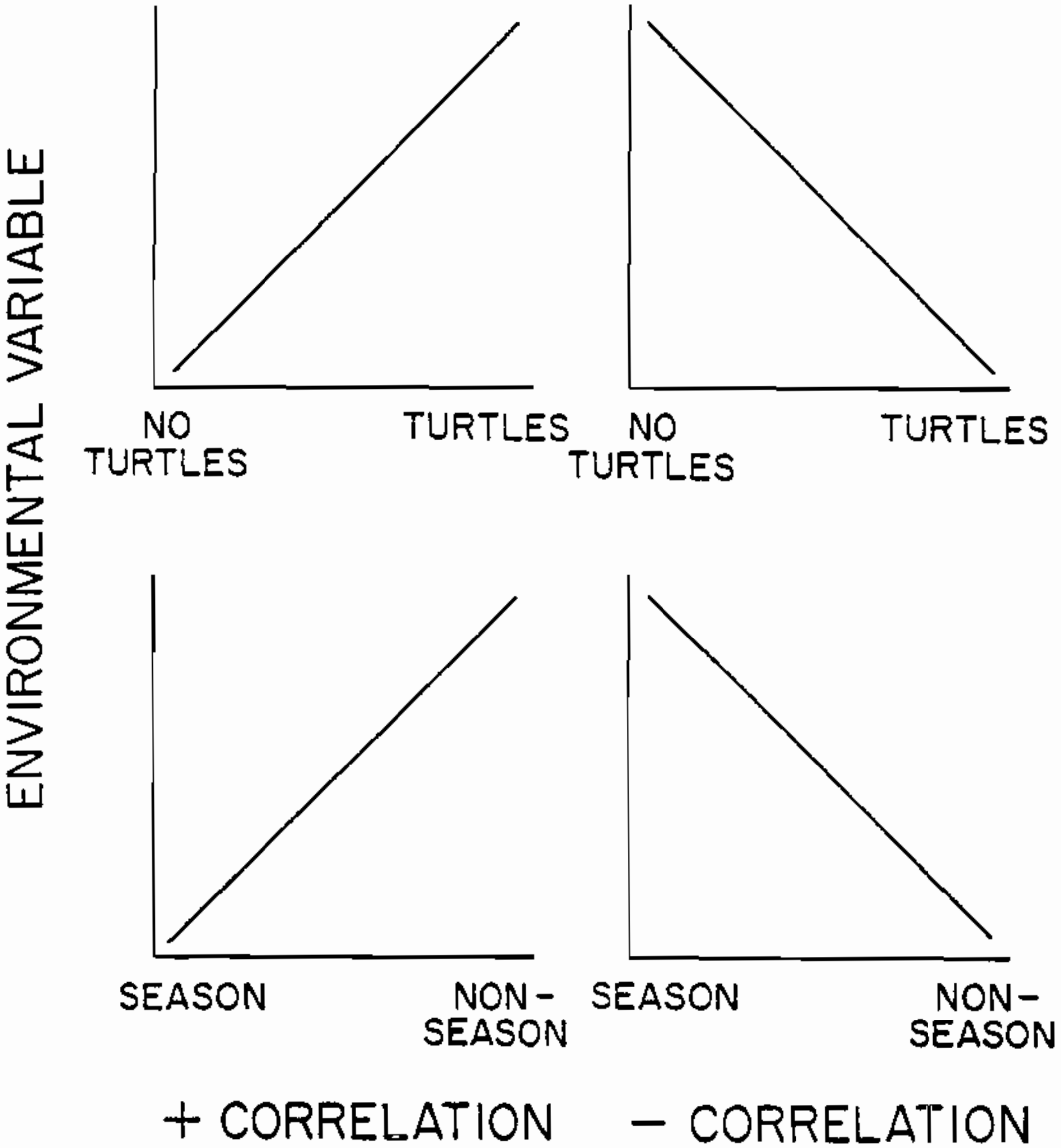


Figure 31. Positive and negative correlation of seasonal occurrence and geographic distribution of green sea turtles in San Diego Bay with environmental variables.

Seasonal Occurrence of Green Sea Turtles in San Diego Bay

A significant correlation was found between the seasonal presence of green sea turtles in San Diego Bay (November-April) and 23 environmental variables. Table 4 lists them and shows their positive or negative correlation with the seasonal presence of green sea turtles and also shows the correlation of these variables with seasonal water and sediment temperatures and with salinity.

Discussion

Water and sediment temperatures and salinity are strongly correlated--not only with the seasonal migration of sea turtles to San Diego and their distribution within the bay--but also with all other environmental variables describing the benthic ecology of the bay (number of plant and invertebrate species, community diversity, biomass and density). The strength of Spearman correlation coefficients indicate that temperature and salinity could act as limiting factors for the seasonal distribution of not only green sea turtles--but for the entire benthic system of San Diego. Because these abiotic factors effect very strongly the bay's benthic system, temperature and salinity have also an indirect effect on sea turtles by controlling the composition and structure of their benthic community.

Green sea turtles are in San Diego during months when water and sediment temperatures and salinity are lowest (November - April) but during these months they are found only in areas of the bay where temperatures and salinity are the greatest (in the southern part of

Table 4. Environmental variables for which a significant correlation exists between the variable and the seasonal appearance of green sea turtles in San Diego Bay and between water and sediment temperatures and salinities. Significance of Spearman rank correlation coefficients were determined using T-tables.

				+/- Correlation With					
Variable	Spearman Correlation Coefficient	t-test for Significance α 0.05		turtle season	surface temp.	bottom temp.	sediment temp.	surface sal.	bottom sal.
Surface Water Salinity	-0.836	-7.603	2.06	-	+	+	+	=	+
Sediment Temperature	-0.834	-8.693	2.03	-	+	+	=	+	+
Seechi (Turbidity)	-0.775	-6.600	2.05	-	+	=	+	+	+
Bottom Water Temp.	-0.700	-5.634	2.03	-	=	+	+	+	+
Surface Water Temp.	-0.670	-5.190	2.03	-	+	+	+	+	=
Bottom Water Salinity	-0.656	-4.989	2.03	-	+	+	+	+	+
Total Biomass Invertebrates	-0.655	-4.984	2.03	-	0	0	0	+	+
Total Biomass Bivalves	-0.522	-3.512	2.03	-	0	0	0	+	+
Density Isopods	-0.458	-2.962	2.03	-	0	0	0	0	+
Total Biomass Coelenterates	-0.432	-2.752	2.03	-	0	0	0	+	+
Density Coelenterates	-0.432	-2.752	2.03	-	0	0	0	0	+
Total Biomass Amphipods	-0.339	-2.069	2.03	-	0	0	0	0	+

Table 4. (continued).

Variable	Spearman Correlation Coefficient	t-test for significance α 0.05		+/- Correlation With: turtle season	surface temp.	bottom temp.	sediment temp.	surface sal.	bottom sal.
Number Crustacean Sp.	0.777	6.416	2.055	+	-	-	-	-	0
Total Number Plant and Invertebrate Species	0.768	6.562	2.04	+	-	-	-	-	0
Total Biomass Oligochaetes	0.752	6.550	2.03	+	-	-	-	-	-
Number Polychaete Sp.	0.740	5.717	2.06	+	-	-	-	-	0
Number Invertebrate Sp.	0.731	5.868	2.04	+	-	-	-	0	0
SWI Crustacean Diversity	0.704	5.694	2.03	+	-	-	-	0	0
SWI Invert. Diversity	0.581	4.100	2.03	+	-	-	-	-	0
Number Plant Species	0.558	3.678	2.04	+	0	0	0	-	-
Density Amphipods	0.552	3.800	2.03	+	-	-	-	-	-
SWI Polychaete Diversity	0.521	3.510	2.03	+	-	-	-	-	-
Density Ostracods	0.489	3.216	2.03	+	-	-	-	-	-

the bay and in the SDG & E channel). During November through April, species diversity, biomass and density of the benthic invertebrate and plant systems are at their annual peak. But ironically, during these months, the green turtles are in areas of the bay where the benthic community is most barren with the lowest number of benthic plant and invertebrate species, lowest community diversity, lowest biomass and density.

Adult green sea turtles are primarily herbivorous and it is not surprising to me that they are not using areas of the bay relatively rich in benthic fauna. Although I did track individual turtles, on what I thought to be feeding sojurns, across stretches of the bay harboring eelgrass (Zostera marina), I do not know to what extent these turtles are feeding. The turtles are found in that part of the bay most barren of benthic life (negative corelation coefficients, Table 3). For this reason, although turtle distribution is significantly correlated with benthic life, I doubt whether these biotic variables have any real effect on the turtles' seasonal migration to the bay or their selective distribution within the bay.

Green turtles occur globally in a tremendous range of ocean temperatures (10-35°C; Forbes and McKey-Fender, 1968; Mrosovsky and Pritchard, 1971; Mendonca, 1983) which easily encompass any temperatures San Diego Bay might offer. Turtles are absent from San Diego Bay from May to October when bay temperatures (24.8-35.6°C; mean 29.06°) are tropical. These temperatures were also recorded very frequently within the SDG & E channel during the 1979 February and March phase of the telemetry tracking part of this study. For these reasons, I believe that hot temperatures are in no way limiting to the turtles and are not the cause of the turtles' exodus in April.

On the other hand, during the turtle season of November through April, areas of the bay void of turtles have temperatures of 14.5-26.5°C. Because during the 1979 telemetry study, turtles were found to be inactive in temperatures as low as 16°C, temperatures of 14.5-16°C could cause turtles to avoid such areas of the bay and the positive correlation between temperature and turtle distribution would be a real function. But this does not account for why turtles avoided areas of the central and northern part of the bay having temperatures of 17-26.5°C. Turtles did not avoid areas of south bay or the SDG & E channel having temperatures in this range.

I do know that certain individual turtles returned to San Diego Bay each year from 1976 to 1983. But I do not know where they went after they left each April. Possibly during the autumn months they are along California when coastal temperatures cool and they somehow remember that the warm waters of south San Diego Bay exist, thus triggering their entry into the bay. But there is nothing about San Diego's environment in April or May, or during the rest of the summer or fall, that is limiting to their existence in the bay. In fact, it is during the summer and fall that San Diego's south bay is most tropical, consequently it cannot be the bay's environment that triggers or causes the turtles' emigration. This suggests, to me, that a cause—from beyond San Diego—controls this migration. Although there are quite small turtles (30-35 cm carapace lengths) within this population, I know of no instance of nesting or breeding within the bay eliminating the possibility of their return signifying San Diego as beaches of their birth, despite suppositions to the contrary in some of the early newspaper accounts.

Thermal Biology of Green Sea Turtles in San Diego Bay

Efforts to study the thermal biology of sea turtles have previously focused almost entirely on the few hours in a female sea turtle's life when she briefly emerges from the sea, and a quick cloacal temperature can be recorded before, during, or after she nests. Choosing from those studies, temperature data recorded before nesting (because those temperatures must be most similar to their temperature at sea before they haul ashore to nest), mean body temperatures of 27.18, 28.0, 28.97 and 30.53°C have been calculated for *Caretta caretta*, *Lepidochelys olivacea*, *Chelonia mydas* and *Dermochelys coriacea*, respectively (Table 5). The only data available for *Eretmochelys imbricata* are those recorded by Hirth (1962) for two females shortly after their nesting (28.5 and 29.0°C).

Unlike other species of sea turtles, *Chelonia* are known to spend time ashore when they are not nesting and are presumably basking (for a review of this behavior see Fritts, 1981, and Snell and Fritts, 1984). Basking studies offer a rare opportunity to record temperatures in male as well as juvenile green sea turtles--but still the animals are ashore. The temperatures recorded on nesting turtles represent data sampled during a very specialized and presumably stressed time in a sea turtle's life (and excludes the possibility of collecting data for males). Temperatures recorded on basking animals must be considered carefully, some authors have suggested that a purpose of this behavior is to raise the turtle's body temperature (Balazs, 1976; Balazs and Ross, 1974; Parsons, 1962). The data obtained from nesting and basking turtles is invaluable but cannot fully represent the thermal biology of turtles at sea. What is needed are ocean records and these are scarce.

Ectotherms are animals which obtain their body heat from their environment. An animal, such as a fish, amphibian or reptile, hypothetically functioning as a perfect ectotherm would have a body temperature indistinguishable from that of its environment (Gordon, 1972). Their body temperatures would be positioned along the "poikilothermic line of thermal equilibrium" where Tb=Ta. But most ectotherms are not passive and perfect; while they still get their body heat from their environment, they control the range of their body temperatures by behavioral means. It is the precision or degree of control and the behavioral methods involved in their thermoregulation that attracts study. Do sea turtles control their range of body temperatures? Do they do this behaviorally?

Range of Body Temperatures

Table 6-11 present body temperatures of five green sea turtles monitored, via underwater telemetry, in San Diego Bay. Their body temperatures ranged from 15.60-27.75°C (in 15.30 - 30.0°C ambient water temperatures). With only three recording exceptions, these five turtles maintained body temperatures between 21.0 - 25.0°C and this range can be considered their "eccritic" or optimum range of body temperatures for activity in San Diego Bay. The "preferred" temperature for a species is the mean of all body temperatures recorded for active animals (Harless and Morlock, 1979). The mean body temperatures, during activity, for each of these green turtles were 22.04, 22.20, 23.55, 23.00 and 24.69°C, respectively. The mean body temperature for all five turtles combined was 23.35°C. Table 12 details the mean and range of body temperatures for each turtle.

The turtles monitored during February (when water temperatures were 20-31°C) as well as the turtle tracked during March (when water temperatures were 23-37°C) all maintained the same range of body temperatures (21-25°C) despite seasonal differences in ambient temperatures. The range of body temperatures maintained by the San Diego turtles is significantly lower than that recorded for Chelonia in the tropics (25.7-31.0°C, Table 5) but similar to that recorded in the Gulf of California, Mexico, (18.50-22.75°C) for one adult green monitored in an enclosed shallow lagoon with water temperatures of 18.0-21.25°C (Heath and McGinnis, 1980). During only one tracking session did a San Diego turtle (#6) have a body temperature similar to that expected for a Chelonia in the tropics.

Data from this study combined with that recorded by Spotila et al. (1979) for a green sea turtle swimming off Costa Rica indicate that Chelonia mydas is a poikilotherm, capable as a species of having a wide range of body temperatures (15.60-37.1°C). Yet in San Diego, the turtles maintain body temperatures in a relatively narrow range (21-25°C during activity). Do they control their body temperature behaviorally?

Behavioral Control of Body Temperature

Temperatures in the tracking channel very greatly—from its floor to surface and along its length--from 20 to 31°C during February and from 23 to 35°C during March. In March, temperatures increased, temporarily even reaching 37.5°C immediately after the San Diego Gas and Electric Company's discharge of warm coolant water into the channel. Generally, temperatures along the channel floor were 5 to 8°C cooler than at the surface. It is apparent from tracking records that the San Diego turtles spend most of their time at, or near, the cool channel floor rising to the surface only long enough to breathe. All five turtles monitored during this study had body temperatures characteristic of the cool channel floor. The San Diego turtles spend little time swimming on the surface and were never observed basking on the surface, as is commonly seen in the tropics.

Because, during these months, the rest of San Diego Bay is relatively cool (13-19°C) and coastal waters along southern California even cooler (11-15°C), it is not surprising that the turtles occupy the warm discharge channel. But it is intriguing that they seemingly avoid, or at least do not frequent, the channel's tropic surface waters. Is the purpose of this "floor" behavior to maintain this range of relatively low body temperatures or are these body temperatures a result of the rest of the turtle's biology—a side result rather than the end goal?

It seems logical that these turtles are either: 1) selecting the cool temperatures characteristic of the channel floor; 2) avoiding the warmer surface temperatures; 3) selecting the floor habitat; or 4) avoiding the surface habitat. There is no precedent data to suggest that as a species Chelonia "prefers" these cooler bottom temperatures, especially since in the tropics (where green sea turtles are most common) Chelonia are active in 27.5 to 29.0°C seas (Table 5). Adult Chelonia are benthic grazers feeding on bottom pastures of eelgrass (Zostera marina), sea lettuce (Ulva sp.) and other algae (i.e., Enteromorpha), various sponges (including Tetilla) and bryozoans (i.e., Zoobotryon), none of which grow in sufficient quantity to support even a small population of turtles, eliminating the obvious suggestion that these turtles are merely foraging along the channel floor. The tremendous flow of discharge water into the channel as well as the dramatic tidal flux and winds create an extremely strong, fast long-shore current throughout the channel. On many days this current is strong enough to prevent scuba diving and seriously affect boat handling. Quite possibly the turtles are simply conserving energy by avoiding this persistently strong surface current—even though it is warm—by staying on or near the channel floor.

Body Temperature During Periods of Cool-Water Inactivity

During the "turtle season" of November through April, green sea turtles primarily occupy a warm discharge channel in San Diego Bay but also travel in that part of the bay immediately joining the channel. Turtle #2 was monitored in both areas. On days when Turtle #2 was in the channel, it was active swimming along the floor. Its body temperatures (21.0 - 22.18°C) equalled those of other turtles monitored in the channel and reflected ambient water temperatures (20.8 - 22.9°C). On other days, Turtle #2 was tracked to a cool-water site immediately outside the channel, where water temperatures ranged from 15 - 23°C (floor to surface). During these interspersed days, Turtle #2 remained stationary at the floor of the bay and remained submerged for periods of at least three hours. Its body temperatures dropped to 15.6 - 16.7°C (its carapace transmitter recorded water temperatures of 15.3 - 17.4°C). Throughout the 1979 season, Turtle #2 was tracked to this cool-water locale on at least seven days. Later that season, this turtle lost its carapace transmitter at this site where it was retrieved from beneath a mud ledge and sunken barge.

As Turtle #2 moved between the warm channel and the cool-water ledge, its body temperatures and activity pattern adjusted to water temperatures in a classical ectothermic manner (Figure 32, regression line). These data suggest that in San Diego Bay, Chelonia become inactive at water temperatures of 15 to 17°C, that their body temperatures decrease accordingly with water temperatures, and that inactive turtles seek out underwater ledges or burrows. Two of the other turtles' carapace transmitters were found in burrows carved in the floor of the channel. This pattern of cool-water inactivity corresponds to Felger's et al., (1976) discovery that Chelonia in the Gulf of California, Mexico, become "dormant" and burrow into the sea floor during colder months (November through March) at water temperatures below approximately 15°C (for a discussion of the apparent behavior of hibernation in hard-shelled sea turtles, see Ogren and McVea, 1982). Unlike the Chelonia in the Gulf of California, which presumably remain inactive and burrowed for weeks or months, the San Diego turtles alternate days of cool-water inactivity with days when they are active in the warm channel and have optimum body temperatures.

Eurythermal Behavior of Green Sea Turtles and Their Tolerance to Low Ocean Temperatures

Green sea turtles are extremely eurythermic—capable of living in a tremendous range of ocean temperatures (10-35°C). In the tropics, the center of their global distribution, greens are in water 29-35°C. In the Gulf of California, Mexico, they are active in temperatures above 18°C (18 - 30.5°C; McGinnis, 1968; Felger, et al., 1976; Robinson, 1973). Along the open coast of southern California they are found all year in ocean temperatures of 13 - 20°C, but are most common from July through October when temperatures are 18 - 20°C (and they are especially common in areas of 19 - 20°C water). They have been sighted as far north as the Gulf of Alaska in temperatures as low as 10°C (see Part II, the Pacific Ocean section of this paper).

In the Pacific, north of Point Conception, when northern temperatures are 14-16°C, greens are present from central California to British Columbia and they are apparently healthy and are vigorous swimmers. These are the same temperatures where greens in San Diego Bay and in the Gulf of California become inactive. When temperatures north of Point Conception drop below 14°C, few greens are sighted north of southern California. A green turtle found in 10°C water in Coos Bay, Oregon, and another in 11°C water in the Gulf of California were reported to be healthy, but most northern greens found in areas of 9-11°C water were discovered stranded on beaches—dead or in poor condition--and those still in the water were apparently having problems swimming and diving which is one reaction to low water temperatures. The greatest number of turtles appearing from Point Conception to the Gulf of California were in 14-16°C water; they show physical evidence of thermal distress only when temperatures drop to 10-11°C. Greens found in 9°C water were dead.

From this study it appears that the tolerance of green turtles to low temperatures changes as they geographically range further north in the Pacific--they become more tolerant of low temperatures. In the Gulf of California they are inactive in 15-18°C (Felger, et al, 1976), in San Diego Bay they were inactive at 15.30°C and yet along the open coast of southern California they are active in temperatures as low as 13°C. The greatest number of greens appearing from Point Conception, California, to the Gulf of Alaska were in 14-16°C water and they were healthy, strong swimmers. In those northern waters they showed physical signs of thermal stress only in temperatures as low as 10-11°C and died in 9-10°C. Northern turtles were active in temperatures (10-15°C) well below the temperatures (15-18°C) when greens become inactive in San Diego Bay and the Gulf of California.

Relationship Between Body and Ambient Temperatures

The study of thermoregulation--how an ectotherm controls its body temperature--requires the ability to simultaneously record body and ambient temperatures and also requires a knowledge of the history of previous ambient temperatures that produced the body temperature. For example, comparing a turtle's body temperature of 21°C with a water temperature of 25°C is erroneous and misleading if the turtle had in actuality been in 21°C water for hours and then moved into 25°C water for only a short time when the body and ambient temperatures were monitored and recorded.

In the San Diego Bay channel, temperatures vary as much as 5 to 8°C within only a few meters swimming depth and the transmitters attached to the turtles' carapaces were sensitive enough to respond very quickly to these temperature changes as the turtle changed depth. I was able to record body temperatures and I was also able to record ambient temperatures but I had no way of knowing whether those particular body and ambient temperatures should be linked for comparison in analysis.

Figure 33 shows the relationship of body and ambient temperatures of five green sea turtles monitored in San Diego Bay during February or March 1979. In this figure, all data points below (to the right of) the "poikilothermic line of thermal equilibrium" where Tb=Ta are misleading. These data suggest that somehow the turtles were able to maintain body temperatures below, or cooler than ambient; however, this was not the case. Simply, these data points involved turtles that had probably just left the cool channel floor but were momentarily swimming in the warmer surface water when their transmitters were monitored. In every case, these turtles' body temperatures were in equilibrium with the cooler temperatures of the channel floor. Knowing the data points below the line of thermal equilibrium are misleading, I cannot trust those data points above the line either. For this reason, none of this data can be used, as initially planned, to determine the correlation between ambient and body temperatures--to determine the effect changes in water temperature have on the turtles' body temperature.

The turtles were difficult to track at all, let continually, and at the time we felt fortunate to be getting any temperature records and especially fortunate when we were able to hear and record the signals from the internal (body) and carapace transmitters at the same time (see Appendix A). Possibly the easiest way to study the effect of ambient temperatures, in sea turtles, would be in the laboratory where a complete history of ambient temperatures could be known and controlled. But this would not tell us what we want to know about thermoregulation of sea turtles in the wild. If possible it would be far better to remain in the ocean but in an area where thermal gradients are not so severe and to use a telemetry system capable of monitoring both water temperatures and time sequence--recording the time history of ambient temperatures over a several hour period before recording body temperature (similar to the system reportedly used by Spotila, et al, 1979).

Table 5. Body temperatures (°C) of sea turtles recorded before nesting.

Species	T body	T sea	Author
Chelonia mydas	31.0	28.0	Hirth, 1962
	30.0	28.0	Hirth, 1962
	31.0	28.0	Hirth, 1962
	30.0	27.5	Hirth, 1962
	30.0	27.5	Hirth, 1962
	28.0	28.0	Hirth, 1962
	29.0	28.5	Hirth, 1962
	29.5	28.0	Mrosovsky and Pritchard, 1971
	30.5	28.75	Mrosovsky and Pritchard, 1971
	30.0	28.5	Mrosovsky and Pritchard, 1971
	30.75	28.25	Mrosovsky and Pritchard, 1971
	28.5	27.5	Mrosovsky and Pritchard, 1971
	29.25	28.0	Mrosovsky and Pritchard, 1971
	27.75	27.75	Mrosovsky and Pritchard, 1971

Table 5. (continued)

Species		T body	T sea	Author
Chleonia mydas		28.5	27.75	Mrosovsky and Pritchard, 1971
		29.5	27.75	Mrosovsky and Pritchard, 1971
		29.25	28.0	Mrosovsky and Pritchard, 1971
		28.75	27.75	Mrosovsky and Pritchard, 1971
		29.5	----	Mrosovsky and Pritchard, 1971
		27.0	----	Brattstrom and Collins, 1972
		26.2	----	Brattstrom and Collins, 1972
		26.6	----	Brattstrom and Collins, 1972
		25.7	----	Brattstrom and Collins, 1972
	Mean	28.97°C		
Caretta caretta		26.75	25.0	Sapsford and Hughes, 1978
		27.75	25.0	Sapsford and Hughes, 1978
		28.25	25.0	Sapsford and Hughes, 1978

Table 5. (continued)

Species	T body	T sea	Author
Caretta caretta	27.25	25.25	Sapsford and Hughes, 1978
	29.00	25.00	Sapsford and Hughes, 1978
	29.00	25.00	Sapsford and Hughes, 1978
	24.6	23.5	Sapsford and Hughes, 1978
	25.0	23.0	Sapsford and Hughes, 1978
	27.0	24.5	Sapsford and Hughes, 1978
Mean	27.18°C		
Lepidochelys coriacea	28.5	27.75	Mrosovsky and Pritchard, 1971
	28.0	28.0	Mrosovsky and Pritchard, 1971
	27.5	27.25	Mrosovsky and Pritchard, 1971
Mean	28.0°C		

Table 5. (continued)

Species	T body	T sea	Author
Dermochelys coriacea	31.25	28.25	Mrosobsky and Pritchard, 1971
	31.0	28.25	Mrosovsky and Pritchard, 1971
	30.5	28.25	Mrosovsky and Pritchard, 1971
	31.0	28.25	Mrosovsky and Pritchard, 1971
	29.0	28.25	Mrosovsky, 1980
	28.5	26.25	Mrosovsky, 1980
	30.0	24.5	Sapsford and Hughes, 1978
	30.5	24.75	Sapsford and Hughes, 1978
Mean	30.53°C		

Table 6. Deep body (gut, Tb), ambient (carapace, Ta) and surface water temperatures (°C) monitored for a juvenile green sea turtle (Turtle #1) tracked in San Diego Bay, California.

Date	Recording Time	T body	T ambient	Δ °C	T water surface
30 January *	1300, 1300	22.50	20.83	+1.67	20.83
2 February	1535, 1535	22.00	20.80	+1.2	23.65
4 February	1411-1449, 1449	21.30	22.35	-1.05	25.25
5 February	1646, 1649	22.80	———	———	28.25
5 February	1659-1701	23.10	———	———	28.25
8 February	0850	21.30	———	———	26.50
9 February	1123, 1125	21.30	21.40	-0.1	28.00

* The 30 January temperature data was recorded in captivity at the Hubbs Sea World Research Institute before returning the turtle to the SDG & E channel in southern San Diego Bay.

Table 7. Deep body (gut, Tb), ambient (carapace, Ta) and surface water temperatures (°C) monitored for an adult male green sea turtle (Turtle #2) tracked in San Diego Bay, California.

Date	Recording Time	T body	T ambient	Δ°C	T water surface
30 January *	1300, 1300	24.50	20.83	+3.67	20.83
1 February	———, 1055-1123	———	20.80	———	26.00
1 February	———, 1217	———	23.60	———	26.00
1 February	———, 1221	———	20.80	———	26.00
1 February	———, 1241	———	22.20	———	26.00
1 February	———, 1350-1352	———	22.80-20.80	———	26.00
1 February	1507, 1519	21.65	22.20-23.60	-0.55, -1.95	26.00
2 February	1530, 1406	22.18	21.5	+0.68	———
3 February	1344, 1333	15.60	15.30	+0.30	21.00
4 February	1217, 1215	21.00	20.8, 22.2	+0.2, -1.2	24.50
4 February	———, 1407	———	23.60	———	24.5
4 February	———, 1426	———	22.35	———	25.00

Table 7. (continued)

Date	Recording Time	T body	T ambient	$\Delta ^{o}C$	T water surface
4 February	1449, 1443	21.65	21.50	+0.15	24.50
4 February	1453, 1451	21.65	23.60	-1.95	24.50
4 February	----, 1526	----	23.60	----	25.00
4 February	----, 1542	----	22.35	----	25.00

* The 30 January temperature data was recorded in captivity at the Hubbs Sea World Research Institute before returning the turtle to the SDG & E channel in southern San Diego Bay.

Table 8. Deep body (gut, Tb), ambient (carapace, Ta) and surface water temperatures (°C) for an adult male green sea turtle (Turtle #3) tracked in San Diego Bay, California.

Date	Recording Time	T body	T ambient	Δ °C	T water surface
30 January *	1300, 1300	23.90	20.83	+3.07	20.83
2 February **	1530, 1450-1520	22.80	24.00	-1.20	————
3 February	1137, 1131	23.40	23.20-24.00	-0.30, -0.60	23.00
3 February	———, 1508	————	27.60	————	————
4 February	1204, 1100-1200	22.80	24.00	-1.20	25.50
4 February	1357, 1322-1411	22.80	25.40	-2.60	25.50
4 February	1439, 1438	22.80	24.00	-1.20	25.50
4 February	———, 1443	————	25.10	————	25.50
4 February	1453, 1451	22.80	25.40	-2.60	25.25
4 February	1538, 1536	22.80	24.00	-1.20	25.25
5 February	1252-1304, 1242	23.40	24.00	-0.6	28.00
5 February	———, 1522	————	25.40	————	28.25

Table 8. (continued).

Date	Recording Time	T body	T ambient	Δ°C	T water surface
5 February	——, 1537	——	26.00	——	28.25
5 February	——, 1546	——	25.10	——	28.25
5 February	——, 1630	——	26.00	——	28.25
6 February	0857, 0859	24.00	20.00	+4.0	27.50
6 February	0913, 0906	24.60	21.40	+3.2	27.50
6 February	1227-1238, 1227-1238	24.00	22.50	+1.50	27.50
8 February	0730-0845, 0717	24.00	22.00	+2.0	26.50
8 February	0810, 0810	24.00	22.40	+1.6	26.50
8 February	——, 0912-0955	——	21.40	——	26.50
8 February	——, 1021	——	20.40	——	26.50
8 February	——, 1103	——	24.00	——	28.00
8 February	——, 1418	——	27.60	——	28.00
9 February	——, 1041	——	20.90	——	28.00

Table 8. (continued).

Date	Recording Time	T body	T ambient	$\Delta ^{o}C$	T water surface
9 February	----, 1047	-----	24.00	-----	28.00
9 February	1110, 1103	23.30	21.40	+1.9	28.00

* The 30 January temperature data was recorded in captivity at the Hubbs Sea World Research Institute before returning the turtle to the SDG & E channel in southern San Diego Bay.

** The 2 February temperature data was recorded 40 minutes after realease; reasonably the turtle could have had a Tb below its normal equilibrium for that particular water temperature.

Table 9. Deep body (gut, Tb), ambient (carapace, Ta) and surface water temperatures (°C) for an adult male green sea turtle (Turtle #4) tracked in San Diego Bay, California.

Date	Recording Time	T body	T ambient	Δ °C	T water surface
30 January *	1300, 1300	24.00	20.83	+3.17	20.83
1 February	1047, 1038–1047	24.00	22.00	+2.00	26.00
1 February	1114, 1101	23.20	23.65	–0.45	26.00
1 February	1114, 1117–1152	23.20	22.00	+1.2	26.00
1 February	———, 1217	———	22.90	———	26.00
1 February	———, 1221	———	22.00	———	26.00
1 February	1227, 1224	23.20	21.20	+2.0	26.00
1 February	1238–1318	23.80	22.90	+0.9	26.00
2 February	1400, 1356	23.20	22.60–22.90	+0.6, +0.3	———
2 February	———, 1406	———	22.90–23.65	———	———
2 February	———, 1408	———	23.65	———	———
2 February	———, 1450	———	22.50–22.90	———	———

Table 9. (continued).

Date	Recording Time	T body	T ambient	Δ °C	T water surface
2 February	1520, 1520	23.20	23.65	-0.45	———
3 February	1106, 1106	21.20	20.75	+0.45	23.00
3 February	1146, 1117-1146	22.20	20.10-20.75	+2.1, +1.45	23.00
4 February	1205, 1215	23.00	21.50	+1.5	25.50
4 February	———, 1426	———	26.00	———	25.50
4 February	1536, 1510-1542	23.00	24.00	-1.0	25.25
5 February **	1106, 1055	22.4	22.00	+0.4	28.00
5 February	———, 1246	———	23.30	———	28.00
5 February	———, 1302	———	24.00	———	28.00
5 February	———, 1346	———	24.20	———	28.00
5 February	———, 1501	———	24.80	———	28.25
5 February	———, 1507-1552	———	25.10	———	28.25
5 February	———, 1616-1619	———	26.00	———	28.25
6 February	———, 0852-0906	———	20.00	———	25.25

Table 9. (continued).

Date	Recording Time	T body	T ambient	Δ °C	T water surface
6 February	----, 0909	----	20.20	----	25.25
6 February	----, 1327	----	25.50	----	27.50
6 February	----, 1331	----	25.10	----	27.50
8 February	----, 0710	----	24.40	----	26.50
8 February	----, 0717	----	22.95-24.00	----	26.50
8 February	----, 0722	----	24.00	----	26.50
8 February	----, 0750	----	22.00	----	26.50
8 February	----, 0813-0815	----	21.20	----	26.50
8 February	----, 0915-0950	----	20.20	----	26.50
8 February	----, 1007	----	20.60	----	26.50
8 February	----, 1015	----	22.00	----	26.50
8 February	----, 1105	----	24.40	----	28.00
8 February	----, 1122	----	24.00	----	28.00

Table 9. (continued).

Date	Recording Time	T body	T ambient	Δ°C	T water surface
8 February	----, 1425	----	27.20	----	29.00
8 February	----, 1429	----	28.30	----	29.00
9 February	----, 1041	----	22.00	----	28.00
9 February	----, 1047-1049	----	20.20	----	28.00
9 February	----, 1051	----	22.95	----	28.00
9 February	----, 1107	----	22.00	----	28.00

* The 30 January temperature data was recorded in captivity at the Hubbs Sea World Research Institute before returning the turtle to the SDG & E channel in southern San Diego Bay.

** The last record of body temperature for this turtle was monitored on 5 February, after this date its internal transmitter was defecated; I continued to monitor its carapace transmitter in order to record the turtle's travel pattern in various ambient temperatures.

Table 10. Deep body (gut, Tb), ambient (carapace, Ta) and surface water temperatures (°C) monitored for an adult female green sea turtle (Turtle #5) tracked in San Diego Bay, California.

Date	Recording Time	T body	T ambient	Δ °C	T water surface
13 March	——, 1603	——	29.60-30.0	——	31.00
13 March	——, 1839	——	29.30	——	36.75
13 March	——, 1852	——	29.60	——	36.75
13 March	——, 1910	——	28.80-29.30	——	36.75
13 March	——, 1938	——	28.80	——	37.50
14 March	1938, 1931	25.00	28.80	-3.80	32.35
15 March	——, 0900-0905	——	26.40-29.40	——	31.00-31.50
15 March	——, 0923	——	28.80	——	31.00-31.50
15 March	——, 0951	——	31.00	——	31.00-31.50
15 March	——, 1019-1138	——	28.20	——	31.00-31.50
17 March	1523, 1523	27.75	28.80	-1.05	30.00

Table 10. (continued).

Date	Recording Time	T body	T ambient	Δ°C	T water surface
19 March	----, 1226	-----	29.40	-----	31.50
19 March	1253, 1241-1349	25.00	28.80	-3.80	31.50
19 March	1429, 1432	24.00	27.00	-3.00	31.00
19 March	1625, 1628	23.25	27.00	-3.75	31.00
19 March	1641, 1643	24.00	27.00	-3.00	31.00
19 March	1915, 2005	23.25	27.00	-3.75	30.00
19 March	----, 2100	-----	27.60	-----	30.00
19 March	2157-2215, 2202-2212	24.00	25.70	-1.70	30.00
19 March	2315, 2320	24.00	28.80	-4.80	30.00
19 March	2346, 2349	24.00	28.30	-4.30	30.00
20 March	0053, 0055	24.00	26.30	-2.30	31.00
22 March	1343, 1346	25.00	30.00	-5.00	-----
22 March	1444, 1502	26.05	30.00	-3.95	-----

Table 10. (continued).

Date	Recording Time	T body	T ambient	Δ°C	T water surface
22 March	1508-1551, 1553	25.00	29.40	-4.40	----
22 March	1616, 1619	25.00	27.10	-2.10	----
23 March	----, 1827	----	25.70	----	29.00-29.50
31 March	----, 1714	----	28.10	----	24.00
31 March	----, 1738	----	28.10	----	24.75

Table 11. Carapace (ambient, Ta) temperatures (°C) monitored for an adult female green sea turtle (Turtle #6) tracked in San Diego Bay, California.

Date	Recording Time	T ambient	T water surface
13 March	1603	31.95	31.00
13 March	1613	31.50	31.00
13 March	1622	31.70	31.00
13 March	1809	28.00	36.75
13 March	1816	32.40	36.75
13 March	1821-1859	33.20	36.75
13 March	1908	32.70-33.20	36.75
14 March	1621	32.20	32.35
14 March	1746	31.70	32.35
14 March	1752	30.70	32.35
14 March	1828	32.20	32.35
14 March	1905	31.70	32.35
14 March	1931	33.20	32.35
15 March	0906	30.00	31.00-31.50
15 March	0912	30.70	31.00-31.50
15 March	0927	26.00	31.00-31.50
15 March	1023	31.20	31.00-31.50
15 March	1025	31.70	31.00-31.50

Table 11. (continued).

Date	Recording Time	T ambient	T water surface
15 March	1132	31.70	31.00-31.50
16 March	0915-0934	32.20	35.00
17 March	1523	29.50	30.00
19 March	1223	31.70	31.50
19 March	1256	30.00	31.50
19 March	1309	31.70	31.00
19 March	1716	32.00	31.0
23 March	1613	31.70	29.00-29.50
31 March	1552	30.15	27.5

This turtle was not fed an internal transmitter.

Table 12. Mean and range of body temperatures (°C) of five green sea turtles, monitored in San Diego Bay, as compared to body weight.

Turtle #	Mean Body Temperature	Range of Body Temperatures When Active	Range of Body Temperatures When Inactive	Body Weight
1	22.04	21.30-23.10 (n=7)		13.6kg 30 lbs
2	22.20	21.00-24.50 (n=5)	15.60	83.5kg 184 lbs
3	23.55	22.80-24.60 (n=11)		86.2kg 190 lbs
4	23.00	21.20-24.00 (n=10)		99.8kg 220 lbs
5	24.69	23.25-27.75 (n=12)		141.5kg 312 lbs
GROUP	23.35	21.00-27.75 (n=45)		

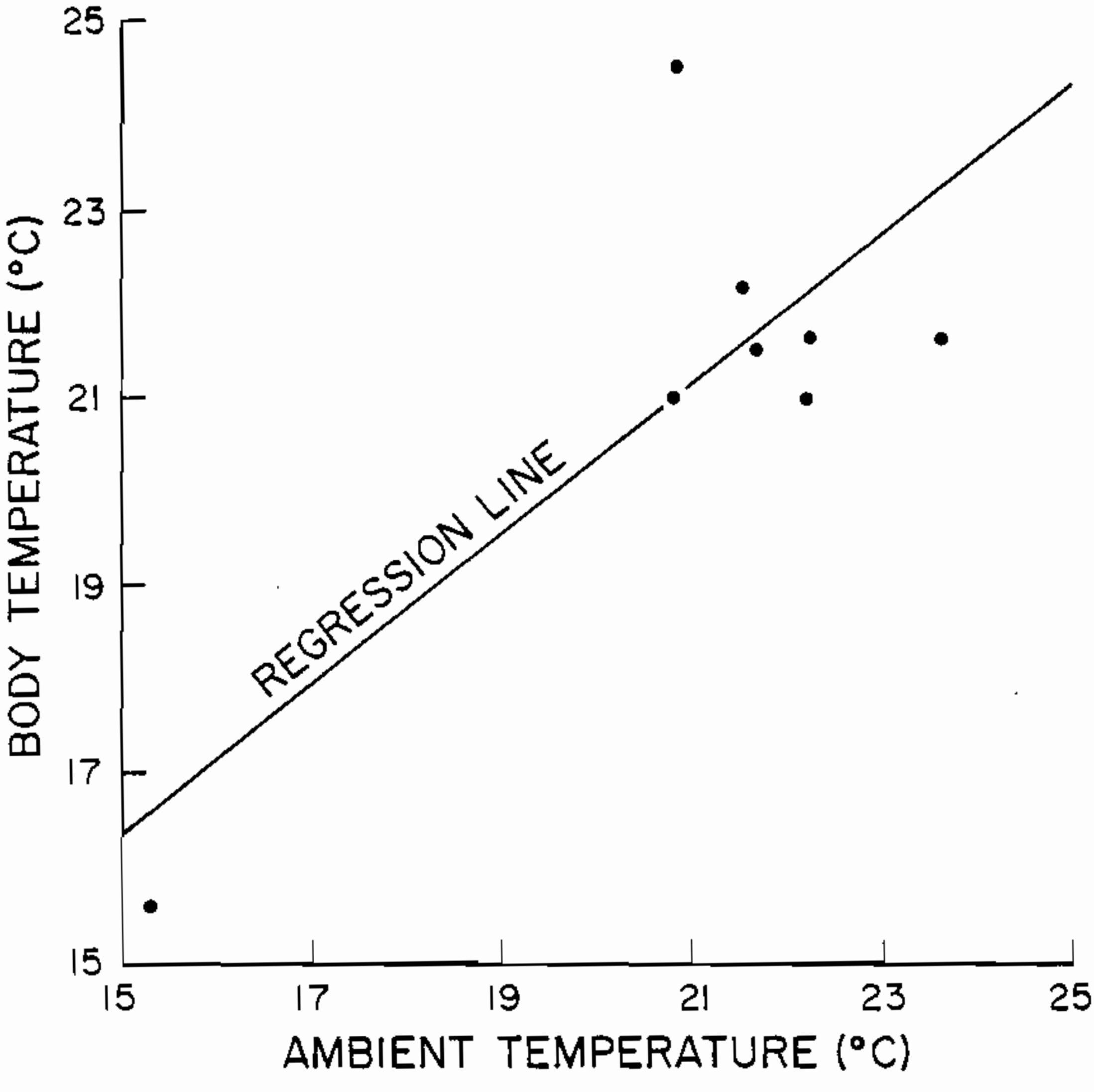


Figure 32. Relationship between body and ambient temperatures of a green sea turtle monitored in San Diego Bay as it moved from a cool-water locale where it was inactive to the warm-water effluent channel where it was active.

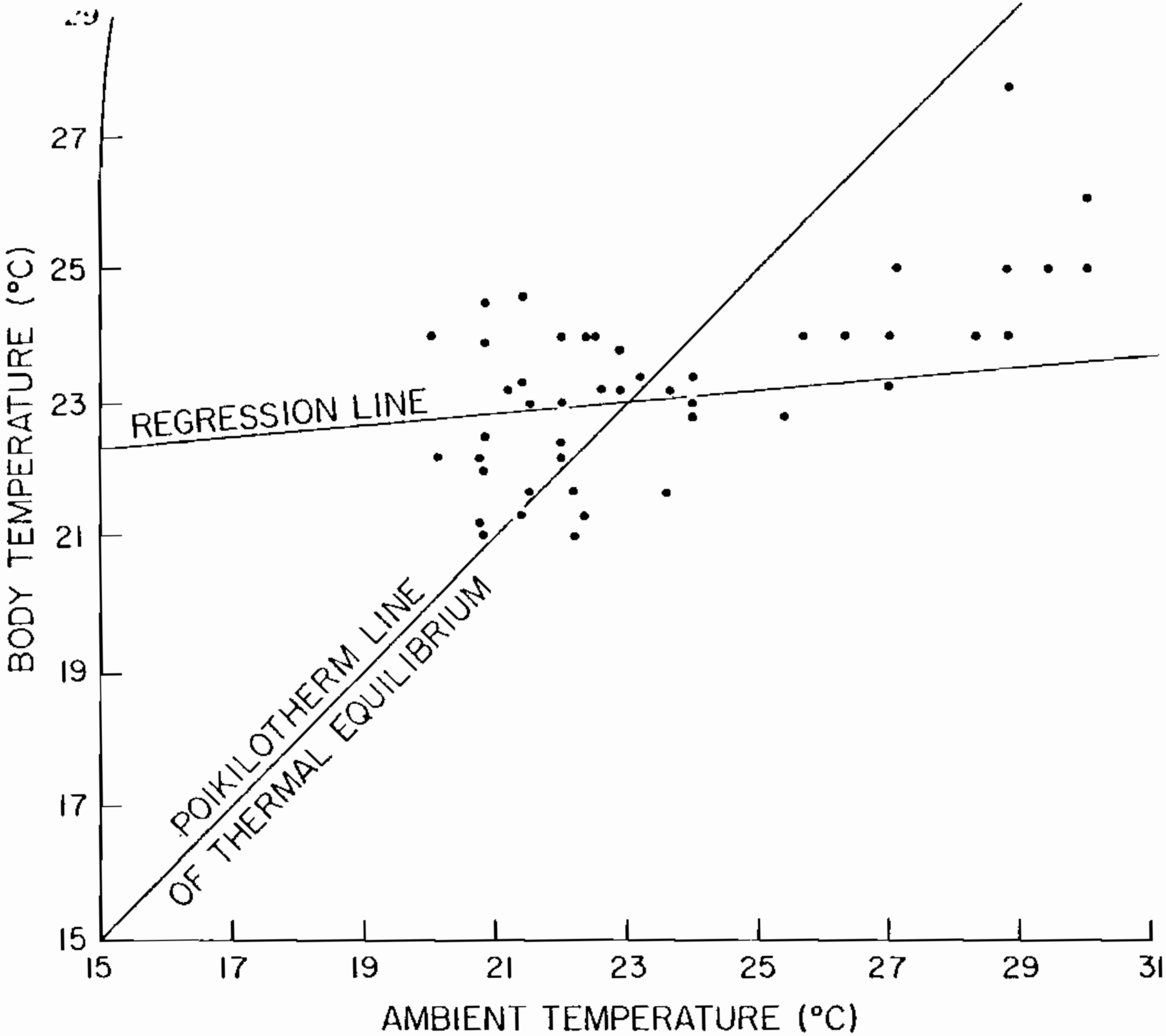


Figure 33. Relationship between body and ambient temperatures of five green sea turtles monitored in San Diego Bay during February or March 1979.

Behavior of Green Sea Turtles in San Diego Bay

Most green sea turtles are oceanic, feeding and nesting along open coastlines or migrating trans-oceanic to more isolated islands, making the study of their daily behavior difficult. Their seasonal behavior is known only through tagging studies—remigrations of tagged females to nesting beaches or the return of flipper tags by turtle fishermen. Until very recently, extremely little was known about their daily behavior and few actual data collected. Meylan (1981) has studied the daily travel patterns of female green turtles, during nesting season, in coastal waters along nesting beaches of Tortuguero, Costa Rica. And Mendonca (1983) has studied the daily and seasonal travel patterns of juvenile greens in Mosquito Lagoon, Florida, and related these activity patterns to changes in water temperature.

One purpose of my research was to study further the daily and seasonal behavior of of green sea turtles using the population in San Diego Bay, California (32°40'N), and to relate these behaviors to water temperature, tidal phase, time of day and to social behaviors of other individual turtles. This population includes turtles of both sexes and includes all age-classes, except juveniles smaller than 30 cm carapace length.

Seasonal

Each year during this study, from 1976 through 1983, green sea turtles have appeared during winter and spring months in the San Diego Gas and Electric Company's discharge channel and surrounding shallows of southern San Diego Bay. The turtles arrive, seemingly as a group, some time during late October—early November. They are seen daily during November through mid-April and depart in late April or early May. Turtles have never been sighted nor located with telemetry within San Diego Bay during summer months. Their arrival and departure to and from south San Diego Bay seems sudden and as a group; if they are arriving as individuals their remigration schedule or timing is fairly identical.

In 1979, I estimated the population to then consist of 25-30 turtles and the level of turtle activity that year appears no different than other years (1976-1983). I do not know if this population consists each year of the same group of individuals, but one adult female (#5, Mex. Tag No. C-06016) who has a deformed carapace and is easily recognized was seen throughout the season each year from 1976 through 1983. A second adult female (#6, Mex. Tag No. C-06015, Fla. Tag No. D-1418) was tracked through the 1979 season and after a summer's absence she returned to the channel the following October still wearing her carapace transmitter and was seen throughout 1980, after that her transmitter had dropped off and, unlike some of the turtles, she had no distinct markings and would not be recognized even if present. A third adult (sex unknown), having a unique carapace pattern of barnacles, was first recognized in 1978 and sighted frequently each subsequent year.

Distribution within San Diego Bay

A separate part of this paper is devoted to analyzing the correlation between each of 47 environmental variables with the seasonal appearance of green sea turtles in San Diego and their selective distribution within the bay.

General Distribution in Turtle Channel

While in San Diego Bay, green sea turtles spend their time entirely within the southern third of the bay; they were never sighted nor tracked more than 2½ miles from the discharge channel where they are seen daily during November through April (Figure 34). Table 13 shows the number of sightings of turtles/hour for each area of the channel. The greatest level of turtle activity is always centered at the eastern end of the channel (at the bridge), where water is discharged into the channel from the power plant. This is the warmest and deepest area of the channel but also the area having the strongest currents and eddies. Turtles are at the bridge during all hours and tidal periods, but there is a marked increase in the number of sightings during low and incoming tides (low tidal mean 27.4 sightings/hour, incoming tidal mean 34.0 sightings/hour, high tidal mean 18.8 sightings/hour and outgoing tidal mean 16.6 sightings/hour). Within the channel, turtle activity (as measured by the number of turtle sightings/hour) is greatest at the bridge (mean 26.2/hr) and the least toward the outer channel (mean 1.3/hr).

Tidal Periods

Table 13 compares turtle activity in different areas of the channel during different tidal periods. Tidal phase, rather than time of day, is of greater importance to turtle activity and travel within the channel. During high tides, most turtles are found from the mid-channel area east to the bridge. During outgoing tides, turtles move away from the bridge swimming down the channel. During low tide, considerable areas of the channel are covered with less than one-half meter of water and turtles were never seen swimming across these tidal shoals during low water periods. Instead during low tides, turtles restrict their activities to either the bridge (where the water is always deep), to deep spots along the channel (such as at Big Flipper Point) or to burrows where they remain until the incoming tide allows passage across shoal areas. During periods of low tides, turtles were frequently located (with telemetry) at a part of the inner channel (rock cairn to telephone pole) which has numerous burrow-like depressions carved in the channel floor (Figure 34). Carapace transmitters of three turtles were retrieved from such depressions. Many of these depressions are located under roof-like mud ledges. During incoming tides, turtles move into the channel. It is during rising tides that the greatest number of turtles in the outer channel or entrance are seen.

Travel patterns of the turtles follow the tides. When they do leave the channel it is usually on an outgoing tide and when they enter the channel it is usually on an incoming tide. Turtles not leaving the channel congregate in the largest numbers at the eastern end of the channel at the bridge. These data support interpreting their movements as response to cool water from the bay during incoming tides or an abundance of warm water in the channel at high and outgoing tides.

Time of Day

There was no significant difference in turtle activity, as measured at the bridge, between morning and afternoon hours (morning mean 27.6 sightings/hour; afternoon mean 24.8/hr). Turtles were active throughout night hours (mean 16.4/hr) both within the channel and outside in southern San Diego Bay--although at a possibly lower level. This depressed level of activity during night hours might have been due only to the increased difficulty in seeing turtles in the dark and also to the less time spent in night tracking. During each night of tracking, turtles were active, and on five occasions I followed Turtle #6 on what I believe were nocturnal feeding sojurns from the channel out across south bay and then back into the channel and up to the bridge. Also, eight of the nine turtles captured in our nets (three escaped) were caught during night hours.

Previously, sea turtles were thought to be diurnal in their behavior in feeding or residential areas and only nocturnal along nesting beaches. My observations prove this is not the case, at least in San Diego. This contrasts Carr's (1954) report that greens are diurnal in feeding grounds in the Caribbean and Mendonca's (1983) report that greens in Mosquito Lagoon, Florida, do not move during night hours but return to sleeping sites at dusk each day.

Individual Travel Patterns

As green sea turtles move about within the SDG & E channel and across the shoals of southern San Diego Bay, they almost exclusively use a path that follows the area's slightly deeper contours (Figure 34). During periods of high water, the turtles have access to their entire system of pathways and have temporary use of areas that are exposed or inaccessible during low tides. Examining some of these areas, exposed by low tide, reveals depressions that during higher water are used by the turtles as loitering or resting areas. These depressions appear carved in the channel floor and often were under mud roof-like ledges. Three of the turtles' carapace tracking devices were recovered from these depressions. Many of their travel patterns seem to have these stop-off areas as their goal and often times turtles congregate at these areas of depressions before reversing direction and repeating the travel pattern. Within the channel most of their travel is between the bridge and these depressions. Turtles entering or exiting the channel tend to congregate in a hole of deeper water at Big Flipper Point while waiting for incoming tides to make passable intervening shoals.

Turtles travel either singly or in loose groups of 2-7 animals. Those travelling in groups surface together, use the same route and end up together at the same stop areas. Turtles travelling alone, like cars on a freeway, often use the same route and their travel patterns overlap so they appear to be following one another. Nothing is known about their social behavior and while they were often seen travelling in small groups, I do not know if they were simply using the same travel pattern and timing or whether they were interacting or communicating in any way.

On five occasions I followed Turtle #6 on what I presume were feeding sojurns. During afternoons she would leave the bridge area of the eastern channel, travel along the underwater path to Big Flipper Point and when water levels were high enough proceed along the dike, quickly exiting the channel crossing to the southwestern side of the bay. From here she would begin a slow circuit through the eelgrass shoals along the southern shore and then during the late night hours (2200 - 0400 hours), depending on the time of incoming or high tides, re-enter the channel returning directly to the bridge where she would remain at least until mid-morning (at which time I would fatigue and end tracking). Unfortunately, we could not marathon track for longer than 24 hours without taking at least a day's rest and absence from the channel, consequently I do not know how often Turtle #6 followed this travel pattern. While tracking Turtle #6 on her nocturnal sojurns, I did hear other turtles surface quite close to the skiff and on moonlit nights could on occasion see turtles surface, consequently I suspect this general travel pattern was used by other turtles--but to what extent I do not know.

Table 13. Effect of tidal phase on activity of green sea turtles (mean number of sightings/hour) within the SDG & E channel in southern San Diego Bay, California during February - April, 1979.

Area in Channel	Mean Number of Turtle Sightings/Hour High Tide	Outgoing	Low Tide	Incoming	Overall
#1 (Bridge)	18.8	16.6	27.4	34.0	26.20
#2	5.3	4.8	1.3	8.8	7.06
#3	2.3	7.4	3.4	3.7	4.88
#4	4.9	4.9	8.8	6.0	5.87
#5	4.0	0.0	0.0	1.0	0.42
#6 (Big Flipper Point)	0.0	3.3	2.3	1.6	2.46
#7	0.0	1.3	0.0	10.4	5.09
#8 (Entrance)	0.0	0.0	1.9	1.0	1.33

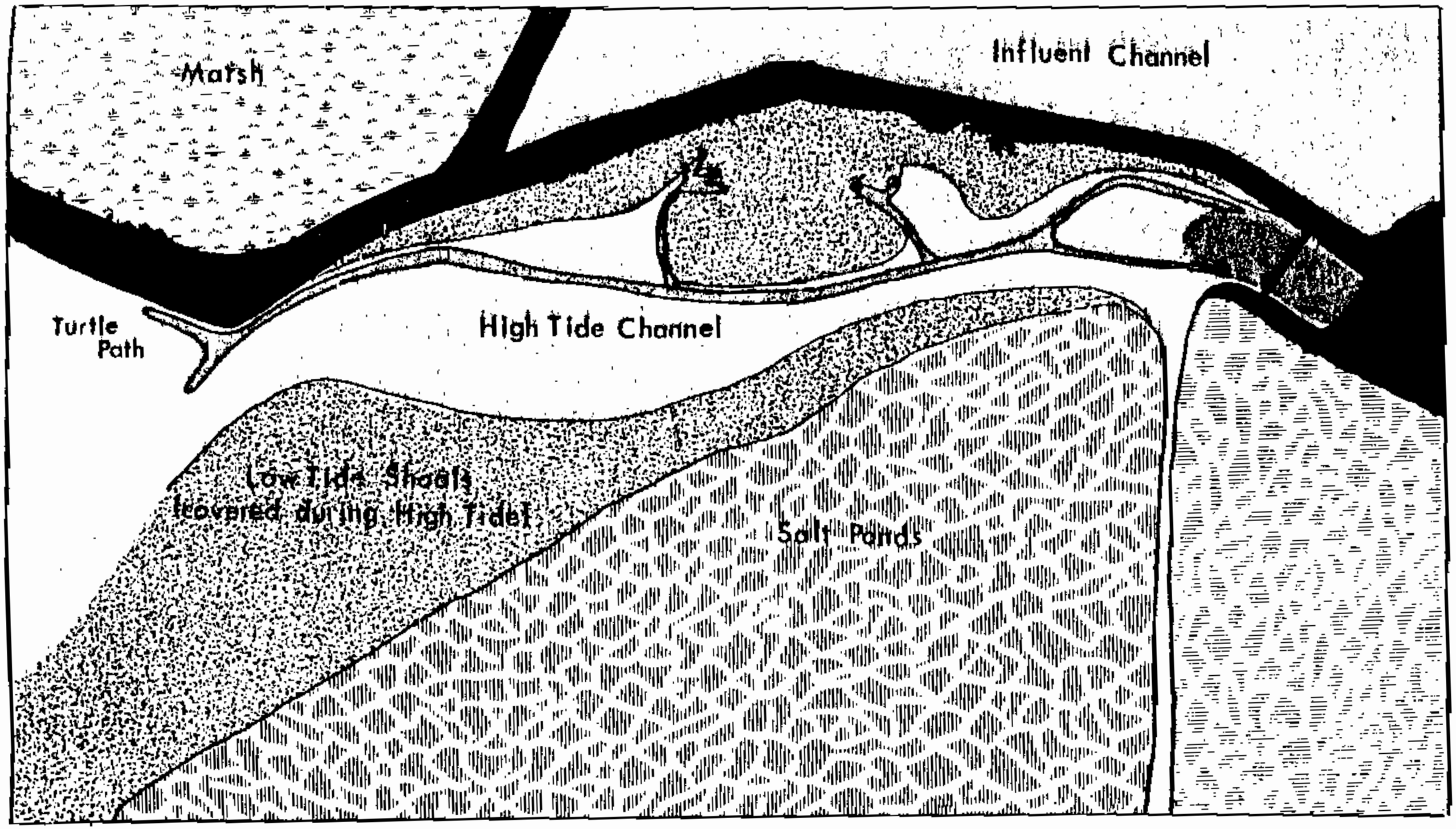


Figure 34. Map of the San Diego Gas and Electric Company's effluent channel showing the extent of high and low tides, the slightly deeper travel path used within the channel by green sea turtles and the locations of depressions in the channel floor where the turtles congregate and spend considerable amounts of time.

Breathing Patterns in Green Sea Turtles in San Diego Bay

Individual Turtles

The breathing behavior of sea turtles has been studied using only captive or beached *Chelonia mydas* (Berkson, 1966; Tenney *et al*, 1974; and Prange and Jackson, 1976). McGinnis (1968) recorded briefly the respiration rate of green sea turtles enclosed in a small lagoon in the Gulf of California, Mexico, but has not published this data. Consequently, breathing and diving patterns have not been documented for free-swimming sea turtles. Respiration rates of green sea turtles recorded in San Diego Bay during 17 sessions (for a total of 31 hours and 45 minutes) are herein reported, providing for the first time an insight into their breathing behavior in the wild.

General breathing patterns. Berkson (1966) described the diving behavior of six captive *Chelonia mydas* as a general sequence of one long submergence, lasting 15 to 50 minutes, followed by several short dives each lasting 20 seconds to 2 or 3 minutes. With some variation, this sequence prevailed in San Diego as well. Turtles here spent most of their time underwater, surfacing periodically only for a single breath or surfacing several times in rapid succession before submerging again for a long period.

Although, in San Diego, turtles quite commonly stayed underwater for as long as 45 minutes, the greatest number of these dives lasted 15 to 25 minutes. Most often turtles broke these long periods underwater by surfacing for a single breath or rising to the surface in a rapid succession of 2 or 3 short dives each lasting 30 to 90 seconds (Figure 35). Typically, when turtles rose to the surface it was only long enough to lift their head clear of the water, breathe and to slide below again. It is surprising that turtles can replenish their oxygen supply with only a single surfacing, yet McGinnis (1968) also found this pattern, of a single breath separating long dives, normal for greens in the Gulf of California. As Berkson does not mention single breaths, this might reflect a behavioral difference between turtles in captivity and those free-swimming.

Berkson (1966) observed another breathing pattern as well, that sometimes captive greens continued for hours making only short dives. This pattern was never observed in San Diego; here, 7 was the greatest number of short dives and surfacings made by any turtle before returning underwater for a long dive and the norm was either a single surfacing or a series of only 2 or 3 short dives and blows.

Dives were considered short if less than six minutes in duration but most in this category lasted only 30 to 90 seconds (Figure 35). Long dives were considered periods of submergence beyond 15 minutes. Though the greatest number of long dives lasted 15 to 25 minutes, dives as great as 40-45 minutes were common and the longest dive recorded during these particular observation sessions lasted 120 minutes, but this does not represent their limit for remaining underwater. During the later telemetry phase of this study, it was apparent that the turtles could remain underwater for at least 3 hours and quite possibly for much longer. In such instances tracking ended before the turtle resurfaced. The upper

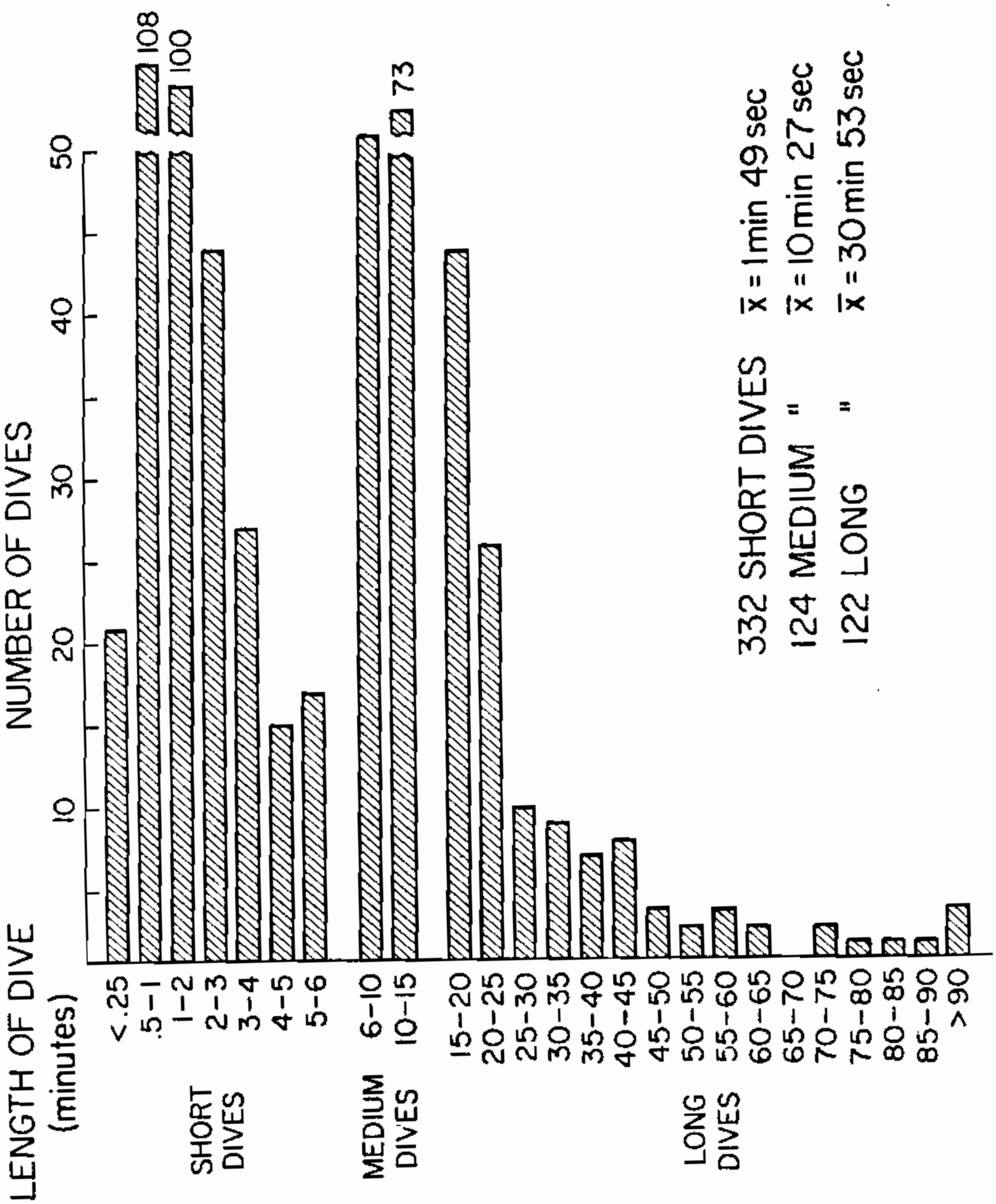


Figure 35. Relative number and length of dives (periods of submergence) for green sea turtles in San Diego Bay.

limit of *Chelonia*'s ability to remain submerged was not determined.

Mean breathing interval : body size. In a study to test the hearing ability of *Chelonia mydas*, Ridgway *et al.* (1969) noted that the turtles usually took 2 to 5 breaths in fairly rapid succession between long dives; that smaller greens (50 lbs; 22.7 kg) generally surfaced at intervals of about 10 minutes, while the larger ones (68 and 75 lbs; 30.8 and 34 kg) remained submerged for longer periods up to 30 minutes.

Analysis of the breathing behavior of large (300 lb; 136 kg), medium (150 lb; 68 kg) and small (50 lb; 23 kg) sized *Chelonia mydas* in San Diego Bay indicates that their ability to remain submerged increases with increased body size. The mean time underwater (length of dive) was 6 min 28 sec for *Chelonia* of a small size; 8 min 46 sec for those of a medium size and 9 min 24 sec for large animals. The analysis of variance of means using the F-distribution of variance ratios (Schefler, 1969) and the Kruskal-Wallis sum of ranks test for nonparametric analysis (Sokal and Rohlf, 1969) indicate that there are statistically significant differences between the mean length of dives made by *Chelonia mydas* of different body sizes.

Group Breathing Behavior

Turtles spend considerable amounts of time in the SDG & E Company's effluent channel and can easily be observed from a foot bridge crossing above the channel. From this vantage point the swimming and breathing patterns of the turtles were observed.

Frequently, turtles seemed to surface (presumably to breathe) in groups. Long stretches of time would lapse (10 to 30 minutes) when few, if any, turtles would surface. And then quite suddenly the quiet would be broken by a flurry of several turtles surfacing in synchrony.

Synchronous breathing which involves several individuals breathing or surfacing simultaneously or in rapid succession, has been observed in eleven families of air-breathing fishes (Svennson, 1933; Shlaifer and Breder, 1940; Forselius, 1957; Dehadrai, 1962; Hill, 1972; Kramer and Graham, 1976; and Loftus, 1979) as well as in the air-breathing African clawed frog (Xenopus laevis [Pipidae]) (Baird, 1980)--but never in any reptile.

Table 14 presents chi square values between the observed and expected frequencies of simultaneous air breathing events among individual turtles. During 8 of the 17 observation periods the turtles surfaced in a nonrandom fashion and did not fit a Poisson distribution. Breaths were significantly clumped indicating synchrony in the turtles' behavior to surface (Table 14). What triggers behavioral shifts from periods of synchrony to periods of nonsynchronous surfacing is not known, but these shifts do occur within a short time frame. For example, on 15 March during the hours of 0900 and 1100 the turtles were in a nonsynchronous mode and then shifted to synchrony during the hours of 1130 and 1335. No correlation was found between the time of day and synchronous breathing. Although turtles are active in the study area during night hours no observations were made to determine their nocturnal breathing

Table 14. Chi square values calculated, using the test for goodness of fit, between observed and Poisson calculated expected frequencies of surfacing or air-breathing events per 2-minute interval as a measure of surfacing synchrony in *Chelonia mydas* in San Diego Bay.

Number of turtles	Date	Time	chi square value			Significant/ Not Significant
15	18 November	0930-1200	9.539	9.210	0.01	S
15	20 March	0730-1120	19.310	10.597	0.005	S
11	17 March	1500-1720	12.349	7.879	0.005	S
11	23 March	1610-1720	8.435	7.879	0.005	S
11	31 March	0800-0935	5.315			NS
10	30 March	1630-1800	3.507			NS
8	1 February	0900-1010	6.360	5.991	0.05	S
8	22 March	1145-1340	0.520			NS
7	14 March	1630-1730	7.879	5.024	0.25	S
7	15 March	1130-1335	21.385	10.597	0.005	S
7	31 March	1030-1310	3.703			NS
7	1 April	1840-1950	0.186			NS
7	4 April	1130-1310	0.150			NS
6	2 February	1530-1700	0.517			NS
6	13 March	1530-1750	0.195			NS
6	15 March	0900-1100	0.056			NS
5	24 March	1120-1300	3.275	2.707	0.10	S

behavior.

An indicator of behavioral synchrony was that when 5 to 15 turtles were present, 3 to 6 of them surfaced during the same 2 minute interval. This does not mean though that the same individuals were involved in each synchronous surfacing, it was not the case of them simply being on the same breathing pattern. Rather, the participants changed from one synchronous bout to the next as each individual's breathing pattern changed. Nor does the occurrence of synchrony in an observation period imply that there were simultaneous group surfacings during each and every time interval of the observation period. Isolated surfacings also occurred. Never did the entire group present surface together.

Group size as related to synchronous or nonsynchronous behavior. The number of turtles present did not regulate the occurrence of synchronous surfacing behavior in *Chelonia mydas*. Synchrony existed during periods in which as few as 5 and as many as 15 turtles were present and yet did not occur on an occasion when as many as 11 turtles were involved. Group sizes were ranked and summed according to the Wilcoxon rank-sum test (Christensen, 1977) and it was determined that there was no statistically significant difference between group size during periods of either behavior (Table 15).

Change in breathing pattern during periods of synchronous and nonsynchronous surfacing. In order to determine if there were statistically significant differences between the turtles' breathing behaviors during sessions of synchronous and nonsynchronous air breathing, two Student's t distributions (Mendenhall, 1969) were generated to compare the mean intervals between breaths during sessions of synchronous and nonsynchronous air breathing for individual turtles and for the entire groups involved (Tables 16 and 17). In neither case were there statistically significant differences thus indicating that there were no changes in breathing behavior. This result might be expected since, as previously stated, the breathing behavior of individual turtles (and all turtles combined) was found to be highly variable at all times regardless of whether the overall effect was synchronous or nonsynchronous surfacing.

Occasionally, individuals only surfaced once during an observation period. Because water visibility often approached zero it was impossible to know whether such an individual was present throughout the entire observation period or had left the study area.

Nonsocial hypotheses to explain synchronous air breathing. Kramer and Graham (1976) discuss two nonsocial hypotheses to explain synchrony in air breathing; that it is caused by a group surfacing together initially by chance and that synchrony was then maintained by the similarity of their internally controlled respiratory cycles; or that synchrony is a similar response by all (or many) individuals to an external stimulus. In their laboratory studies involving the catfish, *Ancistrus*, [Loricariidae] Kramer and Graham were able to refute both of these nonsocial causes of synchrony in that species.

Table 15. Results of the Wilcoxon rank-sum test (Christensen, 1977) to determine if group size effects the occurrence of synchronous air-breathing in *Chelonia mydas* in San Diego Bay.

Air Breathing Behavior			
Synchronous		Nonsynchronous	
Number Turtles Present	Rank	Number Turtles Present	Rank
15	16.5	11	14
15	16.5	10	12
11	14	8	10.5
11	14	7	7
8	10.5	7	7
7	7	7	7
7	7	6	3
5	1	6	3
n1=8	T1= 86.5	6	3
	α = 0.046	n2=9	T= 66.5

Accept Ho: there is no statistically significant difference between group size during periods of synchronous and nonsynchronous air-breathing behavior of *Chelonia mydas*.

Table 16. Student's t-distribution for comparing the mean length of intervals between breaths for individual Chelonia mydas during sessions of synchronous and nonsynchronous or random air-breathing in San Diego Bay.

Synchronous		Nonsynchronous	
Session #	y interbreath interval	Session #	y interbreath
INDIVIDUAL TURTLES			
1	8.460 minutes *	1	6.364 minutes
2	16.380	2	27.775
3	31.992	3	9.317
4	7.967	4	8.847
n1=4	$\bar{y}$1= 12.538	n2=4	$\bar{y}$2= 9.194

s = 152.436; μ= 8.650 minutes; n = 4

$$t = \frac{\bar{y}-\mu}{\frac{s}{\sqrt{n}}} = 0.043 \not> 2.353 \; \alpha \; 0.05$$

accept Ho: the data do not present sufficient evidence to indicate that an individual's mean interval between breaths is different during periods of group synchronous and random breathing.

* Minutes have been changed from base 6 to base 10 to allow calculations as decimals.

Table 17. Student's t-distribution for comparing the mean length of intervals between breaths during sessions of group synchronous and nonsynchronous or random air-breathing by _Chelonia mydas_ in San Diego Bay.

Synchronous		Nonsynchronous	
Date	y interbreath interval	Date	y interbreath interval
18 November	9.199 minutes *	2 February	11.844
1 February	5.071	13 March	11.770
14 March	9.118	15 March	7.712
15 March	10.518	22 March	15.336
17 March	9.092	30 March	5.875
20 March	12.913	31 March	8.148
23 March	6.086	1 April	11.385
24 March	5.961	4 April	4.371
$n1 = 8$	$\bar{y}1 = 9.466$	$n2 = 8$	$\bar{y}2 = 8.319$

$s = 3.305$; $\mu = 8.650$ minutes; $n = 8$

$$t = \frac{\bar{y} - \mu}{\frac{s}{\sqrt{n}}} = 0.698 \ngtr 1.895 \propto 0.05$$

accept Ho: the data do not present sufficient evidence to indicate that the mean interbreath interval (mean diving time) for groups is different between periods of synchronous and random air-breathing.

* Minutes have been changed from base 6 to base 10.

The hypothesis that synchronous air breathing is caused by a group's individual breathing patterns overlapping--that is by a group surfacing together initially by chance and that synchrony is then maintained simply by the similarity in the animals' internally controlled respiratory cycles--is unlikely. Agreeing with Kramer and Graham, this hypothesis is inadequate because of the variability in the length of time between bouts involving synchronous surfacings; because of the variability in the periods between breaths in individuals, because of the flexibility in their breathing patterns; because the turtles can physiologically remain submerged for periods longer than the observation session--they do not have to breathe; and because the participants of a synchronous bout were not locked together acting as a group always surfacing together, but rather the participants involved continually changed from one interval to the next.

Environmental stimuli. It would be extremely difficult to determine if environmental stimuli account for the sea turtles surfacing simultaneously in the study area. Four pipes from the SDG & E facility enter the channel and continually pump 405,200 gallons of coolant water from the facility into the study area per minute. These underwater pipes eject the water as vertical eddies and turtles frequently were seen to surface in the discharge eddies of two of these pipes each releasing 78,000 gallons of water per minute. The other two pipes, each releasing 124,000 gallons per minute, are located approximately 30 meters from the study area and would contribute both to the effects of currents and underwater noise.

The levels and frequencies of underwater noise were not measured in the study area but it can be assumed that noise caused by the discharge of water, tidal currents and noises from the power plant absorbed through the ground or transmitted through the discharge pipes could be considerable.

Ridgway, et al. (1969) demonstrated that Chelonia mydas can hear sounds between 60 and 1000 Hz and is most sensitive to sounds in the 300 to 500 Hz range. It is not known what or how much the turtles hear in the study area. It is doubtful that they could hear conspecifics surface.

Sounds typical of one's environment probably cannot evoke a sharp response such as synchronous surfacing. A turtle can react to any stimulus if it is sufficiently different from those typical of its sensory input. It would be difficult to imagine such an alien noise occurring in this noise-impacted environment with the same frequency as the bouts of synchrony without the turtles becoming acclimatized to it as well.

Loftus (1979) studying the walking catfish (Clarias batrachus) and Baird (1980) working with the African clawed frog (Xenopus laevis) suggested that submerged individuals might use their lateral line to detect vibrations made by a conspecific breathing at the water's surface. Sea turtles lack a lateral line and the eddies and strong currents sweeping through the study area would overpower any vibrations caused by a neighboring turtle surfacing.

Kramer and Graham (1976). Baird (1980) and Shlaifer and Breder (1940) suggest that visual cues might be very important in maintaining synchrony in fishes and frogs, especially in clear water. It is doubtful that vision plays a primary role in sea turtles surfacing simultaneously in this particular environment since water visibility there is often minimal. The study area in question was 7 to 10 meters in depth depending on tidal conditions and usually vertical visibility was less than one meter (and sometimes approached zero). Synchrony did not necessarily involve neighboring turtles, although frequently this was the case, and turtles separated by as much as 30 meters surfaced simultaneously.

Swimming patterns. The turtles maintained individual swimming routes and patterns in the study area at the bridge. This implies that they were able to locate and recognize environmental cues in order to repeat these swim patterns. Often the swim paths of various turtles present overlapped one another. Other individuals apparently were sedentarsurfacing in the exact spot repeatedly, and often several turtles would share a discharge eddy, an area about 3 meters across. And yet never were turtles seen to bump into each other. This indicates that they have some sensory ability to maintain spatial or temporal separation in this murky, noise and chemically impacted area.

Synchronous air breathing behaviors can be caused by nonsocial (physiological or environmental) factors or by social factors. These sea turtles lack any fixed breathing pattern or physiological need to breathe as frequently as synchronous bouts occurred and a stimulus sufficiently alien as to produce a group response has not been identified as yet.

Social causes of synchronous behaviors. In order for any synchronous behavior to be socially motivated, the cues must be communicated. Not enough is understood about these turtles' sensory abilities in this highly unusual environment in order to know what sensory cues are effective for them. Since they are able to maintain and repeat overlapping swim patterns without bumping into each other, we can assume that there is some way for them to communicate some cue and thus there is some avenue for developing a group behavior such as synchronous surfacing.

Baird (1980) labelled the synchronous air-breathing (or surfacing) behavior he observed in clawed frogs as a "socially facilitated" behavior. This describes situations when in a group, individuals will either increase the frequency of engaging in a specific behavior in reponse to seeing other members doing the behavior or will synchronously do something in response to a cue of some individual within the group (Clayton, 1978). This term does not describe the behavior I observed in *Chelonia mydas*; 1) a communicating cue that would link the turtles together as a group is apparently lacking--they are not in visual contact. They are not known to produce sounds and sounds would most probably be indifferentiable in this environment, 2) I have no evidence to indicate that they surfaced more frequently when sharing the area with other turtles than when solitary. Yet when a group of turtles were present synchronous surfacing occurred.

Adaptive significance of synchronous surfacing. Despite the fact that not all sympatric species of air-breathing fish engage in synchronous surfacing, Kramer and Graham (1976) suggest this behavior might confuse their predators. Testing this hypothesis, synchrony increased after models of aerial and aquatic predators were presented to tarpon (Shlaifer and Breder, 1940) and clawed frogs (Baird, 1980).

Studies of fishes (Kramer and Graham, 1976), frogs (Baird, 1980) and sea turtles (personal observations during this study) illustrate the fact that in any bout involving synchrony, not all members of the total group surfaced and that there is considerable variation in the length of time between such bouts so a predator would not be able to predict when and which individuals would surface.

Ontogeny of synchronous surfacing in *Chelonia mydas*. Possibly, but not necessarily, these green sea turtles occupying the narrow confines of the discharge channel are the only green sea turtles to engage in synchronous surfacing. Quite probably green sea turtles do not aggregate so closely in normal habitats in lagoons or the open ocean. Unfortunately, *Chelonia mydas* has not been observed on a daily basis elsewhere and nothing is known about their social nature.

Obviously, 300 pound [136 kg] sea turtles do not need a tactic to confuse predators and even the smallest sea turtles seen in the channel were large enough (at least 30 cm in length) to be immune to most local predators.

Sea turtle hatchlings enter the ocean as a group and are heavily preyed upon by birds such as frigate birds (Fregata magnificens). A tactic, such as synchronous surfacing, successful in confusing aerial predators would be a selective factor in the survival of hatchlings.

Frick (1976) observed Chelonia mydas hatchlings in the ocean immediately after their release and noted that they surfaced at 5 to 10 second intervals and would dive upon close approach of a boat, aircraft and the presence of predatory birds overhead. She observed that the hatchlings showed obvious evasive behavior, diving quickly with each near approach of a frigate bird. During these periods, the hatchlings' swimming rate decreased.

It would be very interesting to know if anyone has observed hatchlings in the ocean engaged in this synchronous surfacing behavior. It would be very easy, and informative, to determine if sea turtle hatchlings breathe synchronously under laboratory conditions and to undertake experiments to test the effects of external stimuli and effects of predator models on them in order to test the hypotheses evoking social and nonsocial causes for such synchronous behavior. Studies involving hatchlings under controlled experimental conditions are necessary to illuminate the occurrence of this phenomenon in sea turtles of all age classes in the admittedly abnormal discharge channel-habitat in San Diego Bay.

PART II

BIOLOGY OF SEA TURTLES IN THE NORTHEASTERN PACIFIC NORTH OF CENTRAL BAJA CALIFORNIA, MEXICO

CHAPTER IV

INTRODUCTION

Upon completion of the field study of the biology of green sea turtles (Chelonia mydas) in San Diego Bay many questions remained unanswered, for these answers and for a more complete appreciation of the biology of turtles in San Diego I had to turn to the Pacific, to the coastal waters of North America, north of central Baja California, Mexico. Little was known of marine turtles in these waters. It was known that four species of sea turtles (Dermochelys coriacea, Chelonia mydas, Caretta caretta and Lepidochelys olivacea) occur along the Pacific coast of the United States and Canada (Caldwell, 1960; 1962). But our knowledge of their biology, or even their distribution, north of the Mexican states of Sinaloa and Baja California was only fragmentary (Carr, 1952; Pope, 1967). Caldwell (1962) summarized existing information on their distribution in Baja California, but no one had similarly reviewed their distribution in waters further north.

To have a better perspective and understanding of the population of green turtles in San Diego, questions had to be asked about turtles along the open coast of North America. What is their geographic distribution? What is the seasonality of these sightings? Are they seasonal migrants to our coastal waters or are they only occasional northern wanderers?

"Temperature appears to be the most important single physical factor limiting the distribution of marine organisms" (Norris, 1963). Ocean temperatures change seasonally causing dramatic seasonal changes in the abundance and geographic distribution of many species of fish. Consequently, most Pacific coast fisheries (i.e., for albacore, bluefin, yellowfin, bigeye tunas, yellowtail, swordfish, thresher shark, bonita and barracuda) are also seasonal reflecting dramatically these changes in ocean temperatures.

In addition to these predictable seasonal changes, events occasionally occur that create periods of abnormally warm or cool ocean temperatures. These periods of anomalous temperatures are generally short in duration resulting in a seasonal or annual extreme. Reid (1960), Roden (1961) and Eber (1971, 1981) critically review temperature anomalies and reconstruct profiles of oceanographic conditions that exist during such periods of extreme temperatures.

During the past century, there have been several prolonged periods when surface sea temperatures were unusually warm along the Pacific coast of North America. During each of these periods (1925-26, 1930-31, 1936, 1941, 1957-59, 1983), southern species of fish, invertebrates and birds were found far north of their usual range and offshore warm-water species moved into cooler coastal areas (Nichols, 1926; Crawford, 1927; Hubbs and Schultz, 1929; Walford, 1931; Hubbs, 1948, 1960; Radovich, 1960, 1961; and Shor, 1978).

During the 1957-1959 warm period, leatherback and green sea turtles were commonly sighted from southern California to British Columbia and a ridley sea turtle was captured in Humboldt Bay, northern California (Radovich, 1961). These sightings prompted Hubbs (1960) and Radovich (1961) to suggest that the prevailing warm ocean conditions allowed sea turtles, like many other tropical species, to be displaced or to disperse considerable distances north along the coast of the eastern Pacific and to exist there until oceanic isotherms resumed normal geographic position and coastal waters cooled.

Purposes of this oceanic extension to the San Diego Bay study were to:

1) To determine the geographic distribution and frequency of sightings of sea turtles in the northeastern Pacific.

2) To determine if these sightings are actually seasonal or if the occurrence of sea turtles in the northeastern Pacific corresponds to, and is caused by, abnormal periods when currents from further south or offshore are positioned along this northern coast bringing with their unusually warm surface temperatures species that are typically found offshore or further south.

3) If it is established that sea turtles do occur seasonally in the northeastern Pacific, another purpose of this study is to determine if their temporal distribution corresponds to the seasonal position and movement of surface isotherms.

4) To detect possible seasonal migratory paths in the northeastern Pacific.

5) To study the thermal biology of sea turtles in these northern waters; determine each species' temperature range for active, vigorous (and apparently healthy) swimming and also their thermal minimum, the temperature at which they become physically stressed by cold water.

6) As a back-door approach in the search for a clue to the seasonal travel patterns of turtles in the northeastern Pacific, a purpose of this study is to review sighting reports to see if turtle sightings were associated with certain habitats or the seasonal appearance of other species such as albacore, bluefin tuna, albatross and wind-sailor jellyfish.

7) To determine if the distribution of sea turtles in the northeastern Pacific is related to water depth as it is for marine turtles along the Atlantic coast of the United States.

8) To determine (in a very general way) the nature and level of man's contact with sea turtles in the northeastern Pacific.

CHAPTER V

METHODS

A search of the literature and museum collections was made to discover records of sea turtle sightings in the northeastern Pacific, north of central Baja California, Mexico. Beginning in 1977, a brochure was distributed, each year, to fishermen and to biologists from southern California to Alaska requesting information on any sightings, strandings or captures of sea turtles. Their response to this brochure was surprising and immediate, uncovering several hundred coastal sightings.

Correlation of the Occurrence of Sea Turtles in the northeastern Pacific and Periods of Anomalous Surface Ocean Temperatures

Records of turtle sightings were compared with surface ocean temperatures to determine if a correlation exists between the occurrence of turtles in the northeastern Pacific and periods of unusually warm ocean temperatures.

Sea-surface temperature data recorded at eleven tidal gauge stations in California, Oregon and Washington were obtained from the U.S. Coast and Geodetic Survey (1956) and from the Scripps Institute of Oceanography (1955-1983 sea temperature data reports). These eleven stations (Figure 36) were selected for use in this analysis because their geographic distribution encompasses that of the majority of sea turtle sightings. Tidal gauge stations began

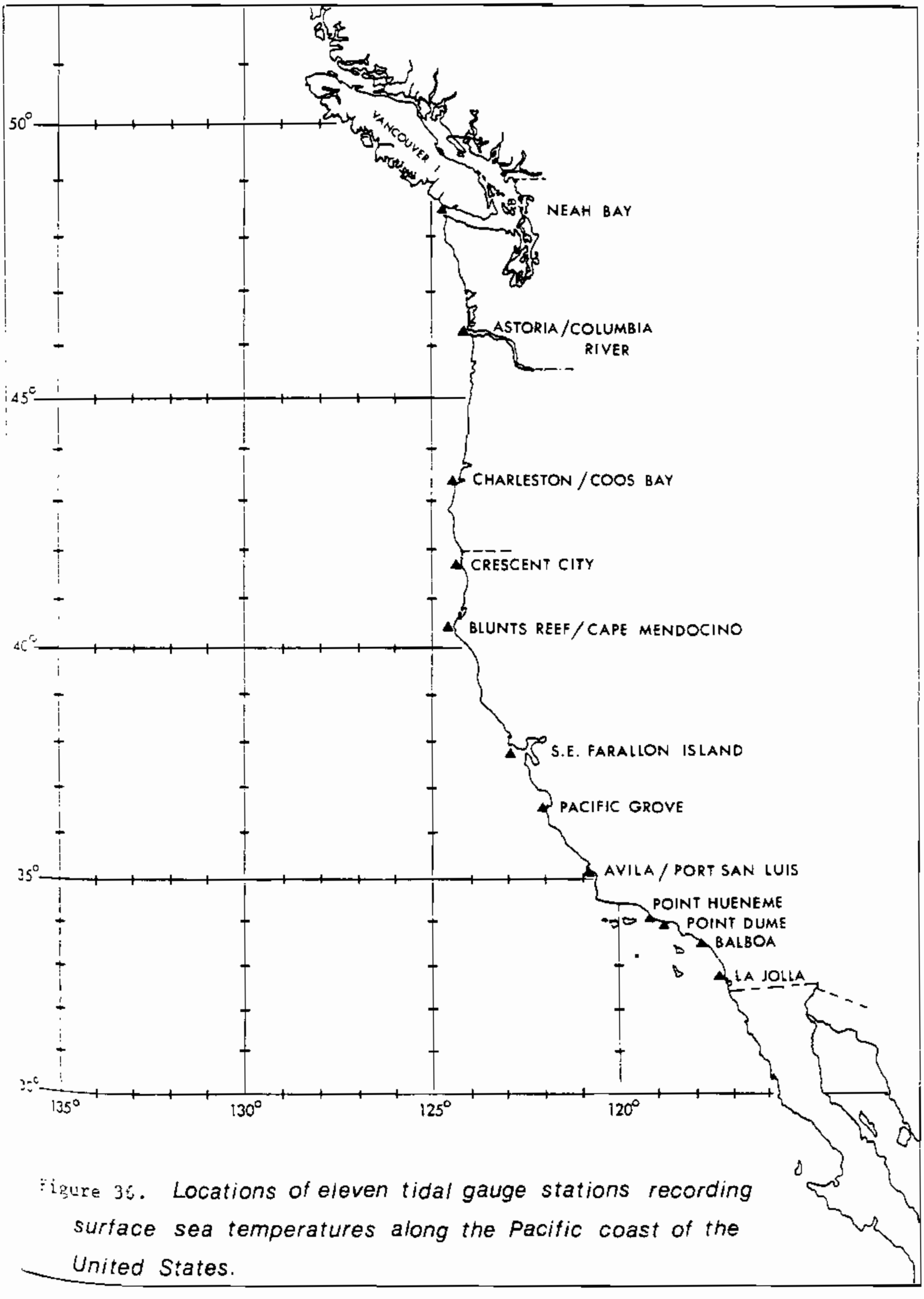


Figure 36. *Locations of eleven tidal gauge stations recording surface sea temperatures along the Pacific coast of the United States.*

collecting daily sea temperature data in 1916 (Table 18). For this analysis I have used only those records of turtles sighted after that time.

For each of the eleven temperature-recording stations, I calculated the mean and standard deviation of monthly and annual surface-sea temperatures (Table 19). Regular seasonal variation was eliminated by taking the differences between the monthly means and the long-term mean for the same month (Roden, 1961 and 1966). Using one standard deviation as an expression of normality, I then identified each month and year as having "normal", "hot" or "cold" surface temperatures for that particular locale.

Using sea-surface temperature data from the nearest tidal gauge station, I identified each turtle sighting as having occurred during a month and a year characterized by "normal", "hot" or "cold" ocean conditions. In doing this, I could determine whether a particular turtle sighting, in July 1970 for example, occurred during a July that was normal, hot or cold when compared to the long term average for all Julys and during a year that was normal, hot or cold for the long term average of annual temperatures at that locale.

Not all turtle sightings occurred conveniently near one of the eleven recording stations. In these cases, I compared the turtle sighting with data from several stations. As shown in Figure 37, anomalies in ocean temperatures most frequently are not just local events but reflect conditions experienced along the entire Pacific coast of North America (Roden, 1961).

Table 18. List of tidal gauge stations used in the correlation between periods of anomalous surface sea temperatures and the distribution of sea turtles in the northeastern Pacific.

Station	Locale	Years of Data
CALIFORNIA		
La Jolla, Scripps Institute of Oceanography	32°52.0'N, 117°15.3'W	1916-1983
Balboa	33°36.0'N, 117°54.0'W	1925-1983
Point Dume/	34°01.1'N, 118°49.5'W	1963-1983
Point Hueneme	34°09.0'N, 119°12.0'W	1919-1963
Avila/	35°10.0'N, 120°44.0'W	1945-1971
Port San Luis	35°10.3'N, 120°45.2'W	1972-1980
Pacific Grove	36°37.3'N, 121°54.2'W	1919-1983
Southeast Farallon Island	37°41.8'N, 122°59.9'W	1925-1983
Blunts Reef Lightship/ Cape Mendocino	40°27.0'N, 124°30.0'W	1922-1971
Crescent City	41°44.8'N, 124°11.0'W	1934-1982
OREGON		
Charleston/Coos Bay	43°21.0'N, 124°19.0'W	1933-1934 1966-1982
Astoria/Columbia River Lightship	46°11.2'N, 124°11.0'W	1925-1979
WASHINGTON		
Neah Bay	48°22.0'N, 124°37.0"W	1936-1983

Table 19. Mean, standard deviation and normal range of monthly and annual surface temperatures (°C) for eleven tidal gauge stations in the northeastern Pacific Ocean.

Station	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
CALIFORNIA													
La Jolla (Scripps, 1916–1983)													
Mean (°C)	14.08	13.57	14.50	15.38	16.92	18.40	19.86	20.76	19.36	17.93	16.24	14.89	16.87
SD	0.97	1.05	0.96	0.94	0.93	0.92	1.10	0.93	0.88	0.81	0.95	0.97	0.55
NR (°C)	13.11	12.52	13.54	14.44	15.99	17.48	18.75	19.83	18.48	17.12	15.29	13.92	16.32
	15.05	14.62	15.46	16.32	17.85	19.32	20.97	21.69	20.24	18.74	17.19	15.86	17.42
Balboa (1925–1983)													
Mean (°C)	14.05	14.10	14.32	14.98	16.14	17.57	18.61	19.32	18.48	17.77	16.23	14.98	16.45
SD	1.06	1.02	1.03	1.14	1.15	1.02	1.16	1.07	1.05	1.10	1.11	1.08	0.97
NR (°C)	12.99	13.08	13.29	13.84	14.99	16.55	17.45	18.25	17.43	16.67	15.12	13.90	15.48
	15.11	15.12	15.35	16.12	17.29	18.59	19.77	20.39	19.53	18.87	17.34	16.06	17.42
Point Hueneme/Point Dume (1919–1983)													
Mean (°C)	13.55	13.40	13.19	13.54	14.13	15.07	16.43	17.31	17.07	16.58	15.43	14.36	15.04
SD	1.04	1.08	1.04	1.13	1.11	1.20	1.38	1.39	1.16	1.01	1.16	1.03	0.77
NR (°C)	12.51	12.32	12.15	12.41	13.02	13.87	15.05	15.92	15.91	15.57	14.27	13.33	14.27
	14.59	14.48	14.23	14.67	15.24	16.27	17.81	18.70	18.23	17.59	16.59	15.39	15.81

Table 19. (continued).

Station	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
Avila/Port San Luis (1945–1980)													
Mean (°C)	12.52	12.67	12.28	12.41	12.91	14.00	15.25	15.84	15.69	14.99	13.73	12.79	13.80
SD	1.04	1.15	1.17	0.91	0.96	0.95	0.90	0.99	0.95	1.03	1.09	0.83	0.80
NR (°C)	11.48	11.52	11.11	11.50	11.95	13.05	14.35	14.85	14.74	13.96	12.64	11.96	13.00
	13.56	13.82	13.45	13.32	13.87	14.95	16.15	16.83	16.64	16.02	14.82	13.62	14.60
Pacific Grove (1919–1983)													
Mean (°C)	11.87	12.08	12.24	12.46	12.74	13.41	13.84	13.98	14.25	13.79	12.92	12.35	12.98
SD	0.91	0.96	0.95	0.82	0.78	0.84	0.74	0.82	0.82	0.87	0.88	0.92	0.56
NR (°C)	10.96	11.12	11.29	11.64	11.96	1.57	13.10	13.16	13.43	12.92	12.04	11.43	12.42
	12.78	13.04	13.19	13.28	13.52	14.25	14.58	14.80	15.07	14.66	13.80	13.27	13.54
Farallon Islands (1925–1943, 1955–1983)													
Mean (°C)	11.80	11.82	11.64	11.28	11.31	11.69	12.22	12.53	13.29	13.47	12.85	12.22	11.81
SD	0.95	1.11	1.18	1.11	1.08	0.93	0.83	1.21	0.97	1.04	1.11	0.94	0.78
NR (°C)	10.85	10.71	10.46	10.17	10.23	10.76	11.39	11.32	12.32	12.43	11.74	11.28	11.03
	12.75	12.93	12.82	12.39	12.39	12.62	13.05	13.74	14.26	14.51	13.96	13.16	12.59
Blunts Reef Lightship (1922–1971)													
Mean (°C)	11.02	10.76	10.36	10.07	10.21	10.26	10.20	10.75	11.34	11.50	11.69	11.46	10.88
SD	0.88	1.09	1.02	1.03	0.92	1.14	0.67	0.74	0.94	0.88	1.02	0.85	0.53
NR (°C)	10.14	9.67	9.34	9.04	9.29	9.12	9.53	10.01	10.40	10.62	10.67	10.61	10.35
	11.90	11.85	11.38	11.10	11.13	11.40	10.87	11.49	12.28	12.38	12.71	12.31	11.41

Table 19. (continued).

Station	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
Crescent City (1934–1982)													
Mean (°C)	9.81	10.10	10.38	10.77	11.54	12.51	13.70	14.42	13.69	12.39	11.31	10.31	11.76
SD	1.06	1.07	1.08	0.92	1.08	1.20	0.95	1.04	1.34	1.12	1.15	0.86	0.69
NR (°C)	8.75	9.03	9.30	9.85	10.46	11.31	12.75	13.38	12.35	11.27	10.16	9.45	11.07
	10.87	11.17	11.46	11.69	12.62	13.71	14.65	15.46	15.03	13.51	12.46	11.17	12.45
OREGON													
Charleston/Coos Bay (1933–1934, 1966–1982)													
Mean (°C)	9.70	9.91	10.44	10.72	11.37	12.32	12.53	12.54	12.54	11.52	11.28	10.53	11.24
SD	0.97	0.95	0.90	0.61	0.66	0.94	0.63	0.91	1.18	0.91	0.90	1.39	0.42
NR (°C)	8.73	8.96	9.54	10.11	10.71	11.38	11.90	11.63	11.36	10.61	10.38	9.14	10.82
	10.67	10.86	11.34	11.33	12.03	13.26	13.16	13.45	13.72	12.43	12.18	11.92	11.82
Astoria/Columbia River Lightship (1925–1979)													
Mean (°C)	5.97	6.61	8.10	10.50	12.80	14.98	17.19	17.87	16.54	13.68	10.09	7.69	11.81
SD	2.29	2.03	1.14	0.97	1.32	1.53	2.45	2.45	1.83	1.01	1.49	2.06	0.59
NR (°C)	3.68	4.58	6.96	9.53	11.48	13.45	14.74	15.42	14.71	12.67	8.60	5.63	11.22
	8.26	8.64	9.24	11.47	14.12	16.51	19.64	20.32	18.37	14.69	11.58	9.75	12.40

Table 19. (continued).

Station	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
Washington													
Neah Bay (1936-1982)													
Mean (°C)	7.27	7.41	7.99	9.13	10.53	11.50	11.74	11.53	11.39	10.65	9.48	8.23	9.74
SD	1.04	0.97	0.81	0.63	0.63	0.92	0.82	0.80	1.03	0.92	1.05	0.98	0.46
NR (°C)	6.23	6.44	7.18	8.50	9.90	10.58	10.92	10.73	10.36	9.73	8.43	7.25	9.28
	8.31	8.38	8.80	9.76	11.16	12.42	12.56	12.33	12.42	11.57	10.53	9.21	10.20

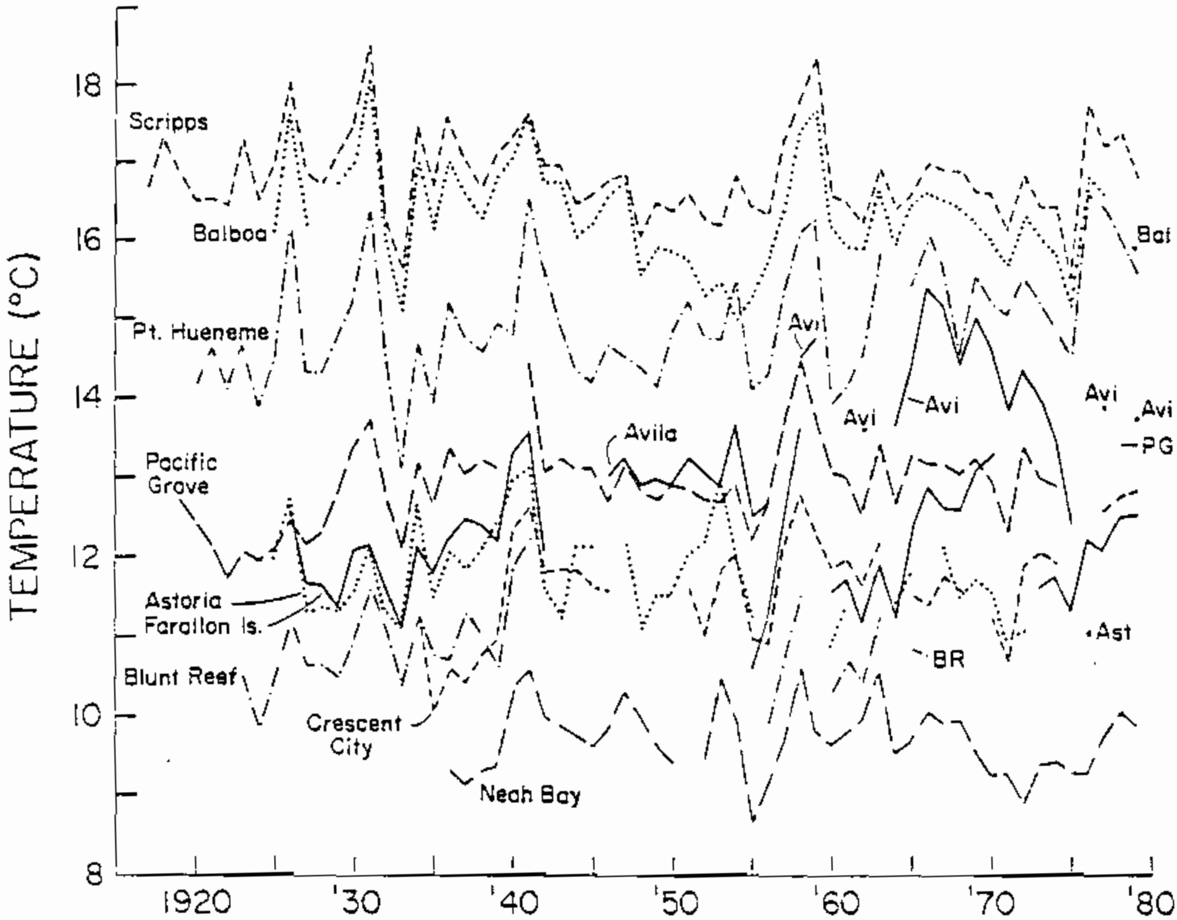


Figure 37. Sea temperature anomalies for longterm monthly means (1920-1978) at stations along the west coast of the United States.

Assuming that the occurrence of temperature anomalies is a random event and using one standard deviation as an expression of normality, 68% of the monthly and annual periods will have sea-surface temperatures within one standard deviation of the mean. Therefore, one can expect that 68% of the turtle sightings will occur during periods of "normal" temperatures, 16% during periods of anomalous hot temperatures and 16% during cold periods. The Chi-square test for goodness of fit (Sokal and Rohlf, 1969) was used to determine if the frequency of sea turtles sighted during each of these categories differed from that statistically expected.

I analyzed the data in three ways. First I compared the frequency of turtle sightings to the frequency of each category of months (normal, hot, cold). I repeated this analysis for years (normal, hot, cold) and finally I compared the frequency of turtle sightings to each of nine categories formed by the combination of months with years (i.e., normal month/normal year, hot month/cold year, cold month/normal year, etc.).

For this last analysis, I used temperature data collected at the Scripps Institute of Oceanography station (for the years of 1917-1983) as my standard in order to develop a contingency table of the percentage frequency of each of these month/year categories
From these percentages I calculated the expected frequency of turtle sightings in each category [% of category X total number of turtle sightings equals the expected number of turtle sightings for that particular month/year category]. Chi-square analysis was then used to compare the observed vs. the expected number of turtle sightings

in each category in order to determine if the pattern of turtle sightings occurs in the same proportion as the array of month/year categories.

Seasonal Distribution of Sea Turtles and the Seasonal Position and Movement of Surface Isotherms in the Northeastern Pacific

Three hundred and sixteen (316) sightings of sea turtles were studied to determine if their seasonal distribution in the northeastern Pacific corresponds to the seasonal position and movement of surface isotherms. This analysis includes 132 sightings from north of Point Conception and 184 from the south. It excludes all sightings for which either the month or locale were in question. Sightings were plotted on monthly maps (Appendix J, Figures 79-117) showing the position of surface sea isotherms. Each month's map shows the average position of isotherms for that month based on 20 years of data compiled by Forrest Miller for the National Marine Fisheries Service's "Fishing Information" reports (NOAA/NMFS, 1948-1967).

CHAPTER VI

RESULTS

Geographic Distribution and Frequency of Sea Turtle Sightings in the Northeastern Pacific Ocean

The occurrence of sea turtles in the northeastern Pacific typically have been dismissed as accidental. No longer is this a valid assumption. Included in this study are records of 363 sea turtles sighted along the Pacific coast of North America from northern Baja California, Mexico, to the Gulf of Alaska (Appendix C, Tables 43-47; Appendices D-H). Of the turtles in the eastern Pacific, only the hawksbill (*Eretmochelys imbricata*) is absent from these sighting records.

Over half (57.7%) of all sightings reported were from south of Point Conception, from along the coast of southern California and northern Baja California, Mexico (34°25'N to 29°45'N latitude). With increasing distance north of Point Conception--towards the Gulf of Alaska--the number of sightings reported rapidly decrease (Table 20).

Dermochelys coriacea

Leatherbacks account for 42% of all sea turtle sightings (Table 20) as well as 58% of those sightings for which the species could be clearly identified. In part, this relative frequency of sightings can be attributed to the leatherback's peculiar appearance.

Table 20. Geographic distribution and frequency of sightings of sea turtles in the northeastern Pacific.

	Dermochelys	Chelonia	Caretta	Lepidochelys	Unidentified Species	Total	Percent
northern Baja southern California*	50	31	40	10	79	210	57.6%
central, northern California	33	8	1	4	7	53	14.6%
Oregon	35	3		2	5	45	12.4%
Washington	9	3	2		4	18	5.0%
Canada	21	3			5	29	8.0%
Alaska	6	2				8	2.2%
Total	154	50	43	16	100	363	
Percentage	42.4%	13.8%	11.9%	4.4%	27.6%		

* includes the coast from 29°45'N to 34°25'N latitude (Point Conception)

Fishermen, not readily recognizing taxonomic distinctions between the species of hard-shelled turtles, quickly recognize the "trunk-back", "tar-back" or "canvas-back" for its black, ridged carapace and for its, often, enormous size. Many accounts describe this animal as a "sea monster", its size frequently dwarfing that of a fishing skiff.

Records were collected on 154 sightings of Dermochelys from northern Baja California to the Gulf of Alaska (Appendix C, Table 43; Appendix I, Figure 63). Of all the species of sea turtles found north of Mexico, Dermochelys is the most northern in its distribution Two-thirds (67%) of these sightings came from north of Point Conception. Of the 154 leatherback sightings, 71 were reported from Oregon and more northern waters, even as far north as 60°34'N latitude--within five degrees of the Arctic Circle--and these extremely northern seas appear to be a normal part of this turtle's summer range (Appendix I, Figure 63; Appendix J, Figures 79-89). Elsewhere in the world, leatherbacks have been captured as far north as 56°45'N latitude off the Atlantic coast of Labrador (Threlfall, 1978) and north of the polar circle (at 69°19'N) along the coast of Norway (Brongersma, 1970).

Chelonia mydas

It is difficult to identify and distinguish species of hard-shelled turtles at sea making it impossible to accurately assess the relative frequency of sightings of Chelonia, Caretta and Lepidochelys (Table 20). Of the sightings involving hard-shelled sea turtles, for which the species could be identified, Chelonia was the most common

(46%). Records were collected for 50 sightings of *Chelonia* (Appendix C, Table 44; Appendix E) and although green sea turtles were recorded as far north as the Gulf of Alaska, almost two-thirds (62%) of *Chelonia* sightings were reported from northern Baja California and southern California (Table 23). In Baja California the most abundant sea turtle is *Chelonia mydas*, known throughout Pacific Mexico as "Prieta".

Historically, Van Denburgh (1922) stated that ... "There are no authentic records of any of these turtles having been taken on the west coast of the United States ...". Many authors have described *Chelonia* as an occasional visitor to southern California. Apparently their inclusion of *Chelonia* in southern California's herpetofauna was based solely upon Stephens' (1922) report that several greens "have been seen in San Diego Bay and in Mission Bay. One was caught at National City [San Diego Bay] several years ago."

Carr (1952), Stebbins (1954) and Banta and Morafka (1966) indicate that there are old "dubious" records of *Chelonia* having occurred in San Francisco Bay. Although records specifically involving *Chelonia* have not been relocated, a giant unidentified sea turtle was captured in San Francisco Bay on 9 December 1907 and again on 11 January 1908 and although this turtle was not identified it might have been the animal in question (Appendix H, Sighting Numbers U14 and U15). These early records might also have originated with the following statement made by Agassiz in 1857 ... "I am indebted for two perfect specimens of this species to my friend Th. G. Gary Jr., of San Francisco, ...As far as I know, this is the first time that sea turtles are mentioned from the western shores of North America. Mr. Gary informs me that they are found along the whole southern coast of California." Unfortunately, Agassiz does not clearly specify where in California these Chelonia were captured or whether this reference was being made of Alta or Baja California. Carr (1952) suggested that the San Francisco turtles might have been brought in from further south by fishing boats. From 1857 until 1930, the Pacific Mail Steamship Company transported green sea turtles from Magdalena Bay in southern Baja California, Mexico, to San Diego and San Francisco markets (Smith, 1894; Jordan, 1887).

During 1957 and 1958, when ocean temperatures were unusually warm along the Pacific coast of North America, there were many reports of turtles in coastal waters as far south as Nootka Sound in British Columbia, Canada (Radovich, 1961). Many of these sightings involved a single turtle or several turtles; rarely were they captured and their species identity is uncertain. Quite possibly, though, come of these turtles were greens, as were those captured in 1957 in Los Angeles Harbor, California (Radovich, 1961).

Chelonia mydas have been captured in Coos Bay, Oregon (Forbes and McKey-Fender, 1968); in Washington off Westport (gray's Harbor) and in the Naselle River estuary of Willapa Bay (Slater, 1963; personal communication 1981); in Ucluelet Inlet on Vancouver Island, British Columbia (Carl, 1955; Logier and Toner, 1961) and at

Point Macartney, Kupreanof Island and in Eliza Harbor, Admiralty Island, Alaska (Hodge, 1981). Greens sea turtles apparently range considerable further north along the Pacific coast of North America than they do along the Atlantic coast. In the Atlantic, greens have been reported in American waters only as far north as Newfoundland, Canada (Carr, 1952) and this is considerably further south than their Pacific counterparts. But on both coasts greens are most common at the same more southern latitudes, from central California south and from North Carolina south.

Caretta caretta

Of the four species of marine turtles found in the eastern Pacific, north of Mexico, *Caretta* tends to be the most southern in its distribution (Table 24; Appenidx I, Figure 65). It is common along the coast of northern Baja California and southern California but has been reported only once from central California and twice from Washington (Appendix C, Table 4). In the Atlantic, *Caretta* is a more common visitor to northern latitudes--along the northern Atlantic coast of the United States; off Nova Scotia and Newfoundland, Canada (Bleakney, 1965); in the English Channel of Great Britain and along the coast of Norway (Matheson, 1960). Loggerheads are sighted within the the Gulf Stream and their distribution in the northern Atlantic is probably tied quite closely to this gyral current. If the loggerheads are using the current, as the data indicates, and ending up in the north Atlantic, why aren't the greens?

Lepidochelys olivacea

The Pacific ridley has not been reported frequently enough to clearly estimate its abundance and range north of Mexico (Table 25). Records were collected on only 16 sightings and of these ten were from southern California, four from central and northern California and two from Oregon as far north as 46°00'N latitude (Appendix C, Table 46; Appendix G; Appendix I, Figure 66).

Interesting enough, the only known instance of any species of sea turtle copulating in the coast studied or the northeastern Pacific involved a pair of Lepidochelys mating, ironically, off the pier at the Scripps Institute of Oceanography (located along San Diego's open coastline) on 29 August 1973 (Hubbs, 1977). The male was captured and species identification confirmed. Some thought should be given to the fact that sea turtles breed off nesting beaches and the Pacific ridley is not known to nest north of Magdalena Bay, southern Baja California, 615 miles south of San Diego (Fritts, et al, 1982). I have also received two intriguing reports--one from the 1960's and the other from June 1980--describing in each case the discovery of a single hatchling turtle (species unidentified) on the beach or in the surf along the Torrey Pines/Del Mar area immediately north of Scripps (Sighting No. U44).

Correlation of the Occurrence of Sea Turtles in the Northeastern Pacific and Periods of Anomalous Surface Ocean Temperatures

Table 21 shows the results of the chi-square analyses comparing observed and expected frequencies of turtle sightings during months of normal, hot or cold surface ocean temperatures for:

1) all turtle sightings;
2) for each species;
3) during the July, August and September "turtle season";
4) during the October through June "nonseason" months;
5) south of Point Conception, California;
6) north of Point Conception;
7) south of Point Conception during the turtle season;
8) south of Point Conception during the nonseason months;
9) north of Point Conception during the turtle season;
10) north of Point Conception during the nonseason months.

Table 30 shows the results of these same analyses for turtle sightings compared with expected frequencies during normal, hot and cold years.

Chi-square Comparison of Observed vs. Expected Frequencies of Turtle Sightings in Months of Normal, Hot, Cold Ocean Temperatures

Chi-square analysis (Table 21) comparing the observed frequency of sea turtle sightings with that expected during each category of months (normal, hot, cold) indicates that for all species combined:

1) A significantly greater number of turtles were reported during months of anomalous hot ocean temperatures and fewer during cold months than was expected.

2) That south of Point Conception, significantly more turtle sightings were reported during hot months than expected.

3) That north of Point Conception, while there was not an increase in sightings during hot months, there was a significant decrease during cold months and more sightings during months of normal temperatures than was expected.

4) That during the nonseason months--October through June--both north and south of Point Conception, there was a significant increase in the number of sightings during months when temperatures were unusually hot. When nonseason months are unusually warm, there is an increase in the number of sea turtles sighted in the northeastern Pacific during those months.

5) That during the turtle season--July, August and September--there were significantly fewer sightings of turtles during years when the months were unusually cold and significantly more than expected when surface sea temperatures were normal. The trend here is toward normal rather than toward hot temperatures.

a. South of Point Conception, there were no statistically significant differences between the observed and expected frequencies of sightings during the turtle season. This indicates that during July, August and September turtle sightings south of Point Conception are independent of, and not caused by, influxes of unusually hot ocean temperatures.

b. North of Point Conception, during years when the "turtle season" months were unusually cold there was a significant decrease in the number of turtle sightings. When these months were normal there was a significant increase in sightings. Again this increase was in "normal" rather than "hot" month sightings. This indicates that there is a turtle season in the northeastern Pacific; that during this three month season turtles occur in these northern waters independent of anomalous hot temperatures.

Chi-square Comparison of Observed vs. Expected Frequencies of Turtle Sightings in Years of Normal, Hot, Cold Ocean Temperatures

Chi-square analysis (Table 22) comparing the observed frequency of sea turtle sightings with that expected during each category of years (normal, hot, cold) indicates that (for all species combined) there was a significantly greater number of turtles sighted during years of unusually hot ocean temperatures and fewer during cold years than was statistically expected.

These results are the same whether considering the total number of sightings or if the sightings are broken down geographically (south of Point Conception - north of Point Conception), seasonally (July, August, September turtle season - October through June nonseason) or geographically and seasonally (south of Point Conception season/nonseason - north of Point Conception season/nonseason).

Dermochelys coriacea. Statistically, a significantly greater number of leatherback sightings occurred during years of hot ocean temperatures—both north and south of Point Conception and during season and nonseason months—than was expected. The occurrence of Dermochelys in the northeastern Pacific reflects the occurrence of years of abnormally hot ocean conditions.

Chelonia mydas. Statistically there are fewer sightings of Chelonia during cold years than were expected. In cold years they are reported less frequently during nonseason months than expected, meaning that in cold years green sea turtles tend to be found in the northeastern Pacific, particularly north of Point Conception, only during the seasonally warmest time of the year—July, August and September. North of Point Conception, Chelonia are statistically more common during hot years than expected. South of Point Conception, green sea turtles appear throughout the year and their occurrence both seasonally and nonseasonally is independent of years of anomalously warm water. South of Point Conception, green sea turtles do not depend on hot years.

Caretta caretta. Overall, loggerhead sea turtle sightings occurred more frequently during hot years and less frequently during cold years than was statistically expected. This indicates that the occurrence of loggerheads in the northeastern Pacific reflects and depends upon years of hot temperatures. An exception to this is that south of Point Conception, during July, August and September their occurrence is independent of hot years, that they are in southern

California (in expected numbers) during years of normal temperatures as well as in cold years.

The results of the separate analysis of northern sightings (north of Point Conception) makes no sense in view of the other chi-square analyses of loggerhead sightings. Analysis of all loggerhead sightings shows this species depends on years of hot temperatures. South of Point Conception loggerheads are independent only during the seasonally warmest months of the year--July, August and September. And yet these additional results also indicate that north of Point Conception (both during the season and nonseason months) loggerheads appear independently of hot years, that they are in the northern waters regardless of whether the year is hot, normal or cold. This last analysis includes only three northern sightings. Because of this very small sample size I do not trust the results of the chi-square analysis run separately for loggerhead sightings north of Point Conception.

Lepidochelys olivacea. Chi-square analysis of the frequency of the Pacific ridley indicates that the occurrence of this species in the northeastern Pacific is not dependent, in any way, upon years of hot sea temperatures. This analysis involves only 16 sightings and possibly these results are in part due to the small sample size.

Table 21. Synopsis of chi-square analyses between the observed and expected numbers of sea turtles sighted in the northeastern Pacific during months of "normal", "hot", or "cold" surface temperatures. Chi square value, with 2 degrees of freedom at the 0.05 level of significance, must be greater than 5.991 to be statistically significant.

Species	chi square	Ho hypothesis	Reason
TOTAL SIGHTINGS (northern Baja California through the Gulf of Alaska)			
Dermochelys	5.1771	accept	
Chelonia	6.6125	reject	too few sightings in months anomalously cold
Caretta	10.7445	reject	too many in months unusually hot
Lepidochelys	1.1415	accept	
All Species Combined	16.8703	reject	too many sightings in months anomalously hot, too few in months anomalously cold
Sightings During the "Turtle Season" of July, August and September			
Dermochelys	7.7544	reject	more sightings in months of normal temperatures than expected and too few in cold
Chelonia	2.2143	accept	
Caretta	0.4639	accept	
Lepidochelys	3.2941	accept	
All Species Combined	7.4431	reject	more sightings in months of normal temperatures and too few in months of cold

Table 21. (continued).

Species	chi square	Ho hypothesis	Reason
Sightings During the "Nonseason" Months (October through June)			
Dermochelys	4.2427	accept	
Chelonia	6.6911	reject	too many in months abnormally hot, too few in cold
Caretta	19.3400	reject	too many in anomalously hot months
Lepidochelys	2.0294	accept	
All Species Combined	43.7047	reject	fewer in normal, more in hot
Sightings South of Point Conception, California (northern Baja and southern California)			
Dermochelys	8.1177	reject	more in months anomalously hot than expected
Chelonia	3.5239	accept	
Caretta	10.1185	reject	more in hot than expected
Lepidochelys	2.5368	accept	
All Species Combined	17.5304	reject	more in hot than expected
Sightings North of Point Conception			
Dermochelys	9.8167	reject	more in months of normal temperatures than expected (equal numbers in months anomalously hot or cold)
Chelonia	3.6781	accept	
Caretta	1.0441	accept	

Table 21. (continued).

Species	chi square	Ho hypothesis	Results
North of Point Conception (continued)			
Lepidochelys	1.4143	accept	
All Species Combined	8.9788	reject	too few in months anomalously cold, more in normal months than expected
Sightings South of Point Conception During Turtle Season (July, August, September)			
Dermochelys	8.0690	reject	more sightings in hot months than expected
Chelonia	1.2009	accept	
Caretta	0.9446	accept	
Lepidochelys	2.8235	accept	
All Species	2.1326	accept	
Sightings North of Point Conception During Turtle Season (July, August, September)			
Dermochelys	13.7401	reject	more in months of normal or anomalously hot temperatures and fewer in months of cold
Chelonia	1.1692	accept	
Caretta	0.9412	accept	
Lepidochelys	0.4706	accept	
All Species Combined	14.7467	reject	more in months of normal temperatures and too few in months of either anomalously hot or cold temperatures

Table 21. (continued).

Species	chi square	Ho hypothesis	Reason
Sightings South of Point Conception, California During "Nonseason" Months (October through June)			
Dermochelys	2.0336	accept	
Chelonia	5.2535	accept	
Caretta	15.6128	reject	more sightings during months of anomalously hot temperatures than expected
Lepidochelys	0.8713	accept	
All Species Combined	23.2956	reject	more in months of anomalous hot temperatures than expected
Sightings North of Point Conception During "Nonseason" Months (October through June)			
Dermochelys	3.4719	accept	
Chelonia	2.6391	accept	
Caretta	5.2500	accept	
Lepidochelys	1.4143	accept	
All Species Combined	21.2671	reject	more in months of anomalous hot temperatures than expected

Table 22. Synopsis of chi square analyses between the observed and expected numbers of sea turtles sighted in the northeastern Pacific during years of "normal", "hot", or "cold" surface sea temperatures. Chi square value, with 2 degrees of freedom at the 0.05 level of significance, must be greater than 5.991 to be statistically significant.

Species	chi square	Ho hypothesis	Reason
ALL SIGHTINGS (northern Baja California - Gulf of Alaska; all months)			
Dermochelys	68.8170	reject	more sightings during months of anomalously hot temperatures and fewer during cold than expected
Chelonia	9.6865	reject	fewer during months of anomalously cold temperatures than expected
Caretta	12.8407	reject	same as for _Dermochelys_
Lepidochelys	1.4862	accept	
All Species Combined	98.7052	reject	same as for _Dermochelys_
Sightings During the "Turtle Season" of July, August and September			
Dermochelys	48.4848	reject	more during months anomalously hot and fewer in months anomalously cold than expected
Chelonia	1.9867	accept	
Caretta	4.7071	accept	
Lepidochelys	3.2941	accept	
All Species Combined	51.5430	reject	same as for _Dermochelys_

Table 22. (continued).

Species	chi square	Ho hypothesis	Reason
Sightings During the "Nonseason" Months (October through June)			
Dermochelys	15.7010	reject	more during months of anomalous hot temperatures than expected
Chelonia	6.1397	reject	fewer during months of anomalous cold than expected
Caretta	10.5855	reject	more in hot, fewer in cold
Lepidochelys	0.3546	accept	
All Species Combined	34.7387	reject	more in hot, fewer in cold
Sightings South of Point Conception, California (includes northern Baja and southern California)			
Dermochelys	19.2921	reject	more in hot than expected
Chelonia	4.8221	accept	
Caretta	11.8107	reject	more in hot, fewer in cold
Lepidochelys	6.6650	reject	more in months of normal temperatures than expected
All Species Combined	37.6518	reject	more in months abnormally hot and fewer during months anomalously cold than expected
Sightings North of Point Conception			
Dermochelys	49.5628	reject	more in hot, fewer in cold fewer in months of normal temperatures than expected

Table 22. (continued).

Species	Chi Square	Ho Hypothesis	Reason
Sightings North Of Point Conception (continued)			
Chelonia	8.2639	reject	more in months of anomalous hot months and fewer during months of abnormally cold
Caretta	1.0441	accept	
Lepidochelys	0.0050	accept	
All Species Combined	67.8693	reject	more in months abnormally hot and fewer in months abnormally cold
Sightings South of Point Conception During Turtle Season (July, August and September)			
Dermochelys	9.1972	reject	more in months abnormally hot and fewer in months abnormally cold
Chelonia	2.4020	accept	
Caretta	5.3062	accept	
Lepidochelys	2.8235	accept	
All Species Combined	12.7982	reject	same as for Dermochelys
Sightings North of Point Conception During Turtle Season (July, August and September)			
Dermochelys	40.4249	reject	more in abnormally hot months than expected
Chelonia	5.5809	accept	
Caretta	0.9412	accept	

Table 22. (continued).

Species	chi square	Ho hypothesis	Reason
Sightings North of Point Conception During the "Turtle Season" (July, August and September) (continued)			
Lepidochelys	0.4706	accept	
All Species Combined	47.7871	reject	more in months abnormally hot and fewer in months abnormally cold than expected
Sightings South of Point Conception, California During "Nonseason" Months (October through June)			
Dermochelys	0.8256	accept	
Chelonia	3.2638	accept	
Caretta	7.9412	reject	more in months abnormally hot and fewer during months anomalously cold
Lepidochelys	0.8713	accept	
All Species Combined	21.5892	reject	same as for Caretta
Sightings North of Point Conception During "Nonseason" Months (October through June)			
Dermochelys	18.9799	reject	more in months abnormally hot than expected
Chelonia	3.8552	accept	
Caretta	5.2500	accept	
Lepidochelys	1.4143	accept	
All Species Combined	26.3347	reject	more in months abnormally hot, fewer in months abnormally cold

Chi-square Comparison of Observed vs. Expected Frequencies of Turtles Sighted during Nine Categories of Months and Years of Hot, Normal, Cold Temperatures

Fifty-one percent of all sightings of sea turtles in the northeastern Pacific occurred during a month of normal temperatures within a year of also normal temperatures (Table 24). In order to test the significance of this seemingly high percentage of sightings reported within this one category, expected frequencies of turtle sightings were generated for each category (Table 24) and chi-square analysis applied. The question was asked, do the observed frequencies of turtle sightings fit the pattern of those expected for each category, does the frequency of turtle sightings occur in proportion to the month/year array.

First, using all turtle data from 1917-1983, results of the chi-square test for goodness of fit (Table 25) indicate that a significantly greater number of turtles were sighted during hot years regardless of the month's temperature (normal, hot, cold) and fewer in cold years (normal, cold months).

Because 1983 was an "El Nino" year throughout the north-eastern Pacific in which each month was abnormally hot and thus there was no other possible temperature category for the turtles to exist in, I ran the analysis again, this time excluding the 1983 data, to see if this altered the results (Table 25). Although this removed the overload of hot month/hot year 1983 sightings, bringing that category into statistical balance, there still were significantly

Table 23. Synopsis of the number of sightings of sea turtles reported along the Pacific coast of North America (north of 29°45'N latitude) during months and years characterized by periods of "normal", "hot" or "cold" surface temperatures.

Surface Temperature Categories	Number and Percentage of Sightings					
	Dermochelys	Chelonia	Caretta	Lepidochelys	Unidentified Species	TOTAL
Normal Months	95 (75.40%)	37 (72.55%)	21 (52.50%)	12 (75.00%)	42½ (59.86%)	207½ (68.3%)
Hot Months	20 (15.87%)	12 (23.53%)	14 (35.00%)	3 (18.75%)	19½ (27.47%)	68½ (22.5%)
Cold Months	11 (8.73%)	2 (3.92%)	5 (12.50%)	1 (6.25%)	9 (12.68%)	28 (9.2%)
TOTAL NUMBER	126	51	40	16	71	304
Normal Years	74 (52.48%)	39 (76.47%)	27 (64.29%)	13 (81.25%)	43 (60.56%)	196 (61.1%)
Hot Years	58 (41.14%)	11 (21.57%)	14 (33.33%)	2 (12.50%)	26 (36.62%)	111 (34.6%)
Cold Years	9 (6.38%)	1 (1.96%)	1 (2.38%)	1 (6.25%)	2 (2.82%)	14 (4.4%)
TOTAL NUMBER	141	51	42	16	71	321

Table 24. Number and percentage of sightings of sea turtles along the Pacific coast of North America (north of 29°45'N latitude) during months and years characterized by "normal", "hot" or "cold" surface temperatures.*

Surface Temperature Categories	Number and Percentage of Sightings					
	Dermochelys	*Chelonia*	*Caretta*	*Lepidochelys*	Unidentified Species	TOTAL
Normal Month/Normal Year	62 (49.21%)	32 (62.75%)	18 (45.00%)	11 (68.75%)	31 (43.66%)	154 (50.7%)
Hot Month/Normal Year	2 (1.59%)	5 (9.80%)	3 (7.50%)	2 (12.50%)	3½ (4.93%)	15½ (5.1%)
Cold Month/Normal Year	3 (2.38%)	2 (3.92%)	4 (10.00%)	0 (0.00%)	8½ (11.97%)	17½ (5.8%)
Subtotal	67 (53.18%)	39 (76.47%)	25 (62.50%)	13 (81.25%)	43 (60.56%)	187 (61.5%)
Normal Month/Hot Year	31 (24.60%)	4 (7.84%)	3 (7.50%)	1 (6.25%)	10 (14.09%)	49 (16.1%)
Hot Month/Hot Year	17 (13.49%)	7 (13.73%)	11 (27.50%)	1 (6.25%)	16 (22.54%)	52 (17.1%)
Cold Month/Hot Year	4 (3.18%)	0 (0.00%)	0 (0.00%)	0 (0.00%)	0 (0.00%)	4 (1.3%)
Subtotal	52 (41.27%)	11 (21.57%)	14 (35.00%)	2 (12.50%)	26 (36.63%)	105 (34.6%)

Table 24. (continued).

Surface Temperature Categories	Number and Percentage of Sightings					
	<u>Dermochelys</u>	<u>Chelonia</u>	<u>Caretta</u>	<u>Lepidochelys</u>	Unidentified Species	TOTAL
Normal Month/Cold Year	3 (2.38%)	1 (1.96%)	0 (0.00%)	0 (0.00%)	1½ (2.11%)	5½ (1.8%)
Hot Month/Cold Year	0 (0.00%)	0 (0.00%)	0 (0.00%)	0 (0.00%)	0 (0.00%)	0 (0.0%)
Cold Month/Cold Year	4 (3.18%)	0 (0.00%)	1 (2.50%)	1 (6.25%)	½ (0.70%)	6½ (2.1%)
Subtotal	7 (5.56%)	1 (1.96%)	1 (2.50%)	1 (6.25%)	2 (2.81%)	12 (4.0%)
TOTAL NUMBER SIGHTINGS	126	51	40	16	71	304

* includes only those sightings occurring during the period of 1916-1983.

greater numbers of sightings reported during normal month/hot year and cold month/ hot year categories and fewer in normal month/cold years than were statistically expected.

While the greatest number of sightings occur during months and years of normal temperatures, their frequency fits statistical expectations. The 1917-1982 and 1917-1983 data clearly indicate that sea turtles do occur in greater numbers than expected during hot years, that although most turtles are in the northeastern Pacific under normal temperature conditions, turtles do react to years of unusually warm ocean conditions and travel in greater numbers into these waters.

In 1977, fishermen and biologists, from Mexico to Alaska, became involved with this project reporting turtle sightings. Because of their intense participation in reporting sightings, I decided to analyze the data again this time separating the 1977-1983 sightings from the 1917-1976 sightings which were obtained from the literature and museum collections. The results from these two sets of data were very different from each other (Table 25).

The observed frequency of turtle sightings during 1917-1976 fit the pattern statistically expected, the frequencies of turtle sightings were in proportion to those expected in each month/year category. This set of data indicates that sea turtles occur in the northeastern Pacific independent of periods of anomalous sea temperatures, ie. that they are here regardless of periods of hot conditions. But results of the 1977-1982 and 1977-1983 data, collected since the start of this project, parallel the results of

Table 25. Synopsis of chi square analyses used to determine if the occurrence of sea turtles in the northeastern Pacific is related to periods of anomalous surface ocean temperatures. Years of data were separately analyzed to determine if results were the same for the years before and those after I began requesting sighting reports from fishermen and coastal biologists and to determine what effects the "el nino" year of 1983 had on the data. Chi square value, with 8 degrees of freedom at a significance level of 0.05 must be greater than 15.507 to be statistically significant.

Years of Data Analyzed	Chi Square	Hypothesis	Reason
1917–1983 (all years of data)	132.2270	reject	more sightings during hot years (normal, hot or cold months) and fewer in cold years (normal or cold months) than expected
1917–1982 (excluding the 1983 "el nino" year)	108.2946	reject	more during hot years (normal or cold months) and fewer during cold year (normal month) periods than expected
1917–1976 (before the distribution of sighting request brochures)	9.7599	accept	
1977–1983 (years when actively requesting sighting reports)	51.9207	reject	more during normal months in hot years and fewer during hot months in normal years
1977–1982 (excluding the "el nino" year of 1983)	82.6116	reject	more during hot or normal months of hot years and fewer during hot months in normal years than expected

the 1917-1982 and 1917-1983 analyses--that more turtles were sighted during hot years (hot, normal, cold months) than were statistically expected.

Discussion

Hubbs (1960) and Radovich (1961) suggested that unusually warm ocean conditions--temperature anomalies--were responsible for the sighting of sea turtles in the northeastern Pacific. These results indicate that this is especially true for sightings during nonseason months (October-June) and for sightings of turtles north of Point Conception.

During the nonseason, October through June, turtles are sighted more frequently if these months are abnormally warm or if the year averaged above normal temperatures. North of Point Conception, sightings of sea turtles are restricted to the warmest season of the year--July, August and September--unless it is an unusually hot year.

Although the greatest number of turtle sightings (51%) occur when ocean temperatures are normal, this is as statistically expected; sea turtles do react to years of unusually warm ocean temperatures and in these warm years greater numbers of turtles travel into the northeastern Pacific. When months or years are abnormally hot, turtle sightings increase. When surface temperatures are abnormally cold, sightings decrease, especially in more northern areas and during nonseason months. This pattern is particularly clear when sightings for all species are totaled together, for sightings of leatherbacks and for loggerheads; and for those green sea turtles sighted north of Point Conception.

It makes sense that this trend should appear strongest in Dermochelys because of all the species of sea turtles involved, it has the most northern distribution and definitely is the most seasonal in its appearance in the northeastern Pacific. Sixty-one percent of its sightings are from north of Point Conception. During years that warm offshore currents move inshore or when isotherms advance unusually or unseasonally far north, coastal temperatures increase and leatherbacks are reported in even greater numbers north of Point Conception. Eighty-one percent of all leatherback sightings were reported durinbg July, August and September. In years when surface ocean temperatures are unusually warm all year, leatherbacks appear earlier or remain longer than usual in the northeastern Pacific.

Green sea turtles can be found in the northeastern Pacific all year. In cold years, and north of Point Conception, they are found only during the warmest season of the year--July, August and September. North of Point Conception, their numbers increase in hot years. In years of normal or cold temperatures, they are restricted to July, August and September. South of Point Conception, ocean temperatures are always warm enough for greens--even in most cold years--and they can appear along southern California all year. While greens are most common during July, August and September, their appearance in southern California does not reflect nor depend upon years of hot temperatures.

Loggerheads occur in low numbers along the coast of southern California in July, August and September during any year--regardless of annual temperature--and in warm years they can be seen even out of season (October-June).

The occurrence of the Pacific ridley in the northeastern Pacific does not appear, in any way, dependent upon years of hot ocean conditions.

I must conclude that, indeed, sea turtles do respond to periods of unusually hot surface temperatures but that this does not detract in any way from the evidence indicating that there is a turtle season in the northeastern Pacific and that sea turtles are a regular part of this northern coast's environment and not merely a result of el nino years or unusual periods of abnormally hot ocean temperatures.

Seasonality of Sea Turtle Sightings in the Northeastern Pacific

Marine turtles appear seasonally along the Pacific coast of North America from northern Baja California (29°45'N) to the Gulf of Alaska--during July, August and September--when surface sea temperatures are warmest each year (Table 26, Figure 38). Sixty-three percent (63%) of all sea turtle sightings were reported during these three peak months (Tables 27). With increasing distance north, the turtle season--July, August and September--becomes more pronounced with a greater percentage of the area's sightings restricted to this three month season. In southern California and northern Baja California, 55% of the sightings were reported during

Table 26. Mean monthly and annual surface sea temperatures (°C) recorded at eleven stations along the Pacific coast of the United States.

Station	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
California													
La Jolla	14.08	13.57	14.50	15.38	16.92	18.40	19.86	20.76	19.36	17.93	16.24	14.89	16.87
Balboa	14.05	14.10	14.32	14.98	16.14	17.57	18.61	19.32	18.48	17.77	16.23	14.98	16.45
Pt. Hueneme/ Pt. Dume	13.55	13.40	13.19	13.54	14.13	15.07	16.43	17.31	17.07	16.58	15.43	14.36	15.04
Avila/ Port San Luis	12.52	12.67	12.28	12.41	12.91	14.00	15.25	15.84	15.69	14.99	13.73	12.79	13.80
Pacific Grove	11.87	12.08	12.24	12.46	12.74	13.41	13.84	13.98	14.25	13.79	12.92	12.35	12.98
Farallon Islands	11.80	11.82	11.64	11.28	11.31	11.69	12.22	12.53	13.29	13.47	12.85	12.22	11.81
Blunts Reef Lightship/ Cape Mendocino	11.02	10.76	10.36	10.07	10.21	10.26	10.20	10.75	11.34	11.50	11.69	11.46	10.88
Crescent City	9.81	10.10	10.38	10.77	11.54	12.51	13.70	14.42	13.69	12.39	11.31	10.31	11.76

Table 26. (continued).

Station	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
Oregon													
Charleston/ Coos Bay	9.70	9.91	10.44	10.72	11.37	12.32	12.53	12.54	12.54	11.52	11.28	10.53	11.24
Astoria/ Columbia River Lightship	5.97	6.61	8.10	10.50	12.80	14.98	17.19	17.87	16.54	13.68	10.09	7.69	11.81
Washington													
Neah Bay	7.27	7.41	7.99	9.13	10.53	11.50	11.74	11.53	11.39	10.65	9.48	8.23	9.74

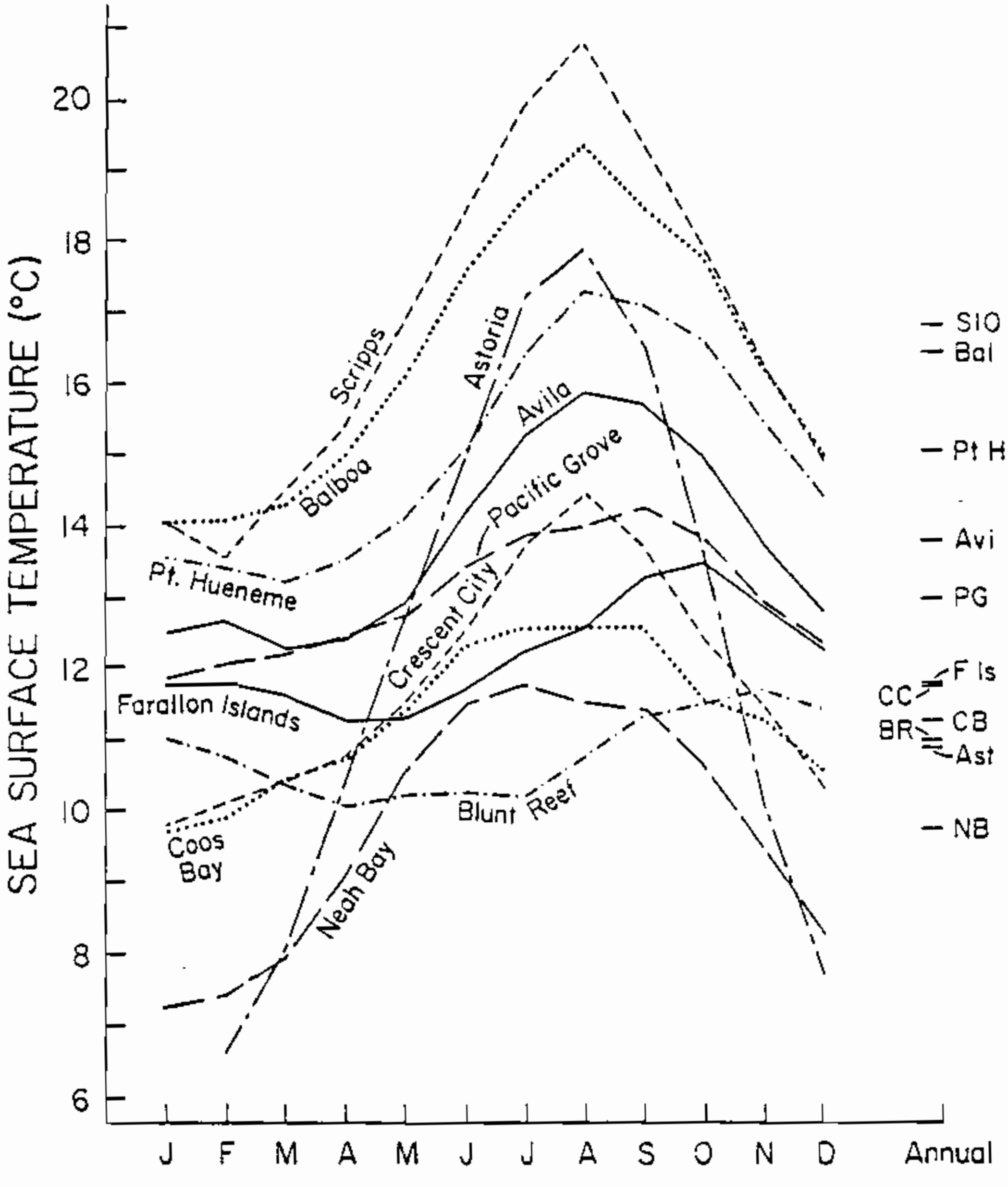


Figure 38. Mean monthly and annual sea surface temperatures at eleven stations along the Pacific coast of the United States.

these months as compared to 62% in California north of Point Conception, 84% in Oregon and 89% in Washington (Table 28).

South of Point Conception

Surface ocean temperatures are adequately warm to allow sea turtles, particularly hard-shelled species, to occur along the coast of southern California all year. But even here, their numbers increase appreciably in May and June, peak in July, August and September and subsequently decrease (Tables 30-32, Appendix J, Figures 67-78). Fifty-five percent (55%) of the sightings in southern California occur during these three months. The decreased number of sightings of hard-shelled sea turtles during winter and spring may possibly represent decreased activity due to seasonally cooler temperatures rather than animals trailing or leading an annual migration (Fritts, et al, 1983).

North of Point Conception

North of Point Conception, sea turtles can be expected only during July, August and September; 75% of the sightings north of the point were reported during these three months.

Beginning in July, turtles are found widespread along the entire coast from southern California to Washington. This explosion in turtle sightings continues into August and September with turtles being reported with increasing frequency in waters even further to the north--off Canada and the Gulf of Alaska (Table 28, Appendix J, Figures 67-78). Along Oregon, turtles first appear in July and are reported with considerable frequency throughout August. In Wash-

Table 27. Seasonal frequency of sea turtles sighted in the northeastern Pacific from northern Baja California (29°45'N) to the Gulf of Alaska.

	Dermochelys	Chelonia	Caretta	Lepidochelys	Unidentified Species	Total	Percent
January	2	1	2	1	3	9	2.7%
February	0	5	3	0	5	13	3.9%
March	2	1	2	1	5	11	3.3%
April	1	1	0	1½	2	5½	1.7%
May	2	4	3	½	9½	19	5.7%
June	5	0	0	0	8½	13½	4.1%
July	44	6	7	0	15½	72½	21.8%
August	36	6	10	5	12½	69½	20.9%
September	31	9½	8	1	18½	68	20.4%
October	6	10½	2	3	5½	27	8.1%
November	4	4	1	2	4	15	4.5%
December	4	2	1	1	2	10	3.0%
Total	137	50	39	16	91	333	

½ values were given when sightings were reported, for example, as "July or August"

Table 28. Seasonal frequency and distribution of sightings of all species of sea turtes in the northeastern Pacific.

	S. Cal.	C/N Cal.	Ore.	Wash.	Can.	Al.	Subtotal	%
January	7	2	0	0	0	0	9	2.7%
February	10	0	2	1	0	0	13	3.9%
March	9	0	0	0	1	1	11	3.3%
April	2	1½	0	0	2	0	5½	1.7%
May	16½	½	0	0	2	0	19	5.7%
June	13½	0	0	0	0	0	13½	4.1%
July	36½	9	18½	4	3½	0	71½	21.5%
August	41½	6	13½	4	2½	2	69½	20.9%
September	25	13	6	8	14	2	68	20.5%
October	15	6	2	1	2	1	27	8.1%
November	10	2	1	0	1	1	15	4.5%
December	2	5	2	0	1	0	10	3.0%
Subtotal	188	45	45	18	29	7	332	
No Month	21	8				1	30	
Geogr. Total	209	53	45	18	29	8	362	
Geogr. %	57.7%	14.6%	12.4%	5.0%	8.0%	2.2%		

S. Cal. includes northern Baja California from 29°45'N latitude to Point Conception
½ values were given when sightings were reported, for example, as "July or August"

Table 29. Seasonal frequency and distribution of sightings of leatherbacks (*Dermochelys coriacea*) in the northeastern Pacific.

	S Cal.	C/N Cal.	Ore.	Wash.	Can.	Al.	Subtotal	%
January	1	1					2	1.5%
February								
March					1	1	2	1.5%
April		1					1	0.7%
May	2						2	1.5%
June	5						5	3.7%
July	12½	9	16	3	3½		44	32.1%
August	9½	6	13	3	2½	2	36	26.3%
September	7	5	2	2	13	2	31	22.6%
October	2	1	2	1			6	4.4%
November	3				1		4	2.9%
December		2	2				4	2.9%
Subtotal	42	25	35	9	21	5	137	
No Month	8	8				1	17	
Geog. Total	50	33	35	9	21	6	154	
Geog. %	32.5%	21.4%	22.7%	5.8%	13.6%	3.9%		

S. Cal. includes northern Baja California from 29°45'N latitude to Point Conception
½ values were given when sightings were reported, for example, as "July or August"

Table 30. Seasonal frequency and distribution of sightings of green sea turtles (Chelonia mydas) in the northeastern Pacific (exclusive of those in San Diego Bay during November - April).

	S. Cal.	C/N Cal.	Ore.	Wash.	Can.	Al.	Subtotal	%
January	1						1	2.0%
February	3	2					5	10.0%
March	1						1	2.0%
April	1						1	2.0%
May	4						4	8.0%
June							0	0.0%
July	6						6	12.0%
August	5			1			6	12.0%
September	3½	3	1	2			9½	19.0%
October	4½	3			2	1	10½	21.0%
November	2	1				1	4	8.0%
December		1			1		2	4.0%
Geogr. Total	31	8	3	3	3	2	50	
Geogr. %	62.0%	16.0%	6.0%	6.0%	6.0%	4.0%		

S. Cal. includes northern Baja California from 29°45'N latitude to Point Conception
½ values were given when sightings were reported, for example, as "July or August"

Table 31. Seasonal frequency and distribution of sightings of loggerhead sea turtles (*Caretta caretta*) in the northeastern Pacific.

	S Cal.	C/N Cal.	Ore.	Wash.	Can.	Al.	Subtotal	%
January	2						2	5.1%
February	2			1			3	7.7%
March	2						2	5.1%
April								0.0%
May	3						3	7.7%
June								0.0%
July	7						7	18.0%
August	10						10	25.6%
September	6	1		1			8	20.5%
October	2						2	5.1%
November	1						1	2.6%
December	1						1	2.6%
Subtotal	36	1		2			39	
No Month	4						4	
Geogr. Total	40	1		2			43	
Geogr. %	93.0%	2.3%		4.7%				

S Cal. includes northern Baja California from 29°45'N latitude to Point Conception

Table 32. Seasonal frequency and distribution of sightings of Pacific ridley sea turtles (*Lepidochelys olivacea*) in the northeastern Pacific.

	S Cal.	C/N Cal.	Ore.	Wash.	Can.	Al.	Subtotal	%
January	1						1	6.3%
February								0.0%
March	1						1	6.3%
April	1	½					1½	9.4%
May		½					½	3.1%
June								0.0%
July								0.0%
August	5						5	31.3%
September			1				1	6.3%
October	2	1					3	18.8%
November		1	1				2	12.5%
December		1					1	2.3%
Subtotal	10	4	2				16	
Geogr. Total	10	4	2				16	
Geogr. %	62.5%	25.0%	12.5%					

S Cal. includes northern Baja California from 29°45'N latitude to Point Conception
½ values were given when sightings were reported, for example, as "July or August"

Table 33. Seasonal frequency and distribution of sea turtles, for which the species could not be clearly identified, in the northeastern Pacific.

	S Cal.	C/N Cal.	Ore.	Wash.	Can.	Al.	Subtotal	%
January	2	1					3	3.3%
February	5						5	5.6%
March	5						5	5.6%
April					2		2	2.2%
May	7½				2		9½	10.6%
June	8½						8½	9.4%
August	12		½				12½	13.9%
September	8½	4	2	3	1		18½	20.6%
October	4½	1					5½	6.1%
November	4						4	4.4%
December	1	1					2	2.2%
Subtotal	69	7	5	4	5		90	
No Month	9						9	
Geogr. Total	78	7	5	4	5		99	
Geogr. %	78.8%	7.1%	5.1%	4.0%	5.1%			

S Cal. includes northern Baja California from 29°45'N latitude to Point Conception
½ values were given when sightings were reported, for example, as "July or August"

ington, turtles appear in July and August but are most common during September. For Canadian waters, September is the critical turtle month with 14 of its 29 sightings being reported. In the Gulf of Alaska, sea turtles are sighted from August through December; but four of the seven Alaskan sightings occurred during August and September and increasingly fewer animals are sighted as the year ends (Table 28, Appendix J, Figures 67-78).

North of Point Conception there are three distinct phases to the seasonality of marine turtles:

1) January through June--lack of northern sightings;

2) July, August, September--turtle season when turtles are widespread from northern Baja California to the Gulf of Alaska;

3) October through December--rapid decline in the number of sightings although a few turtles are still being seen in the Gulf of Alaska.

Seasonal Distribution of Sea Turtles and the Seasonal Position and Movement of Surface Isotherms in the Northeastern Pacific

During January through June, most sea turtles found in the northeastern Pacific are south of Point Conception (Appendix J, Figures 67-72). Their seasonal distribution corresponds with surface sea temperatures. Sea turtles seen in southern California and northern California during January through June are in 13-15°C water; elsewhere to the north sea turtles are uncommon and surface sea temperatures are cooler (3-13°C). From January through April there is astonishingly little movement in the position of surface isotherms across the Pacific Ocean. In May, isotherms begin to shift north along the coast; in southern California coastal temperatures increase to 16°C and turtle sightings there almost double (Table 34).

In June isotherms rapidly move north, 13° and 14°C water reaches the coast of Washington and northern Oregon (Figure 39). In July, 13° water reaches central Canada. Simultaneously, from Point Conception to Canada, warmer (16-17°C) offshore water pushes the 13-15° isotherms inshore pressing them tightly against the coast of central California and again in along northern Oregon and Washington (Figure 40). Wherever, in July, the 13-15° isotherms meet the northern coast there is a corresponding increase in the number of turtle sightings.

In August, isotherms reach their most northern position; 13°and 14° water spreads across the Gulf of Alaska (Figure 41). Sea turtles appear from central California to the Gulf of Alaska--wherever temperatures are 13-15°C. In July, August and September a narrow band of cool (10-12°C) upwelled water develops inshore of the 13-15° strata along northern California and southern Oregon and few turtles, if any, are reported from these areas.

In September, most northern reports come from Canada (Table 28). Warm offshore temperatures continue to hold the 13-15° strata in along the coast. As in July and August, sea turtles are seen in central California and again in northern Oregon and Washington--but in fewer numbers. With the northward spread of 13 and 14° water across the Gulf of Alaska, sea turtles become increasingly common in Canada and Alaska and are reported even as far north as 60°34'N latitude (Table 28, Figures 41, 42).

In October, the 13° isotherm withdraws from the Gulf of Alaska and few sea turtles are seen in northern waters. By November warm offshore waters retreat moving southwest away from the coast and sea turtles become rare north of Point Conception.

North of Point Conception. Of the 144 sea turtles sighted north of Point Conception, 106 (74%) were reported during July, August and September and 70% of these were observed in areas of 13-15°C temperatures. The origin of these northern sea turtles is still a mystery. Did they come from southern California moving north along the coast, with the annual northward movement of the 13-15°C isotherms? Or are they offshore members of the 13-15°C isotherms that move into coastal waters seasonally (July, August and September) when these isotherms are pushed shoreward by the warmer 16-18°C currents?

During January through April most (26 of 37) sea turtles are found south of Point Conception and they are in 13-15°C water. In July, August and September the 13-15°C isotherms are positioned along the coast of central California, Oregon, Washington and Canada and sea turtles appear in those areas. If turtles are simply moving along the coast within the 13-15° isotherms leaving southern California in April and arriving in central California, Oregon and Washington in July then we should see sea turtles somewhere along the coast inbetween during May and June. But so far no sightings have been reported north of Point Conception in either May or June.

Table 34. Seasonal frequency of sea turtles as related to surface ocean temperatures in the northeastern Pacific.

	Surface Temperature	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Subtotals North	Subtotals South	TOTAL
North of Point Conception	8°C			1										1		1
	9°C		1		2							1	1	5		5
	10°C		1									1	1	3		3
	11°C	1				2					2		1	6		6
	12°C				1			1½		2	1	1		6½		6½
South of Point Conception	13°C	1	2	1				3	8	13	1		2	27	4	31
	14°C	5	6		1			21	5½	11		1		38½	12	50½
	15°C		1	5	1			½	8	4	4			16½	7	23½
	16°C					17½			3½	3		2	1	6½	20½	26½
	17°C						12½	½				3			16	16
	18°C							14½	1	1	1				17½	17½
	19°C							14	10	12	9½				45½	45½
	20°C									20½	6				26½	26½
Subtotal North		1	2	1	3	2		26	25	33	8	4	5	110		
Subtotal South		6	9	6	2	17½	12½	29	31½	19	10½	5	1		149	
TOTAL		7	11	7	5	19½	12½	55	56½	52	18½	9	6			259

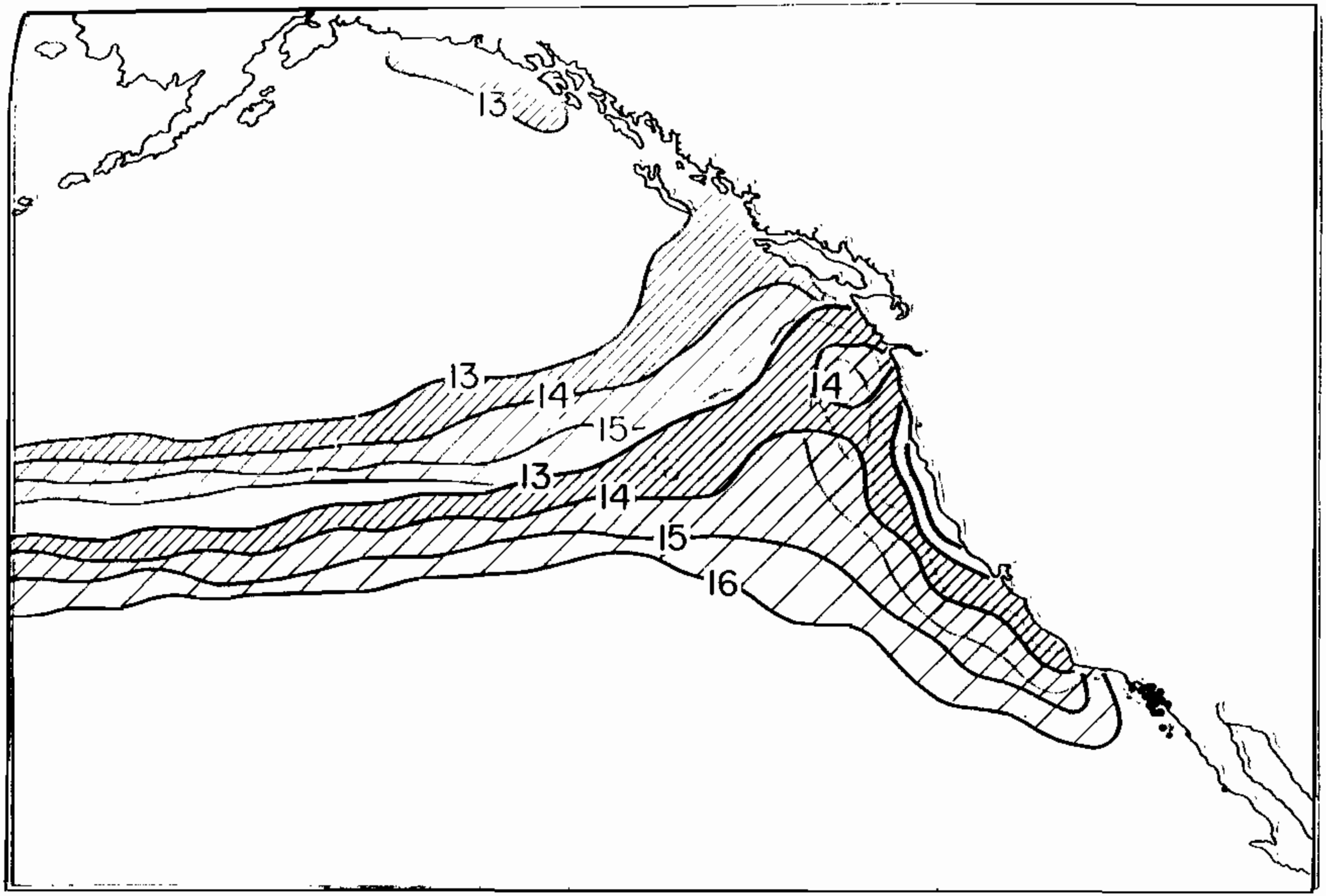


Figure 39. Average position of 13, 14 and 15°C surface isotherms during June in the northeastern Pacific (based on longterm data). Map shows the distribution of sea turtles during June.

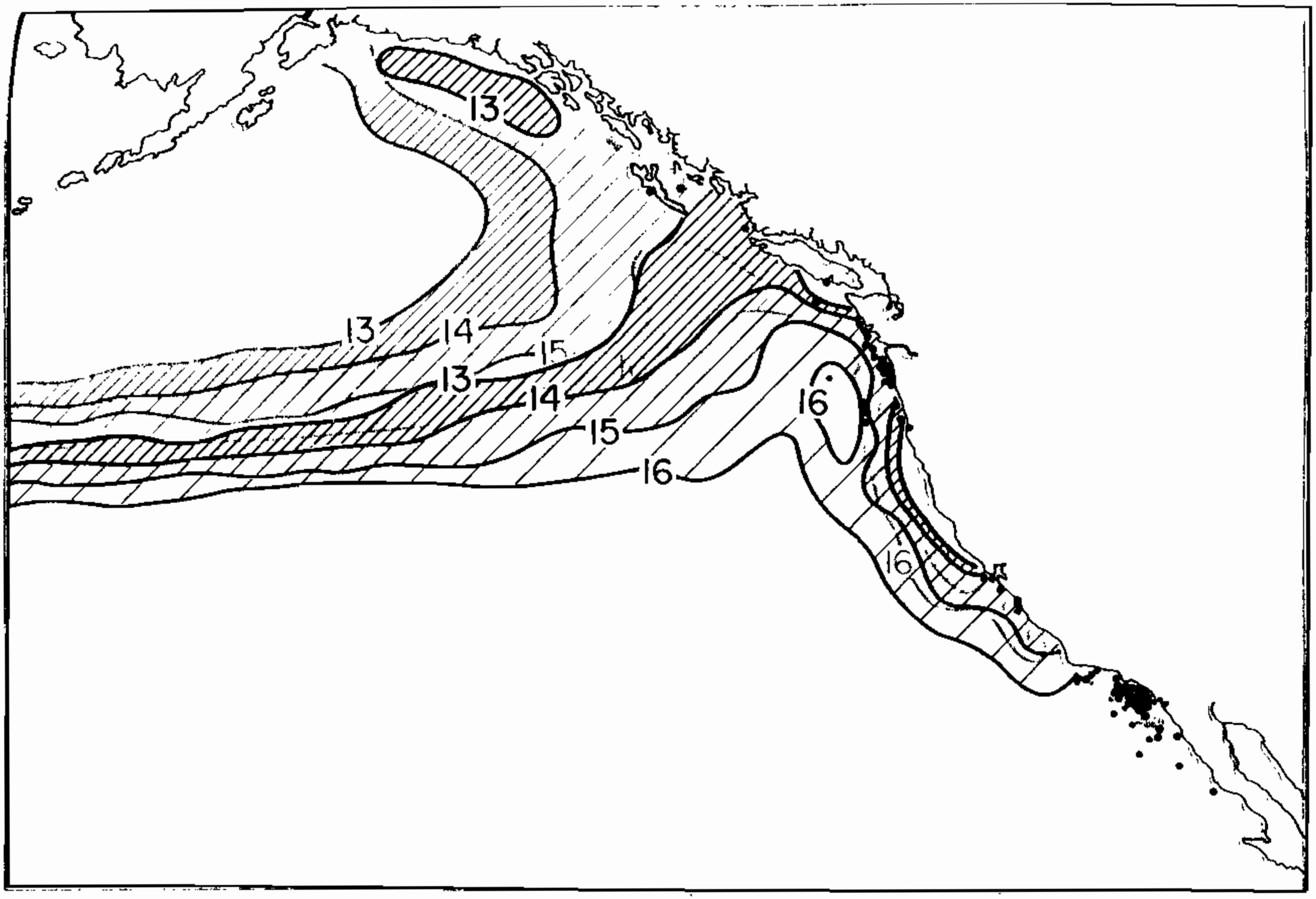


Figure 40. Average position of 13, 14 and 15°C surface isotherms during July in the northeastern Pacific (based on longterm data). Map shows the distribution of sea turtles during July.

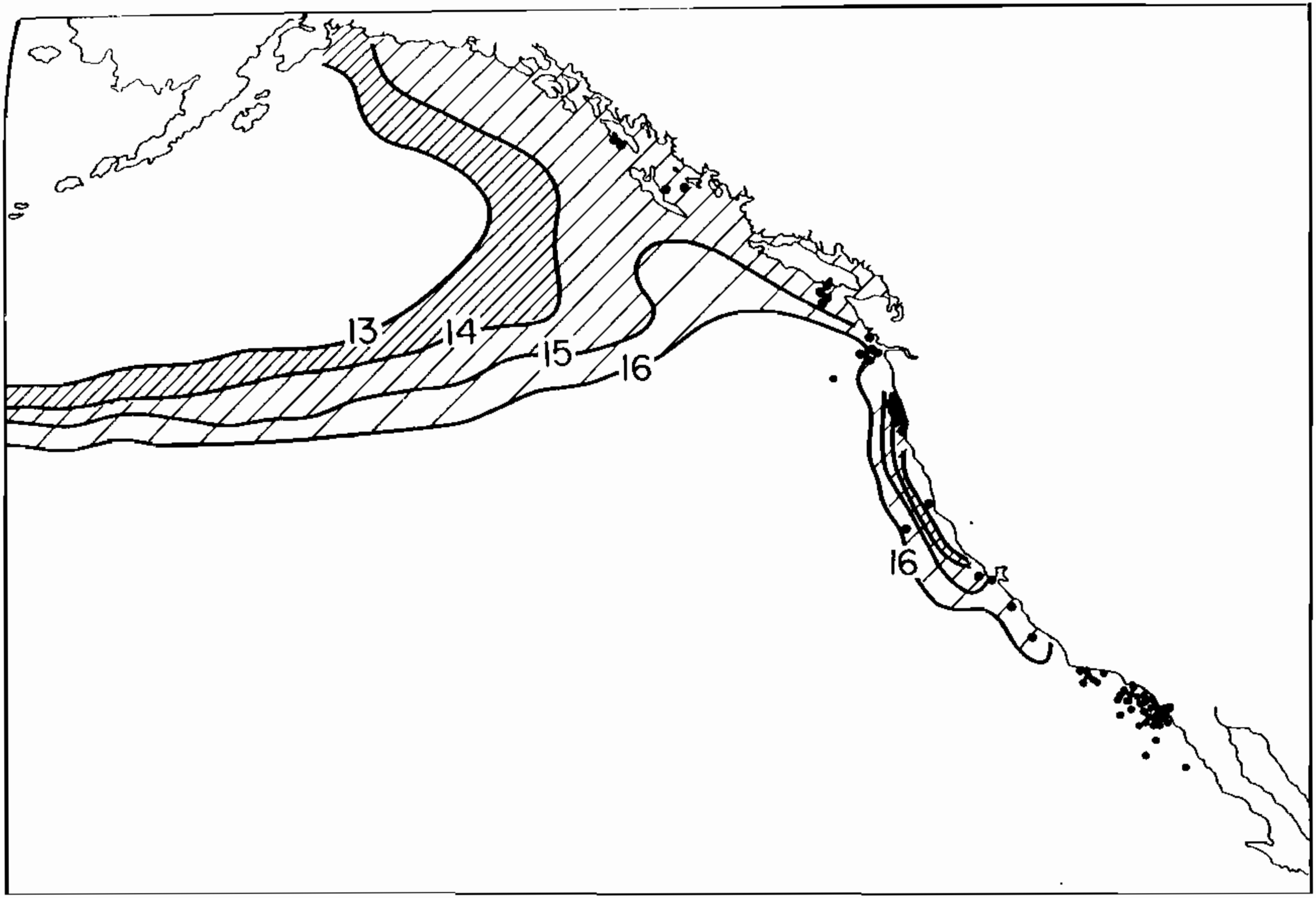


Figure 41. Average position of 13, 14 and 15°C surface isotherms during August in the northeastern Pacific (based on longterm data). Map shows the distribution of sea turtles during August.

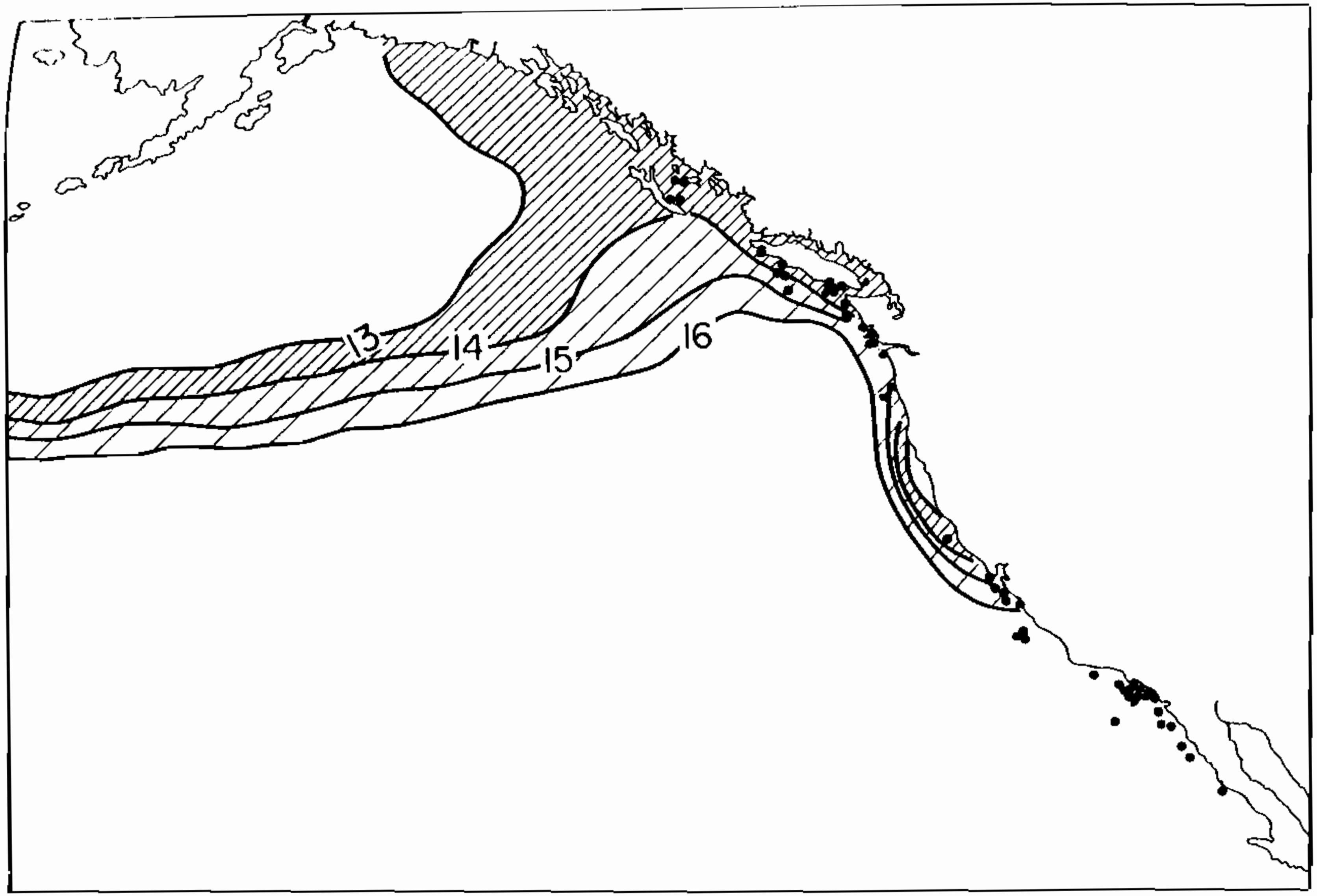


Figure 42. Average position of 13, 14 and 15°C surface isotherms during September in the northeastern Pacific (based on longterm data). Map shows the distribution of sea turtles during September.

This could be due to a lack of data or it could suggest that sea turtles appearing north of Point Conception in the summer have a different origin than those found year-round to the south; that turtles are not arriving in Oregon simply by moving along the coast from southern California but that north of Point Conception sea turtles are moving inshore-offshore across the Pacific in the 13-15°C isotherms. It has been suggested to me that an alternative possibility accounting for the lack of May and June sightings, north of Point Conception, is that the animals are simply moving rapidly through this intervening area and are therefore less likely to be detected (personal communication with Dr. Fritts, 1984). I am not able to disprove this suggestion, yet it is not one I feel comfortable with.

Those turtles found south of Point Conception during the winter and spring are hard-shelled species (particularly Chelonia mydas) and those found to the north, first arriving along Oregon in July, are leatherbacks. In the case of the relatively few hard-shelled sea turtles that are sighted north of Point Conception, their origin is probably coastal, that they moved north with the seasonal northward shifting of isotherms, and their numbers are few enough to escape detection during May and June, especially if these are not prime months for fishermen in those areas. But the appearance of leatherbacks in the eastern Pacific is two-pronged. South of Point Conception they begin appearing in May and June in 16° and 17°C water and these individuals probably arrived in southern California by traveling north along the coast of Mexico. But even if all of these leatherbacks continued their coastal trek north into Oregon they could not account for the July explosion in sightings there. Two-thirds of leatherback sightings in the northeastern Pacific come from north of Point Conception and they first appear in Oregon during July in 13-15°C water. Leatherbacks were not found in southern California during the winter and spring when the 13-15°C isotherms were positioned there. They do not appear until the warmer central Pacific isotherms expand shoreward pushing the 13-15°C isotherms tight against the coast of North America—and this first happens in July along Oregon.

Consequently, while hard-shelled sea turtles and some leatherbacks move north along the coast expanding their range as surface temperatures seasonally warm, other leatherbacks arrive from offshore on the Great Pacific Drift current and reaching the coast at Oregon in July and then move north in the Alaskan Gyral or south in the California coastal current.

South of Point Conception

Sea turtles are found along the coast of southern California and northern Baja California all year in surface sea temperatures ranging seasonally from 13-20°C. During January through April temperatures are 13-15°C. In May the 13-15°C isotherms shift north and are replaced by 16° water and sightings of sea turtles in southern California almost double. In June, southern California temperatures increase to 17°C and sea turtle sightings continue. In July, August and September water temperatures increase to 18-20° and there is an explosion in the number of sea turtles sighted in the Southern California Bight.

Where do these new turtles come from? The nearest source is from along southern Baja California and mainland Mexico. Sea turtles are most common in southern California when surface sea temperatures are 16-20°C and are especially common in 19-20°. These temperatures are typical of southern Baja California from January through April (Robinson, 1973). In May, the isotherms move a considerable distance north along the peninsula, 16° water arrives in southern California and sightings of sea turtles there almost double; 18 and 19° water arrives in July and there is an explosion in the number of sightings; 20° water arrives in August bringing even more turtles (Figure 41).

It is very possible that the sea turtles appearing in southern California, in May through the summer, originate in southern Baja California and that they travelled north in 16-20°C water as those isotherms moved north to southern California.

As isotherms shift southward again in the fall, fewer turtles are seen along southern California and those sighted might simply be remnants of the summer influx who stayed because although temperatures are lower (13-15°C) they are still sufficiently warm to support turtles. An alternative explanation for increased sightings during warm winter months may be increased activity in response to elevated body temperatures (Fritts, _et al_, 1983).

Thermal Biology and Seasonal Distribution of Sea Turtles in Relation to Ocean Temperatures in the Northeastern Pacifc

Dermochelys coriacea

During winter and spring, leatherback sea turtles are rarely reported from along the Pacific coast of America north of Mexico (Appendix C, Table 43; Appendix J, Figures 79-88). Both north and south of Point Conception, they are most frequently reported during July, August and September.

South of Point Conception--along the coast of northern Baja California and southern California--they first appear in May and June in 16 and 17°C water and are most common during July, August and September when surface ocean temperatures are 18-20°C (Table 34). As suggested in the preceeding section, it is very possible that the leatherbacks appearing in southern California during the summer have arrived here by travelling north from southern Baja California, where they are known to nest during October through March (Fritts, et al, 1982) or from the mainland of Mexico. Their appearance in southern California coincides with the summer arrival of the 18-20°C isotherms which seasonally move north from southern Baja California.

North of Point Conception, 87% of the leatherback sightings are reported during July, August and September (Table 29). They first appear in July along the coast of central California and along northern Oregon and Washington. In August and September they continue to be commonly reported in these areas but are sighted even further north within the Gulf of Alaska (Appendix J, Figures 84-85).

North of Point Conception, 88% of the leatherbacks sighted during July, August and September were in areas of 13-15°C water (Table 34; Appendix J, Figures 83-85). Where do these turtles come from? Sea turtles found in 13-15°C water during the winter and spring are in southern California and they could, quite simply, leave southern California, travel north along the coast as the 13-15°C isotherms shift north and arrive in Oregon in July. But none of the turtles wintering in southern California are leatherbacks! Leatherbacks first appear in the northeastern Pacific in summer. It is highly unlikely that the Oregon leatherbacks are simply moving up the coast from southern California. More likely, these leatherbacks appearing during July along central California, Oregon and Washington are coming in from offshore; that they originate in the offshore portion of the 13-15°C isotherms and move into coastal areas as these isotherms are pushed inshore against the northern coasts--perhaps in response to seasonal abundance of food sources during July, August and September (Appendix J, Figures 83-85).

Certainly there is not enough data yet to suggest the origin of these offshore leatherbacks. Do they come from Mexico, sweep northwest into offshore waters and then return to the coast at the latitude of Oregon in July as the 13-15°C isotherms are pushed inshore? Or are they coming across the ocean on the Japanese requesting information from commercial fishermen, I have received several accounts of albacore jigboats seeing leatherbacks 500 to 1,000 miles off the coast of central California and Oregon during summer months. Bleakney (1965) suggests that the leatherbacks appearing along the northern Atlantic coast of the United States and Canada—at the same latitudes and during the same months as for those in the northeastern Pacific--come in from the offshore Gulf Stream in the Atlantic. Data collected by Shoop, et al (1981) support the hypothesis that leatherbacks migrate along the Atlantic coast of North America--north in the Gulf Stream appearing during summer and fall in the Gulf of Maine and returning south in the shallow continental shelf waters closer to shore.

Dermochelys have been sighted in the northeastern Pacific in sea temperatures ranging from 3 to 20°C (3-15°C north of Point Conception and 13-20°C south of the point). Unlike the hard-shelled species of sea turtles, the leatherbacks sighted in the northern Pacific do not appear affected by temperatures as low as 8°C. The leatherbacks sighted in water as cool as 8°C were healthy and swimming vigorously. Only the turtle found in an area of in 3°C water was dead. It was discovered in March 1983, on the southern part of the Alaskan Peninsula, near the Aleutian Islands in the western Gulf of Alaska. During normal years, March temperatures, in that area, along the Alaskan Peninsula are 3°C. But during 1983, ocean temperatures were abnormally hot throughout the northeastern Pacific and, as yet, we do not know what the actual sea temperature was on the date of the discovery of this dead leatherback (Sighting No. D120). Most injuries or fatalities suffered by leatherbacks in the Pacific are inflicted by man--from gun shots, nets, intentional mutilation, boat propellars, etc..

Leatherbacks, seen during their nesting season in the American tropics of Mexico and French Guiana, are in sea temperatures of 26.25 - 28.25°C (Mrosovsky and Pritchard, 1971; Mrosovsky, 1979) and those nesting in southern Baja California are in temperatures of 18-28°C (Fritts, *et al*, 1982). Yet while on long feeding journeys in the northern Pacific and Atlantic they encounter considerably colder waters. Leatherbacks so commonly seen during July, August and September along the Atlantic coast of the United States and off Nova Scotia, New Brunswick and Newfoundland, Canada are in 12-17°C water (Bleakney, 1965) and the leatherback captured off Labrador, Newfoundland (56°45'N, 61°00'W) was "taken from waters where the temperature could not have exceeded 6°C" (Threlfall, 1978). Leatherbacks are not strangers to northern waters and have the ability to survive temperatures as low as 6°C in the Atlantic and 8°C in the northeastern Pacific.

Chelonia mydas

Green sea turtles seasonally migrate to San Diego Bay in southern California, spending the months of November through April in the bay. Their biology has been studied separately in this paper and so they have been excluded from this analysis of coastal sightings.

Although green sea turtles have been sighted as far north as 57°N latitude at Admiralty and Kupreanof Islands in Alaska (Appendix C, Table 44; Appendix I, Figure 64), two-thirds of the sightings have come from northern Baja California and the Southern California Bight (Table 30).

South of Point Conception, green sea turtles are seen year-round in temperatures seasonally ranging from 13-20°C. But they are most common in July, August, September and October when local surface temperatures are 18-20°C and especially common in 19-20°C water (Appendix J; Figures 89-99).

Green sea turtles have been reported north of Point Conception on 19 occasions—eight times in central California and the rest spread equally from Oregon to the Gulf of Alaska. Those greens sighted in central California were in temperatures of 15-16°C and were active, swimming strongly apparently of vigorous health. The greens found further north were in temperatures as low as 9°C; those found in areas of 9-11°C water were discovered either stranded on the beach dead or in poor condition or in the water but apparently having problems swimming and diving.

Schwartz (1978) describes thermal distress in sea turtles; that when temperatures are too low the turtle cannot breathe properly, consequently it floats and diving becomes difficult or impossible. Parker (1925) suggests that this is caused by large amounts of gas forming and collecting underneath the posterior portion of the carapace as a result of low temperatures.

Frequently, but not always, diving and health problems are caused by low temperatures. A green sea turtle (Sighting Cm9) was captured off Washington in August, a month when surface temperatures are normally 14°C. The turtle was a strong swimmer but could not dive. A pocket of infection and air was located under its carapace and this, rather than temperature, was the probable cause for its diving problems.

Schwartz reports that captive *Chelonia* experience difficulties in swimming and diving at temperatures of 9.0°C (and lower) and that this is due to thermal distress. He also determined that sudden or prolonged "cold snaps which lower water temperature (acute changes) kill just as readily as slower seasonal lowering of water temperatures (chronic)". A green sea turtle was observed off Kupreanof Island, Alaska during October 1976. Surface temperatures are normally 11°C for that area during October and air temperatures were recorded at the time of the sighting as 8-10°C. Although this turtle was actively swimming and capable of diving, Hodge (1981) states that in all probablility this was the same green found dead nine miles to the southeast (in Eliza Harbor, Admiralty Island) the following month. The turtle was found ashore, dead; terrestrial predators had been feeding on the carcass so the cause of death could not be ascertained. November surface temperatures for that area are typically 9°C and possibly the green remained in the northern waters too long and died of thermal distress. Mendonca (1983) reports that that in Mosquito Lagoon, Florida, juvenile *Chelonia* were "very active (moving 8-10 km/day) at water temperatures as low as 11.0°C"

Another green was found ashore on Vancouver Island in December when sea temperatures are normally 9°C. This turtle was "covered with oil and slime from a near-by reduction plant. Apparently it was in a weakened condition because it died a week later" (Logier and Toner, 1961; Sighting Cm2). It could have been weakened by the seasonally low temperatures.

In comparison, two green sea turtles were found in Oregon during the month of February when surface temperatures are normally 10°C. One was captured in Coos Bay. It appeared to be "swimming normally, seemingly in good health and no one ever mentioned any unusual temperatures at the time" (personal communication with Dr. Forbes; Forbes and McKey-Fender, 1968). The second February green turtle was discovered in Harbor, Pelican Bay after a winter storm and this turtle was dead. Witnesses could see no apparent cause of death and presumed lower temperatures, brought on by the storm, had killed it (Sightings Cm11 and Cm41).

Active, healthy green sea turtles are seen in the northern Pacific. But when ocean temperatures drop too low, they are found dead or in poor condition. In Alaska, the green observed actively swimming and diving in 11°C water during October was presumably the same turtle found dead the next month in 9°C (Sightings Cm15 and Cm16). In Oregon, greens are capable of surviving 10°C water but die if subjected to the additional stresses and lower temperatures of a storm.

Green sea turtles found in 14-20°C water, such as those south of Point Conception, are active strong swimmers. They have even been observed actively swimming and diving in 11°C water—but this seems to be their thermal limit. Lower temperatures or these temperatures compunded by additional stresses, such as a storm, are fatal. Schwartz (1978) found that in captivity, greens did not die of thermal distress until 6.5 to 5.0°C but the captive state does not have as many stresses and complexities as the ocean and the environmental thermal limit for a turtle at sea might be at a higher temperature than for a captive animal.

Ehrhart (1977) found that when exposed to temperatures averaging 10°C, juvenile Chelonia became stunned and float at the surface of Mosquito Lagoon in Florida. He also reported that at water temperatures of 10-11°C, they quite possibly become dormant, partially burying into the lagoon's mud bottom. In January 1981, Ehrhart again rescued 88 juvenile green sea turtles, 74 loggerheads and one Kemp's ridley from Mosquito Lagoon. When the first of these cold-stunned turtles were rescued, water temperatures were 3.5°C (Ehrhart and Lee, 1981). Felger et al. (1976) used indirect evidence to conclude that at water temperatures as low as 15°C green sea turtles in the Gulf of California, Mexico, become inactive and dormant burying in the Gulf's floor during the winter months. In the spring when temperatures are 18°C the turtles were seen actively swimming. For a review of cold-water stunning and overwintering dormancy in sea turtles refer to Ogren and McVea (1982).

Caretta caretta

Of the four species of marine turtles found in the Pacific, north of Mexico, Caretta tends to be the most southern in its distribution. It is relatively common along the coast of northern Baja California and southern California, but has been reported only once from central California and twice from Washington.

While loggerheads have been observed throughout the year, especially south of Point Conception, 65% of the sightings were reported during July, August and September (Table 31) in temperatures of 18-20°C. Loggerheads are much more common along the Atlantic coast of the United States where they are consistently found in temperatures of 16-26°C. They expand and contract their range north and south along the Atlantic seaboard as surface ocean temperatures seasonally warm and cool (Shoop, et al, 1981).

In the eastern Pacific, South of Point Conception, loggerheads were reported on 36 occasions (year-round) in temperatures of 13-20°C. North of the point, they were reported three times—twice during September in 14 and 15°C and once in February in 9°C (Appendix J; Figures 100-109). Schwartz (1978) reports that captive Caretta exhibit thermal stress at temperatures below 9.5°C resulting in problems with gas bouyancy, swimming and diving.

A subadult loggerhead came ashore in Washington during a four day storm in February, 1981, when the water temperature was 9°C (Sighting No. Cc29). After two or three days the turtle was removed from the beach and mistaken as dead placed in a warm building. When examined the next day it was found to be alive and its body temperature 56°F (13°C); it had survived 45°F (7°C) temperatures on the beach. The turtle was then placed in a tank of water at 63°F (17.2°C) and it is believed that its body temperature stabilized at 61°F (16°C). This turtle could not dive but floated with its tail and posterior carapace higher than its head as if air was trapped under its shell.

Another loggerhead, this time in 20°C water off San Clemente Island in southern California, exhibited problems with bouyancy (Sighting No. Cc19). It rolled on the surface and again, as if gas was trapped beneath its carapace, it could not dive. Either this turtle had recently left water considerably colder or bouyancy and diving/swimming difficulties (as previously discussed) can be caused by factors other than low temperatures. Schwartz (1978) described loggerheads as lethargic when sighted in 12.8°C temperatures in the Atlantic. A loggerhead observed off southern California during February when water temperatures were 13.3°C also appeared lethargic (Sighting No. Cc21).

Carr et al. (1980) investigated a population of juvenile and subadult loggerheads (with a few Kemp's ridleys) that overwinter along the east coast of Florida. The turtles were in a torpid condition when found buried in the ocean's floor during February and March when water temperatures were 11° and 18°C, respectively. This behavior of burying into the mud has been described as an adaptation to survive seasonally cold temperatures (Mendonca, 1983; Carr et al, 1980; and Ehrhart, 1977).

It is noteworthy that of 38 loggerheads captured or stranded in the northeastern Pacific, for which the body size was described, only 2 were adults, 3 were subadults and the remaining 33 were juveniles (Appendix F). In sea turtles, generally the juveniles and subadults disperse to the extreme edges of the species' distribution while the adults are limited more to its main population center (personal communication with Fritts, 1984).

Lepidochelys olivacea

The Pacific or olive ridley has been reported in the northeastern Pacific only 16 times and of these only six were from north of Point Conception (4 in California and 2 in Oregon). South of Point Conception, ridleys have been reported throughout the year (Table 32; Appendix J, Figures 110-117) in 15-20°C water and those found in 18-20°C temperatures were in healthy condition. North of Point Conception, five of the ridleys were sighted from October to December and another during spring. They were found in 12° and 14°C water, those in 12° were either dead or else emaciated and lethargic.

According to Schwartz (1978), captive Kemp's ridleys (Lepidochelys kempi) exhibit "a sluggish floating behavior" with diving and breathing difficulties at water temperatures below 13°C. This corresponds with reports for the Pacific ridleys--those found in 14-20°C water were healthy while those in 12°C were not.

Records for the Kemp's ridleys in the Gulf of Maine, New England and Canada show this species to seasonally inhabit the northern Atlantic during the summer and autumn—at the same latitude as for the olive ridley in the northeastern Pacific—in water temperatures of 13-18°C (Bleakney, 1965 and Lazell, 1980). Lazell reports that Lepidochelys kempi found during November in New England were "active, healthy, and fed voraciously at ambient water temperatures" (as low as 7-10°C).

Sea Turtles' Associations with other Species and Habitats in the Northeastern Pacific

South of Point Conception, leatherbacks are seen in kelpbeds or near kelp paddies. Off Oregon, Washington and more northern waters, they are seen in areas of surface drifts of jellyfish and coelenterates, particularly in waters blanketed with wind-sailor jellyfish (*Velella*). Fishermen note that often just prior to good catches of albacore, *Velella* appear and when albacore and bluefin tuna appear off Oregon--in July, August and September--leatherbacks also appear. Fishermen mention that when they see leatherbacks they also see albatross and other more oceanic species of birds.

Albacore and other species of tunas annually migrate following the seasonal movement of isotherms, travelling with a current of a specific temperature. It is clear that the distribution of leatherbacks in the northeastern Pacific is strongly related to seasonal ocean temperatures. Whatever is timing the appearance of albacore and tunas along Oregon could be doing the same for leatherbacks.

In southern California, green sea turtles are seen along shore in areas of eelgrass and are often reported in waters near electrical power-generating facilities. This tendency to occupy waters near power companies seems unique to green sea turtles. Only greens have been reported in the San Diego Gas and Electric Company's effluent channel in south San Diego Bay and in the San Gabriel River (at Seal Beach near Los Angeles), downstream from several power plants and only greens have had to be rescued from the electrical plants in Carlsbad and El Segundo and from the intake pipe at the San Onofre nuclear power generating facility.

Loggerheads are well known by coastal fishermen south of Point Conception. They are often found floating in kelp paddies, their rusty color blending well with the kelp (Macrocystis). Though loggerheads are typically benthic feeders, eating molluscs and crustaceans, they are seen at the surface in areas of pelagic red crabs (Pleurnocodes planiceps) and could be making use of this pelagic crustacean.

Pacific ridleys are most often reported by boats catching albacore, bluefin, yellowfin and skipjack tunas. Often these fishermen note that in the same area are other exotic, southern species of fish such as black and striped marlin and mahi mahi (the dolphin fish). Since many of these species feed on pelagic red crabs and shrimp, possibly the ridley is similarly using these crustacea as a surface source of food in areas too deep for benthic feeding.

Frequently, fishermen reporting the sighting of leatherbacks, loggerheads and Pacific ridleys mention that the turtles were in areas of bait or along scud (debris) lines that concentrate zooplankton. I suspect that these turtles, like the tunas, swordfish, sharks and marlin so often reported in the same area as the turtles, are at least opportunistically using these pelagic sources of food.

Bathymetry of Sea Turtle Sightings in the Northeastern Pacific

Tables 35-39 show the distribution of sea turtle sightings in the northeastern Pacific as related to water depth. Generally over half of all sea turtles were reported from waters less than 100m (55 fathoms) in depth, but numerous sightings were in waters considerably deeper. Leatherbacks were seen in the same proportion (66%) as other species in waters less than 100m but ranged, also, into the deepest waters (maximum 7273m, 4000 fms). As pelagic surface feeders their distribution is not limited by water depth, but rather by the abundance of pelagic food sources on the surface in a particular area. Other species of marine turtles are essentially benthic feeders and their food resources restrict them, in feeding areas, to shallow waters.

Along the Atlantic coast of the United States, the distribution of sea turtles is correlated with water depth with most sightings occurring over the continental shelf in waters less than 60m (33 fms) (Fritts, et al, 1983; Fritts and Reynolds, 1981; and Shoop, et al, 1981). There the continental shelf is very distinct, almost perfectly paralleling the entire coastline and is marked by the 200 meter (110 fathom) isobath.

In contrast, although sea turtles in the northeastern Pacific are most common in shallow areas (less than 100m), they are frequently sighted in coastal areas far deeper. The reason for this is because along the Pacific coast there is no definite or distinct continental shelf break nor an average depth of water over the continental borderlands. Coastal topography is extremely irregular with many areas uplifted as banks and sea mounts and intervening areas downthrust as canyons and valleys. The continental borderlands form instead a series of terraces decreasing in depth like steps. The contour of these terraces undulate along the coast, approaching the shore quite closely in some areas and widening out in other areas. Consequently, within very little swimming distance turtles can surface in coastal waters ranging from less than 25 meters to thousands of meters (or fathoms) in depth.

Most sightings reported were in coastal waters, a subsequent paper, plotting these sightings with distance from shore should offer a more meaningful approach to studying their coastal behavior. This raises an important, and unanswered, question--is their distribution actually coastal or is this an artifact of the opportunistic nature of collecting these sightings reports...that most fishermen, reporting sightings, work in coastal areas; fewer boats were in offshore waters, consequently there were fewer offshore records.

Table 35. *Number* of sightings of sea turtles (all species combined) in various depths of water in the northeastern Pacific.

Depth	North of Point Conception Season	Nonseason	Month not given	Subtotal	South of Point Conception Season	Nonseason	Month not given	Subtotal	TOTAL
0–24m	13	14		27 (20.6%)	34	37	2	73 (40.8%)	100 (32.3%)
25–49m	7	7		14 (10.7%)	11	9	1	21 (11.7%)	35 (11.3%)
50–74m	27	3	3	33 (25.2%)	2	2	2	6 (3.4%)	39 (12.6%)
75–99m	13	1	1	15 (11.5%)	4	1	1	6 (3.4%)	21 (6.8%)
100–149m	9	1		10 (7.6%)	2	4		6 (3.4%)	16 (5.2%)
150–199m	4			4 (3.1%)	2	2		4 (2.2%)	8 (2.6%)
200–299m	1	1		2 (1.5%)		3		3	5 (1.6%)
300–399m	2			2 (1.5%)	2	2		4 (2.2%)	6 (1.9%)
400–499m	1	2		3 (2.3%0	3	3		6 (3.4%0	9 (2.9%)
500–599m					6	2		8 (4.5%)	8 (2.6%)
600–999m	1	1		2 (1.5%)	15	12		27 (15.1%)	29 (9.4%)
1000–1999m	11			11 (8.4%)	11	4		15 (8.4%)	26 (8.4%)

Table 35. (continued).

Depth	North of Point Conception				South of Point Conception				TOTAL
	Season	Nonseason	Month not given	Subtotal	Season	Nonseason	Month not given	Subtotal	
2000-2999m	1		1	2 (1.5%)					2 (0.7%)
3000-3999m									
4000-4999m			1	1 (0.8%)					1 (0.3%)
5000-5999m		3	1	4 (3.1%)					
6000-7999m	1			1 (0.8%)					1 (0.3%)
TOTAL	91	33	7	131	92	81	6	179	310

Table 36. Number of sightings of leatherback sea turtles (<u>Dermochelys coriacea</u>) in various depths of water in the northeastern Pacific.

Depth	North of Point Conception				South of Point Conception				TOTAL
	Season	Nonseason	Month not given	Subtotal	Season	Nonseason	Month not given	Subtotal	
0-24m	6	4		10 (11.2%)	10	5	2	17 (43.6%)	27 (21.1%)
25-49m	5			5 (5.6%)	2	2		4 (10.3%)	9 (7.0%)
50-74m	25	3	3	31 (34.8%)	1	1	1	3 (2.6%)	34 (26.6%)
75-99m	12	1	1	14 (15.7%)		1		1 (2.6%)	15 (11.7%)
100-149m	9	1		10 (11.2%)	1			1 (2.6%)	11 (8.6%)
150-199m	4			4 (4.5%)	1			1 (2.6%)	5 (3.9%)
200-299m	1	1		2 (2.3%)		1		1 (2.6%)	3 (2.3%)
300-399m					2			2 (5.1%)	2 (1.6%)
400-499m					3			3 (2.6%)	3 (2.3%)
500-599m									
600-999m		1		1 (1.1%)	3	1		4 (10.3%)	5 (3.9%)
1000-1999m	7			7 (7.9%)	2			2 (5.1%)	9 (7.0%)

Table 36. (continued).

Depth	North of Point Conception				South of Point Conception				TOTAL
	Season	Nonseason	Month not given	Subtotal	Season	Nonseason	Month not given	Subtotal	
2000-2999m	1		1	2 (2.3%)					2 (1.6%)
3000-3999m									
4000-4999m			1	1 (1.1%)					1 (0.8%)
5000-5999m			1	1 (1.1%)					1 (0.8%)
6000-6999m									
7000-7999m	1			1 (1.1%)					1 (0.8%)
TOTAL	71	11	7	89	25	11	3	39	128

Table 37. Number of sightings of green sea turtles (Chelonia mydas) in various depths of water in the northeastern Pacific.

Depth	North of Point Conception				South of Point Conception				TOTAL
	Season	Nonseason	Month not given	Subtotal	Season	Nonseason	Month not given	Subtotal	
0-24m	3	3		6 (54.6%)	6	9		15 (50.0%)	21 (44.7%)
25-49m		3		3 (17.7%)	2	3		5 (16.7%)	8 (17.0%)
50-74m						1		1 (3.3%)	1 (2.1%)
75-99m									
100-149m					1			1 (3.3%)	1 (2.1%)
150-199m						1		1 (3.3%)	1 (2.1%)
200-299m						1		1 (3.3%)	1 (2.1%)
300-399m	2			2 (11.8%)		1		1 (3.3%)	3 (6.4%)
400-499m						1		1 (3.3%0	1 (2.1%)
500-599m						1		1 (3.3%)	1 (2.1%)
600-699m					1	1		2 (6.7%)	2 (4.3%)
700-999m									

Table 37. (continued).

Depth	North of Point Conception Season	Nonseason	Month not given	Subtotal	South of Point Conception Season	Nonseason	Month not given	Subtotal	TOTAL
1000-1999m	3			3 (17.7%)	1			1 (3.3%)	4 (8.5%)
2000-4999m									
5000-5999m		3		3 (17.7%)					3 (6.4%)
TOTAL	8	9		17	11	19		30	47

Table 38. Number of sightings of Pacific loggerhead sea turtles (*Caretta caretta*) in various depths of water in the northeastern Pacific.

Depth	North of Point Conception				South of Point Conception				TOTAL
	Season	Nonseason	Month not given	Subtotal	Season	Nonseason	Month not given	Subtotal	
0-24m	2	1		3 (60.0%)	3			3 (8.8%)	6 (15.4%)
25-49m					1	2	1	4 (11.8%)	4 (10.3%)
50-74m							1	1 (2.9%)	1 (2.6%)
75-99m	1			1 (20.0%)	3		1	4 (11.8%)	5 (12.8%)
100-149m						1		1 (2.9%)	1 (2.6%)
150-199m					1	1		2 (5.9%)	2 (5.1%)
200-299m									
300-399m						1		1 (2.9%)	1 (2.6%)
400-499m									
500-599m					2			2 (5.9%)	2 (5.1%)
600-699m	1			1 (20.0%)	5	4		9 (26.5%)	10 (25.6%)
700-999m									

Table 38. (continued).

Depth	North of Point Conception Season	Nonseason	Month not given	Subtotal	South of Point Conception Season	Nonseason	Month not given	Subtotal	TOTAL
1000-1999m					5	2		7 (20.6%)	7 (18.0%)
2000-7999m									
TOTAL	4	1		5	20	11	3	34	39

Table 39. Number of sightings of Pacific ridley sea turtles (Lepidochelys olivacea) in various depths of water in the northeastern Pacific.

Depth	North of Point Conception				South of Point Conception				TOTAL
	Season	Nonseason	Month not given	Subtotal	Season	Nonseason	Month not given	Subtotal	
0-24m	1	4		5 (100%)	2	2		4 (40.0%)	9 (60.0%)
25-99m									
100-149m						1		1 (10.0%)	1 (6.7%)
150-499m									
500-599m					1			1 (10.0%)	1 (6.7%)
600-799m									
800-899m					1			1 (10.0%)	1 (6.7%)
900-999m					1			1 (10.0%)	1 (6.7%)
1000-1999m					1	1		2 (20.0%)	2 (13.3%)
2000-7999m									
TOTAL	1	4		5	6	4		10	15

Comparison of the Numbers of Sea Turtles Sighted, Found Dead at Sea, Stranded Ashore or Captured (Incidentally or Intentionally) in the Northeastern Pacific

Of the 363 records of sea turtles reported in the northeastern Pacific, 356 included additional information describing the circumstances of the sighting—for example, whether the turtle was simply sighted at sea, stranded ashore, entangled in a fishing net, caught by fishing pole, injured by boat, deliberately mutilated, captured for market, etc., allowing us to determine (in a very general way) the nature and level of man's contact with sea turtles in the northeastern Pacific. Table 40 shows the relative frequency of sightings in each category.

Sightings

The greatest majority of sea turtles reported were simply sighted at sea having no additional contact with man (this category included 64% of all records, 68% of leatherback sightings and 45% of those sightings involving hard-shelled turtles).

Floating Dead at Sea

Of 356 sightings, only two leatherbacks and one loggerhead were found dead at sea.

Strandings Ashore

Relatively few (8.7%, n= 31) of the records involved turtles stranded ashore. Of these turtles, 28 (90%) were dead or died after rescue; only three others (all hard-shelled) lived to be returned to the sea. In 16 of these 28 strandings the cause of death was unknown (no sign of injury) but for some death might have been caused by ocean temperatures at the time being too low. Four deaths were caused by boat injuries, one due to the animal's previous entanglement in a net (net chafe marks on its head, flippers and shell) and one probably due to storm conditions at the time of the stranding. Table 41 details stranding information for each species.

Captures

One quarter (27%, n=95) of the turtle reports involved captured animals; of these, 35 were "incidental" or accidental captures and 60 were "intentionally" captured (Table 42).

Incidental captures. Incidental captures involve cases when a turtle accidentally or "incidentally" becomes entangled in fishing gear or trapped in the filters of coastal electrical generating facilities. Of 35 incidental captures, 29 involved turtles entangled in fishing gear and 6 entrapped at electric plants.

Twenty-two turtles (half of which were leatherbacks) were found in fishing nets, 1 tangled in the bouy line of a crab pot, and 6 caught by fishing pole. Of the 22 turtles caught in nets only 2 were dead, 11 were released alive, 7 killed and for 2 not enough information was available to know if the animal was dead or alive. These statistics show that there is no species specific difference in whether a turtle is apt to be released or not by fishermen. Fishermen are just as apt to release a leatherback found in a net as they would a hard-shelled turtle. Commercial fishermen today are much more conscientious about releasing turtles alive from nets than several decades ago. This might be due to the fishermen's increased awareness of the legal protection awarded sea turtles, the absence of a market for turtle products and to the fishermen's improved professional regard for and cooperation with fisheries service biologists (NMFS, Oregon Department of Fish and Wildlife, Canadian Department of Fisheries and Oceans).

The one leatherback entangled in the bouy line of a crab pot was released alive. Of the 6 turtles caught by fishing pole, the 5 hard-shelled turtles were released alive but the one leatherback was reeled in close to the boat, gaffed and then killed by gunshot.

All six turtles (all hard-shelled) entrapped in the filter racks of coastal electrical companies were released alive.

Intentional captures. Intentional captures involve incidents when man sees a turtle and then captures it--either to measure, photograph and release, to donate to a public aquarium, to take to market, or to deliberately injure or kill.

Of 60 turtles intentionally captured, 11 were brought aboard (using a dip-net) for measurements, photographs and then immediately released; another 11 were transported alive to aquaria such as Scripps, Sea World, Marineland and the San Diego Zoo. But almost two-thirds (63%, n=38) were captured and killed. Of these, for which information is available, 16 were captured for market (mostly during the 1800's and early part of this century) and another 15 were killed and eventually donated as specimens to museum and university collections. On four disturbing occasions, all involving leatherbacks, turtles were accidentally struck by boats but then the crews retaliated by capturing and killing the injured turtle (by gunshot, gaffing or causing the turtle to tow the boat).

Killing of leatherbacks. In a total of 93 captures (including all species), for which sufficient information is available, turtles were released alive 46 times, accidentally killed twice, and deliberately killed 45 times. But it is very clear that leatherbacks were killed a greater percentage of the time than were hard-shelled species; 77.5% of captured leatherbacks were deliberately killed versus only 25% of captured hard-shelled turtles. In reverse, 32 of 44 (73%) of the hard-shelled turtles were released alive while only 6 of 34 (21%) of leatherbacks were so released. I know of no explanation for this inequity other than to suggest that because of its often huge size and strange appearance, the leatherback makes a more "novel" capture prize and thus finds itself the victim of gunshot, harpoon and machete.

Conclusions

1) Most turtles (64%) were simply sighted at sea with no additional contact with man.
2) Relatively few turtles were found stranded ashore, but of these 90% were dead.
3) 27% (n=95) of the turtles reported were captured—either accidentally (n=35) or intentionally (n=60).

a. Of the 35 incidental captures, 22 were found entangled in fishing nets (2 dead, 11 released alive, 7 killed, 2 unknown), 1 turtle was released from a tangled bouy line of a crab pot, 6 were caught by fishing pole (1 killed, 5 released) and 6 were released from electrical companies' filter racks.

b. Of the 60 intentional captures, 11 were released immediately, 11 transferred to marine aquaria and 38 killed.

4) Half of the captured turtles were released alive. But captured leatherbacks were killed a greater percentage of the time (77.5%) than hard-shelled species (25%). This is probably due to their huge size and strange appearance which makes them a more "novel" capture prize and victim of gunshot and harpoon.

Table 40. Relative frequency of sightings, strandings and captures of sea turtles in the northeastern Pacific.

Species	Sightings	Floating Dead	Strandings	Captures	Total Records
Dermochelys	106 (68.4%)	2 (1.3%)	11 (7.1%)	36 (23.2%)	155
Chelonia	28 (50.0%)		7 (12.5%)	21 (37.5%)	56
Caretta	18 (40.9%)	1 (2.3%)	5 (11.4%)	20 (45.5%)	44
Lepidochelys	5 (35.7%)		6 (42.9%)	3 (21.4%)	14
Subtotal for Hard-shelled Species	51 (44.7%)	1 (0.9%)	18 (15.8%)	44 (38.6%)	114
TOTAL *	227 (63.8%)	3 (0.8%)	31 (8.7%)	95 (26.7%)	356

* Includes records of observations in which the species identification was not known.

Table 41. Synopsis of strandings of sea turtles in the northeastern Pacific.

Circumstance of Stranding							
Rescued and Released		1	1	1	3		3
Died after Rescue	1	1	1	3	5		6
Found Dead, cause unknown	7	3	2	2	7	2	16
Found Dead, injury caused by boat	2	1	1		2		4
Found Dead, injury caused by net	1						1
Found Dead during a Storm		1			1		1
TOTAL	11	7	5	6	18		31

Table 42. Synopsis of incidental and intentional captures of sea turtles in the northeastern Pacific.

Circumstance of Capture							
INCIDENTAL CAPTURES							
Entangled in Net, Released Alive	4	4	1		5	2	11
Entangled in Net, then Killed	4	3			3		7
Found Dead in Net	1		1		1		2
Found in Net, additional information unavailable	2						2
Entangled in Crab Pot Line, Released Alive	1						1
Caught by Fishing Pole, Released Alive		3			3	2	5
Caught by Fishing Pole, then Killed	1						1
Entrained-Electrical Company, Released Alive		3			3	3	6
TOTAL	13	13	2	0	15	7	35

Table 42. (continued).

Circumstance of Capture							
INTENTIONAL CAPTURE							
Captured, Released Alive	1	2	8		10	11	
Captured donated to Public Aquaria		2	8	1	11	11	
Captured, then Killed	18	4	2	2	8	8	34
Retaliatory Killing by Boats	4						4
TOTAL	23	8	18	3	29	8	60

CHAPTER VII

CONCLUSIONS

San Diego Bay

History of Sea Turtles in San Diego Bay

A survey of newspaper articles, reporting sea turtle sightings in San Diego Bay, indicates that historically turtles in San Diego preceeded the construction of the SDG & E Company's facility and warm water channel by at least a century. Sea turtles, primarily greens, escaped into the bay from Captain Bogart's holding pens in 1857, but whether these were the first turtles introduced to San Diego or whether they already existed here is unknown—there are no earlier turtle accounts in San Diego's newspapers.

In the decades following the escapes, newspaper accounts indicate that sea turtles were present in large numbers in both San Diego and False [Mission] Bays. Articles reporting turtle sightings in San Diego's bays were conspicuously absent after 1903. We have no indication that turtles occurred here again until after the mid-1960's when the SDG & E Company began discharging warm water into the southern part of the bay.

If in fact turtles were gone, the factors causing their disappearance are unknown; but following the turn of the century San Diego underwent significant growth and the bay became an increasingly important port for maritime traffic and ship yards. Also, there remains the possibility that the turtles had not disappeared but that they had become less "newsworthy" to this growing metropolis, especially in comparison with world events that would take precedent over any article reporting simply that a fisherman had hauled another turtle from the bay--San Diego was changing.

Seasonal and Geographic Distribution of Green Sea Turtles in San Diego Bay

Today, green sea turtles are in San Diego Bay during months when water and sediment temperatures and salinities are lowest (November - April), but during these months they are found only in areas of the bay where temperatures and salinities are the greatest (in the southern part of the bay and in the SDG & E channel). Turtles are generally absent from the bay from May to October when bay temperatures (24.8°-35.6°C; mean 29.06°C) are tropical. These temperatures were also recorded very frequently during the turtle season within the SDG & E channel. For these reasons, I believe that hot temperatures are in no way limiting to them or causing their annual exodus in April.

Turtles do not occur in the central or northern areas of the bay and in these areas temperatures range from 14.5-26.5°C. While there is evidence to suggest greens in south bay become inactive when temperatures are as low as 16°C, and the avoidance of lower temperatures could account for their nonexistence in central and northern bay areas, they also avoided these areas of the bay when temperatures were 17-26.5°C--temperatures which they frequently had encountered and which did not limit their activity in south bay.

Rather than avoiding central and northern San Diego Bay for any biological reason I think they are avoiding the extensive boat traffic of these areas. Water depths in south bay are too shallow for most boats and only skiffs can venture into these shoals. The greatest disturbances in south bay are small speed boats pulling water skiers and high speed, high noise jet skiers. Without having made a comparative study of turtle activity during times when water and jet skiers are in the area and periods when they were not, it was clear that fewer turtles surfaced when they were in the vicinity. A turtle swimming in these shoals would have no escape from the propellar of a speed boat or from collision with a jet skier.

There is nothing about San Diego's environment in April or May, or during the rest of the summer or fall, that is limiting to their existence in the bay. In fact, it is during the summer and fall that San Diego's south bay is most tropical, consequently it cannot be the bay's environment that triggers or causes their emigration. This suggests that their migration is controlled by a factor beyond San Diego. I know of no instance of nesting or breeding within the bay eliminating the possibility of their return signifying San Diego as beaches of their birth. Possibly during autumn months they are along California when coastal temperatures cool and they somehow remember that the warm waters of south San Diego Bay exist, thus triggering their entry into the bay. Although I tracked greens across stretches of the bay harboring eelgrass, I do not know to what extent they are feeding. Consequently I cannot comment on the possibility of their leaving during late spring, when coastal temperatures are beginning to warm, to feed elsewhere. Though green sea turtles are relatively common all summer in the Southern California Bight, I do not know anything about the migration of the San Diego greens outside the bay; I do not know where they go or from whence they return.

Thermal Biology of Green Sea Turtles in San Diego Bay

Body temperatures of five turtles monitored in south San Diego Bay ranged from 15.60-27.75°C (in 15.30-30.0°C ambient water temperatures). With only three exceptional recordings, these five turtles maintained body temperatures between 21.0 - 25.0°C and this range can be considered their optimum range of body temperatures for activity in San Diego Bay. Their mean temperatures were individually 22.04, 22.20, 23.55, 23.00 and 24.69°C (23.35°C mean for group). Their range of body temperatures here in San Diego is significantly lower than that recorded for *Chelonia* in the tropics (25.7-31.0°C) but similar to that recorded in the Gulf of California, Mexico (18.50-22.75°C). They maintained this range of body temperatures both during February when water temperatures were 20-31°C and during March when water temperatures had increased to 23-37°C.

Temperature data from this study combined with that recorded by Spotila (*et al*., 1979) for a green swimming off Costa Rica indicate that *Chelonia mydas* is a poikilotherm, capable as a species of having a wide range of body temperatures (15.60-37.1°C). Yet in San Diego, they maintain body temperatures in a relatively narrow range (21-25°C during activity).

Generally, temperatures were 5 to 8°C cooler along the channel floor than at the surface. All five turtles monitored during this study had body temperatures characteristic of the cool channel floor. Behaviorally, green turtles is San Diego spent most of their time at the bottom, surfacing only long enough to breathe.

It is not surprising that sea turtles occupy the SDG & E channel during the winter and spring months. But it is intriguing that they seemingly avoid, or at least do not frequent, the channel's more tropical surface. Because they are seen in the greatest numbers at the eastern end of the channel where discharge water enters the channel and temperatures are the warmest, and because in the tropics they are active in 27.5 to 29.0°C seas, it cannot be the case that they are avoiding the warm temperatures of the surface. Although benthic feeders, they are probably not foraging along the channel floor because the channel is significantly barren of food sources. Quite possibly, the turtles are simply conserving energy by avoiding the persistently strong surface current and wind chop characteristic of the channel.

Cool-water Inactivity

During the turtle season of November through April, most turtle activity is centered in the SDG & E channel, but the turtles do move back and forth between the channel and southern shoals of the bay. One turtle was tracked on seven occasions to a spot right outside the channel where temperatures were considerably cooler (15-

23°C, floor to surface). When at this cool water locale, the turtle remained stationary at the floor underneath a sunken barge and would remain submerged for at least three hours without surfacing. Its body temperatures dropped to 15.6 - 16.7°C (its carapace transmitter recorded water temperatures of 15.3 - 17.4°C). As the turtle moved between the warm channel and the cool-water locale, its body temperatures and activity pattern adjusted to water temperature in a classical ectothermic manner. Chelonia in San Diego Bay become inactive at water temperatures of 15 to 17°C, their body temperatures decrease accordingly and they seek out underwater ledges or burrows. This pattern of cool-water inactivity corresponds to Felger's (et al, 1976) discovery that greens in the Gulf of California, Mexico become "dormant" and burrow in the sea floor during colder months (November through March) at water temperatures below approximately 15°C. Unlike Chelonia in the Gulf of California, that presumably remain inactive and burrowed for weeks or months, the San Diego turtles alternate days of cool-water inactivity with days when they are active in the warm channel and have optimum body temperatures.

Tolerance of Green Sea Turtles to Low Temperatures

Green sea turtles are extremely eurythermic—capable of living in a tremendous range of ocean temperatures. In the tropics, the center of their global distribution, surface temperatures are 29-35°C. Along the open coast of southern California they are found all year in temperatures of 13 to 20°C, but are most common from July through October when surface temperatures are 18 to 20°C (and they are especially common in areas of 19-20°C water). They have been sighted as far north as the Gulf of Alaska in temperatures as low as 10°C.

In the Pacific, north of Point Conception, when temperatures are 14-16°C, greens are present from central California to British Columbia and they are vigorous swimmers and apparently healthy. These are the same temperatures when greens in San Diego Bay and in the Gulf of California become inactive. When temperatures north of Point Conception drop below 14°C, few greens are sighted. Although a green found in 10°C water in Coos Bay, Oregon, and another in 11°C water in the Gulf of California were reported healthy, most northern greens found in areas of 9-11°C water were discovered stranded on beaches--dead or in poor condition--and those still in the water were apparently having problems swimming and diving which is one reaction to low water temperatures. From this study it appears that the tolerance of green turtles to low temperatures changes as they geographically range further north in the Pacific--they become more tolerant of low temperatures.

Annual Migration of Green Sea Turtles to San Diego Bay

Each year during this study, from 1976 through 1983, green turtles have appeared during winter and spring months in the SDG & E Company's discharge channel and surrounding shallows of southern San Diego Bay. The turtles arrive, seemingly as a group, some time during late October-early November. They are seen daily through mid-April when they again depart. During these years, turtles were never sighted nor located using ultrasonic telemetry within San Diego Bay during summer months. Their arrival and departure seems sudden and as a group; if they are arriving as individuals their remigration schedule or timing is fairly identical.

In 1979, I estimated the population to then consist of 25-30 turtles of both sexes, ranging in size from adults to juveniles having a carapace length of approximately 35cm. Several turtles that could be recognized (including two with transmitters) were observed several years in a row. Turtle #5 that has a very conspicuous shell deformity was seen, on a daily basis, throughout the turtle season each year from 1976 through 1983.

Daily Travel and Activity Patterns in San Diego Bay

While in San Diego, green turtles spend their time entirely within the southern third of the bay; they were never sighted nor tracked more than 2½ miles from the discharge channel. The greatest level of turtle activity was always centered at the eastern end of the channel (bridge area), where discharge water enters the channel and temperatures and water depth are greatest. Turtles are at the bridge during all hours and tidal periods, but there is a marked increase in the number of sightings during low and incoming tides.

Tidal phase, rather than time of day, is of greater importance to turtle activity and travel within the channel. During high tide, most turtles were found from the mid-channel area east to the bridge. During outgoing tides, turtles move away from the bridge swimming down or out the channel. During low tides, they restrict their activities to the bridge area where depths are the greatest or to burrows along the channel where they remain until the incoming tide allows passage across shoal areas. Their travel patterns follow the tides. When they do leave the channel it is usually on an outgoing tide and when they enter the channel it is usually on an incoming tide. Turtles not leaving the channel congregate in the largest numbers at the eastern end of the channel at the bridge. These data support interpreting their movements as a response to incoming cool water from the bay or an abundance of warm water in the channel at high and outgoing tides.

There was no significant difference in turtle activity between morning and afternoon hours. Turtles were active throughout the night hours both within the channel and outside in the southern third of the bay--but at a possibly lower level. This lower level of activity during night hours might have only been due to the increased difficulty in seeing turtles in the dark and also to the less time spent in night tracking. Eight of the nine turtles captured in our nets (three escaped) were caught during night hours. Also on five occasions I tracked Turtle #6 on what I presume were nocturnal feeding sojurns. During afternoons she would leave the bridge, and depending on the time of the outgoing tide, exit the channel crossing to the southwestern side of the bay. From here she would begin a slow circuit through the eelgrass shoals along the southern shore and then during late night hours (2200 - 0400 hours, depending on the time of the incoming or high tides) re-enter the channel returning directly to the bridge.

As turtles move about within the channel and across the southern part of the bay, they almost exclusively use a path that is slightly deeper than surrounding shoals. During periods of high water, they have access to their entire system of pathways and have temporary use of areas that are exposed or inaccessible during low tides. Examining some of these areas, exposed during low tide, reveals depressions that during higher water are used by the turtles as loitering or resting areas. Many of the turtles' travel patterns seem to have these depressions as their goal, where they often congregate before reversing direction and repeating the travel pattern.

Turtles travel either singly or in loose groups of 2-7 members. Those travelling in groups surface together, use the same route and end up together at the same stop areas. Turtles travelling alone, like cars on a freeway, often use the same route and their travel patterns overlap so they appear to be following one another. Nothing is known about their social behavior and while they were often seen together in small groups, I do not know if they were simply using the same travel pattern and timing or whether they were interacting or communicating in any way.

Breathing Behavior

Green sea turtles in San Diego spend most of their time underwater, surfacing periodically only for a single breath or surfacing several times in rapid succession before re-submerging again for 15 to 25 minutes. Dives as long as 40-45 minutes were common but it was apparent that turtles could remain underwater for at least 3 hours without surfacing and quite possibly for much longer. Their ability to remain submerged decreases with decreasing body size. The mean dive time (including all dives, even the short surfacings between longer dives) was 9 min 24 sec for adults (300 lb; 136kg), 8 min 46 sec for subadults (150 lb; 68kg) and 6 min 28 sec for juveniles (50 lb; 23kg).

Synchronous Surfacing Behavior

Frequently, turtles seemed to surface (presumably to breathe) in groups. Long stretches of time would lapse (10 to 30 minutes) when few, if any, turtles would surface. And then quite suddenly several, or more, turtles would surface in synchrony. Synchronous breathing was observed in 8 of 17 observation periods. No correlation was found between the time of day and whether or not the turtles surfaced in synchrony. The number of turtles present did not regulate the occurrence of synchronous surfacing. Synchrony existed during periods when as few as 5 and as many as 15 turtles were present and yet did not occur on an occasion when as many as 11 turtles were involved. There was no difference in length of dives during periods of synchrony or nonsynchrony.

The hypothesis that synchronous air breathing is caused by a group's individual breathing patterns overlapping--that is by a group surfacing together initially by chance and that synchrony is then maintained simply by the similarity of their breathing patterns--is unlikely. This hypothesis is inadequate because of the variablility in the length of time between bouts involving synchronous surfacings; because of the variability in lengths of dives and the flexibility in breathing patterns, because they can remain submerged for periods longer than the observation sessions--they do not have to breathe, and because the participants of a synchronous bout were not locked together as a group always surfacing together but rather the participants involved continually changed from one interval to the next.

An environmental stimuli has not been found to account for, causing or timing, their synchronous breathing. In order for such a behavior to be socially motivated, the cues must be communicated. Baird (1980) labelled the synchronous air-breathing behavior he observed in African clawed frogs as a "socially facilitated" behavior. This describes situations when in a group, individuals will either increase the frequency of engaging in a specific behavior, in response to seeing other members doing the behavior, or will synchronously do something in response to a cue of some individual within the group (Clayton, 1978). This term does not describe the behavior I observed in Chelonia mydas. First, a communicating cue that would link the turtles together as a group is apparently lacking--they are not in visual contact. They are not known to produce sounds and sounds would most probably be indifferentiable in this environment. Second, there is no evidence to indicate that they surfaced more frequently when sharing the area with other turtles than when solitary.

Kramer and Graham (1976) suggest that synchronous surfacing in air-breathing fishes might serve to confuse aerial predators. In any bout involving synchrony, not all members of the total group surfaced in any given interval and because there is considerable variation in the length of time between such bouts, a predator would not be able to predict when and which individuals would surface. Sea turtle hatchlings enter the ocean as a group and are heavily preyed upon by birds. A tactic, such as synchronous surfacing, successful in confusing aerial predators would be a selective factor in their survival.

Biology of Sea Turtles in the Northeastern Pacific

Species

Sea turtles do occur in the northeastern Pacific, north of central Baja California (leatherbacks *Dermochelys coriacea*, greens *Chelonia mydas*, Pacific loggerheads *Caretta caretta*, and Pacific (olive) ridleys *Lepidochelys olivacea*). Over half (57.7%) of the sightings were reported from along the coast of southern California and northern Baja California, Mexico. For the hard-shelled species, sightings decreased in number with increasing distance north.

Dermochelys coriacea. Leatherbacks were most commonly reported. This can be attributed to their greater tendency to travel into northern waters but also because of their peculiar appearance and enormous size which makes them easily identified and more apt to be remembered and reported. Of all the species of sea turtles found north of Mexico, Dermochelys is the most northern in its distribution Two-thirds (67%) of its sightings came from north of Point Conception. It was reported as far north in the Gulf of Alaska as 60°34'N latitude--within five degrees of the Arctic Circle and as far west as the Aleutian Islands.

Chelonia mydas. Of the hard-shelled sea turtles for which the species could be identified, Chelonia was the most common. It ranges as far north as in the Gulf of Alaska but is most common along northern Baja California and southern California.

Caretta caretta. Of the four species of marine turtles found in the eastern Pacific, Caretta tends to be the most southern in its distribution. It is common along the coast south of Point Conception but has only been reported once from central California and twice from Washington.

Lepidochelys olivacea. The Pacific ridley has not been reported frequently enough to clearly estimate its abundance and range north of Mexico. Of 16 sightings reported, 10 were from southern California, 4 from central and northern California and 2 from Oregon.

Correlation of the Occurrence of Sea Turtles with Periods of Anomalous Surface Ocean Temperatures

A significantly greater number of turtles were reported during months when surface ocean temperatures were unusually hot for the northeastern Pacific and fewer during months when temperatures were abnormally cold. South of Point Conception, a significantly greater number were reported during months abnormally hot while north of Point Conception, there was a significant decrease in sightings during months abnormally cold and an increase in the number of sightings during months when temperatures were normal.

During October through June, there was a significant increase in sightings during months when temperatures were anomalously hot (both north and south of Point Conception). During July, August and September there were significantly fewer sightings during years when these months were unusually cool and a number significantly greater than expected were reported during years when these months had normal surface temperatures. The trend was toward normal rather than toward hot temperatures during July, August and September. South of Point Conception, there were no significant differences between the observed and expected frequencies of sightings during July, August and September. This indicates that during these three months turtle sightings south of Point Conception are independent of, and not caused by, influxes of currents with temperatures abnormally hot for this area. North of Point Conception, during years when these three months were unusually cold there was a significant decrease in the number of sightings, but when temperatures were normal there was a significant increase in sightings. Again this increase was during these three months when temperatures were normal rather than when these months were abnormally hot. This indicates that there is a turtle season in the northeastern Pacific; that during July, August and September sea turtles do occur in these northern waters independent of anomalous hot temperatures.

There was a significantly greater number of turtles sighted during years when currents of temperatures unusually hot for this area were positioned along the coast of the northeastern Pacific. There was a significant decrease in the number of sightings during years when surface sea temperatures were unusually cold. The results are the same both north and south of Point Conception and during July-September or during October - June.

A greater number of leatherbacks were sighted during years of hot temperatures.

In years when surface temperatures are abnormally cold, green sea turtles (particularly those north of Point Conception) are found only during the seasonally warmest months of the year--July, August and September. North of Point Conception they are more common during years of hot temperatures (than expected). South of Point Conception, they appear year-round and their occurrence is independent of years of abnormally hot temperatures. South of Point Conception, green sea turtles do not depend on hot years.

Overall, loggerhead sightings occurred more frequently during hot years and less frequently during cold years than was statistically expected. This indicates that their occurrence in the northeastern Pacific reflects and depends on years when warm currents are positioned in these northern coastal waters. An exception to this is that south of Point Conception they are sighted during July, August and September regardless of the year's overall temperature (normal, hot or cold).

Chi square analysis of the frequency of sightings of Pacific ridleys indicates that their occurrence in the northeastern Pacific is not dependent in any way upon years of hot surface temperatures. But this analysis only involves 16 sightings and possibly these results are in part due to the small sample size.

While the greatest number (51%) of sightings occurred during months and years of normal temperatures, their frequency fits statistical expectations. Sea turtles do occur in greater numbers than expected during hot years, although most are here under normal conditions they are here (in numbers greater than expected) during years when warm currents are positioned in these northern, coastal waters.

Hubbs (1960) and Radovich (1961) suggested that unusually warm ocean conditions--temperature anomalies--were responsible for sightings of sea turtles in the northeastern Pacific. These results indicate that this is especially true for sightings reported during nonseason months (October-June) and for sightings of turtles north of Point Conception.

During nonseason months, October through June, turtles are sighted more frequently if these months are abnormally warm or if the year averaged above normal temperatures. North of Point Conception, sightings of sea turtles are restricted to the warmest season of the year--July, August and September--unless it is an unusually hot year.

Although the greatest number of turtle sightings (51%) occurred during months and years of normal temperatures, their frequency fits statistical expectations. Sea turtles do occur in numbers greater than expected during years when warm currents are positioned along this northern coast. I must conclude that, indeed, sea turtles do respond to periods of unusually hot surface temperatures and by staying in these warm currents could end up along our northern shore. But this does not detract in any way from the evidence indicating that there is a turtle season in the northeastern Pacific and that sea turtles are a regular part of this northern coast's environment and not merely a result of el nino years or unusual periods of abnormally hot ocean temperatures.

Seasonal Occurrence of Sea Turtles in the Northeastern Pacific

Marine turtles appear seasonally along the Pacific coast of North America from northern Baja California to the Gulf of Alaska--during July, August and September—when surface sea temperatures are warmest each year. With increasing distance north, the season becomes more pronounced with a greater percentage of the area's sightings restricted to these three months.

South of Point Conception, temperatures are adequately warm allowing turtles, particularly hard-shelled species, to occur year-round. But even here, sightings increase appreciably in May and June, peak in July, August and September and subsequently decrease. North of Point Conception, turtles can be expected only during July, August and September.

Beginning in July, turtles are widespread along the coast from southern California to Washington. Along Oregon, turtles first appear in July (and in relatively great numbers) and are reported with considerable frequency throughout August. In Washington, turtles appear in July and August but are most common during September. For Canada, September is the critical month with 14 of its 29 sightings being reported. In the Gulf of Alaska, sea turtles are sighted from August through December; but four of its seven sightings were in August and September.

In conclusion hard-shelled species of turtles are found in southern California year-round but in greatest numbers during July, August and September. Leatherbacks also are found south of Point Conception but only during July-September. North of Point Conception, turtle sightings are restricted to July-September and most involve leatherbacks. Leatherbacks (any turtles in general) first appear north of Point Conception in July along Oregon. From here some move south appearing in northern and central California during late July, August and September. Others move north from Oregon, as part of the Alaska Gyral Current, appearing later in the season in waters further north.

Seasonal Distribution of Sea Turtles and the Seasonal Position and Movement of Surface Isotherms in the Northeastern Pacific

Turtles found in southern California from January through June are in 13-15°C water; elsewhere to the north turtles are uncommon and temperatures cooler (3-13°C). In July, 13°C water extends north as far as central Canada; warmer offshore water (16-17°C) pushes these 13-15°C isotherms inshore against the coast of central California and again in along northern Oregon and Washington. Wherever, in July, the 13-15°C isotherms meet the northern coast there is a corresponding increase in turtle sightings. In August, isotherms reach their most northern position; 13° and 14° water spreads across the Gulf of Alaska and turtles appear from central California to the Gulf of Alaska—wherever temperatures are 13-15°C. This pattern continues through September. In October, the 13°C water withdraws from the Gulf of Alaska and few turtles are seen in northern areas. By November warm offshore waters retreat moving southwest away from the coast and turtles become rare north of Point Conception.

During winter and spring months a population of green sea turtles occupies San Diego Bay and hard-shelled turtles, particularly greens, are found along the coast north to Point Conception. Later in the year, during July-September, they are found considerably further north (into the Gulf of Alaska for some). These northern individuals probably simply moved north with the seasonal northward advance of the 13-15°C isotherms. And those appearing along southern California could be individuals that remain there all year or arrive by following the northward shift of 16-20°C water from Baja California. Nothing is known about the migration of the San Diego greens during the summer and fall months when they are absent from the bay. They might stay in local waters moving back into the bay in November as coastal temperatures cool. This would account for some of southern California's summer sightings. But there is nothing requiring them to stay local and they could travel considerable distances--but in what direction I do not yet know.

North of Point Conception, most turtles sighted are leatherbacks and their appearance in the northeastern Pacific is two-pronged. They are not found in the northeastern Pacific during the winter and spring. They begin appearing in southern California in May and June in 16-17°C water, temperatures that are typical of southern Baja California during winter months, and probably arrived in southern California by travelling north along the coast of Mexico. But even if all of these leatherbacks continued their coastal trek north into Oregon they could not account for the July explosion in the number of sightings there. When they do appear north of Point Conception it is in 13-15°C water but they probably did not arrive here by travelling in this current, along the coast, as these isotherms shifted north from southern California. I say this because they are not found in intervening areas during May or June as those isotherms are passing north along central or northern California. Instead, they do not appear until the warmer offshore isotherms have expanded shoreward pushing the 13-15°C isotherms tight against the coast of North America—and this first happens in July along Oregon.

Consequently, while hard-shelled sea turtles and some leatherbacks move north along the coast expanding their range as surface temperatures seasonally warm, other leatherbacks arrive from offshore on the Great Pacific Drift current and reaching the coast at Oregon in July and then move north in the Alaskan Gyral or south in the California coastal current. Since I began requesting information from commercial fishermen, I have received several accounts of albacore jigboats seeing leatherbacks 500 to 1,000 miles off the coast of central California and Oregon during summer months.

Off Oregon, Washington and more northern waters leatherbacks are seen in areas rich in jellyfish and coelenterates, particularly in waters blanketed with wind-sailor jellyfish. When albacore and bluefin tuna appear off Oregon—in July, August and September—leatherbacks also appear. Often albatross and other oceanic species of birds are reported with the turtles. Albacore and other species of tunas annually migrate following the seasonal movement of isotherms, travelling in a current of specific temperature. Whatever is timing the appearance of albacore and tunas and the drifts of jellyfish along Oregon could be doing the same for leatherbacks.

Tolerance to Low Ocean Temperatures

Leatherbacks have been sighted in the northeastern Pacific in sea temperatures ranging from 3 to 20°C (3-15°C north of Point Conception and 13-20°C to the south). They do not appear affected by temperatures as low as 8°C, leatherbacks found in that temperature were appearently healthy and swimming vigorously. Only the turtle found in an area of 3°C water was dead.

Green sea turtles are seen year round along the coast of southern California in temperatures seasonally ranging from 13-20°C, but are most common in July, August and September in 18-20°C. Those greens occupying the southern third of San Diego Bay during the winter and spring months had available strata of water ranging in temperature from 15 to 35°C. They avoided central and northern areas of the bay that were 13-19°C—temperatures encountered by turtles outside the bay in coastal waters. From body temperature data, measured on five turtles tracked during February and March in south San Diego Bay, the turtles spent most of their time in 22-25°C temperatures. Turtles monitored at a cool spot in the southern part of the bay, where temperatures were 15-17°C, were inactive and their body temperatures decreased, accordingly, to 15.6°C. Felger et al. (1976) used indirect evidence to conclude that at water temperatures as low as 15°C green sea turtles in the Gulf of California, Mexico, become inactive and dormant burying into the Gulf's floor during winter months. In the spring when Gulf temperatures increase to 18°C turtles again are seen actively swimming.

Greens sighted in temperatures of 15-16°C water along central California were, unlike the San Diego Bay greens, active swimming strongly. Only those further north in cooler temperatures, 9-11°C, were discovered either stranded on the beach dead or in poor condition, or in the water but apparently having problems swimming and diving. One green was sighted in 11°C water in Alaska during October. It was actively swimming and capable of diving. A month later a green was found dead nine miles to the southeast in 9°C water and it was presumed to be the same animal (cause of death could not be ascertained). In Oregon, greens are capable of surviving 10°C water but die if subjected to the additional stresses and lower temperatures of a storm.

Mendonca (1983) found that greens in Mosquito Lagoon, Florida are active (moving 8-10 km/day) at water temperatures as low as 11°C. During a different phase of that Mosquito Lagoon study, Ehrhart (1977) found that they became stunned and floated at the surface when temperatures averaged 10°C and suggested that they become dormant, partially burying into the lagoon's mud bottom during periods of cold temperatures.

From this study it appears that the tolerance of green sea turtles to low temperatures changes geographically. In the northeastern Pacific, those greens found further north are more tolerant of low temperatures than those in San Diego Bay or the Gulf of California.

Loggerheads were sighted on 38 occasions in temperatures of 13-20°C and only once in 9°C. This latter turtle was at first mistaken as dead but after being placed in a warm building overnight it was examined, found to be alive and its body temperature then 13°C.

Pacific ridleys have been reported, south of Point Conception, throughout the year in 15-20°C water and those found in 18-20°C were apparently healthy. North of Point Conception, five were sighted from October to December and another in spring. They were found in 12° and 14°C water, those in 12° were either dead or else emaciated and lethargic.

Bathymetry

Generally half of all sightings were from waters less than 100 meters (55 fathoms) in depth, but numerous sightings were in waters considerably deeper. Leatherbacks were seen in the same proportion (66%) as other species in waters less than 100m but ranged also into the deepest waters (maximum 7273m, 4000 fms). As pelagic surface feeders their distribution is not limited by water depth, but rather by the abundance of pelagic food sources in a particular area. Other species of sea turtles are essentially benthic feeders and their food resources restrict them, in feeding areas, to shallow waters.

However, turtles were sighted in a great range of water depths. This is because along this coastline there is no distinct continental shelf break; there is no average depth of water over the continental borderlands; the coastal topography is extremely irregular with many areas uplifted as banks and sea mounts and intervening areas downthrust as deep canyons. The continental borderlands form instead a series of terraces decreasing in depth like steps. The contour of these terraces undulate along the coast, approaching shore quite closely in some areas and widening in other areas. Consequently, within very little swimming distance turtles can surface in coastal waters ranging from less than 25 meters to thousands of meters (or fathoms) in depth. A subsequent paper plotting sightings with distance offshore should offer a more meaningful approach to the study of their coastal biology.

Man's Contact with Sea Turtles

Most turtles reported (64%) were simply sighted at sea with no additional contact with man. Twenty-seven percent (n=95) were captured (35 accidentally, 60 intentionally). Of those captured accidentally, 22 were found entangled in fishing nets (2 dead, 7 killed, 11 released alive, 2 cases unknown results), 1 was released from a tangled bout line of a crab pot and 6 caught by fishing pole (1 killed, 5 released). Six (all greens) turtles were rescued from electrical companies' filter racks and pipes. Of 60 turtles taken aboard, 11 were released immediately, 11 transferred to marine aquaria and 38 killed.

Half of the turtles captured were released alive. But captured leatherbacks were killed a greater percentage of the time (77.5%) than the hard-shelled species (25%). This is probably due to their huge size and strange appearance which makes them a more "novel" capture prize and victim of gunshot and harpoon.

Relatively few (8.7%, n=31) of the records involved turtles stranded ashore, but of these 90% were dead. Of 356 sightings, only two leatherbacks and one loggerhead were found floating dead at sea.

ACKNOWLEDGEMENTS

ACKNOWLEDGEMENTS

This study of the biology of sea turtles in San Diego Bay and in the northeastern Pacific has crossed many disciplines and has required the participation of a league of oceanographers—scientists offering their technical and academic expertise and fishermen offering their perspective and knowledge that results only from years at sea. This study has been wonderfully like the fitting together of a jigsaw puzzle—each scientist and fishermen holding his own piece of knowledge or skill without knowing how it would fit when the picture was more complete. This picture—the story of the biology of sea turtles in the northeastern Pacific—is not complete (only closer). But it is my hope that this paper will in part repay each person involved by revealing to them how various pieces of the puzzle seem to fit and from here we can proceed with a new perspective.

A very special thanks is offered to Ed McEwen, captain of the *Pacific Queen*, who first introduced me to the turtles in San Diego Bay; his livelihood depends on his knowledge of the sea, from this knowledge he has taught me an oceanography not available in text books. To my parents and family and to Mary and Ed Simpson who were the backbone (or carapace) of the project. To Nina McEwen who always offered encouragement and laughter when it was most needed. To Diane Gibson for her editorial criticism and field work, her participation brought humor to several otherwise miserable rain drenched, sleepless mornings. To Dr. Raymond Gilmore, of the San Diego Museum of Natural History, who continually pushed for me to finish this project so he could share my conclusions. Gratitude and appreciation are extended to the following:

To Tom and Pat Fritts—of my committee members Tom's participation was most active. At the start of the project he was curator of herpetology at the San Diego Museum of Natural History and has since moved to the U.S. Fish and Wildlife Service and to its sea turtle projects elsewhere. Tom and Pat helped throughout the field portion of this study--setting and pulling nets, traveling to Mexico to learn how really to catch sea turtles and eventually helping to track them in San Diego Bay. To other committee members Dr. Richard Etheridge (San Diego State University) and Dr. Greg Pregill (San Diego Museum of Natural History) for their advise and editorial review of this paper.

I offer sincere gratitude to Mr. Joe Dietz, chief environmentalist for the San Diego Gas and Electric Company, for arranging our access to the study site (the effluent channel at the SDG & E South Bay facility) and for use of a storage building which offered some protection from wind and rain during weekends when our nets were set and had to be checked day and night. To Mr. Jack Jones, maintenance supervisor at the facility, for his help during crucial moments and to the SDG & E security guards for their concern and shore-watch when I was out alone tracking. To Susan Vergne, biologist for the SDG & E Company, for reporting turtle sightings at their Encino facility.

This project proceeded under the auspices of the National Fish and Wildlife Laboratory, Denver Research Center of the United States Fish and Wildlife Service (Washington, D.C.). They obtained the federal permit required in order to work with these animals and provided funds for telemetry equipment.

Thanks are given to Mr. Ray Keyes, curator of fishes at the Hubbs Sea World Research Institute, for allowing the turtles, captured in San Diego Bay, to be transferred to Sea World for several days for attachment of carapace transmitters and observation. Mr. Keyes and his staff, particularly John Hewitt and Mike Shaw, provided excellent care to the turtles and made available all of Sea World's resources in designing a successful method for attaching transmitters to the turtles' carapaces.

A deep gratitude is expressed for the biologists at the Naval Undersea Center in San Diego, particularly to Don Carder, Bill Lowell and Bill Gilmartin. These biologists (as well as Hal Goforth, Bob Seeley, Bill Flannigan, Todd Johnson, Tom Peeling and Marilyn Dahlheim) gave valuable advise and help in testing telemetry equipment, solving tracking problems and in helping design various methods for attaching transmitters to turtles. These biologists also served as divers and helped to set our nets and recover transmitters.

A very special thanks (one that can never be repaid in full) is deserved by those who helped to set and check the turtle nets and to those who helped in the tracking of turtles in San Diego Bay. The following gave up many weekends, of rain and gale force winds, to set and pull nets each hour: my parents, Mary and Ed Simpson, Tom and Pat

Fritts, Brian Cooper, Dave Albritton, Bob Crim, Jim Zimmer, Tom Cozens, Marc Hofstetter, Diane Gibson, Terry Hoban, Gail Culver, Mike and Laurel Card, Kay MacArthur, Cyndy Lewis, Nancy and Alan Miller, Bill Matchett and Sue Bradley. A special thanks is offered to my brothers Mike and Richard, and to Terry Hoban (California Department of Fish and Game), Bob Peters, Joe Koller and Don Glasser (Navy's Seal Team) who also served as divers.

To Dr. John Hendrickson (University of Arizona) for loaning us telemetry equipment to use as a back-up in the event that ours should fail. To Dave McGhee and Jane Jacobs of Helle Engineering who supplied a pinger locator for our divers to use to locate and recover transmitters buried in the channel's mud floor. To my brother, Roy, who made available his truck to transport turtles to Sea World--their smell lingered for months. To Dr. Richard Ford and Ron Byrd of the Center for Marine Studies at San Diego State University for the use of a 13 foot Boston Whaler skiff and 20hp Mercury motor. To Bill Hubbard of the San Diego Sheriff's Astrea helicopter squad who kept watch over us when we were out on the bay tracking, who reported coastal sightings of turtles and who rescued our Boston Whaler when it was stolen from the channel--it was especially nice knowing we had a friend above.

To Lou Brito, vice president of Ocean Fisheries, who gave me a piece of tuna net to use for my first attempt at capturing turtles in San Diego Bay. To Tony DiScala, commercial fisherman from Dana Point, who gave me my next stretch of net and who taught me how to hang a net's lead and float lines. To Bobby Allen and Mike and Jan

Grosbeck (Fisherman's Landing) who provided lead weights, line and floats for subsequent turtle nets. To The San Diego Herpetology Society for providing money to pay for the printing of the sea turtle sighting request form. To Ed and Nina McEwen (Pacific Queen) and to Paul Morris (Fisherman's Landing) for donating money to the project when it was critically needed. To Dr. Archie Carr (University of Florida) and Dr. Rene Marquez (Mexico's Departmento de Pesca) for providing metal identification tags to be attached to the fore-flippers of turtles being released.

To Senor Jose Francisco Mayoral Gonzalez and other turtle hunters in La Laguna, Baja California for teaching us how to catch and handle a sea turtle and for their information concerning the historical population levels of sea turtles in Baja California.

To Dr. Carl Hubbs, and his wife Laura, for their excitement when we came to their office showing a picture of a turtle's head photographed as the animal surfaced in San Diego Bay. Dr. Hubbs identified the turtle as a green and immediately shared all he knew of sea turtles in San Diego Bay and his memories of the bay as it was in the early decades of this century. He donated his files and photographs (and those maintained earlier by Professor Ritter, founder of Scripps).

To Mr. and Mrs. Booth, curators of the San Diego Historical Society's Ticor Photographic Collection; their search of its archives uncovered wonderful historical photographs of sea turtles in San Diego Bay. To Mr. Edwin Bertin and other members of the San Diego Maritime Museum who spent days recounting what they could remember of turtles in San Diego at the turn of the century. To Mr. Donald Blackman, son of John Blackman owner of the Blackman Turtle Cannery which operated in San Diego Bay until 1934 and who was part owner of the Lower California Charter Company that established the first turtle cannery in Baja California (located on Isla Santa Margarita in Magdalena Bay) and sent canned and live turtles north to San Diego. Mr. and Mrs. Blackman shared all they could remember of his father's turtle operation.

To Dr. Tom Fritts (U.S. Fish and Wildlife Service) and to Drs. Carl Hubbs, Tim Barnett, Joseph Reid, Robert Wisner, and George Snyder of the Scripps Institute of Oceanography, Frank Rokop (UCSD) and to Mike Laurs, Aleta Hoehn and Forrest Miller of the National Marine Fisheries Service (Southwest Fisheries Center) who generously shared their knowledge, ideas and questions.

To Dr. Farris (SDSU) for offering suggestions and answering questions concerning statistics used in this study. To Jim Varnell and Susan Archer (SDSU) who provided tremendous help during the computer anaysis portion of this study. To Guy Tapper (SDSU) who prepared the final graphics for some of the figures used herein.

To Captains Ed McEwen, Steve Loomis, Garry Black, Buz Brizzendine, Dean Adams, Nick Cates (all from Fisherman's Landing) and Bill Johnson (Point Loma Sportfishing) for their interest in this study and for their encourging other vessels to log and report turtle sightings. When I distributed sighting request forms along this coast I never dreamed I would receive such cooperation. So many fishermen and biologists responded (from central Baja Californa to the Gulf of Alaska) that I cannot acknowledge them individually in this chapter, however, I am extremely appreciative of their taking time from their work to log and report sightings. Those who have been most instrumental in sending reports (and who have not already been acknowledged) are the following: Dale Snow, Neil Richmond, Dave Douglas and Darrel Demory of Oregon's Department of Fish and Wildlife; Marilyn Dahlheim, Aleta Hohn, Sarah Hinckley, Jim Bybee, Charles Koski of the National Marine Fisheries Service; Robert Lea of the California Department of Fish and Game; Mike Ellis of the Point Reyes Bird Observatory; L.V. Gordon fisheries biologist for the Canadian Government on the Queen Charlotte Islands; Kenneth Harley (Canadian Department of Fisheries and Oceans); Gordon Bell, fisheries biologist at the Pacific Biological Station in Nanaimo, British Columbia; Paul Collins, Santa Barbara Museum of Natural History; Dr. Murray Johnson, University of Puget Sound Museum of Natural History; Elaine Carlin, Lockheed Corporation fisheries biologist working at the SDG & E Comapny's facilities; Brian Wiersema (Mira Costa College in Oceanside, California); and to the following commercial fishermen: Bill Vas, Gary Schniepp, Danny West and Ivan Aldis and to Mike Crawford (operator for Catalina Cruises).

To all of these people, thank you for the part you played in making it possible for us to learn this much about sea turtles in the northeastern Pacific.

LITERATURE CITED

LITERATURE CITED

Agassiz, L. 1857. Contributions to the natural history of the United States of America. Vol. I. Boston, MA: Little, Brown & Co., 452 pp.

Anonymous. 1915-1953. Observations of sea water temperature, salinity and density on the Pacific coast of Canada. M.S. Rept. I-XIII. Fish. Res. Bd. Canada.

__________. 1957. 1957, the year of warm water and southern fish. Preliminary Rept. Mar. Res. Comm., Calif. Coop. Oceanic Fish. Invest. Dec. 19. 1957, 1-15.

__________. 1981. Natural history specimens: marine turtles. Smithsonian Inst. SEAN Bull. 6(11):15.

Averett, W.E. 1920. Lower California green turtle fishery. Pacific Fisherman 18(7):24-25.

Baird, T. 1980. The influence of social and predatory factors on the air breathing behavior of the African clawed frog *Xenopus laevis* (Daudin). Master's Thesis, San Diego State Univ., California. 76 pp.

Balazs, G.H. 1976. Green turtle migrations in the Hawaiian Archipelago. Biol. Conserv. 9:125-140.

Balazs, G.H. and E. Ross. 1974. Observations on the basking habit in the captive juvenile Pacific green turtle. Copeia 1974:542-544.

Banta, B.H. and D. Morafka. 1966. An annotated check list of the recent amphibians and reptiles inhabiting the city and county of San Francisco, California. Wasmann J. Biol. 24(2):223-238.

Bell, P.L. and H.B. MacKenzie. 1923. Mexican west coast and Lower California, a commercial and industrial survey. Dept. Commerce Bur. Foreign & Domestic Commerce. Special Agents Ser. No. 220:340 pp.

Berkson, H. 1966. Physiological adjustments to prolonged diving in the Pacific green turtle (*Chelonia mydas* Agassizii). Comp. Biochem. Physiol. 18:101-119.

Bernal, P.A. 1979. Large scale biological events in the California Current. Calif. Coop. Oceanic Fish. Invest. Rept. 20:89-101.

Bleakney, J.S. 1965. Reports of marine turtles from New England and eastern Canada. Canadian Field Naturalist 79(2):120-128.

Brattstrom, B.H. and R. Collins. 1972. Thermoregulation. Int. Turtle and Tortoise Soc. J. 6:15-19.

Brongersma, L.D. 1970. Het,, Verloren" jaar en de verspreiding van enkele zeeschildpadden. [The lost year and distribution of sea turtles.] Proc. Kon. Ned. Akad. Wetensch. 79:70-72.

Caldwell, D.K. 1960. Sea turtles of the United States. U.S. Fish and Wildl. Serv., Fish. Leaf., 492:1-20.

________. 1962. Sea turtles in Baja Californian waters (with special reference to those of the Gulf of California), and the description of a new subspecies of northeastern Pacific green turtle. Los Angeles Co. Mus., Contr. Sci. 61:1-31.

Carl, G.C. 1944. The reptiles of British Columbia. first edition. Brit. Col. Prov. Mus. Handbook No. 341,47,48.

________. 1947. Leather-back turtle off Denman Island. Victoria Naturalist 4(4):45,46.

________. 1955. The green turtle in British Columbia. Brit. Col. Rep. Prov. Mus. Nat. Hist. Anthro. :B76-B78.

________. 1960. The reptiles of British Columbia. 3rd edition revised from 1951 & 1944. Brit. Col. Prov. Mus. Handbook No. 3:50-53.

Carr, A. 1952. Handbook of turtles. The turtles of the United States, Canada, and Baja California. Ithaca, NY: Cornell Univ. Press: 341-410, 441-460.

________. 1954. The passing of the fleet. A.I.B.S. Bull. 4:17-19.

________. 1967. Adaptive aspects of the scheduled travel of <u>Chelonia</u>. <u>In</u>: Animal Orientation and Navigation. Corvallis: Oregon State Univ. Press: 33-55.

________. 1972. The case for long-range chemoreceptive piloting in <u>Chelonia</u>. NASA SP-262:469-83.

Carr, A., Ogren, L. and C. McVea. 1980. Apparent hibernation by the Atlantic loggerhead turtle off Cape Canaveral, Florida. Biol. Conserv. 19:7-14.

Carr, A., Ross, P. and S. Carr. 1974. Internesting behavior of the green turtle, Chelonia mydas, at a mid-ocean island breeding ground. Copeia 1974:703-706.

Chambers, R.W. and R.L. Chambers. 1973. San Diego Gas and Electric Company. Final Report. Thermal distribution at the South Bay power plant. Prepared for the San Diego Gas and Electric Company. Purchase Order #P-25072.

Christensen, H.B. 1977. Statistics step by step. Boston, MA: Houghton Mifflin Co.; 624-627 pp, Appendix A.15.

Clayton, D.A. 1978. Socially facilitated behavior. The Quart. Rev. Biol. 53(4):370-392.

Craig, J.A. 1926. A new fishery in Mexico. Calif. Fish and Game 12(4):166-169.

Crawford, D.R. 1927. Records of rare fishes from the North Pacific during 1925. Copeia 1927(160):182-184.

Dehadrai, P.V. 1962. Respiratory function of the swim bladder of Notopterus (Lacepede). Proc. Zool. Soc. London 139:341-357.

Ditmars, R.L. 1949. The reptiles of North America. Garden City, NY: Doubleday & Co.: 380-384.

Dixon, W.J. and M.B. Brown. 1979. BMDP-79 Biomedical computer programs P-series. University of California Press, 880 pp.

Dohl, T. 1980. Sea turtles of central and northern California. In: Marine mammal and seabird survey central and northern California. University of California Santa Cruz Center for Marine Studies unpublished manuscript. pp:143-146.

Eber, L.E. 1971. Characteristics of sea-surface temperature anomalies. Fish. Bull., U.S. 69:345-355.

________. 1981. Large-scale sea-surface temperature anomalies in the northeast Pacific Ocean. Calif. Coop. Oceanic Fish. Invest. Rep. 22:19-33.

Ehrhart, L.M. 1977. Cold water stunning of marine turtles in Florida east coast lagoons: Rescue measures, population characteristics and evidence of winter dormancy. Paper presented at 1977 ASIH meeting. Gainesville, Florida.

________ and R.C. Lee. 1981. Hypothermic stunning of marine turtles in east-central Florida lagoons in 1981. Paper presented at the joint meeting of Society for the Study of Amphibians and Reptiles and of the Herpetologists'

League. 9-14 August 1981. Memphis State University, Tennessee. p:39.

Felger, R.S., Cliffton, K. and P.J. Regal. 1976. Winter dormancy in sea turtles: Independent discovery and exploitation in the Gulf of California by two local cultures. Science 191 (4224):283-285.

Forbes, R.B. and D. McKey-Fender. 1968. A green turtle from the Oregon coast. Canadian J. Zool. 46:1079.

Ford, R.F. and R.L. Chambers. 1973a. San Diego Gas and Electric Company. Thermal distribution and biological studies for the South Bay power plant. Final report Volume 4B Thermal Measurements, May 1973. Submitted to California Regional Water Quality Control Board, San Diego Region.

____________________. 1973b. San Diego Gas and Electric Company. Thermal distribution and biological studies for the South Bay power plant. Final Report Volume 5A Biological Measurements. Submitted to California Regional Water Quality Control Board, San Diego Region. 188 pp.

____________________. 1974. San Diego Gas and Electric Company. Final Report. Biological Studies at the South Bay power plant during the period September 1972 - July 1973. San Diego Gas and Electric Company Contract # P-25072. 131 pp.

Ford, R.F., Chambers, R.L. and J.M. Merino. 1970. Ecological effects of power station cooling water discharge in south San Diego Bay during August 1970. Environmental Engineering Laboratory Tech. Rept. on Contract C-821. 52 pp.

______________________________. 1971. Ecological effects of power station cooling water discharge in south San Diego Bay during February - March 1971. Environmental Engineering Laboratory Tech. Rept. on Contract C-821. 92 pp.

______________________________. 1972. Ecological effects of power station cooling water discharge in south San Diego Bay during August 1972. Environmental Engineering Laboratory Tech. Rept. on Contract C-821. 50 pp.

Forselius, S. 1957. Studies of anabantid fishes. I. A qualitative description of the reproductive behavior in territorial species investigated under laboratory conditions with special regard to the genus Colisa. An introduction. Zool. Bridgrag Uppsala 32:93-301.

Frazier, J. 1985. Misidentification of sea turtles in the east Pacific: Caretta caretta and Lepidochelys olivacea. J. Herpet. 19(1):1-11.

Frick, J. 1976. Orientation and behavior of hatchling green turtles (Chelonia mydas) in the sea. Anim. Behav. 24:849-857.

Fritts, T.H. 1981. Marine turtles of the Galapagos Islands and adjacent areas of the Eastern Pacific on the basis of observations made by J.R. Slevin 1905-1906. J. Herpet. 15(3):293-301.

_________, Hoffman, W. and M.A. McGehee. 1983. The distribution and abundance of marine turtles in the Gulf of Mexico and nearby Atlantic waters. J. Herpet. 17(4):327-344.

_________, and R.P. Reynolds. 1981. Pilot study of the marine mammals, birds and turtles in OCS areas of the Gulf of Mexico. U.S. Department of the Interior, Fish and Wildlife Service, Biological Services Program. FWS/OBS-81/36:1-139.

_________, Stinson, M.L. and R. Marquez M. 1982. Status of sea turtle nesting in southern Baja California, Mexico. Bull. So. Calif Acad. Sci. 8(12):51-60.

Gilmore, C.W. 1937. A new marine turtle from the Miocene of California. Calif. Acad. Sci., Proc. 4th Ser. 23(10):171-174.

Gordon, M.S. 1972. Animal physiology; principles and adaptations. 2nd ed. New York, NY: Macmillan Publ. Co., Inc., 592 pp.

Grinell, J. and C.L. Camp. 1917. A distributional list of the amphibians and reptiles of California. Univ. Calif. Publ. Zool. 17(10):127-208.

Guess, R.C. 1981. A Pacific loggerhead captured off California's northern Channel Islands. Herp. Rev. 12(1):15.

Harless, M. and H. Morlock. 1979. Turtles: perspectives and research. New York, NY: John Wiley & Sons; 695 pp.

Hayes, B. 1929. Pioneer notes from the diaries of Judge Benjamin Hayes 1849-1875. Los Angeles, Calif.: McBride Printing Co., 158p.

Heath, M.E. and S.M. McGinnis. 1980. Body temperature and heat transfer in the green sea turtle, Chelonia mydas. Copeia 1980(4):767-773.

Henderson, D.A. 1972. Men and whales at Scammon's Lagoon. Los Angeles, Calif.: Dawson's Book Shop Publ.; Baja California Travels Series No. 29:313 pp.

Hensley, H.C. 1952. The history of San Diego city, county and region through the memories, anecdotes and recollections of the author, compiled and edited by him over a period of three years, 1949-1952. Deposited in the archives of the San Diego Hist. Soc., October 6, 1952. Accession No. 1750.(Ref. Acc. 2404):497, 500 pp.

Hill, L.G. 1972. Social aspects of aerial respiration pf young gars (Lepisosteus). Southwest. Nat. 16:239-247.

Hirth, H.F. 1962. Cloacal temperatures of the green and hawksbill sea turtles. Copeia 1962:647-648.

Hodge, R.P. 1979. Geographic distribution: Dermochelys coriacea schlegeli. SSAR Herp. Rev. 10(3):102.

_________. 1981. Geographic distribution: Chelonia mydas agassizi. SSAR Herp. Rev. 12(3):83-84.

Houck, W.J. and J.G. Joseph. 1958. A northern record for the Pacific ridley, Lepidochelys olivacea. Copeia 1958(3):219-220.

Hubbs, C.L. 1948. Changes in the fish fauna of western North America correlated with changes in ocean temperature. J. Mar. Res. 7(3):459-482.

_________. 1960. The marine invertebrates of the outer coast. In: The biogeography of Baja California and adjacent seas, part 2. Systematic Zool. 9(2-3):134-147.

_________. 1977. First record of mating of ridley turtles in California, with notes on commensals, characters, and systematics. Calif. Fish & Game 63(4):262-267.

_________. and L.P. Schultz. 1929. The northward occurrence of southern forms of marine life along the Pacific coast in 1926. Calif. Fish & Game 15(3):234-240.

Jordan, D.S. 1887. The fisheries of the Pacific coast. In: The Fisheries and Fishing Industries of the United States. Part XVI In Section II by G.B. Goode.: 591-598pp.

Karmelich, K. 1937. Turtles. In: The commercial fish catch of California for the year 1935. Calif. Div. Fish Fish Bull. 49:122-123.

Kermode, F. 1932. A remarkable capture of leatherback turtles off Bajo Reef, near Nootka Sound, west coast of Vancouver Island, British Columbia. Brit. Col. Rept. Prov. Mus. Nat. Hist. 1932:B6-B8.

Ketchen, K.S. 1956. Climatic trends and fluctuations in yield of marine fisheries of the Northeast Pacific. J. Fish. Bd. Canada 133):357-374.

Klauber, L.M. 1928. A list of the amphibians and reptiles of San Diego County, California. 1st ed. Zool. Soc. San Diego, Bull. 4:1-8.

__________. 1930. A list of the amphibians and reptiles of San Diego County, California. 2nd ed. Zool. Soc. San Diego, Bull. 5:1-8.

__________. 1934. Annotated list of amphibians and reptiles of the southern border of California. Zool. Soc. San Diego, Bull. 11:1-28.

Koski, C.H. 1981. Unusual sight off the coast. Oregon Wildlife 36(10):13.

Kramer, D.L. and J.B. Graham. 1976. Synchronous air breathing, a social component of respiration in fishes. Copeia 1976(4): 689-697.

Lazell, J.D. 1980. New England waters:critical habitat for marine turtles. Copeia 1980:290-295.

Lockheed Center for Marine Research. 1979. South Bay power plant receiving water monitoring program. Prepared for San Diego Gas & Electric Company. Contract #J-828019. 56 pp.

______________________________. 1978. San Diego Gas and Electric Company South Bay power plant receiving water monitoring program. Submitted to the California Regional Water Quality Control Board, San Diego Region. Contract # J-828019. 58 pp.

______________________________. 1977. San Diego Gas and Electric Company South Bay power plant receiving water monitoring program. Submitted to the California Regional Water Quality Control Board, San Diego Region. Contract # S-720031. 66 pp.

Loftus, W.F. 1979. Synchronous aerial respiration by the walking catfish in Florida. Copeia 1979(1):156-158.

Logier, E.B.S. and G.C. Toner. 1961. Check list of the amphibians and reptiles of Canada and Alaska. Toronto: Royal Ontario Mus., Life Sci. Div., Contr. No. 53:55-56.

Loveridge, A. 1945. Reptiles of the Pacific world. New York, NY: MacMillan Co.; 259 pp.

Lowe, C.H. and K.S. Norris. 1955. Measurements and weight of a Pacific leatherback turtle, Dermochelys coriacea schlegeli, captured off San Diego, California. Copeia 1955(3):256.

MacAskie, I.B. and C.R. Forrester. 1962. Pacific leatherback turtles (Dermochelys) off the coast of British Columbia. Copeia 1962(3):646.

Marquez, R. 1969. Additional records of the Pacific loggerhead turtle, Caretta caretta gigas, from the north Mexican Pacific coast. J. Herpet. 3(2):108-110.

Matheson, C. 1960. Caretta kempi Garman on Welsh coast. Nature 4729:989.

McEwen, G.F. 1916. Summary and interpretation of the hydrographic observations made by the Scripps Institution for Biological Research of the University of California 1908 to 1915. Univ. Calif. Publ. Zool., 15:255-356.

McGinnis, S.M. 1968. Respiration rate and body temperature of the Pacific green turtle Chelonia mydas agassizii. Amer. Zool. 8:766.

McGrew, C.A. 1922. City of San Diego and San Diego county, the birthplace of California. Amer. Hist. Soc. Chicago and New York. Vol. I:391.

Mendenhall, W. 1969. Introduction to probablitiy and statistics. 2nd ed. Belmont, Calif.: Wadsworth Publ. Co., Inc.; 393 pp.

Mendonca, M.T. 1983. Movements and feeding ecology of immature green turtles (Chelonia mydas) in a Florida lagoon. Copeia 1983(4):1013-1023.

________, and L.M. Ehrhart. 1982. Activity, population size and structure of immature Chelonia mydas and Caretta caretta in Mosquito Lagoon, Florida. Copeia 1982(1):161-167.

Metz, C.W. 1913. The fishes of Laguna Beach, California. I. 1st Annual Rept. Laguna Marine Lab., 19-66.

Meylan, A, 1981. Behavioral ecology of the west Caribbean green turtle (Chelonia mydas) in the internesting habitat. In: Biology and conservation of sea turtles. Bjorndal, K.A., ed.. Proc. World Conf. Sea Turtle Cons. Wash. D.C. 26-30 Nov. 1979. Smithsonian Inst. Press; 67-80 pp.

Morejohn, G.V. 1969. Occurrence of a Pacific ridley and a young northern fur seal in Monterey Bay. Calif. Fish & Game 55(3):239-242.

Mrosovsky, N. 1980. Thermal biology of sea turtles. Amer. Zool. 20:531-547.

________. 1983. Conserving sea turtles. British Herpetological Society, Zoological Society of London; 176 pp.

________ and P.C.H. Pritchard. 1971. Body temperatures of Dermochelys coriacea and other sea turtles. Copeia 1971(4):624-631.

Mulford, P. [pseudonym, "Dogberry"]. 1865. Whales, and some other things. The Union Democrat. Sonora, Tuolumne County, Calif.: 1865 April 15: 1(col. 3-6).

________. 1889. Prentice Mulford's story: Life by land and sea. New York, NY: F.J. Needham, Publ.; p. 57.

Myers, G.S. 1933. Two records of the leatherback turtle on the California coast. Copeia 1933(1):44.

Nelson, E.W. 1921. Lower California and its natural resources. Mem. Natl. Acad. Sci. 16(1):194 pp.

Nichols, J.T. 1926. Impressions of Alaska, --where east and west approximate. Nat. Hist. 26(6):605-612.

Nishimura, S. 1964. Considerations on the migration of the leatherback turtle, Dermochelys coriacea (L), in the Japanese and adjacent waters. Publ. Seto. Mar. Biol. Lab. 12:177-189.

Nordhoff, C. 1888. Peninsular California: account of the climate, soil, productions, and present condition chiefly of the northern half of Lower California. Franklin Square Square, New York, NY: Harper & Brothers; 130 pp.

Norris, K.S. 1963. The functions of temperature in the ecology of the percoid fish Girella nigricans (Ayres). Ecol. Monog. 33(1):23-62.

Ogren, L. and C. McVea, Jr. 1982. Apparent hibernation by sea turtles in North Aemrican waters. In: Bjorndal, K.A. (ed.. Biology and conservation of sea turtles. Proc. World Conf. Sea Turtle Conserv., Washington, D.C. 26-30 November 1979.

Smithsonian Inst. Press: 127-132.

Parker, G.H. 1925. The time of submergence necessary to drown alligators and turtles. Occas. Pap. Boston Soc. Nat. Hist. 5:157-159.

Parsons, J.J. 1962. The green turtle and man. Gainesville, Univ. Fla. Press; 126 pp.

Peeling, T.J. 1975. A proximate biological survey of San Diego Bay, California. Naval Undersea Center; San Diego, California. NUC TP 389 Revision 1; 83 pp.

Phillips, I. (no date). A decade in San Diego history 1850-1860 as told by the San Diego Herald. San Diego Hist. Soc. 479-498 phi:141-142.

________. 1960. National City pioneer town. National City, Calif.: Southbay Press; 142 pp.

Pickard, G.L. and D.C. McLeod. 1953. Seasonal variation of temperature and salinity of surface waters of the British Columbia Coast. J. Fish. Res. Bd. Canada 10(3):125-145.

Pickwell, G. 1947. Amphibians and reptiles of the Pacific states. Stanford, Calif.: Stanford Univ. Press; 62, 208, 209 pp.

Pope, C.H. 1967. Turtles of the United States and Canada. New York, NY: Alfred A. Knopf; 255-297.

Prange, H.D. 1976. Energetics of swimming of a sea turtle. J. Exp. Biol. 64:1-12.

________, and D.C. Jackson. 1976. Ventilation, gas exchange and metabolic scaling of a sea turtle. Respir. Physiol. 27:369-377.

Pritchard, P.C.H. 1969. Sea turtles of the Guianas. Bull. Florida State Mus. 13(2):85-140.

Radovich, J. 1960. Redistribution of fishes in the eastern North Pacific Ocean in 1957 and 1958. Mar. Res. Comm., Calif. Coop. Oceanic Fish. Invest. Rept. 7:163-171.

________. 1961. Relationships of some marine organisms of the northeast Pacific to water temperatures, particularly during 1957 through 1959. Calif. Fish & Game, Fish. Bull. 112:1-62.

Reid, J.L., Jr. 1960. Oceanography of the northeastern Pacific Ocean during the last ten years. Calif. Coop. Oceanic Fish. Invest. Rept. 7(1 Jan. 1958 to 30 June 1959):77-90.

________, Roden, G.I., and J.G. Wyllie. 1958. Studies of the California current system. Contr. SIO, New Series No. 998 In: Calif Coop. Oceanic Fish. Invest. Prog. Rept. 1 July 1956 to 1 Jan. 1958: 27-56.

________ and R.A. Schwartzlose. 1962. Direct measurements of the Davidson Current off Central California. J. Geophysical Res. 67(6):2491-2497.

Ridgway, S.H., Wever, E.G., McCormick, J.G., Palin, J. and J.H. Anderson. 1969. Hearing in the giant sea turtle, Chelonia mydas. Pschology 64:884-890.

Robinson, M.K. 1957. Sea temperature in the Gulf of Alaska and the northeast Pacific Ocean, 1941-52. Univ. Calif. S.I.O., Bull. 7(1):1-98.

____________ 1965. Climatic implications derived from the comparison of bathythermograph (BT) data with two types of historic and modern sea surface data. Calif. Coop. Oceanic Fish. Invest. Rept. 10(1 July 1962 to 30 June 1963):141-152.

____________ 1973. Atlas of monthly mean sea surface and subsurface temperatures in the Gulf of California, Mexico. San Diego Soc. Nat. Hist. Memoir 5:97pp.

Roden, G.I. 1961. On nonseasonal temperature and salinity variations along the west coast of the United States and Canada. Calif. Coop. Oceanic Fish. Invest. Rept. 8(1 July 1959 to 30 June 1960):95-119.

________. 1963. On statistical estimation of monthly extreme sea-surface temperatures along the west coast of the United States. J. Mar. Res. 21(3):172-190.

________. 1966. A modern statistical analysis and documentation of historical temperature records in California, Oregon and Washington, 1821-1964. J. Applied Met. 5(1):3-24.

San Diego Unified Port District. 1980. Environmental impact report on master plan. Report by the Environmental Management Department. San Diego, California.

Sapsford, C.W. and G.R. Hughes. 1978. Body temperature of the loggerhead sea turtle Caretta caretta and the leatherback sea turtle Dermochelys coriacea during nesting. Zool. Africana 13(1):63-69.

Scammon, C.M. 1874. The marine mammals of the north-western coast of North America. Together with an account of the American whale-fishery. 1968 ed. New York, NY: Dover Publ., Inc.; 319 pp.

________. 1970. Journal aboard the bark Ocean Bird on a whaling voyage to Scammon's Lagoon, winter of 1858-1859. Los Angeles, Calif.: Dawson's Book Shop Publ., Baja California Travels Series No. 21:78 pp.

Schefler, W.C. 1969. Statistics for the biological sciences. Reading, MA: Addison-Wesley Publ. Co.; 231 pp.

Schlaifer, A. and C.M. Breder, Jr. 1940. Social and respiratory behavior of small tarpon. Zoologica 30:493-513.

Schmidt, K.P. 1953. A checklist of North American amphibians and reptiles. 6th ed. Amer. Soc. Icthy. & Herpet., 280 pp.

Schwartz, F.J. 1978. Behavioral and tolerance responses to cold water temperatures by three species of sea turtles (Reptilia, Cheloniidae) in North Carolina. Florida Marine Research Publication 33:16-18.

Schwartzlose, R.A. and J.L. Reid. 1972. Near-shore circulation in the California Current. Calif. Mar. Res. Comm., Calif. Coop. Oceanic Fish. Invest. Rept. 16:57-65.

Shaw, C.E. 1946. An anomalous Pacific loggerhead turtle from the northwestern coast of Baja California. Herpetologica 3:123-124.

________. 1947. First records of the red-brown loggerhead turtle from the eastern Pacific. Herpetologica 4:55-56.

Shoop, C., Doty, T., and N. Bray. 1981. Sea turtles in the region between Cape Hatteras and Nova Scotia in 1979. In: A characterization of marine mammals and turtles in the mid- and north Atlantic areas of the U.S. outer continental shelf: Annual Report for 1979:IX 1-85. Univ. of Rhode Island, Kingston.

Shor, E.N. 1978. Scripps Institute of Oceanography: probing the oceans 1936 to 1976. San Diego, CA: Tofua Press; 502 pp.

Slater, J.R. 1963. Distribution of Washington reptiles. Univ. Puget Sound Dept. Biol., Occas. Paper 24:212-233.

Slevin, J.R. 1927. An additional record of the leather-back turtle on the coast of California. Copeia 159:172-173.

________. 1931. Log of the schooner "Academy". On a voyage of scientific research to the Galapagos Islands 1905-1906.

Calif. Acad. Sci., Occas. Paper 17:1-162.

Smith, H.M. 1894. Notes on a reconnaisance of the fisheries of the Pacific coast of the United States in 1894. U.S. Fish Comm., Bull. 14:223-288.

Smith, S.A. and J. Houck. 1984. Three species of sea turtles collected from northern California. Calif. Fish & Game 70(1):60-62.

Snell, H.L. and T.H. Fritts. 1982. Terrestrial emergence of Chelonia mydas in the Galapagos. Biotropica 15(4):285-291.

Sokal, R.R. and F.J. Rohlf. 1969. Biometry: the principles and practice of statistics in biological research. San Francisco, Calif.: W.H. Freeman and Co.; 776 pp.

Spotila, J.R., Standora, E.A. and R.E. Foley. 1979. Body temperatures of green turtles: Free swimming and active on land at Tortuguero, Costa Rica. Amer. Zool. 19:982 (abstr.).

Stebbins, R.C. 1954. Amphibians and reptiles of western North America. New York, NY: McGraw-Hill; 183-187, 190-192 pp.

Stephen, A.C. 1953. Scottish turtle records previous to 1953. The Scottish Naturalist 65:108-114.

Stephens, F. 1921. An annotated list of the amphibians and reptiles of San Diego County, California. San Diego Soc. Nat. Hist., Trans. 3(4):57-69.

Stewart, H.B., Jr. 1960. Coastal water temperature and sea level--California to Alaska. Calif. Coop. Oceanic Fish. Invest. Rept. 7(1 Jan. 1958 to 30 June 1959):97-102.

_________, Zetter, B.D. and C.B. Taylor. 1958. Recent increase n coastal water temperature and sea level--California to Alaska. U.S. Coast and Geodetic Survey Tech. Bull. 3:1-11.

Svensson, G.S.O. 1933. Freshwater fishes from the Gambia River. Kungl. Svenska Vetenskapasakad. Stockholm, Ser. 3(12):1-102.

Sverdrup, H.U. and R.H. Fleming. 1941. The waters off the coast of southern California, March to July, 1937. Univ. Calif., S.I.O. Bull. 4(10):261-378.

_________, Johnson, M.w. and R.H. Fleming. 1942. The oceans: their physics, chemistry and general biology. New York, NY: Prentice Hall; 1087 pp.

Tenney. S.M., Bartlett, D., Jr., Farber, J.P. and J.E. Remmers. 1974. Mechanics of the respiratory cycle in the green turtle (Chelonia mydas). Resp. Physiol. 22:361-368.

Thompson, W.F. 1917. Temperature and the albacore. Calif. Fish and Game 3(4):153-159.

________. 1919. The occurrence of the albacore north of San Francisco. Calif. Fish and Game 5(4):203-204.

Threlfall, W. 1978. First record of the Atlantic leatherback turtle (Dermochelys coriacea) from Labrador. Can. Field-Naturalist 92(3):287.

Townsend, C.H. 1916. Voyage of the "Albatross" to the Gulf of California in 1911. In: Scientific results of the expedition to the Gulf of California in charge of C.H. Townsend, by the U.S. fisheries steamship "Albatross" in 1911. Commander G.H. Burrage. U.S.N., commanding. Bull. Amer. Mus. Nat. Hist., 35(24):399-476.

________ 1926. Items of interest: the size of the leatherback turtle. New York Zool. Soc. Bull. 29(6):217.

Tsuchiya, M. 1976. California undercurrent in the Southern California Bight. Calif. Coop. Oceanic Fish. Invest. Rept. 18(1 July 1973 to 30 June 1975):155-158.

Tully, J.P. 1950. Seasonal cycles in the sea. Fish. Res. Bd. Canada, Pac. Prog. Rept. No. 85:88-90.

________, Dodimead, A.J. and S. Tabata. 1960. An anomalous increase of temperature in the ocean off the Pacific coast of Canada through 1957 and 1958. J. Fish. Res. Bd. Canada 17(1):61-80.

U.S. Dept. Commerce Coast & Geodetic Survey. 1956. Surface water temperatures at tide stations: Pacific coast North and South America ad Pacific Ocean islands. Spec. Publ. No. 280, 5th ed.: 74 pp.

U.S. Dept. of Commerce NOAA. 1970. Surface water temperature and density [of the] Pacific coast [of] North and South America and Pacific Ocean islands. NOS Publ. 31-3.

University of California, Scripps Institute of Oceanography. 1955-1983. Data report: surface water temperatures at shore stations, United States West Coast and Baja California. (one report published per year)

Van Denburgh, J. 1905. On the occurrence of the leather-back turtle, Dermochelys, on the coast of California. Calif. Acad. Sci., Proc. 4(3):51-61.

__________. 1922. The reptiles of western North America. Vol. II, Snakes and turtles. Calif. Acad. Sci., Occas. Paper 10:993-1004.

__________. 1924. A fifth record of the Pacific leatherback turtle on the coast of California. Copeia 1924:53.

Walford, L.A. 1931. Northward occurrence of southern fish off San Pedro in 1931. Calif. Fish and Game 17(4):401-405.

Whittow, G.C. and G.H. Balazs. 1979. The thermal biology of Hawaiian basking green turtles (Chelonia mydas). Amer. Zool. 19:1981 (abstr.).

Willett, H.C. 1950. Temperature trends of the past century. Centenary Proc. of the Royal Met. Soc.: 195-206.

Willgohs, J.F. 1956. Nye funn av leerskilpadde i Nordsjoen, og litt om artens utbredelse og levevis. Saertrykk av "Naturen" Nr. 9:532-544.

__________. 1957. Occurrence of the leathery turtle in the northern North Sea and off western Norway. Nature 179:163-164.

__________. 1958. Har laerskilpadden (Dermochelys coriacea) ogsa overvintret i vare farvahn? --nytt funn i vesteralen. Saertrykk av "Naturen" Nr. 8:508-510.

Williamson. 1978. Alaska. Alaska Northwest Publ. Co. Anchorage, AL. 11:22.

Wyllie, J.G. 1966. Geostrophic flow of the California Current at the surface and at 200 meters. Calif. Coop. Oceanic Fish. Invest. Atlas No. 4:288 pp.

BIOLOGY OF SEA TURTLES IN SAN DIEGO BAY, CALIFORNIA, AND IN THE NORTHEASTERN PACIFIC OCEAN

A Thesis

Presented to the

Faculty of

San Diego State University

In Partial Fulfillment

of the Requirements for the Degree

Master of Science

in

Biological Sciences

by

Margery L. Stinson

Fall 1984

VOLUME II

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

APPENDIX A

METHODS AND MATERIALS

Capture of Turtles

Poor water visibility prevented divers from catching the sea turtles by hand. The San Diego Bay turtles were never observed basking or floating for extended periods at the surface. Typically, these turtles spent only 5 to 15 seconds at the surface inhaling before again diving. After watching their breathing patterns, I noted that they often surfaced repeatedly in the same spot. Exploiting this behavior, we first tried to catch them by positioning a skiff at the predicted spot and waiting to either scoop the turtle out of the water with a dip net or by grabbing the turtle's shell. Although the turtles surfaced alongside the skiff, and we were posed in readiness, we were always too slow to catch a turtle with this method.

Knowing, simply, that in Mexico nets are used to catch sea turtles, for our second attempt we tried using 50 fathoms of tuna net ($1\frac{1}{2}$ inch mesh, 3 inch diagonal stretch) as a beach seine, with the intention of drawing turtles ashore. This net proved too heavy for our divers and skiffs to pull. A boat with a hydraulic spool capable of working net this heavy would have required a much deeper entry into the channel. In order for a beach seine to function and encircle the turtles, it would have to be pulled quickly into a semicircle against the current and then pulled shoreward. This lumbrous net could not be moved.

Next, two seabass gillnets (9 gauge cotton twine, 3 inch mesh, 6 inch diagonal stretch; 18 feet deep, 150 feet long) were set parallel to each other across the channel. We tried to use these lighter nets again as beach seines, drawing them together, wrapping the channel and moving shoreward in a semicircle of net. These nets could at least be moved by skiffs and long lines of people, standing deep in mud onshore, pulling lines attached to the nets—but not quickly enough to trap any turtles.

Recognizing our ignorance and failures, several of us (Margie Stinson, Tom and Patricia Fritts and Tom Cozens) went to Mexico and watched turtle fishermen work their nets in shallow coastal lagoons. These lagoon turtlers have found that sea turtles tend to be found in the deep channels of the lagoons in areas with eelgrass (Zostera marina). They set their nets across these channels against the current so that the turtles become entangled as they swim with the tide.

Their typical turtle net, light weight (24 gauge cotton or nylon twine) and large meshed (12 inch mesh, 24 inch diagonal stretch), is about 25 to 50 fathoms in length and 15-30 meshes deep. The ends of the stretched net are anchored to prevent the net from folding and tangling together. A surface floatline (using 5" football and #300 plastic tubular floats) is attached to the mesh giving it enough bouyancy to sit at the surface of the water and the lead line rests on the channel floor to prevent the net from rolling.

The top floatline and bottom leadline hold the mesh vertical and the end anchors stretch the net horizontally. This also describes the net (nylon) that we finally used with success in capturing the turtles in San Diego Bay.

In Mexico, the net is set at the beginning of their eight month turtle season (April-November) and is checked each morning for entangled turtles. While a net is productive, catching turtles at a particular location, it is not moved during the entire season. Unlike most American gillnetters, Mexican netters do not have hydraulic spools to draw the net aboard and the net is pulled by hand. Starting at one end, the mesh is gathered up to lift the leadline to the surface. The lead and float lines are then held together above the water and as the mesh is checked for turtles the boat is pulled along the length of the net.

In San Diego, we set our net during weekends for periods of about 48-56 hours. It was checked at least once every hour and half, both day and night, and all animals captured were alive. In Mexico, sea turtle fishermen check their nets only once a day, at dawn, and they estimate that 50% of their catch is dead. Our net was set using a 13' Boston Whaler skiff and a 20hp Mercury 200 outboard motor. To avoid disturbing the turtles, the boat motor was not used for checking the net. Rather we rowed to an end of the net, gathered up the mesh and leadline, held the lead and float lines together high above the water and pulled the boat along looking for turtles.

An entangled turtle is first manuevered so its head is up (vertical) and is then drawn closer to the boat and lifted over the bow. When removing a turtle from a net, it is important to first make certain that the animal is quite entangled so it cannot escape (it can be untangled once aboard) and to position the turtle. If the turtle is relatively free of the mesh and is in swimming or diving position, it has the advantage and can escape. While learning this, several turtles escaped our nets even though two or three people had hold of a flipper or edge of shell.

Ideally a turtle net should have a large mesh, be light weight and strong. Turtles seem to be "net-wise" and will swim along a small-meshed net and avoid capture every time. The mesh must be large (at least 10 inch side) and loose so the turtle's flipper or head can be entangled. The net should be light weight so the animal can pull the mesh to the surface for air; generally mesh this large is also loose enough to allow turtles to rise. I would also suggest using a net that has not been dipped in tar because, although the tar protects the net from sunlight, it makes the net heavier and prevents it from hanging loose and graceful in the water. The mesh must also bevery strong to prevent the turtles from breaking through the knotted mesh. We found that turtles were able to swim through a brand new cotton net of 24 gauge twine (intended for catching thresher sharks and swordfish but were captured by a similar net of nylon.

For the leadline, lead beads (2 ounce) were threaded onto a one half inch nylon line. I would recommend using instead, a commercially made lead rope (a line with a lead core). Most American gillnetters who still use the 5" plastic football and #300 floats have begun using lead rope in order to prevent the two lines from tangling when setting and pulling the net.

If faced with catching more turtles, I would seriously consider using a different system for flotation. I would remove the plastic tubular floats from the surface line and, instead, attach bouys to the top line as the net is let into the water. This would eliminate the tangling otherwise experienced. Shark and swordfish netters use a lead rope for the bottom line and for bouyancy they simply attach an appropriate number of 60" bouys to the surface line. The bouys are attached to the top line with longliner clips (salmon snaps) and although a turtle net must be set so it rests on the surface, the bouys can be tethered so the hangs at any desired depth.

When a net is set, pulled or stored the lead and float lines lie together with the mesh gathered to one side. The lines must never be twisted, but always laid together in the same order. When gillnetters set a net they are very careful to make sure that the floatline is not twisted or mixed with the mesh. They basically ignore the leadline and the remaining mesh ... "if you take care of the float line, the leadline takes care of the rest of the net". It is equally important to protect the net from sunlight. Sunlight and the chlorine in sea water quickly age a net and gillnetters often cover their nets even while on the deck of the boat. A net should be stored out of the sun, otherwise the plastic floats melt into distorted shapes. A net should be cleaned and air-dried before long storage.

Transport and Maintenance of the Turtles at the Hubbs Sea World Research Institute

The captured turtles were transported to and from the Hubbs Sea World Research Institute in a van-type truck to protect the turtles from wind and abrupt temperature changes. Aware of the controversy on how a turtle should be transported, plastron-up or plastron-down, I decided to use the plastron-up position to prevent them from crawling. The plastron can easily be injured if the turtle is allowed to crawl on a rough boat deck or ground. The turtles were placed in this position upon thick mats of foam or upon rimless truck tires. It is important to support a turtle's neck when transported in this position.

While at the Hubbs Sea World Research Institute, the turtles were isolated from aquarium animals and kept in an outdoor, shaded concrete tank (18' diameter, 4' water depth). Filtered ocean water was pumped continually into the Sea World tank from the adjoining Mission Bay. The tank was not headed and water temperatures reflected those of Mission Bay (20.83°C, 69.5°F).

Telemetry System

Because the San Diego Bay turtles only surface long enough to breathe (5–15 seconds) an undwerwater tracking system had to be used. Sound waves travel further in water than radio waves making ultrasonic telemetry the only efficient system for tracking submerged animals (Kanwisher, Lawson and Sundnes, 1974).

Unfortunately, the range of ultrasonic transmissions is greatly reduced in hot, shallow, turbid water over a silt or mud substrate (Brumbaugh, 1978; pers. comm.). And this exactly describes the southern San Diego Bay turtle habitat. The carapace transmitter was designed to transmit 12 miles in the open ocean but under these adverse study conditions, Smith-Root, Inc. projected a maximum range of 1½ miles for these carapace transmitter and 500 meters for the tiny internal transmitters used to measure the turtle's body temperatures.

In practice, it was difficult to measure the actual transmitting range unless the turtle, being tracked, was observed at the surface. The maximum reception range ever recorded during the study was over 2½ miles. But typically the reception range was as little as 100-300 meters for the large carapace transmitters. This range fluctuated daily or even hourly throughout the study area and seemed to depend on local surface water conditions. Reception was best during calm periods.

The turtles spent considerable time in a relatively small area where the SDG & E Company discharges coolant water into the channel. Unfortuantely the telemetry system did not function within 50 meters of this area even though a turtle being tracked was within two meters of the boat and receiver. This discharge area was the deepest and typically the warmest part of the channel but also the site of the strongest eddies and currents.

Carapace transmitters. The carapace transmitters were designed to hold enough batteries to operate at least 15 months and to produce a signal strong enough to be recorded over a tracking distance of 2½ miles (maximum range). Because of these specifications, this transmitter weighed 1.8 kg (4 lbs), it was sealed in a length of PVC plastic pipe (20 cm long, 8.5 cm diameter).

In evolving a successful method for attaching such a large heavy transmitter to a sea turtle we consulted people familiar with the problem of designing and attaching radio packs to marine mammals (Don Carder, Bill Gilmartin and Bill Seeley of the U.S. Navy; Bill Evans of the Hubbs Sea World Research Institute). Carr (1967 and 1972) and Carr et al. (1974) tethered radios to sea turtles so the radio was pulled along. I rejected this method fearing that the San Diego turtles might snag their transmitter on an underwater piling or rock thus losing the tracking device or causing the turtle to drown.

Because the transmitter was so bulky and heavy we reasoned that it would be best to position it along the midline of the carapace to reduce any excess asymmetrical weight that could cause the turtle to swim off balance. Nylon harnesses were tried, but we could not prevent them from slipping and becoming too loose around the turtle's shell; we rejected this method, again, for fear that the turtle might become snagged and drown or because the harness might interfere with flipper movement.

In sea turtles, the lung is very extensive underlying most of the carapace eliminating any surgical methods of attaching the transmitter to the midline area of the shell. Instead, two pieces of grooved plexiglass were glued as a base onto a flat area of the shell (anterior midline). The transmitter was placed on top these strips of plexiglass and then plastic cinch ties were threaded under the plexiglass base and tightened around the transmitter to hold it in place. This proved to be a very simple, quick method of attachment—but also a failure. Four turtles were released with transmitters attached with this method. Unfortunately, within two weeks all of the transmitters had fallen off (or were scraped off).

There are two plausible reasons for this method's failure. First, the Duro Super Glue #3 used to attach the plexiglass cradle to the carapace might have dissolved. The use of this glue had been highly recommended but we did not have time to test it in advance. Since then, we have tested Super Glue in sea water and it does dissolve in approximately 7-10 days. Second, all of these large transmitters were eventually recovered under ledges and in mud burrows carved in the channel floor. Possibly the turtles jarred or scraped the transmitters off. The epidermal scale covering the carapace bone is quite thin and stratified and could flake under a scraping pressure.

With one exception, all of the turtles captured were adults weighing 184-380 pounds [83.5 - 172.4 kg], therefore it seemed sensible to assume that even a transmitter as large and heavy as the ones used in this study would have little effect on the turtle's swimming dynamics. For the last two turtles released, their transmitters were sewn onto the carapace through holes in the marginals along the edge of the shell. These two female turtles were released in March 1979; the one turtle lost her transmitter in October 1979 and the other was still being tracked in May 1980. This method was later adopted and used successfully for long term tracking of loggerhead and green sea turtles in Mosquito Lagoon, Florida (Mendonca, 1983).

With this successful method, plastic cinch ties were threaded into holes ($\frac{1}{4}$ inch in diameter) drilled into the marginal scales of the carapace and looped around the transmitter which rested above the holes. Marine epoxy (Splash Zone and Seagoing Epoxy Putty) was applied as a bed under the transmitter for extra attachment strength. For one turtle the transmitter was positioned above the hindflipper (it did not interfere in any way with the flipper's movement). For the second female the transmitter was attached to the posterior tip of the carapace. This turtle's posterior carapace was extremely deformed, sweeping up like a duck's tail, providing a natural cradle for the transmitter (Figures 16 and 17).

When attaching a transmitter to the edge of the carapace, it is important to center the drilled holes so the edge of the marginals is not weakened. The drill bit and resulting hole should be sterilized and antibacterial ointment applied to the area. Drilling into the marginals does not require the turtle to be anesthesized. After the transmitter was attached, silastic sealant was applied to the holes around the plastic cinch ties to reduce friction-caused irritation.

The juvenile turtle captured was so small (13.6 kg) that instead of using a large transmitter we used a tiny transmitter, intended for swallowing, as its carapace transmitter. This transmitter was first sealed within a plexiglass tube and then glued onto the carapace (Figure 18).

Internal transmitters. Turtles were fed a small transmitter (SR-69-T) one hour before release. This transmitter measured 5.7 cm in length, 14 mm in diameter and weighed 9.1 grams. The feeding procedure was simple. The end of the transmitter was pushed slightly into the end of soft, flexible Tygon tubing (15 mm inside diameter, 20 mm outside diameter, 30 cm length) which was then lubricated and gently guided to the turtle's esophagus. A length of smaller Tygon tubing (13 mm outside diameter, 45 cm long) was inserted into the other end of the larger tube and used as a plunger to push the transmitter out of the tube and into the turtle's esophagus. Once the transmitter was in the esophagus, and the tubes removed, the turtle's throat was gently rubbed until the transmitter was swallowed. A wedge of wood was placed in the angle of the turtle's jaw to prevent it from biting but the turtles were docile throughout this entire procedure.

The use of a swallowed transmitter was justified after determining that a transmitter of this size and shape would not block the digestive tract of even a small sea turtle. Several preserved juvenile ridley sea turtles, in the collection of the San Diego

Museum of Natural History, were dissected and their digestive sphincters measured. The smallest (pyloric) sphincter was at least 7 mm in diameter and would allow the transmitter to pass though easily.

Although the gut transport (digestive) time of captive turtles (Sea World animals) was only approximately 30 hours, we decided to proceed. Using these internal transmitters was the only method available to measure body temperatures of turtles in the wild. Anyway, we had no guarantee that the turtles would remain in the study area beyond 30 hours after their release. And we did not know whether the San Diego Bay turtles were actively feeding and could not predict their expected gut-transported times.

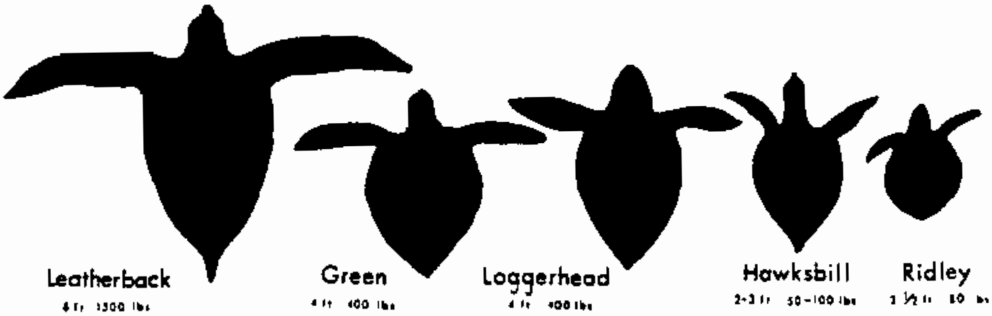
Problems in tracking and the telemetry system. Turtles were to be identified by the specific transmitting frequency and pulse rate of their transmitters. The carapace transmitters were set to transmit specifically at either 39, 42 or 46 KHZ and the internal transmitters were set to transmit at either 67, 68, 70, 72 or 74 KHZ. Unfortunately, in practice, the transmitters did not have a sufficiently narrow transmitting band width and they overlapped each other's signal causing confusion in identifying transmitters. For example, a transmitter designed to transmit specifically at 39 KHZ could be received over a range of 20 to 50 KHZ thus overlapping the frequencies of the transmitters set at 40, 42 or 46 KHZ. Also sound waves transmit on harmonics, so a tracking device transmitting at 39 KHZ would also be received again at 78 KHZ. The effect of harmonics, combined with the extremely wide transmitting band width of each transmitter and the unsophisticated receiver caused a serious problem in distinguishing transmitters. Ideally, had the receiver been more sophisticated, the tone and sensitivity of teh signal could have identified the proper transmitting frequency and solved this critical problem. Each transmitter was supposed to have its own pulse rate, unfortunately, Smith-Root used the same pulse rate on more than one transmitter.

Recording the temperature data. The pulse rate of each transmitter was designed to change speed to reflect changes in temperature. Every time a transmitter was monitored, its pulse rate signal was recorded onto a portable cassette tape recorder for 60 seconds. These recordings were later played back to count the pulses/second for comparison with a pulse rate/temperature curve that accompanied each transmitter. The tape recorder used was a battery powered, single channel model. Even though its batteries (9 volt) were replaced daily, they produced power surges that altered the speed of the tape distorting the actual number of pulses/second. This problem was not discovered until the tapes were reviewed at the end of the tracking season. Fortunately each recording of data was preceeded by a standardized sentence of introductory information. The data was able to be re-recorded onto reel to reel tape at corrected speed, using these standardized sentences as calibration controls, by a variable speed Marantz Superscope recorder.

This critical problem could have been eliminated if a two-channel recorder had been used with one channel continually recording the international time pulse, if a different power source had been used for the recorder in the skiff, or if a pulse counter had been used in conjunction with the hydrophone to count the pulses at the time of recording.

APPENDIX B. SEA TURTLE SIGHTING REPORT FORM

Report SEA TURTLE Sightings



Relative Sizes and Shapes of Their Shells

DATE ______ TIME ______ WATER TEMP. ______ WATER DEPTH ______

EXACT LOCATION ______

APPROX SHELL LENGTH ______ WIDTH ______ COLOR ______ WEIGHT ______

TYPE OF TURTLE IF YOU COULD IDENTIFY IT ______

No. COSTAL PLATES ON TOP SHELL ______ TAG IDENTIFICATION NUMBERS ______
USUALLY ON FLIPPERS

Please note any behavior (feeding, breeding, sleeping, turtle in/near net, etc.) and describe any unusual sea conditions or presence of other animals (schools of jellyfish, etc.).

If it is reasonable (Southern California) I would like to be called immediately {619-726-2228 COLL} if you find a live turtle ashore. If the turtle appears injured or ill (and if you cannot reach me) please call a local wildlife agency (Zoo, Sea World, Museum, Fish & Game).

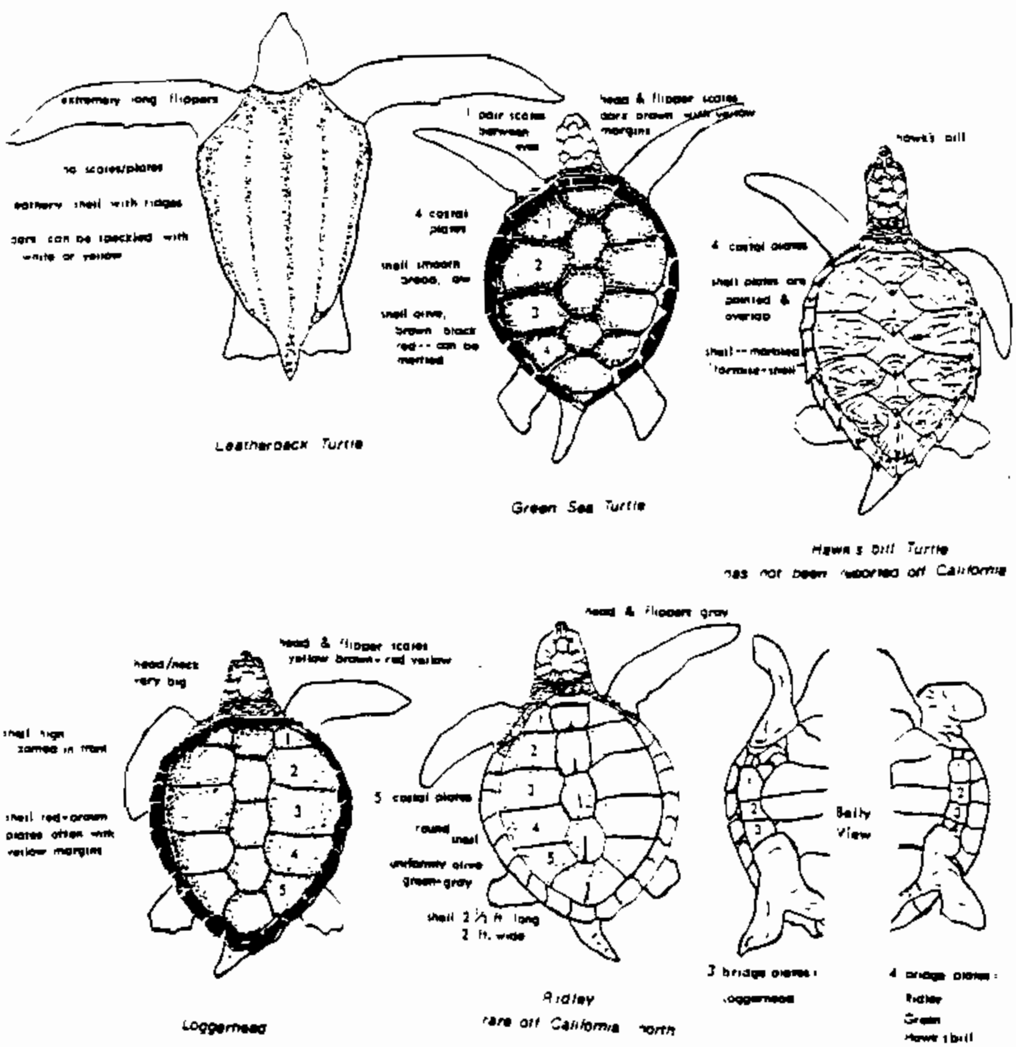
YOUR NAME ______ VESSEL NAME ______

YOUR ADDRESS ______ PHONE ______

LANDING/MARINA NAME & ADDRESS ______

APPENDIX B. SEA TURTLE SIGHTING REPORT FORM

Tropical sea turtles have been reported as far north as Alaska and frequently are seen off southern California. I need information about each sea turtle sighted in order to learn more about their migratory routes, abundance and distribution in the northeastern Pacific Ocean.



Please tell me anything you can remember of turtle sightings during past years (no matter how far back).

APPENDIX C

LISTS OF SIGHTINGS OF SEA TURTLES

Table 43. List of sightings of leatherback sea turtles (*Dermochelys coriacea*) in the eastern Pacific from northern Baja California (29°45'N), Mexico, to the Gulf of Alaska

Table 44. List of sightings of green sea turtles (*Chelonia mydas*) in the eastern Pacific from northern Baja California (29°45'N), Mexico, to the Gulf of Alaska.

Table 45. List of sightings of loggerhead sea turtles (*Caretta caretta*) in the eastern Pacific from northern Baja California (29°45'N), Mexico, to the Gulf of Alaska.

Table 46. List of sightings of Pacific ridley sea turtles (*Lepidochelys olivacea*) in the eastern Pacific from northern Baja California (29°45'N), Mexico, to the Gulf of Alaska.

Table 47. List of the sightings of sea turtles, for which the species could not be identified, in the eastern Pacific from northern Baja California (29°45'N), Mexico, to the Gulf of Alaska.

Table [illegible]. List of sightings of leatherback sea turtles (*Dermochelys coriacea*) in the eastern Pacific from northern Baja California (29°45'N), Mexico, to the Gulf of Alaska.

Sighting No.	Date	Latitude	Longitude	Fathoms	Locale
D1	16 May 1887	32°40'N	117°15'30"W	6 fms	off San Diego, California
D2	1 June 1887	32°39'12"N	117°14'30"W	4 fms	off the Point Loma kelpbeds, San Diego, California
D3	1888	32°32'N	117°16'W	34 fms	between Point Loma, San Diego, California and the Coronado Islands, Baja California del Norte, Mexico
D4	July/August 1901	34°24'N	119°40'W	? fms	Santa Barbara, California
D5	2 January 1905	34°22'N	119°46'W	25 fms	2 mi. SW of Santa Barbara, California
D6	20 June 1907	32°38'N	117°14'W	? fms	off San Diego, California
D7	22 June 1908	32°51'N	117°17'W	7 fms	in kelpbeds, La Jolla, California
D8	before 1922	32°24'30"N	117°14'W	10 fms	in kelpbed at the Coronado Islands, Baja California del Norte, Mexico
D9	1922	37°11'N	122°23'30"W	? fms	near Pigeon Point, San Mateo County, California

Table 43. (continued).

Sighting No.	Date	Latitude	Longitude	Fathoms	Locale
D10	25 July 1923	36°55'N	122°06'W	29 fms	5 mi. SE of Santa Cruz, Monterey Bay, California
D11	early July 1929	36°36'30"N	121°55'W	? fms	brought to Monterey Pier, Monterey Bay, California
D12	12 July 1929	37°40'N	122°50'W	34 fms	14-15 mi. beyond the heads of San Francisco Bay, California
D13	16 August 1931	49°27'N	125°53'W	61 fms	8 mi. S of Bajo Reef, Nootka Sound, Vancouver Island, British Columbia, Canada
D14	early September 1931	49°27'N	127°53'W	61 fms	8 mi. S of Bajo Reef, Nootka Sound, Vancouver Island, British Columbia, Canada
D15	August 1942	46°15'N	124°05'-20'W	60 fms	within 10 mi. off Astoria, Oregon
D16	September 1942				"specimens were sighted off the Pacific coast from California to Vancouver Island"
D17	28 March 1947	49°35'N	124°45'W	39 fms	near Denman Island and off Cordova Bay, east side of Vancouver Island, British Columbia, Canada

Table 43. (continued).

Sighting No.	Date	Latitude	Longitude	Fathoms	Locale
D18	25 July 1947	32°57'N	118°20'W	? fms	off San Clemente Island, Channel Islands, California
D19	16 September 1947	48°33'N	123°21'W	6 fms	200 yards off Sayward Beach, Cordova Bay, east side Vancouver Island, British Columbia, Canada
D20	September 1952	33°30'N	118°00'W	256 fms	off Newport Beach, California
D21	26 June 1953	32°29'N	117°12'W	? fms	Coronado Islands, Baja California del Norte, Mexico
D22	20 September 1954	48°42'N	125°37'W	38 fms	on La Perouse Bank, Vancouver Island, British Columbia, Canada
D23	21 September 1954	48°41'N	125°11'W	13 fms	off Pachena Point, Vancouver Island, British Columbia, Canada
D24	21 September 1954	49°48'N	127°12'W	19 fms	off Esperanza Inlet, Vancouver Island, British Columbia, Canada
D25	22 September 1954	48°40'N	125°19'W	40 fms	off Pachena Point, Vancouver Island, British Columbia, Canada
D26 2 turtles	23 September 1954	50°10'N	128°00'W	22 fms	in Brooks Bay, Vancouver Island, British Columbia, Canada

Table [illegible]. (continued).

Sighting No.	Date	Latitude	Longitude	Fathoms	Locale
D27	26 September 1955	32°22'15"N	117°15'W	stranded	Rosarito Beach, Baja California del Norte, Mexico
D28	22 July 1957	48°56'N	125°32'W	? fms	in Useless Inlet, Barkley Sound, western Vancouver Island, British Columbia, Canada
D29	1st week September 1957	48°56'N	125°32'W	? fms	in Useless Inlet, Barkley Sound, western Vancouver Island, British Columbia, Canada
D30 5 sightings	1959	33°18'-30'N	118°15'-36'W	? fms	between Santa Catalina Island and the San Pedro Channel, Channel Islands, California
D31	1 November 1959	50°37'N	127°04'W	9 fms	off McNeill Bay, Victoria, Vancouver Island, British Columbia, Canada
D32	16 November 1959	34°01'N	120°20'W	13 fms	San Miguel Island, Channel Islands, California
D33	7 July 1961	33°40'30"N	118°17'12"W	25 fms	2 mi. off the San Pedro breakwater, San Pedro (Los Angeles), California
D34	23 September 1961	52°36'N	131°32'W	78 fms	Sedgwick Bay, Queen Charlotte Islands, British Columbia, Canada

Table [illegible]. (continued).

Sighting No.	Date	Latitude	Longitude	Fathoms	Locale
D35	1962	29°44'30"N	115°45'W	9 fms	Arrecife Sacramento [Reef], Baja California del Norte, Mexico
D36	1 September 1962	60°34'N	145°38'W	? fms	Near Cordova, Alaska
D37	4 September 1963	60°22'56"N	145°43'10"W	? fms	in Egg Island Channel, Copper River Flats, Cordova, Alaska
D38	25 May 1967	33°23'15"N	118°18'30"W	150 fms	Catalina Channel (San Pedro Channel), Channel Islands, California
D39	July 1969	31°45'N	116°44'45"W	stranded	Punta Banda, Baja California del Norte, California
D40	17 July 1970	32°58'09"N	117°16'06"W	stranded	Del Mar, California
D41	mid-July 1970	51°30'N	128°45'W	? fms	Sharbau Island, east from Calvert Island at the mouth of Rivers Inlet, British Columbia, Canada
D42	December 1971	35°33'N	121°38'45"W	478 fms	40 mi. (270°) from Morro Bay towards Pyramid Head, California
D43	3 days between 20-30 August 1976	48°34' - 48°52'N	126°07' - 126°34'W	670 fms	between 60 - 75 mi. W x N and WSW of Cape Flattery, Washington

Table [illegible]. (continued).

Sighting No.	Date	Latitude	Longitude	Fathoms	Locale
D44	Summer 1977	48°55'N	126°38'W	58 fms	off Ucluelet, west coast of Vancouver Island, British Columbia, Canada
D45	July or August 1977	33°08'N	117°21'W	8-9 fms	just off the SDG & E Co. Encina power facility, Carlsbad, California
D46	July or August 1977	33°24'12"N	117°41'30"W	75 fms	3-5 mi. (270°) off Point San Mateo, San Clemente, California
D47	13 August 1977	40°45'N	124°32'W	960 fms	27 km (16 3/4 mi.) W of Humboldt Bay, California
D48	14 August 1977	32°33'30"N	117°23'12"W	100 fms	10 mi. (220°) from Point Loma, San Diego, California
D49	20 August 1977	32°29'00"N	117°33'48"W	680 fms	20 mi. (230°) from Point Loma, San Diego, California
D50	recently 1978	55°44'N	132°11'W	? fms	near Myers Chuck, Cleveland Peninsula, Alaska
D51	1978	35°25'N	120°58'05"W	30 fms	4 mi. offshore from Cayucos and Point Estero, Estero Bay, California
D52	August 1978	32°22'15"N	117°15'W	stranded	Rosarito Beach, Baja California del Norte, Mexico

Table 43. (continued).

Sighting No.	Date	Latitude	Longitude	Fathoms	Locale
D53	6 August 1978	32°50'N	117°26'30"W	340 fms	8 mi. (calc. as 256°) off La Jolla, California
D54 2 sightings	21 August 1978	55°28'N	133°03'W	? fms	near Craig, Alaska
D55	7 September 1978	33°42'N	118°18'W	stranded	Cabrillo Beach, San Pedro, California
D56	October 1978	29°49'N	115°48'W	16 fms	Isla San Jeronimo, Bahia del Rosario, Baja California del Norte, Mexico
D57	4 July 1979	29°46'N	115°47'W	11 fms	between Isla San Jeronimo and Arrecife Sacramento [Reef], Baja California del Norte, Mexico
D58	early November	33°57'00"N	119°38'45"W	49 fms	5 mi. SW from east end (Sandstone Point) of Santa Cruz Island, Channel Islands, California
D59	1980	36°35'N	122°37'W	1400–1500 fms	estimated as in Monterey Canyon, 33 mi. (250°) from Point Pinos, California
D60	1980	36°51'30"N	121°55'W	20–40 fms	Monterey Bay, California

Table 43. (continued).

Sighting No.	Date	Latitude	Longitude	Fathoms	Locale
D61	1980	37°25'30"N	122°47'W	49 fms	estimated as 15 mi. (240°) W of Half Moon Bay, California
D62	1980	37°40'N	122°54'W	20-30 fms	estimated as 5 mi. E of Southeast Farallon Island, California
D63	1980	38°43'N	124°10'W	3000 fms	estimated as 30 mi. (235°) from Point Arena, California
D64	1980	40°44'N	125°22'W	2400-2800 fms	estimated as 50 mi. (266°) from Humboldt Bay, California
D65	9 April 1980				"Central California"
D66	1 June 1980	33°07'36"N	117°21'36"W	35 fms	in throat of Carlsbad Canyon off the SDG & E Co. Encina power facility, Carlsbad, California
D67	2 July 1980	33°24'N	118°08'W	500 fms	between Lausen Knoll and the Avalon Bank (228 fathoms), San Pedro Channel, Channel Islands, California
D68 2 turtles	8 July 1980	37°23'15"N	122°42'30"W	47 fms	12 mi. (calc. as 225°) SW of Half Moon Bay, California
D69	8 July 1980				"Central California"

Table 43. (continued).

Sighting No.	Date	Latitude	Longitude	Fathoms	Locale
D70	10 July 1980				"Central California"
D71	27 July 1980				"Central California"
D71	27 July 1980				"Central California"
D72	mid-August 1980	36°36'07"N	122°34'00"W	1500 fms	30½ mi. (200°) off Davenport on 1500 fathom line on upper edge of See Valley, Monterey Canyon, 30½ mi. (69°) from Point Pinos, California
D73	31 August 1980	37°58'N	123°01'W	37 fms	in Drakes Bay off Point Reyes, California
D74	1 September 1980	36°54'N	122°05'30"W	36 fms	off Santa Cruz in Monterey Bay, California
D75	1 September 1980	39°32'N	123°51'W	50 fms	off Ten-mile River Beach north of Fort Bragg, California
D76 2 leatherbacks and 1 loggerhead	3 September 1980	37°22'45"N	122°40'30"W	51 fms	18 mi. SW of Half Moon Bay (outside the reef), California
D77	5 December 1980				"Central California"

Table [illegible]. (continued).

Sighting No.	Date	Latitude	Longitude	Fathoms	Locale
D78	21 January 1981	41°46'10"N	124°14'30"W	stranded	Pebble Beach (Point Saint George), Del Norte County, California
D79	July 1981	33°18'N	118°40'W	715 fms	15–20 mi. (calc. as 16 mi.) W of east end of Santa Catalina Island, Channel Islands, California
D80	8 July 1981	44°19'45"N	124°54'45"W	250+ fms	40 mi. SW of Newport, Oregon
D81 5 sightings	11 & 12 July 1981	45°35'30"N	124°02'20"W	32 fms	3–4 mi. off Rockaway and Tillamook Bay, Oregon
D82 2 sightings	15 July 1981	46°40'N	124°40'W	90 fms	between Astoria, Oregon and Grays Harbor, Washington
D83	16 July 1981	45°37'10"N	124°02'30"W	35 fms	4 mi. W (270°) of Twin Rocks, Oregon
D84	16 July 1981	47°16'30"N	124°49'W	90 fms	21 mi. (235°) off Cape Elizabeth, Washington
D85	19 July 1981	45°12'N	124°05'W	40 fms	4 mi. off Pacific City, Oregon
D86	23 July 1981	33°02'48"N	117°17'49"W	surf	Moonlight Beach, Encinitas, Calif.

Table 43. (continued).

Sighting No.	Date	Latitude	Longitude	Fathoms	Locale
D87	27 July 1981	43°50'45"N	124°33'W	85-90 fms	18 mi. (285°) from Winchester Bay, Oregon [Loran C lines (97)13280, (98)27809]
D88	30 July 1981	46°06'N	124°09'W	40 fms	West off the coast between Tillamook Head and the Columbia River, Oregon
D89 several	15-30 July 1981	44°21'20"N	126°26'00"W	48 fms	35 km (21 3/4 mi.) WSW of Newport, Oregon
D90	17 July 1981	47°05'N	124°38'W	48 fms	North of Grays Harbor, between Westport and Point Grenville, Wash. [Loran A 4100 line (1-60)]
D91	1 August 1981	35°25'N	120°58'30"W	30 fms	4 mi. offshore from Cayucos and Point Estero, Estero Bay, California
D92	1 August 1981	37°41'15"N	122°57'15"W	27 fms	2 mi. East of Southeast Farallon Island, California
D93 2 turtles	2 August 1981	44°33'N	124°13'W	40 fms	inside Stonewall Bank (about 17 mi. SW of Yaquina Headlight which is 4 mi. N of Yaquina Bay), Oregon
D94 3 turtles	2 August 1981	46°21'N	125°13'W	980 fms	50 mi. (255°) off the Columbia River, Oregon

Table 4[illegible]. (continued).

Sighting No.	Date	Latitude	Longitude	Fathoms	Locale
D95 3 turtles	3 August 1981	44°31'30"N	124°26'W	35 fms	Rockpile on Stonewall Bank, Oregon
D96	11 August 1981	43°41'45"N	124°20'W	60 fms	5 3/4 mi. (264°) off the mouth of the Umpqua River (Winchester Bay), Oregon [Loran C lines 13361, 27818]
D97	13 August 1981	44°32'50"N	124°14'45"W	31 fms	inside Rockpile, Stonewall Bank, 8 mi. (222°) from Newport, Oregon [Loran C lines 12909, 27905]
D98	16 August 1981	43°40'00"N	124°15'30"W	36 fms	2 mi. (250°) from Winchester Bay, Oregon
D99	30 August 1981	53°15'00"N	131°57'30"W	30–35 fms	in Skidigate Inlet off Image Point, Queen Charlotte Islands, Canada
D99	30 August 1981	53°20'N	130°30'W		Released in Hectate Strait off Dead Tree, Queen Charlotte Island, British Columbia, Canada
D100	early September 1981	46°55'N	124°30'W	45 fms	15 mi. (270°) off Westport, Grays Harbor, Washington
D101 2 turtles	1 September 1981	53°20'N	130°30'W	10–40 fms	in Hectate Strait off Dead Tree Point, Queen Charlotte Islands, British Columbia, Canada

Table [illegible]. (continued).

Sighting No.	Date	Latitude	Longitude	Fathoms	Locale
D102	12 September 1981	45°58'10"N	124°06'30"W	41 fms	5 mi. W of Tillamook Head, Oregon [Loran C lines 5990-Y-27850 x 43923]
D103	14 September 1981	33°27'N	117°42'15"	4 fms	300-500 yard (on SW course) out of Dana Point Harbor entrance (close to breakwater), Dana Point, California
D104	28 September 1981	33°31'25"N	117°57'30"W	200 fms	6 mi. SW (208°) of Newport Beach, California [Loran C lines 28221.2, 40893.2]
D105	3 October 1981	48°15'N	123°25'W	65 fms	in Straits of Juan de Fuca, 4-6 mi. out of Ediz Hook, off Port Angeles, Washington
D106	26 October 1981	44°36'50"N	124°21'20"W	44 fms	11½ mi. (251°) from Yaquina Bay, Oregon
D107	22 December 1981	44°17'N	124°12'W	30 fms	off Cape Perpetua, Oregon
D108	22 December 1981	43°26'30"N	124°21'00"W	36 fms	5 mi. North of Coos Bay, Oregon
D109	early July 1982	33°22'15"n	117°57'W	250 fms	18½ mi. (86°) from Avalon, Santa Catalina Island, Channel Islands, California

Table ... (continued).

Sighting No.	Date	Latitude	Longitude	Fathoms	Locale
D110	early July 1982	33°26'15"n	118°01'W	250 fms	$16\frac{1}{4}$ mi. (68°) from Avalon, Santa Catalina Island, California
D111	4 July 1982	37°48'N	123°09'W	45 fms	25 mi. offshore from San Francisco Bay, 13 mi. (208°) from Pt. Reyes, above North Farallon Island, Calif. [Loran C lines 43211.9, 27095.6]
D112	August 1982	39°30'N	126°25'W	4000 fms	120 mi. offshore from Fort Bragg, California
D113	13 August 1982	44°38'50"N	124°12'00"W	31 fms	5 3/4 mi. WSW of Newport, Oregon
D114	18 August 1982	33°12'36"N	117°27'W	floating dead in 17 fms	2 mi. off Stuart farms, Camp Pendleton, California
D115	23 August 1982	33°26'N	118°18'10"W	460 fms	5-6 mi. (355°) from Avalon, Santa Catalina Island, Channel Islands, California
D116	25 August 1982	33°27'22"N	118°29'10"W	39 fms	Isthmus, Santa Catalina Island, Channel Islands, California
D117	30 August 1982	33°24'23"N	118°21'55"W	15 fms	100 feet off Long Pt. Santa Catalina Island, Channel Islands, California

Table [illegible]. (continued).

Sighting No.	Date	Latitude	Longitude	Fathoms	Locale
D118	24 September 1982	33°32'45"N	117°53'W	170 fms	$2\frac{1}{2}$ mi. off Newport jetty, Newport Beach, California
D119	17 October 1982	34°02'45"N	118°40'W	stranded	Latigo Shores, Malibu Beach, California
D120	early March 1983	56°N	159°W	stranded	Perryville, Alaskan Peninsula, Alaska
D121	17 July 1983	53°36'50"N	133°01'30"W	est. 60 fms	$1\frac{1}{2}$ mi. (332°) NW of Selvensen Point, Graham Island, Queen Charlotte Islands, Canada
D122	13 July 1983	43°27'25"N	124°35'30"W	80 fms	12 mi. (299°) NW of Coos River entrance, Oregon [Loran C line (97) 13480]
D123	14 July 1983	43°30'N	124°28'30"W	60 fms	10 mi. (326°) NNW of Coos River entrance, Oregon [Loran C line (97) 13460]
D124	27 July 1983	34°21'N	119°26'50"W	stranded	1 mi. E of Emma Wood Beach, Rincon Point, Ventura County, California
D125	7 October 1983	37°52'15"N	122°35'50"W	stranded	Little Beach at Muir Beach between San Francisco and Bolinas Bays, Ca.

Table [illegible]. (continued).

Sighting No.	Date	Latitude	Longitude	Fathoms	Locale
D126	25 October 1983	45°06'02"N	124°21'25"W	123 fms	20½ mi. (226°) from Cape Lookout, Oregon
D127	29 November 1983	32°53'N	132°31'W	412 fms	Erben Tablemount, 127 mi. (270°) W of San Diego, California

Table [illegible]. List of sightings of green sea turtles (*Chelonia mydas*) in the eastern Pacific from northern Baja California (29°45'N), Mexico, to the Gulf of Alaska.

Sighting No.	Date	Latitude	Longitude	Fathoms	Locale
Cm1	August 1952	30°20'N	115°55'W	16 fms	Bahia San Quintin, Baja California del Norte, Mexico
Cm2	6 December 1954	48°55'30"N	125°32'W	stranded	Spring Cove, west side entrance to Ucleulet Inlet, Vancouver Island. British Columbia, Canada
Cm3 2 turtles	1957 season	32°50'N	117°17-25'W	? fms	La Jolla, California
Cm4	20 August 1957	33°43'N	118°16'W	11 fms	1 mi. from shore in Los Angeles Harbor, California
Cm5	1957 and 1958				see Appendix 3: Sighting Cm5
Cm6 Several Turtles	10-16 September	35°40'18"N	122°40'21"W	729 fms	Davidson Seamount, California
Cm7	30 September 1958	46°25'50"N	123°54'15"W	estuarine	in Naselle River (beneath Highway 101 bridge), Willapa Bay, Washington
Cm8	31 October 1959	32°29'N	117°12'W	? fms	Los Coronado Islands, Baja California del Norte, Mexico

Table 44. (continued).

Sighting No.	Date	Latitude	Longitude	Fathoms	Locale
Cm9	August 1963	46°51'30"N	124°09'45"W	9 fms	3 mi. S of Westport, Grays Harbor, Washington
Cm10	18 September 1964	33°35'15"N	117°54'20	25 fms	between the Newport Beach jetty and Balboa pier, Newport Beach, California
Cm11	8 February 1966	43°21'20"N	124°20'W	25 fms	North Spit inside Coos Bay, Oregon
Cm12	July 1967	32°46'15"N	117°14'W	1 fm	Dana Landing, Mission Bay, San Diego, California
Cm13	27 July 1967	32°34'46"N	117°08'09"W	4 fms	Imperial Beach Pier, Imperial Beach, California
Cm14	14 December 1969	41°17'35"N	124°05'25"W	stranded	mouth Redwood Creek, Humboldt Co., California
Cm15	9 October 1976	57°03'N	134°03'W	? fms	Point Macartney, Kupreanof Island, Alaska
Cm16	1 November 1976	57°16'N	134°15'W	? fms	Eliza Harbor, Admiralty Island, Alaska
Cm17	late September or early October 1977	33°22'33"N	117°37'18"W	15 fms	$1\frac{1}{2}$ mi. off Nixon's Point (San Mateo Point), San Clemente, California

Table ... (continued).

Sighting No.	Date	Latitude	Longitude	Fathoms	Locale
Cm18	September 1978	29°50'24"N	115°48'06"W	12 fms	6 mi. (160°) from Punta Baja toward Isla San Jeronimo, Baja California del Norte, Mexico
Cm19	October 1978	29°53'N	115°48'30"W	17 fms	4 mi. (160°) from Punta Baja toward Isla San Jeronimo, Baja California del Norte, Mexico
Cm20	14 March 1979	32°39'N	117°07'W	stranded	24th Street, National City, San Diego Bay, California
Cm21	20 July 1979	33°08'24"N	117°19'12"W	1 fm	Agua Hedionda Lagoon, Carlsbad, California
Cm22	2nd week July 1979	33°24'N	118°47'W	670 fms	7 mi. (246°) from west end Santa Catalina Island, Channel Islands, California [Loran C lines 41080, 28110]
Cm23	17 August 1979	33°23'30"N	118°16'45"W	347 fms	3½ mi. (25°) from Avalon, Santa Catalina Island, Channel Islands, California
Cm24	28 August 1979	32°41'06"N	117°08'40"W	5 fms	½ mi. S of Coronado Bridge, San Diego Bay, California
Cm25	14 November 1979	33°08'13"N	117°20'26"W	entrained	SDG & E Co. Encina power facility, Carlsbad, California

Table 44. (continued).

Sighting No.	Date	Latitude	Longitude	Fathoms	Locale
Cm26	10 February 1980	31°27'30"N	116°45'45"W	100 fms	just N of Punta Santo Tomas and El Isolote, Baja California del Norte, Mexico
Cm27	22 February 1980	33°27'N	118°07'10"W	312 fms	15 mi. (222°) off Newport Beach in San Pedro Channel, Channel Islands, California
Cm28	April 1980	33°29'W	119°02'W	6° fms	North side of Arch Rock, Santa Barbara Island, Channel Islands, California
Cm29	May 1980	33°16'N	117°31'W	25 fms	7 mi. (286°) from Oceanside Harbor, Oceanside, California
Cm30	8 May 1980	33°08'03"N	117°20'03"W	entrained	SDG & E Co. Encina power facility, Carlsbad, California
Cm31	11 May 1980	33°05'30"N	117°18'54"W	stranded	Ponto Beach, Carlsbad, California
Cm32	29 July 1980	33°23'40"N	118°00'W	57 fms	on Lausen Knoll (14 mile bank), San Pedro Channel, Channel Islands, California
Cm33	8 October 1980	32°28'54"N	117°17'24"W	40 fms	2 1/8 mi. N of west end of North Coronado Island, Baja Calif., Mexico

Table 44. (continued).

Sighting No.	Date	Latitude	Longitude	Fathoms	Locale
Cm34	17 November 1980	33°15'30"N	118°13'15"W	125 fms	5 mi. off east end of Santa Catalina Island, Channel Islands, California
Cm35	3 January 1981	33°44'44"N	118°06'45"W	1 fm	San Gabriel River, Seal Beach, California
Cm36	early February 1981	33°34'40"N	118°18'30"W	350 fms	7½ mi. (170°) from Point Fermin, California
Cm37	5 September 1981	49°07'30"N	127°08'W	100–250 fms	100 mi. (270°) from entrance of the Straits of Juan de Fuca, Washington
Cm38	1-9 October 1981	33°55'10"N	118°25'45"W	entrained	El Segundo power facility, El Segundo, California
Cm39 3 sightings	mid-October 1981	36°30'N	123°55'W	3000 fms	80 mi. (210°) from the Farallon Islands, California
Cm40 2 turtles	17 October 1981	48°42'30"N	125°07'W	20 fms	½ mi. seaward of Pachena Point lighthouse, Vancouver Island, British Columbia, Canada
Cm41	15 February 1982	42°02'45"N	124°16'05"W	stranded	Harbor in Pelican Bay, Brookings, Oregon
Cm42	27 May 1982	33°07'N	117°20'W	stranded	south Carlsbad Beach, Carlsbad, Cal.

Table ... (continued).

Sighting No.	Date	Latitude	Longitude	Fathoms	Locale
Cm43	5 March 1983	31°27'40"N	116°48'30"W	258 fms	10 mi. (270°) off Punta San Jose, Baja California del Norte, Mexico
Cm44	8 September 1983	44°37'45"N	124°46'W	215 fms	30 1/3 mi. (263°) W of Yaquina Head light, Oregon [Loran C lines 12884, 27857]
Cm45	16 September 1983	32°03'N	117°02'W	217 fms	end of Finger Bank, 13½mi. (182°) S of Punta Descanso, Baja California del Norte, Mexico
Cm46	early November 1983	37°36'30"N	122°30'W	stranded	Linda Mar Beach, near San Pedro Point, San Francisco, California

Table [illegible]. List of sightings of loggerhead sea turtles (*Caretta caretta*) in the eastern Pacific from northern Baja California (29°45'N), Mexico, to the Gulf of Alaska.

Sighting No.	Date	Latitude	Longitude	Fathoms	Locale
Cc1 2 turtles	1907	32°50'N	117°17-18'W	? fms	off La Jolla, California
Cc2	May 1926	33°20-30'N	117°45-55'W	300-400 fms	deepwater off Newport Beach, California
Cc3	7 August 1946	32°22'30"N	117°46'W	809 fms	25-30 mi. WSW of North Coronado Island, Baja California del Norte, Mexico
Cc4	10 August 1947	32°43'30"N	119°01'30"W	400 fms	35 mi. WSW of San Clemente Island, Channel Islands, California
Cc5 2 captures	August 1951	32°40'N	117°20'W	54 fms	off Point Loma (calc. as 256°), San Diego, California
Cc6	January 1958 or	32°34'21"N	117°19'11"W	66 fms	7 mi. (calc. as 210°) off Point Loma, San Diego, California
Cc7	1961	30°15'N	115°55'W	10-60 fms	Bahia San Quintin to Isla San Martin, Baja California del Norte, Mexico

Table 4?. (continued).

Sighting No.	Date	Latitude	Longitude	Fathoms	Locale
Cc8	16 January 1961	32°33'N	117°15'30"W	29 fms	7 mi. (calc. as 180°) off Point Loma, San Diego, California
Cc9	20 July 1963	31°56'N	117°28'37"W	829 fms	45 mi. S of Point Loma, San Diego, California
Cc10	21 August 1963	32°49' –	118°09'–21'W	400–650 fms	10 mi. inshore of San Clemente Island, Channel Islands, California
Cc11	27 February 1964	32°26'N	117°39'W	464 fms	25 mi. SW of San Diego, California
Cc12	2 March 1964	32°23'N	117°14'W	20 fms	due S of South Coronado Island, Baja California del Norte, Mexico
Cc13	16 September 1965	32°29'N	117°12'W	? fms	Los Coronado Islands, Baja California del Norte, Mexico
Cc14	May 1974	34°01'N	118°47'W	5 fms	near Paradise Cove, Malibu, Calif.
Cc15	12 August 1975	33°25'N	118°21'30"W	109 fms	3/4 mi. off Long Point, Santa Catalina Island, Channel Islands, California
Cc16	15 March 1978	33°56'N	119°39'W	200+ fms	3 mi. (164°) off Valley Anchorage, Santa Cruz Island, Channel Islands, California

Table [illegible]. (continued).

Sighting No.	Date	Latitude	Longitude	Fathoms	Locale
Cc17	7 August 1978	32°38'N	117°08'32"W	stranded	on Pacific side of Silver Strand State Beach, Coronado Peninsula, San Diego, California
Cc18	26 May 1979	32°41'06"N	117°54'42"W	25 fms	35 mi. (260°) from Point Loma, San Diego, California
Cc19	last week 1979	32°59'N	118°26'W	600 fms	6 mi. (86°) from Wilson Cove, San Clemente Island, Channel Islands, California
Cc20	August 1979	31°03'N	118°34'W	300 fms	119 mi. (200°) off Point Loma, San Diego, California (west of Cabo Colnett, Baja California del Norte, Mexico
Cc21	February 1980	33°11'06"N	117°28'06"W	90 fms	3 3/4 mi. off Oceanside Harbor, Oceanside, California
Cc22	16 July 1980	33°40'N	118°40'W	? fms	off Los Angeles, California
Cc23	3 September 1980	37°22'45"N	122°40'30"W	51 fms	outside the reef 18 mi. SW of Half Moon Bay, California
Cc24	8 September 1980	31°05'N	116°53'45"W	698 fms	30 mi. W of Cabo Colnett, Baja California del Norte, Mexico

Table [illegible] (continued).

Sighting No.	Date	Latitude	Longitude	Fathoms	Locale
Cc25	9 September 1980	30°52'N	116°43'45"W	730 fms	110 mi. (155°) from San Diego, California (20½ mi. off Cabo Colnett, Baja California del Norte, Mexico)
Cc26	15 September 1980	47°00'N	124°10'W	stranded	Ocean Shores, Grays Harbor County, Washington
Cc27	16 December 1980	33°27'02"N	118°47'06"W	450 fms	captured 9 mi. (246°) from west end of Santa Catalina Island, Channel Islands, California
Cc27	16 December 1980	33°27'02"N	119°21'08"W	861 fms	released 14 mi. (02°) from east end San Nicholas Island, Channel Islands, California
Cc28	1981	33°40'17"N	118°18'12"W	41 fms	2 mi. (180°) from Los Angeles Light, Los Angeles, California
Cc29	18 February 1981	46°18'25"N	124°01'45"W	stranded	Benson Beach, Fort Canby State Park, Ilwaco, Washington
Cc30	6 July 1981	32°57'40"N	118°01'15"W	510 fms	18½ mi. (49°) from Pyramid Head, San Clemente Island, Channel Islands, California [Loran C lines 40830.6, 28180.8]

Table [illegible]. (continued).

Sighting No.	Date	Latitude	Longitude	Fathoms	Locale
Cc31	15 August 1981	32°38'23"N	117°15'12"W	22 fms	2 mi. SW of Point Loma, San Diego, California
Cc32	July 1982	32°52'N	118°10'W	469 fms	off the east end San Clemente Island, Channel Islands, California
Cc33	July 1982	33°02'N	118°23'W	390 fms	$9\frac{1}{2}$ mi. east of north end of San Clemente Island, on the Mackerel 390 fathom Bank, Channel Islands, California
Cc34	July 1982	33°13'45"N	118°13'W	294 fms	between the Mackerel Bank and Newport Beach, estimated as $6\frac{1}{2}$ mi. (132°) off east end of Santa Catalina Island, Channel Islands, California
Cc35	2 September 1982	33°06'06"N	117°21'30"W	42 fms	2 mi. offshore, 2 mi. S of SDG & E Co. Encina facility, Carlsbad, Calif.
Cc36	3 August 1983	34°24'N	119°42'W	stranded	Butterfly Beach at Ortega Hill between Summerland and Montecito, Santa Barbara, California
Cc37	7 September 1983	33°03'15"N	117°18'W	stranded	between Beacon and Moonlight Beaches, Encinitas, California

Table ... (continued).

Sighting No.	Date	Latitude	Longitude	Fathoms	Locale
Cc38	28 September 1983	33°55'40"N	119°33'15"W	500 fms	8 mi. SSW of West Anacapa Island, 5 mi. SSE of Yellow Bluff, Santa Cruz Island, Channel Islands, California
Cc39	2 October 1983	31°41'54"N	116°58'06"W	530 fms	11 3/4 mi. (253°) from Cabo Punta Banda, Baja California del Norte, Mexico [Loran C lines 28245.4, 40504.1]
Cc40	22 October 1983	34°15'N	121°25'W	948 fms	San Juan Seamount, 100 mi. (264°) W of Santa Barbara, California
Cc41	2 November 1983	34°03'N	121°05'W	356 fms	Rodriguez Seamount, 31 mi. (270°) W of San Miguel Island, Channel Islands, California

Table [illegible]. List of sightings of Pacific ridley sea turtles (Lepidochelys olivacea) in the eastern Pacific from northern Baja California (29°45'N), Mexico, to the Gulf of Alaska.

Sighting No.	Date	Latitude	Longitude	Fathoms	Locale
L1	10 October 1957	40°42'N	124°16'W	stranded	Table Bluff Beach, Humboldt County, California
L2	19 November 1962	46°00'N	123°55'30"W	stranded	Seaside, Oregon (18 mi. south of the Columbia River)
L3	January 1963	32°40'21"N	117°13'52"W	$2\frac{1}{2}$ fms	East side of Point Loma, mouth of the San Diego Bay, San Diego, California
L4	25 August 1963	32°55'N	118°25'W	approx. 440 fms	San Clemente Island, Channel Islands, California
L5	29 August 1963	33°00'N	118°20'W	400-650 fms	between San Clemente and Santa Catalina Islands, California
L6	3 October 1963	32°12'30"N	119°12'35"W	810 fms	15 mi. S of Cortez Bank, California
L7	8 November 1967	36°36'30"N	121°53'40"W	1-2 fms	breakwater off Cannery Row, Monterey Bay, California
L8	14 April 1969	33°00'N	117°16'12"W	stranded	between Del Mar and Solana Beach, California

Table 46. (continued).

Sighting No.	Date	Latitude	Longitude	Fathoms	Locale
L9	Spring 1971	37°53'18"N	122°30'00"W	< than 2 fms	4 mi. N of Golden Gate at Strawberry Point Lagoon, San Francisco Bay, California
L10	21 October 1972	32°36'18"N	117°19'39"W	62 fms	6 mi. SW of Point Loma, San Diego, California
L11 2 turtles	29 August 1973	32°50'57"N	117°16'48"W	5 fms	Scripps Institute of Oceanography pier, La Jolla, California
L12	16 September 1975	44°20'45"N	124°05'45"W	stranded	2 mi. N of Yachats, Waldport, Oregon
L13	29 August 1980	30°35'00"N	116°32'00"W	820 fms	20 mi. W of Isla San Martin, Baja California del Norte, Mexico
L14	16 December 1981	41°03'N	estimated as 124°20'W	unknown	ocean near Trinidad, Humboldt County, California
L15	16 March 1983	30°41'45"N	116°26'30"W	320 fms	20 mi. (296°) from Isla San Martin, Baja California del Norte, Mexico

Table 47. List of the sightings of sea turtles, for which the species could not be identified, in the eastern Pacific from northern Baja California (29°45'N), Mexico, to the Gulf of Alaska.

Sighting No.	Date	Latitude	Longitude	Fathoms	Locale
U1	10 February 1872	32°40'35"N	117°13'40"W	6 fms	near the head of San Diego Bay, San Diego, California
U2	March 1872	32°40'N	117°08'W	1 fm	San Diego Bay, San Diego, California
U3	13 October 1872	32°39'N	117°15'30"W	8 fms	kelpbeds off Point Loma, San Diego, California
U4	18 August 1884	32°40'N	117°07'W	1 fm	San Diego Bay, San Diego, California
U5	March 1888	32°40'N	117°07'W	1 fm	San Diego Bay, National City, California
U6	July 1888	32°40'N	117°06'W	1 fm	San Diego Bay, San Diego, California
U7	8 January 1889	32°40'N	117°14'W	5 fms	San Diego Bay, San Diego, California
U8	June 1890	32°40'N	117°07'W	1 fm	San Diego Bay, National City, California
U9	June 1890	32°46'25"N	117°13'30"W	3 fms	False (Mission) Bay, San Diego, California

Table 47. (continued).

Sighting No.	Date	Latitude	Longitude	Fathoms	Locale
U10	10 July 1890	32°46'30"N	117°13'30"W	1 fm	False (Mission) Bay, San Diego, California
U11	22 July 1892	32°49'N	117°17'18"W	7 fms	kelpbeds, La Jolla, California
U12	23 May 1903	32°39'N	117°07'W	1 fm	San Diego Bay, San Diego, California
U13	7 July 1905	31°46'30"N	116°48'W	? fms	vicinity Todos Santos Island and Punta Banda, Baja California del Norte, Mexico
U14	9 December 1907	38°00'N	122°25'W	? fms	San Francisco Bay, California
U15	11 January 1908	37°48'N	122°16'W	estuary	East Oakland Harbor, San Francisco Bay, California
U16 multiple	September 1942				from California to Vancouver Island
U17	March 1945	32°45'30"N	117°15'12"W	2 fms	Mission Bay, San Diego, California
U18 several	September 1957	37°40-50'N	122°55' - 123°10'W	? fms	near the Farallon Islands, California
U19 multiple	April & May 1958	49°30'N	126°40'W	27 fms	near Nootka Sound, Vancouver Island, British Columbia, Canada

Table 47. (continued).

Sighting No.	Date	Latitude	Longitude	Fathoms	Locale
U20	17 September 1962	32°49'05"N	117°16'24"W	2 fms	La Jolla Cove, California
U21	June 1963	32°47'47"N	117°12'45"W	$\frac{1}{2}$ fm	De Anza Cove, Mission Bay, San Diego, California
U22	September 1963	32°12'30"N	119°12'35"W	810 fms	15 mi. S of Cortez Bank (S of San Clemente Island), California
U23	Summer 1969	32°47'42"N	117°12'48"W	2 fms - beach	shore at Bahia Motel, Mission Bay, San Diego, California
U24 9 sightings	1975 - 1978	32°30'N - 34°30'N	118° - 120°30'W	? fms	Southern California Bight area, Channel Islands, California
U25	July or August 1975	33°11'42"N	117°26'30"W	20 fms	$2\frac{1}{4}$ mi. off Las Flores, Camp Pendelton, just N of Oceanside, Cal.
U26	14 August 1976	33°42'N	118°18'W	stranded	Cabrillo Beach, San Pedro, California
U27	July 1977	48°04'N	126°14'W	900 fms	62 mi. (230°) from Cape Flattery, Washington
U28	30 June 1978	32°46'14"N	117°14'W	2 fms	Mission Bay, San Diego, California
U29	August 1978	32°50' - 33°20'N	118°20'W	400-600 fms	between east end of Santa Catalina Island and east end of San Clemente

Table 47. (continued).

Sighting No.	Date	Latitude	Longitude	Fathoms	Locale
U30	31 August 1978	33°25'N	118°17'W	461 fms	out of Avalon, Santa Catalina Island [calc. as 4½ mi. 25°], Channel Islands, California
U31	13 September 1978	48°23'N	123°09'W	35 fms	6 mi. off San Juan Island, Washington
U32	May or June 1979	33°08'03"N	117°20'03"W	entrained	SDG & E Co. Encina power facility, Carlsbad, California
U33	6 June 1979	33°28'15"N	117°56'50"W	277 fms	between Newport Beach and Lausen Knoll (193° from Newport), San Pedro Channel, California
U34	July 1979	32°51'46"N	118°24'55"W	2½ fms	lee side of Mesquite Point, San Clemente Island, Channel Islands, California
U35	21 July 1979	32°44'15"N	117°37'30"W	570 fms	21 mi. W of Point Loma (calc. as 270°), San Diego, California
U36	19 August 1979	33°08'08"N	117°20'03"W	entrained	SDG & E Co. Encina power facility, Carlsbad, California
U37	September or October 1979	33°08'23"N	117°20'18"W	1 fm	Agua Hedionda Lagoon, Carlsbad California

Table 47. (continued).

Sighting No.	Date	Latitude	Longitude	Fathoms	Locale
U38	1 October 1979	33°08'03"N	117°20'03"W	entrained	SDG & E Co. Encina power facility, Carlsbad, California
U39 Pair Together	25 February 1980	34°43'N	121°00'W	250 fms	20 mi. W of Point Arguello, California
U40	9 May 1980	33°20'33"N	118°19'09"W	stranded	Lover's Cove, Santa Catalina Island, Channel Islands, California
U41	10 May 1980 capt. 10 May 1980 rel.	33°08'30"N 33°01'N	117°23'W 117°17'W	60 fms in surf	Carlsbad Canyon, Carlsbad, California Cardiff-by-the-Sea, California
U42 3 turtles	13 May 1980	33°31'30"N	118°15'45"W	423 fms	15 mi. (195°) from east end Long Beach breakwater, Los Angeles, Calif.
U43	26 May 1980	33°29'15"n	118°02'30"W	270 fms	10 mi. (220°) from Newport Beach, California
U44	2nd week June 1980	32°59'N	117°16'30"W	stranded	beach at north end Del Mar race track, between Via de la Valle, Del Mar and Seaside, Solana Beach, Calif.
U45 3 turtles	July 1980	33°08'15"N	117°21'15"W	25 fms	1 3/4 mi. off SDG & E Co. Encina power facility, Carlsbad, California
U46	3 July 1980	33°28'24"N	117°53'06"W	316 fms	7 mi. (170°) from Newport Beach, Cal.

Table 47. (continued).

Sighting No.	Date	Latitude	Longitude	Fathoms	Locale
U47	15 July 1980	31°44'07"N	117°17'30"W	600 fms	above the 295 fathom bank, 55 mi. (170°) from San Diego, California
U48	July or August 1980	45°33'40"N			in the tuna fishing grounds off Garibaldi, Oregon
U49	1 September 1980	33°22'22"N	117°52'30"W	341 fms	10 mi. SW of Dana Point Harbor, Dana Point, California
U50	6 September 1980	33°23'10"N	118°01'W	300+ fms	Lausen Knoll, near 14 mi. bank, San Pedro Channel (195° from Newport Beach), California
U51	10 September 1980	33°35'50"N	117°54'W	1–4 fms	Balboa Pier, Newport Beach, California
U52	14 September 1980	33°34'45"N	117°59'30"W	26 fms	3½ mi. off the Santa Ana River jetty, Newport Beach, California
U53	19 October 1980	33°44'44"N	118°06'45"W	1 fm	jetty at mouth of the San Gabriel River, Seal Beach, California
U54	21 February 1981	32°39'00"N	117°15'15"W	10 fms	off the kelpbeds and green tank, Point Loma, San Diego, California

Table 47. (continued).

Sighting No.	Date	Latitude	Longitude	Fathoms	Locale
U55	15 March 1981	32°39'27"N	117°21'48"W	119 fms	7 mi. (260°) off Point Loma, San Diego, California
U56 2 turtles	17 July 1981	45°37'N	123°59'W	15–20 fms	off Rockaway Beach, between Twin Rocks (N of Tillamook Bay) and the Nehalem River, Oregon
U57	1 August 1981	32°05'N	118°14'W	53 fms	60 mile Bank (220°) from San Diego, California
U58	2 August 1981	32°38'35"N	117°16'58"W	38 fms	3 mi. off Point Loma (240°), San Diego, California
U59	mid-August 1981	31°44'04"N	117°17'30"W	295 fms	on the 295 fathom Bank, 55 mi. (170°) from San Diego, California
U60	14 September 1981	32°26'15"N	117°12'45"W	18 fms	2 mi. NE of South Coronado Island, Baja California del Norte, Mexico
U61	15 September 1981	47°49'09"N	125°12'02"W	225 fms	40 mi. (187°) from Cape Flattery, Washington
U62	22 September 1981	46°00'N	123°58'30"W	10 fms	2 mi. W of Seaside, Oregon
U63	24 October 1981	37°43'10"N	122°55'10"W	30 fms	3.9 mi. (56°) from Southeast Farallon Island, California

Table 47. (continued).

Sighting No.	Date	Latitude	Longitude	Fathoms	Locale
U64	early November 1981	33°40'N	118°30'W	450 fms	10 mi. off Point Fermin, Los Angeles, California
U65 3 turtles	each day 9–13 August 1982	33°27'39"N	118°05'54"W	$1\frac{1}{2}$ fms	2 mi. up the San Gabriel River (at Westminster Blvd.), Seal Beach, California
U66	6 November 1982	31°11'00"N	117°05'30"W	500 fms	90 mi. (175°) from Point Loma, San Diego, California (208° from Punta Banda, Baja California del Norte, Mexico)
U67	12 December 1982	33°27'31"N	118°06'20"W	1–2 fms	inland from the Pacific Coast Highway bridge, in the San Gabriel River, Seal Beach, California
U68	11 January 1983	32°52'52"N	118°25'05"W	1–8 fms	between White Rock and Purse Seine Point, San Clemente Island, Channel Islands, California
U69	19 February 1983	30°08'40"N	116°01'30"W	59–72 fms	10 mi. S of Bahia San Quintin, Baja California del Norte, Mexico; 13 mi. offshore
U70	5 March 1983	31°27'40"N	116°48'30"W	258 fms	10 mi. (270°) off Punta San Jose, Baja California del Norte, Mexico

Table 47. (continued).

Sighting No.	Date	Latitude	Longitude	Fathoms	Locale
U71	4 June 1983	32°34'48"N	117°14'36"W	25 fms	5 mi. (180°) S of Point Loma, San Diego, California
U72	29 June 1983	32°00'N	117°13'30"W	610 fms	40 mi. (180°) S of San Diego, California; 28½ mi. (301°) from Cabo Punta Banda, Baja California del Norte, Mexico
U73	4 October 1983	32°51'18"N	117°18'18"W	26 fms	kelpbeds off Point La Jolla, La Jolla, California
U74	6 November 1983	32°26'36"N	117°22'48"W	606 fms	4 mi. (270°) W of North Coronado Island, Baja California del Norte, Mexico
U75	9 November 1983	32°49'14"N	118°20'45"W	2½ fms	reef off Pyramid Head, San Clemente Island, Channel Islands, California

APPENDIX E

DESCRIPTION OF GREEN SEA TURTLE SIGHTINGS

Sighting No. Cm1
Chelonia mydas

August 1952 Sea Temp. Normal Month/Cold Year

30°20'N, 115°55'W [16 fms]
Bahia San Quintin, Baja California del Norte, Mexico

Chuck Shaw, curator of reptiles at the San Diego Zoo, donated this turtle (#CS 55) to the San Diego Museum of Natural History herpetology collection (SDMNH No. 56587).

Sighting No. Cm2
Chelonia mydas

6 December 1954 Sea Temp. Normal Month/Normal Year

48°55'30"N, 125°32'W [stranded]
Spring Cove, west side entrance to Ucleulet Inlet, Vancouver Island, British Columbia, Canada

Carl (1955); Logier and Toner (1961) ..."turtle found near high-tide mark on a gravel beach and was covered with oil and slime from a near-by reduction plant. Apparently it was in a weakened condition because it died a week later at Port Alberni at the head of Alberni Canal, where it was being held in temporary confinement." Carapace length 18 3/4 inches [47.6 cm], 52 pounds [23.6 kg]. A number of small barnacales, Balanus crenatus Bruguiere, the largest being 4 mm in diameter, were attached to the carapace (Carl, 1955).

Sighting No. Cm3 2 Sightings
Chelonia mydas

1957 season | Sea Temp. June Hot, July-November Normal Months/Normal Year

32°50'N, 117°17'-25'W [? fms]
La Jolla, California

Letter from Dr. Carl Hubbs (SIO) to Dr. Warren Houck (Humboldt State College) dated 4 December 1957.

Sighting No. Cm4
Chelonia mydas

20 August 1957 | Sea Temp. Normal Month/Normal Year

33°43'N, 118°16'W [11 fms]
1 mile from shore in Los Angeles Harbor, California

"Several greens were seen and some were caught by live bait haulers in Los Angeles Harbor. One was caught in a lampara net one mile from shore by Herb Mueller on the Donna K." Its carapace length was 21¼ inches [54 cm] and weight 38½ pounds [17.5 kg]. Temperatures in the harbor were 71-74°F (21.7-23.3°C) on the surface and 70°F (21°C) at the bottom (Radovich, 1961).

"Several have been taken in Los Angeles Harbor, and these were said to be green turtles by fishermen who have had experience with turtles in Mexico. However, the Laboratory has not been able to see any of these specimens which were taken for food." (Dr. Carl Hubbs (SIO) memo dated 3 December 1957 reviewing his discussion with Mr. John E. Fitch of the California State Fisheries Laboratory).

Sighting No. Cm5
Chelonia mydas

1957 and 1958

"Many green turtles were caught off southern California during 1957 and 1958, and several, presumably the same species, were sighted off central California. A few were seen near Nootka Sound, British Columbia, Canada" (Radovich, 1961).

Sighting No. Cm6 Several Turtles
Chelonia mydas

10–16 September 1957 Sea Temp. Normal Month/Normal Year

35°40'18"N, 122°40'21"W [729 fms]
Davidson Seamount, California

"Several green turtles were seen in the vicinity of the Davidson Seamount by the albacore boat Aquarius" (Radovich, 1961).

Sighting No. Cm7
Chelonia mydas

30 September 1958 Sea Temp. Normal Month/Normal Year

46°25'50"N, 123°54'15"W [estuarine]
in Naselle River estuary, Willapa Bay, Washington

"Denizens of tropical waters—even a green sea turtle—explored the normally cold coasts of the Pacific Northwest and Alaska as the northern ocean warmed to 7 degrees above normal in 1958 (Tacoma News Tribune. 1959 Jan. 11: Sect. B:15).

This turtle (weighing 67 lbs; 30.4 kg) was caught in a gillnet on an evening tide. "It came to life when placed in a tub of warm water." It was displayed for busloads of children at Johnson's Resort for three days. It was then transferred to the Portland Zoo and soon died. Dr. Murray Johnson, curator of mammals at the Puget Sound Museum of Natural History, froze the specimen and presented it to Dr. James Slater of the College of Puget Sound where it now remains (Tacoma News Tribune. 1959 May 11; pers. comm. with Dr. Slater). This sighting is listed in Slater (1963).

Sighting No. Cm8
Chelonia mydas

31 October 1959 Sea Temp. Hot Month/Hot Year

32°29'N, 117°12'W [? fms]
Los Coronados Islands, Baja California del Norte, Mexico

A 50 pound [23 kg] green sea turtle was caught on rod and reel by Clark and Carter Mahrdt at the Coronado Islands. Two pilot fish were attached to the turtle's shell. Dr. Carl Hubbs (SIO) identified the turtle in the newspaper photo as being Chelonia mydas (San Diego Union. 1 November 1959).

Sighting No. Cm9
Chelonia mydas

August 1963 Sea Temp. Normal Month/Hot Year

46°51'30"N, 124°09'45" [9 fms]
3 miles south of Westport, Grays Harbor, Washington

Westport charter boat skipper Jim Lafferty hooked the turtle using 20 lb test line. The turtle was estimated to weigh 250 lbs and to have a carapace 3 feet [91 cm] in length. The turtle was transferred to the Point Defiance Aquarium for medical treatment of a pocket of infection and air located under its carapace which apparently orevented it from diving (Tacoma News Tribune. August 1963). This record is listed in Slater (1963).

Sighting No. Cm10
Chelonia mydas

18 September 1964 Sea Temp. Normal Month/Normal Year

33°35'15"N, 117°54'20"W [25 fms]
Newport Beach, California

Collected by J.W. Turley between Newport jetty and the Balboa pier in 150 feet of water (25 fathoms). Los Angeles County Museum Herpetology Collection Nos. 35074 and 62394.

Sighting No. Cm11
Chelonia mydas

8 February 1966 Sea Temp. Normal Month/Normal Year

43°21'20"N, 124°20'W [? fms]
North spit inside Coos Bay, Oregon

"The turtle was taken alive by hand from the quieter water within the margin of the bay. The turtle appeared to be swimming normally, seemingly in good health. No one ever mentioned any unusual water temperatures at that time. The turtle was put in a freezer by Ms. McKey-Fender, which is how it died. No post-mortem was performed. The preserved specimen is in the vertebrate collection at Portland State University" (pers. comm. with Dr. Forbes). Carapace length 23.9 cm, carapace width 20.2 cm, shell depth 7.5 cm (Forbes and McKey-Fender, 1968).

Sighting No. Cm12
Chelonia mydas Sea Temp. Normal Month/Normal Year

32°46'15"N, 117°14'W [1 fm]
Dana Landing, Mission Bay, San Diego, California

Dr. Carl Hubbs (SIO) described this turtle as a female green having a carapace length of 572 mm; carapace width 429 mm; carapace height 199 mm; 1 pair of prefrontals; precentral and first lateral not in contact; 5 centrals; laterals 4-4; marginals 11-11; inframarginals 4-4; inframarginals in contact with ventrals 3-3; enlarged laminae over bridge 6-6; shell margin being indented above hind flippers; color very dark with some light variation.

Sighting No. Cm13
Chelonia mydas

27 July 1967 Sea Temp. Normal Month/Normal Year

32°34'46"N, 117°08'09"W [4 fms]
Imperial Beach pier, Imperial Beach, California

Dr. Hubbs (SIO) described this turtle as a female green having a carapace length of 592 mm; carapace width 447 mm; carapace height 98 mm; 1 pair of prefrontals; precentral and first lateral not in contact; 5 centrals; laterals 4-4; marginals 11-11; inframarginals 4-4; inframarginals in contact with ventrals 3-3; enlarged laminae on bridge 7-7; shell margin indented above hind flippers; color very dark and nearly uniform. Barnacles (Platylepas hexastylos) were partly embedded in plates, smallest one from between the precentral and central in carapace, others on plastral plates (Dr. Carl Hubbs notes).

Sighting No. Cm14
Chelonia mydas

14 December 1969 Sea Temp. Normal Month/Normal Year

41°17'35"N, 124°05'25"W [stranded]
mouth of Redwood Creek, Humboldt County, California

Smith and Houck (1984) report that this female green sea turtle washed ashore alive. It weighed 28.8 kg; carapace measured

64.2 cm in length, 51.2 cm in width.

Sighting No. Cm15
Chelonia mydas

9 October 1976 Sea Temp. Normal Month/Normal Year

57°03'N, 134°03'W [? fms]
Point Macartney, Kupreanof Island (9 km SE of Eliza Harbor), Alaska

Hodge (1981) reports that there was a slight ripple at the surface, overcast, the turtle was alongside the boat basking at the surface, as the boat approached within 1.5 meters the turtle submerged and surfaced approximately 9 meters away and then disappeared, swimming actively. The air temperatures were 8-10°C." He estimates the turtle's carapace length to be 76 cm. He suggests that this and the next sighting (No. Cm16) involve the same animal.

Sighting No. Cm16
Chelonia mydas

1 November 1976 Sea Temp. Hot Month/Normal Year

57°16'N, 134°15'W [? fms]
Eliza Harbor, Admiralty Island, Alaska

This turtle was "dead on the beach at mean high tide level; head, body and limbs intact; apparent predation on neck by terrestrial mammal (mink), no cause of death spotted". Estimated shell length 76 cm (Hodge, 1981).

Sighting No. Cm17
Chelonia mydas

late Sept./early October 1977 Sea Temp. Normal Months/Normal Year

33°22'33"N, 117°37'18"W [15 fms]
1 mile off Nixon's Point [San Mateo Pt.], San Clemente, California

...Caught alive in a halibut gillnet in 15 fathoms and later killed. Measured and photographed by Margie Stinson. Straight carapace length 64.8 cm; straight carapace width 53.3 cm; curved carapace width 67.3 cm; plastron length 47.6 cm; plastron width 45.7 cm (Pers. comm. with Tony DiScala, owner of the Dana Point Fish Market that displayed the turtle).

Sighting No. Cm18
Chelonia mydas

September 1978 SeaTemp. Hot Month/Hot Year

29°50'24"N, 115°48'06"W [12 fms]
6 miles from Punta Baja toward Isla San Jeronimo, Baja California del Norte, Mexico

This turtle weighed 50 kg [110 lbs] and was captured by sea urchin divers who came upon it sleeping on the bottom. They grabbed its shell and wrestled it to the weater's surface and boat. (pers. comm. with Brian Wiersema, Journalism Instructor, Mira Costa College, Oceanside, California).

Sighting No. Cm19
Chelonia mydas

October 1978 Sea Temp. Hot Month/Hot Year

29°53'N, 115°48'30"W [17 fms]
4 miles from Punta Baja toward Isla San Jeronimo, Baja California del Norte, Mexico

"...captured in a sea urchin bed. Senor Norberto Alvarado, who has fished this area for 20 years, recalls only two "prieta" [green sea turtles] having ever been captured near here and both were recent (Sighting Nos. Cm18, 19). (pers. comm. with Brian Wiersema, Journalism Instructor, Mira Costa College, Oceanside, California).

Sighting No. Cm20
Chelonia mydas

14 March 1979 Sea Temp. Normal Month/Normal Year

32°39'N, 117°07'W [stranded, dead]
24th Street, National City, San Diego Bay, California

This turtle was examined and described by Tom and Pat Fritts as follows: female, approximately 300 lbs [136kg]; head width 14.0cm, carapace length 104cm, carapace width 96.8cm over 3rd neural; 4 postoculars on both sides; ultimate marginals with broad suture, only slight indication of posterior notch. The turtle's injuries were apparently caused by a boat propellar. There was a 3mm slash on right frontal scale of head, not completely piercing bone; 2nd slash apparently 2cm posterior to first marginal pulling first, second and third marginals on right side away from body; second slash extending approximately 10cm to right of mid-line to 20cm to left of mid-line; 3rd-5th slashes at 10cm intervals along midline, slashes oriented obliquely, further anterior on left side of body; fifth slash terminates at junction between 2nd and 3rd costals on right side of body and originates on left 2nd costal lateral to 3rd leural; scutes translucent olive-brown with much black streaks and flecks; head and limb scales dark with light sutures. On the basis of width of injuries on carapace the propellar was at least 30cm in diameter and probably much larger. The propellar hit five times at 10cm intervals. [This was the only turtle in the San Diego population discovered dead during this study.]

Sighting No. Cm21
Chelonia mydas

10 July 1979 Sea Temp. Normal Month/Normal Year

33°08'24"N, 117°19'12"W [less than 1 fathom]
Agua Hedionda Lagoon, Carlsbad, California

Preston Porter, biologist for Woodward Clyde Consultants, reports seeing a 2½-3 ft [46-91 cm] sea turtle swimming in a shoal area of eelgrass in the innermost lagoon of Agua Hedionda and again as it swam into the middle lagoon. The turtle was dark brown, its head was light brown with darker brown spots. Observed at 1145-1200.

Sighting No. Cm22
Chelonia mydas

second week in July 1979 Sea Temp. Normal Month/Normal Year
above 70°F (21°C)
33°24'N, 118°47'W [670 fms]
7 miles (246°) from the west end of Santa Catalina Island, Channel Islands, California [Loran C lines 41080, 28110]

Commercial fisherman Gary Schniepp (vessel Jo Ann) records seeing a medium sized, dark, hard-shelled turtle which to him looked like a typical green sea turtle. Water temperatures were above 70°F (21°C).

Sighting No. Cm23
Chelonia mydas

17 August 1979 Sea Temp. Normal Month/Normal Year

33°23'30"N, 118°16'45"W [347 fms]
3-4 miles (25°) from Avalon, Santa Catalina Island, Channel Islands, California

Turtle was captured, photographed and immediately released by commercial fisherman Bill Vas (Newport Beach). Barnacles removed from the turtle's carapace were sent to Dr. William Neuman (SIO) for identification.

Sighting No. Cm24
Chelonia mydas

28 August 1979 Sea Temp. Normal Month/Normal Year

32°41'06"N, 117°08'40"W [5 fms]
½ mile S of Coronado Bridge, San Diego Bay, San Diego, California

According to Marine biologist John Duffy of the California Department of Fish and Game, a fisherman hooked a large turtle (estimated body length as 4 ft or 122 cm) on squid bait. The turtle broke the line after pulling the 13 ft skiff for a short distance at a high speed. The turtle was described as dark and having a hard shell. Although I regularly surveyed San Diego Bay, using hydrophone equipment to listen for turtle transmitters, I never heard or saw any turtles during the summer of 1979. This turtle sighting is very significant and raises the questions—are some of the San Diego turtles really present in the bay during the summer and for some reason not observed or was this particular turtle simply an early arrival?

Sighting No. Cm25
Chelonia mydas

14 November 1979 Sea Temp. Normal Month/Normal Year

33°08'13"N, 117°20'26"W [entrained]
San Diego Gas & Electric Co. Encina power facility, Carlsbad, California

A live Chelonia weighing 53½ lbs [24.27 kg] was removed from the bar racks at the SDG & E power generating facility at Agua Hedionda Lagoon. The turtle was measured and released: straight carapace length 55.5 cm, straigth carapace width 45.5 cm. Elaine Carlin, Lockheed Corporation fisheries technician at the facility, indicated that a 1 inch by 1½ inch [2.54 x 3.8 cm] gouge on the left anterior part of the carapace and two long scrapes on the plastron were apparently inflicted by the facility's bar racks. The turtle was identified as Chelonia having a single pair of prefrontals, 5 costals and 4 inframarginals. The turtle's tail did not extend beyond the carapace. The carapace was uniformly dark, part of the shell was covered with algae. The turtle was released into the surf across from the facility. Water temperatures at the bar racks on the previous day were 15°C at 0720 hours, 15.5°C at 1200 and 16.0°C at 1955 hours [pers. comm. with Elaine Carlin, Lockheed Corporation].

Sighting No. Cm26
Chelonia mydas

10 February 1980 — Sea Temp. Hot Month/Normal Year

31°27'30"N, 116°45'45"W — [100 fms]
just north of Punta Santo Tomas and El Isolote, Baja California del Norte, Mexico

Recorded by Captain Steve Loomis and biologist Ronn Storro-Patterson during a Smithsonian Institution expedition aboard the Royal Polaris (Fisherman's Landing, San Diego). Margie Stinson was aboard. Surface sea temperature was 61°F (16°C).

Sighting No. Cm27
Chelonia mydas

22 February 1980 — Sea Temp. Normal Month/Normal Year

33°27'N, 118°07'10"W — [312 fms]
15 miles (220°) off Newport Beach, in San Pedro Channel, Channel Islands, California

Commercial fisherman Gary Schniepp photographed a large, dark olive-green turtle from his vessel (Jo Ann, Newport Beach).

Sighting No. Cm28
Chelonia mydas

April 1980 Sea Temp. Normal Month/Normal Year

33°29'N, 119°02'W [6½ fms]
North side of Arch Rock, Santa Barbara Island, Channel Islands, California

Rich De Felice (SIO) and Dave Parker (California Department of Fish and Game) report that while they were diving in a sandy clearing in a bed of Macrocystis that they saw an olive-brown turtle. They estimate its weight as 100 pounds [45 kg] and its shell as being 2½ feet [76 cm] long and 2 feet [61 cm] wide. Bottom water temperature 19°C; 1600 hours observation.

Sighting No. Cm29
Chelonia mydas

May 1980 Sea Temp. Normal Month/Normal Year

33°16'N, 117°31'W [25 fms]
7 miles (286°) from Oceanside Harbor, Oceanside, California

...Caught in a gillnet by Danny West (vessel Cowboy), brought in to Oceanside Harbor where it was photographed by Mike Espiritu (California Department of Fish and Game) and released. Previous to its entanglement in the net the turtle had been shot in its carapace. The injury had already healed. Weight 125 lbs [56.7 kg]; neck 6-8 inches [15-20 cm] across.

Sighting No. Cm30
Chelonia mydas

8 May 1980 Sea Temp. Normal Month/Normal Year

33°08'03"N, 117°20'03"W [entrained]
San Diego Gas & Electric Co. Encina power facility, Carlsbad, California

A live 28 kg [59.6 lb] green sea turtle was removed from the bar racks at the SDG&E Co. power generating facility. The turtle had 5 pairs of costals, 4 pairs of inframarginals and one pair of prefrontals; straight carapace length 60 cm, straight carapace width 53 cm, tail length 7 cm. Ten flattened barnacles were attached to the carapace and a large gooseneck barnacle was attached to the plastron. The turtle was immediately released into the surf across from the facility (pers. comm. with Susan Vergne, SDG&E Co. biologist).

Sighting No. Cm31
Chelonia mydas

11 May 1980 Sea Temp. Normal Month/Normal Year

33°05'30"N, 117°18'54"W [dead on beach]
Ponto Beach, Carlsbad, California

A small (1°-2 ft; 46-61 cm carapace length) sea turtle was found dead on the beach. Its oval shape, brown-green carapace was cracked and its flippers damaged. It is not known what happened to the carcass (pers. comm. with Sandy Vas, Carlsbad resident).

Sighting No. Cm32
Chelonia mydas

29 July 1980 Sea Temp. Cold Month/Normal Year

33°23'40"N, 118°00'W [57 fms]

On 14 mile bank, Lausen Knoll, San Pedro Channel, Channel Islands, California

Commercial fisherman Bill Vas, observed a sea turtle swimming just beneath the surface. A blue shark was following, bothering the turtle but apparently not biting it. "We approached closely and the shark left and so I jumped in after the turtle. It was quite a chase with no fins, but I managed to capture the turtle, probably only because it was tired due to the shark." The shell was brown and somewhat streaked; although it lacked any barnacles, about 20% of the posterior carapace was covered with algae ("moss"). Curved carapace length 22½ in [57.2 cm], width 21 in [53.3 cm], total body length 31 in [78.7 cm]. Its tail did not extend beynd the carapace. A sketch of the carapace and plastron definitely identified the turtle as Chelonia. Observed at 1150 hours and released at 1230 hours. Ocean tempearture 70°F (21°C).

Sighting No. Cm33
Chelonia mydas

8 October 1980 Sea Temp. Cold Month/Normal Year

32°28'54"N, 117°17'24"W [approx. 40 fms]
2 1/8 miles N of the west end of North Coronado Island, Baja California del Norte, Mexico

According to Herb and Ida Buehler (Cucamongan), they saw what they initially thought to be a swordfish on the water's surface. They approached within 50 feet [13 m] and as they realized it was a turtle it submerged. They describe the turtle as being large (4 ft; 122 cm long), having a brown shell and light green and cream colored flippers. It was observed at 1435 hours in very heavy, choppy seas with a big swell running. Ocean temperature 68.5°F (20.28°C).

Sighting No. Cm34
Chelonia mydas

17 November 1980 Sea Temp. Normal Month/Normal Year

33°15'30"N, 118°13'15"W [125 fms]
5 miles off the east end of Santa Catalina Island, Channel Islands, California

Commercial fisherman Robbie Barker (swordfish/shark driftnet boat *Pacific Fin*, San Pedro) observed a large dark green-brown turtle lying on the surface at 1330 hours (shell 3 ft; 91 cm long). The ocean was very clean blue and there were balls of bait, anchovies, birds and many blue sharks in the area. Ocean temperature 63°F (17.2°C).

Sighting No. Cm35
Chelonia mydas

3 January 1981 Sea Temp. Normal Month/Normal Year

33°44'44"N, 118°06'45"W [1 fm]
San Gabriel River, Seal Beach, California

Ken Nakada, seasonal employee of the California Department of Fish and Game marine mammal project, reports seeing a large turtle in the San Gabriel River, which carries warm discharge water from several power generating facilities upriver. He describes this turtle as having a shell about 3½-4 ft [107-122 cm] long and a head just smaller than a football; its shell was solidly dark green. An "oldtimer" who fishes this area regularly told Mr. Nakada that he frequently sees turtles here and that he often sees turtles 40-50 times a night (also see Unidentified Species Sightings Nos. 52, 64 and 66).

Sighting No. Cm36
Chelonia mydas

early February 1981 Sea Temp. Normal Month/Hot Year

33°34'40"N, 118°18'30"W [350 fms]
7½ miles (170°) from Point Fermin, California

Bob Ezell, skipper of the daily sportfisher Western Pride (Newport Beach) logged seeing a fairly large (carapace length 4 ft; 122 cm), dark hardshelled turtle. The turtle was slowly swimming in clear 58°F (14.4°C) water. He estimates that over the years he has seen 10 turtles in the area midway between Point Fermin and Santa Catalina Island when water temperatures were about 62°F (16.7°C).

Sighting No. Cm37 2 Sightings
Chelonia mydas

5 September 1981 Sea Temp. Normal Month/Hot Year

49°07'30"N, 127°08'W [100-250 fms]
100 miles due W (270°) from entrance of the Straits of Juan de Fuca, Washington

While sailing 100 miles west of the entrance of the Straits of Juan de Fuca, Wayne Barton and Kathi Pfennig (vessel Breezin') saw two similar turtles within 50 miles of each other. The turtles appeared to be basking, they were huge and dark olive in color.

Sighting No. Cm38
Chelonia mydas

1-9 October 1981 Sea Temp. Normal Month/Normal Year

33°55'10"N, 118°25'45"W [entrained]
El Segundo, California

A small green sea turtle became trapped in a large filtering reservoir at the El Segundo power generating facility after it was sucked from coastal waters into an inflow pipe. After a week, a method was devised to rescue the turtle and it was transferred to Sea World in San Diego where Margie Stinson photographed, measured and tagged the turtle. It was released in the kelpbeds 3 miles west of Mission Bay, San Diego. A University of Florida identification tag was attached to its left foreflipper (D 1421) and a Mexico Pesca tag was attached to the right foreflipper (C-06025).

Measurements: weight 13.3 kg, total body length 24 in [60.96 cm]; curved carapace length 20 in [50.8 cm]; curved carapace width 19.75 in [50.17 cm]; tail length 1¼ in [3.12 cm] to cloaca which does not extend beyond the carapace; length of right foreflipper 10.75 in [27.3 cm]; width of right foreflipper 3¼ in [8.26 cm], no nail present; length of right hindflipper 6½ in [16.5 cm]; width of right hindflipper 3½ in [8.89 cm]; 5 vertebral plates; costals 4-5 (2nd split on right); inframarginals 4-4. Rock scallops were loosely attached by byssal threads to the carapace (pers. comm. with Kevin Harbinson, environmentalist for the El Segundo Power Company).

Sighting No. Cm39 3 Sightings
Chelonia mydas

mid-October 1981 Sea Temp. Normal Month/Normal Year

36°30'N, 123°55'W [3000 fms]
80 miles (210°) from the Farallon Islands, California

While fishing albacore commercially, Dean Adams skipper of the Cortez (Fisherman's Landing, San Diego) saw two turtles within three miles of each other during one day and saw a third later in the trip in the same area. All of these turtles were of the same small size (2 ft; 61 cm length). "Unlike Caretta, these Chelonia do not let the boat approach closely before diving. Chelonia show up in areas where albacore are feeding."

Sighting No. Cm40 2 Turtles Together
Chelonia mydas

17 October 1981 Sea Temp. Hot Month/Hot Year

48°42'30"N, 125°07'W [20 fms]
½ mile seaward of Pachena Point Light House, Vancouver Island, British Columbia, Canada

J.L. Mitchell sighted two olive/brown turtles together near a net set ½ mile seaward of the Pachena Point light house. He estimated their shell lengths as 3½ ft [107 cm]. Another fisherman identified them as greens and both agreed that the turtles matched the description and drawings of Chelonia in their sea turtle sighting report form (supplied by this study).

Sighting No. Cm41
Chelonia mydas

15 February 1982 Sea Temp. Normal Month/Normal Year

42°02'45"N, 124°16'05"W [stranded]
Harbor in Pelican Bay, Brookings, Oregon

During a February storm, an adult green sea turtle was found dead on the beach at Harbor, Oregon. It was examined and measured by Frank Hammond. He will send photographs and exact measurements, but recalls the turtle to have been about 50 in [127 cm] from the tip of its nose to the tip of its tail and 48 in [122 cm] from tip-tip of foreflippers. The turtle was slightly decomposed; Mr. Hammond buried the carcass in the beach sand to allow it to decompose sufficiently to salvage the skeleton. The carapace was cracked in two spots but Mr. Hammond did not think the injuries were sufficient to cause death. Examining a picture of the turtle (in the Curry Coastal Pilot. 1982 Feb. 17: 2; Brookings, Oregon) those cracked areas appear oval or round in shape and might be scars where large barnacles flaked off with the top layers of the scutes. They were not the long cracks that would be caused by a boat propellar. Mr. Hammond questioned whether the low ocean temperatures and rough ocean conditions brought on by the storm could have caused its death.

Sighting No. Cm42
Chelonia mydas

27 May 1982 Sea Temp. Normal Month/Normal Year

33°07'N, 117°20'W [dead on beach]
south Carlsbad Beach, Carlsbad, California

Captain Kastner (California Department of Fish and Game) reported the stranding of a dead green sea turtle on south Carlsbad Beach. Richard and Myrte Stinson (Vista, California) photographed and measured the carcass. Its carapace was cracked its entire length, the right side of the shell was smashed and internal organs were exposed. Straight carapace length 95.25 cm; straight carapace width 91.44 cm; head length (to carapace) 38 cm; length rear flipper 30.5 cm.

Sighting No. Cm43
Chelonia mydas

5 March 1983 Sea Temp. Hot Month/Hot Year

31°27'40"N, 116°48'30"W [258 fms]
10 miles (270°) off Punta San Jose, Baja California del Norte, Mexico

Margie Stinson and Captain Ed McEwen of the *Pacific Queen* (Fisherman's Landing, San Diego) observed this green sea turtle in an area with a pod of common porpoise (*Delphinus delphis*). The turtle's carapace was estimated to be 0.5 m in diameter.

Sighting No. Cm44
Chelonia mydas

8 September 1983 Sea Temp. Hot Month/Hot Year
64°F (17.78°C)

44°37'45"N, 124°46'W [215 fms]
30 1/3 miles (263°) W of Yaquina Head light, Oregon [Loran C lines 12884, 27857]

Gill Gross on the *old Grandad* reported seeing this turtle swimming vigorously in a northerly direction. Killer whales (*Orcinus orca*) and a huge elephant seal (*Mirounga angustirostris*) were seen in the area. Turtle's color greenish; approximate shell length 3 ft [91 cm]; shell width 2½ ft [76 cm]. Sighting made at 1000 hours. Report submitted by Mr. C. Dale Snow, Oregon Department of Fish and Wildlife, Newport Laboratory.

Sighting No. Cm45
Chelonia mydas

16 September 1983 Sea Temp. Hot Month/Hot Year
71.5°F (21.9°C)
32°03'N, 117°02'W [217 fms]
end of Finger Bank, 13½ miles (182°) S of Punta Descanso, Baja California del Norte, Mexico

Irv Grisbeck of the Sundowner (Point Loma Sportfishing Assoc., San Diego) observed this green sea turtle in a kelp paddy. Yellowfin tuna were caught on this paddy. The turtle's carapace was described as dark green with yellow patches; shell 18 in [46 cm] long; shell longer than wide with a pointed posterior end.

Sighting No. Cm46
Chelonia mydas

early November 1983 Sea Temp. Hot Month/Hot Year

37°36'30"N, 122°30'W [stranded]
Linda Mar Beach, near San Pedro Point, San Francisco, California

This turtle was found dead ashore in rocks by Vicky Trujillo (Pacifica, California). It was reported to Dr. Robert Lea of the California Department of Fish and Game (Monterey office). The turtle was estimated to weigh 200 pounds [90.72 kg]. Its shell was dark brown in color. It had four costal shields on each side of the shell.

APPENDIX F

DESCRIPTION OF PACIFIC LOGGERHEAD SEA TURTLE SIGHTINGS

Sighting No. Cc1 2 Juveniles
Caretta caretta

1907

32°50'N, 117°17'-18'W [? fms]
off La Jolla, California

Included in Stebbins (1954).

Sighting No. Cc2
Caretta caretta

May 1926 Sea Temp. Hot Month/Hot Year

33°20'-30'N, 117°45'-55'W [300-400 fms]
deepwater off Newport Beach, California

Los Angeles County Museum herpetology Collection Nos. 25317 and LACM 481.

Sighting No. Cc3
Caretta caretta

7 August 1946 Sea Temp. Normal Month/Normal Year

32°22'30"N, 117°46'W [809 fms]
25-30 miles WSW of North Coronado Island, Baja California del Norte, Mexico

Mr. N.F. Cordileone donated this juvenile loggerhead to the San Diego Zoo for display. It was given the name "Morteuse" (Chuck Shaw herpetology collection No.CS50); it lived until June 15, 1951 and was then given to the San Diego Museum of Natural History (herp-tology collection No. SDNMH 56552). Although Shaw (1946) described this turtle as an aberrant Lepidochelys olivacea olivacea, he suggested that it may have been an intermediate between Caretta c. gigas and Lepidochelys o. olivacea. Caldwell (1962) re-examined the turtle and identified it as Caretta caretta gigas. At the time of capture it measured a straight carapace length of 9 in [22.9 cm] and plastron length of 8 in [20.3 cm] (Carl Hubbs notes). Jueveni1e Caretta and Lepidochelys are difficult to distinguish without careful examination (Frazier, 1985).

Sighting No. Cc4
Caretta caretta

10 August 1947 Sea Temp. Normal Month/Normal Year

35 miles WSW of San Clemente Island, Channel Islands, California

Dick Shively, aboard the Hulda, gaffed this apparently sleeping turtle (Shaw, 1947). It was donated by Chuck Shaw of the San Diego Zoo (CS#5) to the San Diego Museum of Natural History (herpetology collection No. 56549). It measured a curved carapace length of 62.87 cm [24 3/4 in] and curved carapace width of 59.8 cm [23 5/8 in].

Sighting No. Cc5 2 Sightings
Caretta caretta

August 1951 Sea Temp. Cold Month/Normal Year

32°40'N, 117°20'W [54 fms]
off Point Loma, San Diego, California

Two small Caretta were brought in from off Point Loma and placed in the Scripps Institute of Oceanography aquarium. According to Dr. Carl Hubbs, "the turtles show an interesting reaction...when a thumb is placed against the tank's glass and vibrated hard to produce low frequency waves in the tank, the little loggerheads drop rapidly to the bottom" [Carl Hubbs notes].

Sighting No. Cc6
Caretta caretta

January 1958 or 1959 Sea Temp. Hot Months/Hot Years

32°34'21"N, 117°19'11"W [66 fms]
approximately 7 miles off Point Loma, San Diego, California

Mr. Carr Tuthill, aquarist for the Scripps Institute of Oceanography, received a small Caretta during January from approximately 7 miles off Point Loma [letter from Dr. Carl Hubbs to Dr. Archie Carr dated 19 January 1961].

Sighting No. Cc7
Caretta caretta

1961 Sea Temp. Normal Year

30°15'N, 115°55'W [10-60 fms]
between Bahia San Quintin and Isla San Martin, Baja California del Norte, Mexico

Recorded in a letter from Dr. David Caldwell (Los Angeles County Museum) to Dr. Carl Hubbs (SIO) dated 25 March 1963.

Sighting No. Cc8
Caretta caretta

16 January 1961 Sea Temp. Normal Month/Normal Year
32°33'N, 117°15'30"W [29 fms]
7 miles off Point Loma, San Diego, California

A 25 pound [11.3 kg] loggerhead was gaffed by Red Rouse, deckhand on the sportfisher Malihini (H&M Landing, San Diego). The turtle was placed in the Scripps Institute of Oceanography aquarium.

Two crabs identified as <u>Planes cyaneus</u> (by Dr. John S. Garth of the Allan Hancock Foundation) were removed from the cavity between the tail and carapace. Dr. Hubbs describes the turtle as having 2 pairs of prefrontals, 5 pairs of lateral laminae, bridge with 3 enlarged inframarginals [letters from Dr. Hubbs to Dr. Archie Carr dated 19 January 1961 and to Dr. Garth dated 20 January 1961; San Diego Union. 1961 Jan. 17: Outdoor Notebook column by Rolla Williams].

Sighting No. Cc9
<u>Caretta caretta</u>

20 July 1963 Sea Temp. Normal Month/Normal Year

31°56'N, 117°28'37"W [829+ fms]
45 miles S of Point Loma, San Diego, California

Carapace length 465 mm, carapace width 415 mm, total weight 8.0 kg; 5 vertebrals, 5-5 costals, 12-12 marginals, 3-3 inframarginals (Marquez, 1969).

Sighting No. Cc10
<u>Caretta caretta</u>

21 August 1963 Sea Temp. Normal Month/Normal Year

32°49' - 33°02'N, 118°09'-21'W [400-650 fms]
10 miles inshore of San Clemente Island, Channel Islands, California

Los Angeles County Museum herpetology collection No. 75036.

Sighting No. Cc11
<u>Caretta caretta</u>

27 February 1964 Sea Temp. Hot Month/Normal Year

32°26'N, 117°39'W [464 fms]
25 miles SW of San Diego (on the 25 Mile Bank), California

This loggerhead was caught (by dip-net) on the 25 mile bank by Ernie Lepacek on the Pappy. It measured a carapace length of 404 mm, carapace width 358 mm, carapace height 175 mm, head width 87 mm, weight 19.75 lbs [8.96 kg]; prefrontal pairs 2-2, precentral and first lateral in contact, 5 centrals, 5-5 laterals, 11-11 marginals, 3-3 enlarged laminae on bridge with slits barely present; coloration reddish brown. This turtle was examined at Sea World by Carl Hubbs (SIO) and Kent Radford (Mesa College, San Diego).

Sighting No. Cc12
Caretta caretta

2 March 1964 Sea Temp. Normal Month/Normal Year

32°23'N, 117°14'W [20 fms]
due south of South Coronado Island, Baja California del Norte, Mexico

Andy Fischal on the Awlunga (Point Loma Sportfishing Assoc., San Diego) dip-netted a 62 pound [28 kg] loggerhead. It was examined at Sea World by Dr. Carl Hubbs and Kent Radford (Mesa College, San Diego). Carapace length 578 mm, carapace width 497 mm, height 236 mm, head width 127 mm; prefrontal pairs 2-2 and separated by a large triangular plate; precentral and first lateral in contact on right; centrals 5, laterals 4-5, marginals 11-11, enlarged laminae on bridge 3-3 and poreless.

Sighting No. Cc13
Caretta caretta

16 September 1965 Sea Temp. Normal Month/Normal Year

32°29'N, 117°12'W [? fms]
Los Coronado Islands, Baja California del Norte, Mexico

Carapace length 25.6 cm, carapace width 25.0 cm, total weight 2.9 kg; caught by dip-net by a sportfishing vessel (Marquez, 1969; Hubbs notes).

Sighting No. Cc14
Caretta caretta

May 1974 Sea Temp. Normal Month/Normal Year

34°01'N, 118°47'W [5 fms]
near Paradise Cove, Malibu, California

Los Angeles County Museum herpetology collection No. 127818; collected by J. Croft.

Sighting No. Cc15
Caretta caretta

12 August 1975 Sea Temp. Cold Month/Cold Year

33°25'N, 118°21'30"W [109 fms]
3/4 mile off Long Point, Santa Catalina Island, Channel Islands, California

Photographs by Dan Miller are in the Los Angeles County Museum herpetology collection.

Sighting No. Cc16
Caretta caretta

15 March 1978 Sea Temp. Hot Month/Hot Year

33°56'N, 119°39'W [200+ fms]
3 miles (164°) off Valley Anchorage, Santa Cruz Isalnd, Channel Islands, California

Straight carapace length 45.7 cm [17.9 in], straight carapace width 38.1 cm [15.0 in], weight 8.6 kg [18 lbs] (Guess, 1981).

Sighting No. Cc17
Caretta caretta

7 August 1978 Sea Temp. Normal Month/Hot Year

32°38'N, 117°08'32"W [stranded]
on Pacific side of the Silver Strand State Beach on the Coronado Peninsula, San Diego, California

This loggerhead was found dead, washed ashore on the ocean side of the Coronado Peninsula, near the state park life guard station opposite the Naval Amphibious Base. Photographs provided by John Duffy, marine biologist for the California Department of Fish and Game, show that its carapace was deeply cracked for at least half its length. Total body length 70 cm, straight carapace length 48 cm, straight carapace width 40 cm.

Sighting No. Cc18
Caretta caretta

26 May 1979 Sea Temp. Cold Month/Normal Year

32°41'06"N, 117°54'42"W [25 fms]
35 miles (260°) from Point Loma, San Diego, California

While enroute to Mosquito Cove, San Clemente Island, Daryl Clark captured this young loggerhead (about the size of a dinner plate). The boat was travelling at 18 knots, just outside the freighter lines when the turtle was sighted on the surface (between 0730 and 0800 hours). The boat was slowed and brought around; the animal remained on the surface swimming in a northerly direction. The turtle was then lifted aboard with a dip-net and kept until the next morning when it was released at Mosquito Cove on the lee side of San Clemente Island. "When the turtle was returned to the water it was placed facing west. The turtle made two flipper strokes and

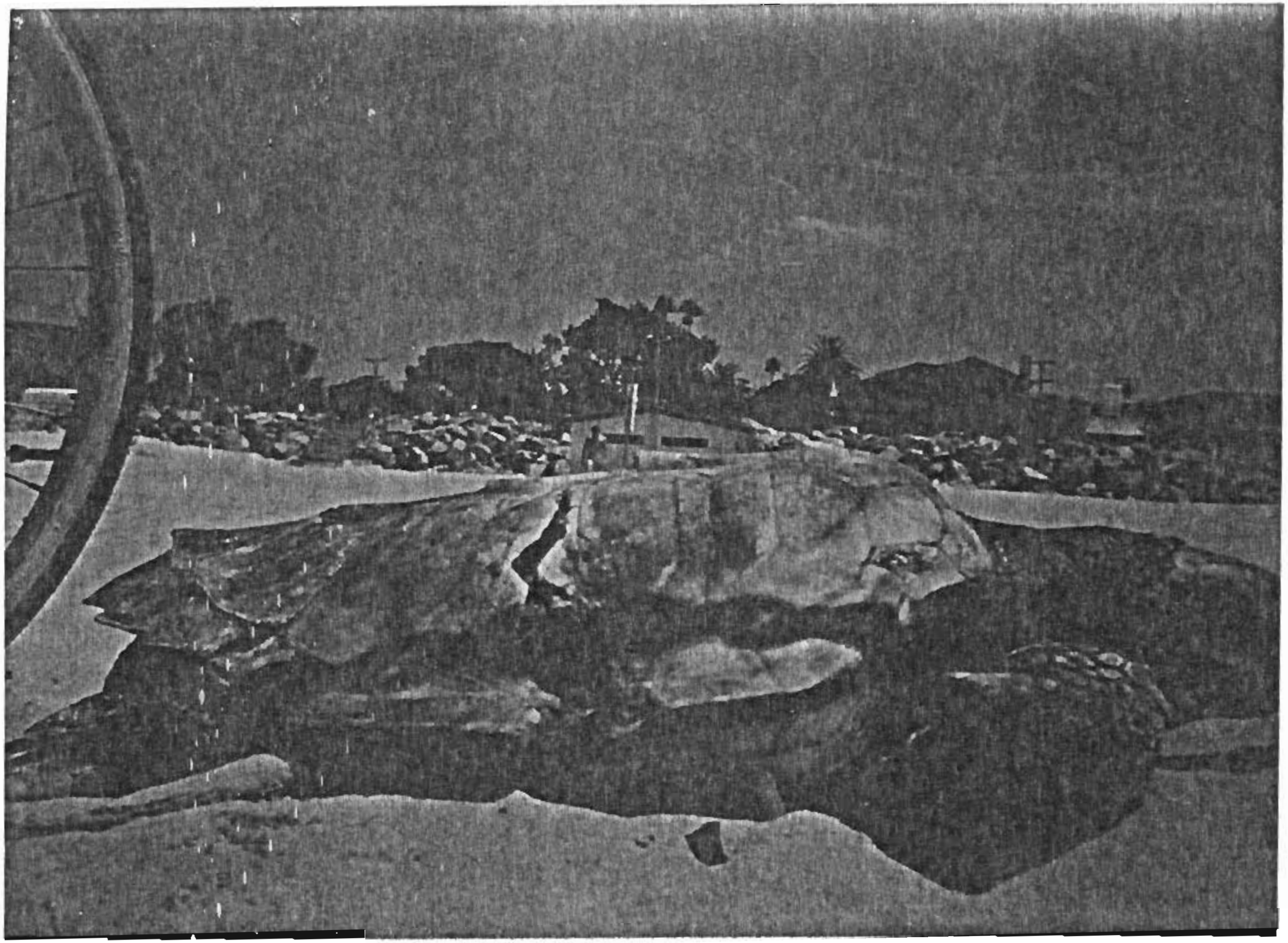


Figure 52. A Pacific loggerhead sea turtle found dead, washed ashore on the ocean side of the Coronado Peninsula, San Diego. Its injuries were probably caused by collision with a boat (Sighting No. Cc17). Photograph provided by John Duffy, California Department of Fish and Game.

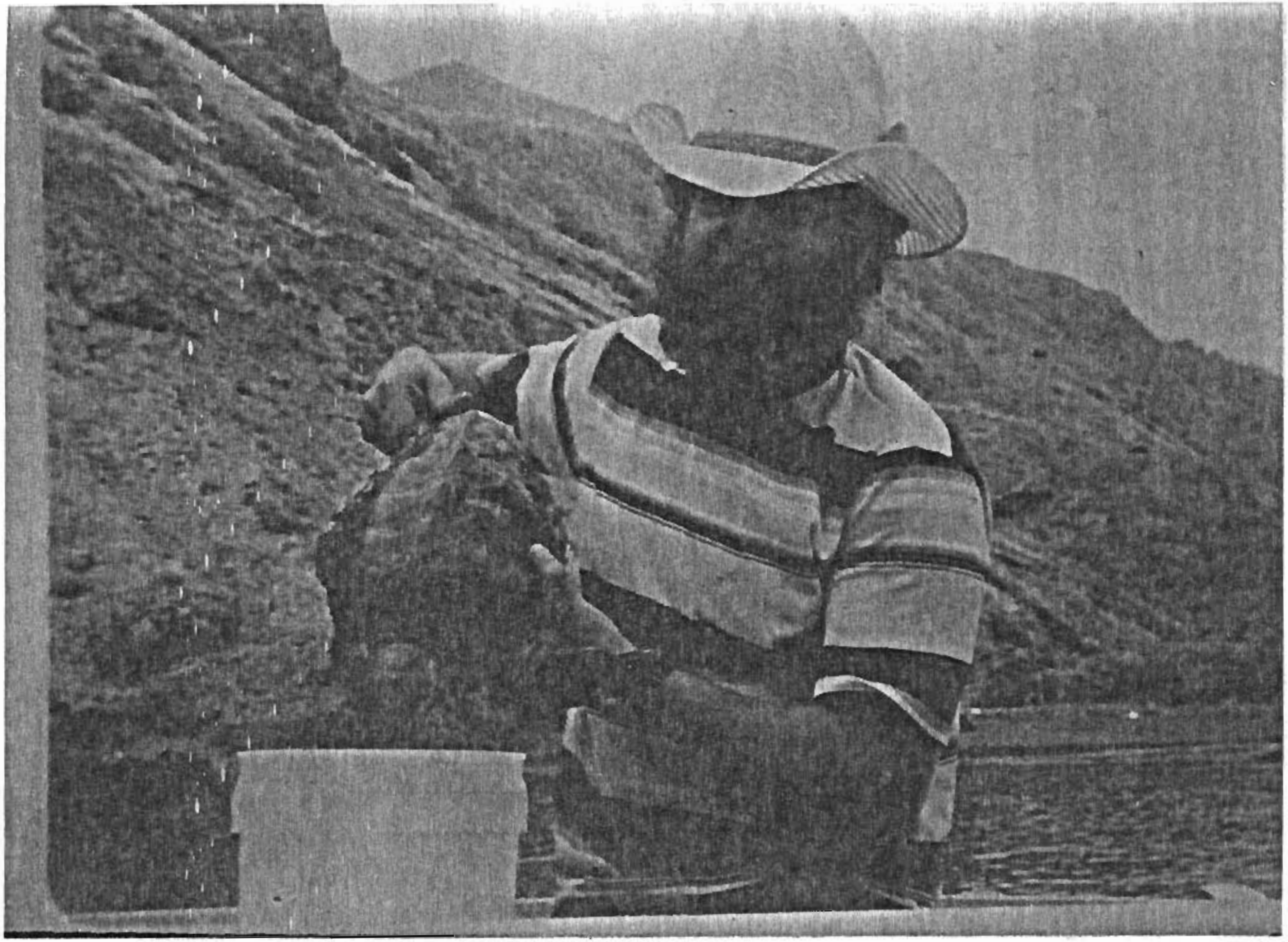


Figure 53. A juvenile Pacific loggerhead sea turtle found 35 miles from Point Loma, San Diego (Sighting No. Cc18). Photograph provided by Daryl Clark.

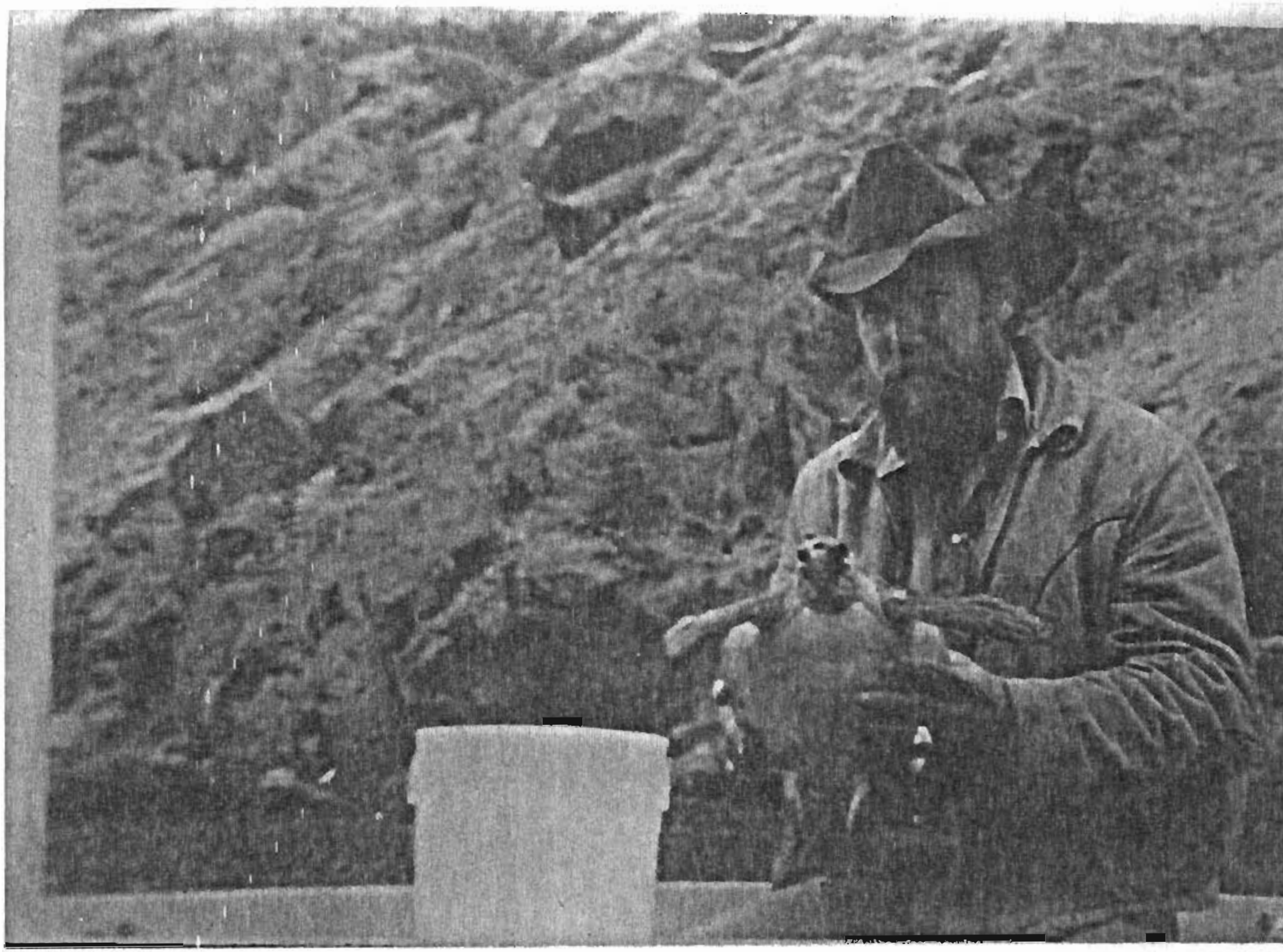


Figure 54. A juvenile Pacific loggerhead sea turtle found 35 miles from Point Loma, San Diego (Sighting No. Cc18; Figure 53). Photograph provided by Daryl Clark.

turned north again." The surface temperature was estimated to be 58°F (14.4°C). Photographs were supplied by Daryl Clark.

Sighting No. Cc19
Caretta caretta

last week July 1979 Sea Temp. Normal Month/Normal Year

32°59'N, 118°26'W [600 fms]
6 miles (86°) from Wilson Cove, San Clemente Island, near the Mackerel Bank, Channel Islands, California

Commercial fisherman Gary Schneipp (vessel _Jo Ann_) found this turtle afloat. Apparently there was gas under its shell because it was extremely bouyant and rolled upon attempting to dive. Mr. Schneipp was able to pet the turtle and to hold it on the surface for photographs. Its carapace was approximately one meter in length and was encrusted with eight large white barnacles. Water temperatures were above 70°F (21°C).

Sighting No. Cc20
Caretta caretta

August 1979 Sea Temp. Normal Month/Normal Year

31°03'N, 118°34'W [300 fms]
119 miles (200°) off Point Loma, San Diego, California
[West of Cabo Colnett, Baja California del Norte, Mexico]

George Cargal, engineer aboard the _Royal Polaris_ (Fisherman's Landing, San Diego) reports seeing a small (8-10 in; 20-25 cm) brown-orange turtle on the water's surface. The turtle's shell had definite plates. "The carapace margin was distinctly edged in black although this could have been caused by the sun's glare. The head did not appear to have distinct plates." The turtle dove as the vessel approached.

Sighting No. Cc21
Caretta caretta

February 1980 Sea Temp. Hot Month/Normal Year

33°11'06"N, 117°28'06"W [90 fms]
3 3/4 miles off Oceanside Harbor, Oceanside, California

Captain Joe Cacciola (Matt Walsh, Ports O'Call, San Pedro) reports seeing a turtle 2½ miles off Stuart's Farm (immediately north of Oceanside Harbor) in 90 fathoms. The distance offshore was actually 3 3/4 miles in order to have been in 90 fathoms. The weather was clear, warm and sunny. The ocean was flat and 56°F (13.3°C). The turtle was about 2 ft [61 cm] long, reddish brown and had a definitely raised ridge on its back. "At first I thought it was dead as I couldn't detect any movement, but after we approached within 20 feet I could ascertain that it was alive but appeared lethargic. After about 15 minutes it made a shallow dive of about 10 feet and then surfaced again, exhaling as it did. Every once in awhile it would move one of its flippers. I left the turtle unmolested and noted the sighting in my whale sighting report."

Sighting No. Cc22
Caretta caretta

16 July 1980 Sea Temp. Cold Month/Cold Year

approx. 33°40'N, 118°40'W [? fms]
off Los Angeles, California

According to Mr. John Heyning, curator of the Cabrillo Beach Museum, this dead loggerhead was found floating near the Los Angeles Fish and Oyster Company in the San Pedro section of Los Angeles Harbor. A witness saw the turtle thrown overboard from a commercial fishing boat that typically fishes using nets in the local waters. The turtle was salvaged by the Cabrillo Beach Museum (Cabrillo collection No. 80-2-11) and then transferred to the herpetology collection of the Los Angeles County Museum. Margie Stinson photographed and measured the specimen. Sex: female, Curved carapace length to center notch 29.75 in [75.6 cm], 30 ¼ in [76.8 cm] to end scale; curved carpace width 28 3/4 in [73.0 cm]; straight carapace length 28¼ in [71.8 cm], straight carapace width 22 in [55.9 cm]; curved plastron length 22 in [55.9 cm]; curved plastron width 22½ in [57.2 cm]; plastron width margin-margin 26 3/4 in [68 cm]; head width 5 7/8 in [14.9 cm]; neck circumference 23 1/8" [58.7 cm]; neck width 6¼ in [15.9 cm].

Sighting No. Cc23
Caretta caretta

3 September 1980 — Sea Temp. Normal Month/Normal Year
Surface sea Temp. 55°F (12.8°C)

37°22'45"N, 122°40'30"W [51 fms]
outside the reef, 18 miles SW of Half Moon Bay, California

See Dermochelys Sighting No. D76.

Sighting No. Cc24
Caretta caretta

8 September 1980 — Sea Temp. Normal Month/Normal Year
Surface sea temp. 68°F (20°C)

31°05'N, 116°53'45"W [698 fms]
30 miles W of Cabo Colnett, Baja California del Norte, Mexico

When Garry Black, skipper of the Conquest (Fisherman's Landing, San Diego), first saw this turtle it appeared to be asleep on the flat calm sea. It was being bumped by a shark. As the vessel

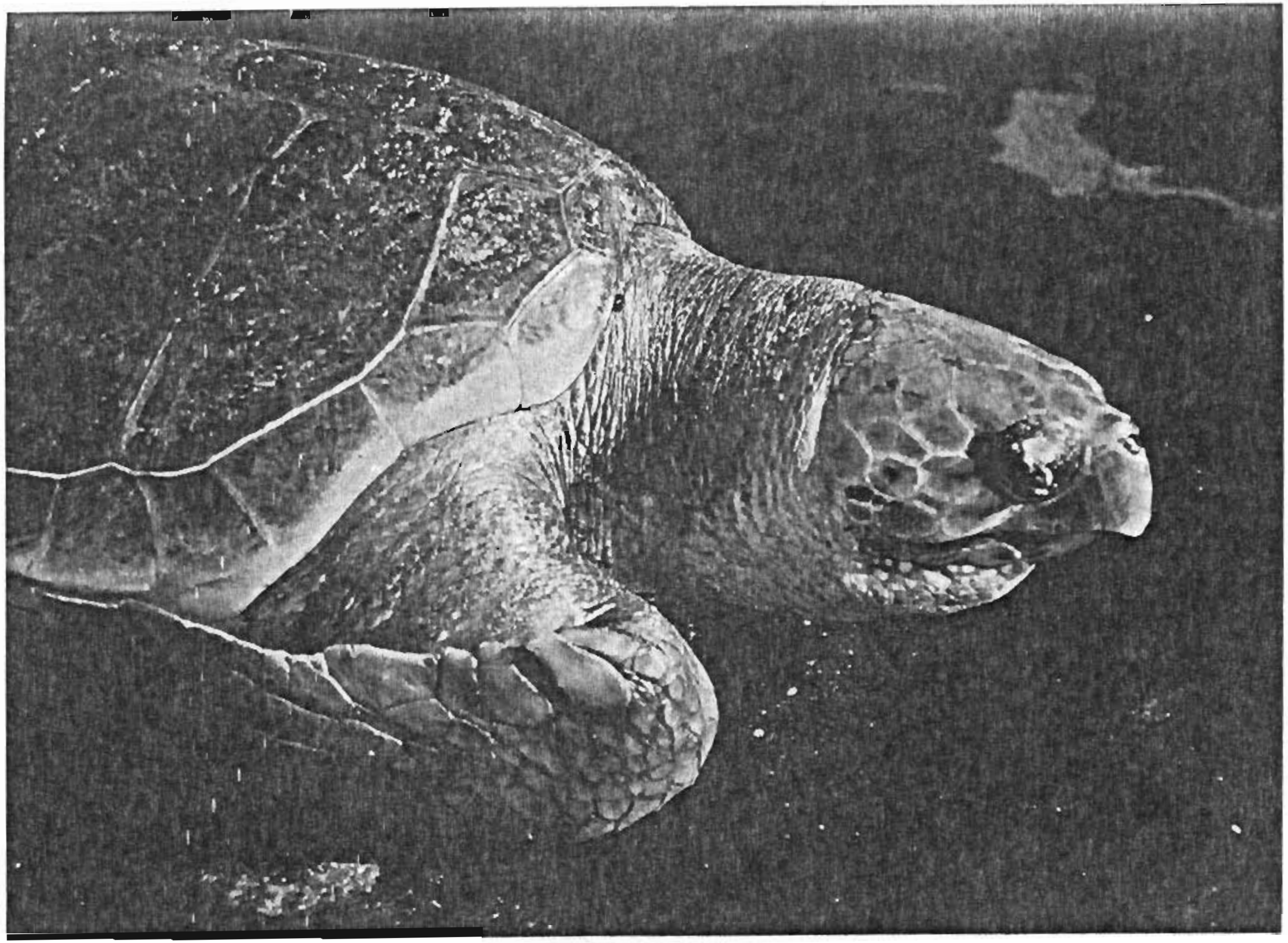


Figure 55. Adult Pacific loggerhead sea turtle found dead in Los Angeles Harbor, California (Sighting No. Cc22). A witness reported that the turtle had been thrown overboard from a local gillnetter.

approached, the shark left and the turtle was lifted aboard for photographs. Costals 5; carapace length 24" [61 cm], carapace width 18" [45.7 cm]; weight 15-20 lbs; color greenish brown; its upper beak was hooked. Photographs were identified as Caretta. Water temperature 68°F (20°C).

Sighting No. Cc25
Caretta caretta

9 September 1980 Sea Temp. Normal Month/Normal Year

30°52'N, 116°43'45"W [730 fms]
110 miles (155°) from San Diego, California
[20½ miles off Cabo Colnett, Baja California del Norte, Mexico]

This loggerhead was observed by Garry Black, skipper of the Conquest (Fisherman's Landing, San Diego) and was possibly smaller than the Caretta he saw the previous day (Sighting No. Cc24). This one had a shell approximately 2 ft [61 cm] in length.

Sighting No. Cc26
Caretta caretta

15 September 1980 Sea Temp. Normal Month/Normal Year

47°00'N, 124°10'W [stranded]
Ocean Shores, Grays Harbor County, Washington

Dr. Murray Johnson, curator of mammals at the University of Puget Sound Museum of Natural History, intends to publish a note of this record. This turtle was found dead, but in fresh condition at Ocean Shores. It was then frozen by the Washington Department of Fish and Game and after a year was given to the University of Puget Sound (MLJ 6256R). Carapace length 45.0 cm, carapace width 40.0 cm, weight 12.26 kg. Species identification was verified by Bill Rainey, University of California at Berkeley [Smithsonian Institute SEAN Bull. 6(12):14; pers. comm. with Dr. Murray].

Sighting No. Cc27
Caretta caretta

16 December 1980 Sea Temp. Normal Month/Normal Year
Ocean temp. 62°F (16.67°C)

captured: 33°27'02"N, 118°47'06"W [450 fms]
9 miles (246°) from west end Santa Catalina Island, Channel Islands, California

released: 33°27'02"N, 119°21'08"W [861 fms]
14 miles (02°) from the east end of San Nicholas Island, Channel Islands, California

Captain Harry Hoover and the crew of the California Department of Fish and Game patrol vessel, Albacore, dip-netted this turtle which was sleeping on the surface in a small patch of kelp (1130 hours). Commercial fishermen commonly set drift nets in this area for swordfish and thresher shark. The turtle was released three hours later after photographs and measurements were taken. Total length (excluding tail) 25 in [63.5 cm], curved carapace length 18" [45.7 cm], curved carapace width 17½ in [44.45 cm], curved plastron length 14½ in [36.8 cm], curved plastron width 17 in [43.2 cm]; weight 28½ lbs [12.9 kg]. Ocean temperature 62°F (16.67°C) [report by Captain Hoover, 9 September 1981].

Sighting No. Cc28
Caretta caretta

Summer 1981 Sea Temp. Normal Year

33°40'17"N, 118°18'12"W [41 fms]
2 miles (180°) from the Los Angeles light, Los Angeles, California

Mike Crawford, operator of the Catalina King (Catalina

Figure 56. Captain Harry Hoover of the California Department of Fish and Game patrol vessel Albacore holds a juvenile Pacific loggerhead found asleep in a kelp paddy in the Channel Islands (Sighting No. Cc27). Photograph provided by Captain Hoover.

Cruises, San Pedro) saw a small loggerhead, 2 miles (180°) from the Los Angeles Light during the summer of 1981.

Sighting No. Cc29
Caretta caretta

18 February 1981 Sea Temp. Hot Month/Hot Year

46°18'25"N, 124°01'45"W [stranded]
Benson Beach, Fort Canby State Park, Ilwaco, Washington

A 130-160 pound [59-73 kg] loggerhead came ashore during a four day storm and after two or three days it was removed from the beach by National Marine Fisheries Service law enforcement agents and taken to the Seattle Aquarium where it was kept until its health improved. Initially the turtle was thought to be dead and was placed in a warm building. By the next morning its body temperature was 56°F (13.3°C); it had survived 45°F (7.2°C) temperatures for several days on the beach before being transferred to the aquarium. The turtle was then placed in a tank of water at 63°F (17.2°C) and it is believed that the turtle's body temperature stabilized at 61°F (16°C). Initially the turtle experienced difficulties in swimming; it floated but could not dive. It floated with its tail and posterior carapace higher than its head as if air was trapped under the shell. Two anterior plastron plates were injured and lifted and one was fractured; the carapace had 8 to 10 gouges each a couple of millimeters in depth and probably resulted from logs washing against the turtle in the surf. The carapace was infested with spaghetti-like white ship worms and one barnacle. The carapace was treated for bacterial infection. The loggerhead was treated by Gary Blew, curator at the Seattle Aquarium and then transferred to Sea World in San Diego where it was released off Mission Bay [pers. comm with John Nightengale, Seattle Aquarium and a report from Terry Link, Astoria, Oregon; Smithsonian Institute SEAN Bull. 6(12):14].

Sighting No. Cc30
Caretta caretta

6 July 1981 Sea Temp. Hot Month/Hot Year

32°57'40"N, 118°01'15"W [510 fms]
18½ miles (49°) from Pyramid Head, San Clemente Island, Channel Islands, California [Loran C 40830.6, 28180.8]

Commercial fisherman Gary Schniepp (vessel Jo Ann, Newport Beach) saw another tiny, very red sea turtle. He estimated its body size as being 18 in [45.7 cm] long. The surface water temperatures were above 70°F (21°C).

Sighting No. Cc31
Caretta caretta

15 August 1981 Sea Temp. Normal Month/Hot Year

32°38'23"N, 117°15'12"W [22 fms]
2 mi. SW of Point Loma, San Diego, California

Karen Blakney, sailing on the Pelican, observed a turtle swimming in a southward direction about 20-25 feet from the boat. At first she thought the turtle was a piece of trash until she saw its head raise. The turtle appeared to be about 3 feet [91 cm] in total length and 2 feet [61 cm] wide. Its head and shell were richly red and yellow in color and its head was the size of a grapefruit. Its flippers appeared elongate rather than thick. The ocean was "greasy calm" with couple foot swells and a good breeze. There were no other animals in the vicinity of the turtle. The ocean felt warm to the touch. The observation was made at 1500 hours.

Sighting No. Cc32
Caretta caretta

July 1982 Sea Temp. Normal Month/Normal Year

32°52'N, 118°10'W [estimated as 469 fms]
off the east end of San Clemente Island, Channel Islands, California

Commercial fisherman, Ivan Aldis photographed a small loggerhead sea turtle (carapace length 18-20"; 46-51 cm) off the east end of San Clemente Island.

Sighting No. Cc33
Caretta caretta

July 1982 Sea Temp. Normal Month/Normal Year

33°02'N, 118°23'W [390 fms]
9½ miles east of the north end of San Clemente Island, on the Mackerel Bank, Channel Islands, California

Two days later (see Sighting No. Cc32), commercial fisherman Ivan Aldis saw a loggerhead of the same size on the Mackerel Bank. A remora fish was attached to this turtle and a blue shark [1 m] was observed trying to eat the remora.

Sighting No. Cc34
Caretta caretta

July 1982 Sea Temp. Hot Month/Hot Year

33°13'45"N, 118°13'W [estimated as 294 fms]
between the Mackerel Bank and Newport Beach, estimated as 6½ miles (132°) from the east end of Santa Catalina Island, Channel Islands, California

Commercial fisherman, Ivan Aldis saw a third [1 m] loggerhad between Newport Beach and the Mackerel Bank off San Clemente Island.

Sighting No. Cc35
<u>Caretta caretta</u>

2 September 1982 Sea Temp. Hot Month/Normal Year
Surface temp. 71°F (21.7°C)
33°06'06"N, 117°21'30"W [42 fms]
2 miles offshore, 2 miles S of the SDG & E Company Encina facility, Carlsbad, California

Mike Marika and Les Thomas of Sea World in San Diego found a young loggerhead sea turtle floating on the ocean's surface. They momentarily captured it with a dip-net in order to measure it and then released it at the same locale. It measured a carapace length of 24.1 cm, carapace width of 20.6 cm, body thickness 11.4 cm. It had a bird feather in its mouth. Two commensal crabs were attached underneath one of its hind flippers. One crab was blond brown in color and the other olive gray. A hammerhead shark was also sighted in the same area. Surface ocean temperature was 71°F (21.7°C); 1230 hours sighting.

Sighting No. Cc36
<u>Caretta caretta</u>

3 August 1983 Sea Temp. Hot Month/Hot Year

34°24'N, 119°42'W [stranded]
on Butterfly Beach at Ortega Hill between Summerland and Montecito, Santa Barbara, California

Paul Collins, associate curator of the Santa Barbara Museum of Natural History, reports this turtle washed ashore alive. It was transferred first to a tank at a fish market by Saul Castinolla and then to the Childs Estate Zoo where it died that evening. The specimen is now in the collection of the Santa Barbara Museum of Natural History. Measurements are as follows: curved carapace length 58.6 cm; straight carapace length 54.6 cm; curved plastron length 45.8 cm; straight plastron length 44.2 cm; shell height 21 cm; 2 pairs of prefrontals; bridge scales 3-4; costals 5-4; one costal touched the nuchal, the costal of the other side did not; weight 52 lbs [23.6 kg].

Sighting No. Cc37
Caretta caretta

7 September 1983 Sea Temp. Hot Month/Hot Year

33°03'15"N, 117°18'W [stranded]
between Beacon and Moonlight Beaches, Encinitas, California

Jeanne Wexler, National Marine Fisheries Service marine mammal/sea turtle salvage program, reported a stranding of a 300 lb [136 kg] loggerhead between Beacon and Moonlight Beaches. A remora fish was attached to the turtle's carapace.

Sighting No. Cc38
Caretta caretta

28 September 1983 Sea Temp. Hot Month/Hot Year

33°55'40"N, 119°33'15"W [500 fms]
8 miles SSW of West Anacapa Island, 5 miles SSE of Yellow Bluff, Santa Cruz Island, Channel Islands, California

Paul Collins, associate curator of the Santa Barbara Natural History Museum, reports this loggerhead was found dead floating eight miles SSW of Anacapa Island. He describes it as follows: female; 120-150 lbs [54-68 kg]; curved carapace length 75 cm; straight carapace length 71.6 cm; curved plastron length 52.6 cm; straight plastron length 53.4 cm; shell height 24.4 cm. Parasites: many barnacles (Chelonibia testudinata) on carapace, plastron, neck and on the leading edge of front flippers. Gut contents: gut full of masses of fish eggs, 3 species of kelp, 1 barnacle (Chelonibia), 3-4 pelagic red crabs (Pleurnocodes planipes). No endoparasites.

Sighting No. Cc39
Caretta caretta

2 October 1983 Sea Temp. Hot Month/Hot Year
Surface temp.: see text

31°41'54"N, 116°58'06"W [530 fms]
11 3/4 miles (253°) from Cabo Punta Banda, Bahia Todos Santos, Baja California del Norte, Mexico

This turtle was seen floating at the surface in a kelp paddy. Observed by Captain Ed McEwen and Margie Stinson of the Pacific Queen (Fisherman's Landing, San Diego). Its shell was estimated to be 2 feet [61 cm] in length, 1½ feet [46 cm] in width. It was orange in color and had several barnacles attached. Fish were flashing under the turtles and immediately skipjack tuna and yellowtail were caught by the vessel. Sea surface temperature 68½°F (20.28°C) dropped from the typical 71°F (21.67°C) of recent, the last four days have been stormy.

Sighting No. Cc40
Caretta caretta

22 October 1983 Sea Temp. Hot Month/Hot Year

34°15'N, 121°25'W [948 fms]
San Juan Seamount, 100 miles (264°) W of Santa Barbara, California

During a cruise looking for oceanic birds and marine mammals, a sea turtle was observed in rough seas. Rich Stallcup described the turtle as being about 2 feet [61 cm] in length, mostly yellow-brown in color, "having 4 costal plates and overlapping, pointed shell plates with their posterior termination forming a spiny dorsal ridge". He tentatively identified it as a hawksbill, but, with the exception of the four costal plates this description equally fits that of a juvenile Pacific loggerhead. The turtle was not brought aboard for closer examination. Without detailed examination, scale counts and photographs I have extreme doubts that this turtle was a hawksbill. Loggerheads at sea are often mistakenly described as hawksbills.

Sighting No. Cc41
Caretta caretta

Sea Temp. Hot Month/Hot Year

34°03'N, 121°05'W [356 fms]
Rodriguez Seamount, 31 miles (270°) W of San Miguel Island, Channel Islands, California

Commercial fisherman Edward Sylvester removed this live loggerhead from his gillnet and transferred the turtle to the Morro Bay Aquarium where it was held until December 23, 1983 when it was transferred to Sea World in San Diego to await release later that Spring. Margie Stinson described this turtle as follows: straight total length 36.8 cm; curved carapace length 28 cm; straight carapace length 27.9 cm; curved carapace width 29 cm; straight carapace width 24.1 cm; curved plastron length 23 cm; straight plastron length 22.86 cm; curved plastron width 26 cm; straight plastron width 24.1 cm; head length 7.5 cm; head and neck length 13.5 cm; length of left fore flipper 22 cm; length of left hind flipper 12 cm; length of tail from carapace to tip 5.5 cm. Precental 2 pairs; laterals 5-5 with the most posterior left lateral divided into two; precentral in contact with first laterals; bridge with three enlarged inframarginals; marginal laminae 13-13; mandibular scales 4-4 with the most posterior scale on each side being tiny. Coloration: carapace warm yellow-red brown with red and yellow-red tones, plastron yellow. Tail does not extend beyond the carapace. One claw on leading edge of each flipper. A wound exists on the leading edge of the left foreflipper (at elbow) and appears as if a barnacle had become detatched leaving a pit-like depression. The wound was treated by Bertha Tyler of the Morro Bay Aquarium with gentian violet. Weight 7 lbs [3.2 kg]. While in captivity at the Morro Bay Aquarium the turtle ate a diet of squid, shrimp and scallops.

APPENDIX G

DESCRIPTION OF PACIFIC (OLIVE) RIDLEY SEA TURTLE SIGHTINGS

Sighting No. L1
Lepidochelys olivacea

10 October 1957 Sea Temp. Hot Month/Normal Year

40°42'N, 124°16'W [alive on beach]
Table Bluff Beach, Humboldt County, California

Houck and Joseph (1958) described this stranding. "During 1957 coastal waters in this area have been warmer than normal with the result that a number of organisms more typical of a southern fauna have been collected locally." Carapace length 24.1 cm, width 23.8 cm. It died a month after capture and the specimen is now part of the Stanford University herpetological collection housed at the California Academy of Sciences in San Francisco.

Sighting No. L2
Lepidochelys olivacea

19 November 1962 Sea Temp. Normal Month/Normal Year

46°00'N, 123°55'30"W [stranded, dead]
Seaside, Oregon (18 miles south of the Columbia River)

Mr. Darrel Demory, biologist at the Oregon Department of Fish and Wildlife Marine Lab in Newport, found the remains of this turtle on the beach at Seaside. The carapace had been removed, however the rest of the carcass was examined and identified at the Oregon State University as those of an adult Pacific ridley [letter from Mr. C. Dale Snow, Assistant Marine Region Supervisor, Oregon

Department of Fish and Wildlife, Newport].

Sighting No. L3
Lepidochelys olivacea

January 1963 Sea Temp. Normal Month/Normal Year

32°40'21"N, 117°13'52"W [2½ fms]
East side of Point Loma, mouth of San Diego Bay, California

Specimen was donated by the Scripps Institute of Oceanography to the San Diego Museum of Natural History herpetology collection (SDMNH No. 49852). Carapace length 24 cm, length of small intestine 90 cm, length of colon 42 cm, width of constricted pyloric sphincter 7 mm (measured by Dr. Crawford Jackson, SDMNH and M.L. Stinson; Dr. Carl Hubbs notes and photographs 2075 A, B and C).

Sighting No. L4
Lepidochelys olivacea

25 August 1963 Sea Temp. Normal Month/Normal Year

32°55'N, 118°25'W [estimated as 440 fms]
San Clemente Island, Channel Islands, California

Listed as "SIO #2" in Dr. Carl Hubbs' notes.

Sighting No. L5
Lepidochelys olivacea

29 August 1963 Sea Temp. Normal Month/Normal Year

33°00'N, 118°20'W [400-650 fms]
between San Clemente and Santa Catalina Islands, Channel Islands, California

Listed as "SIO #3" in Dr. Carl Hubbs' notes.

Sighting No. L6
<u>Lepidochelys olivacea</u>

3 October 1963 Sea Temp. Normal Month/Normal Year

32°12'30"N, 119°12'35"W [810 fms]
15 miles S of Cortez Bank, California

This young ridley was captured by Steve Prvdonovich, donated to the Scripps Institute of Oceanography and described by Dr. Hubbs as weighing 4.5 lbs [2.04 kg], with a carapace length of 22.6 cm, carapace width of 21.0 cm, height 10.9 cm; head width 5.5 cm; 2 pairs of prefrontals; precentral and first laterals in contact; 5 centrals; 11-11 marginals; 5-5 enlarged laminae on bridge (second and third laterals on left and the first on right with pores); dusk purplish color on bridge, with yellow tubercles, yellow below with some dark spots, anterior lateral edged in yellow, trace of rusty color on frontal; frontal-parietal has deep radiating groove.

"This turtle was seen in an area at the same time many albacore, a few skipjack, yellowfin and bluefin tuna, striped and black marlin, and dolphin fish were seen or captured. Ten days earlier at the same area a similar turtle escaped capture. Hence a definite tropical invasion." [Carl Hubbs, notes].

Sighting No. L7
<u>Lepidochelys olivacea</u>

8 November 1967 Sea Temp. Hot Month/Normal Year

36°36'30"N, 121°53'40"W [1-2 fms]
breakwater off Canery Row, Monterey Bay, California

Sighting described by Morejohn (1969).

Sighting No. L8
Lepidochelys olivacea

14 April 1969 Sea Temp. Normal Month/Normal Year

33°00'N, 117°16'12"W [stranded, dead]
between Del Mar and Solana Beach, California

This animal was in fairly fresh condition when found washed ashore at the Seaside Cottages. Dr. Carl Hubbs described the specimen as having "a carapace a little broader than long. Head dark and too small for *Caretta*. Four enlarged inframarginals; laterals 6-6." Dr. William Neuman (SIO) identified two small barnacles attached to the carapace as *Chelonibia* cf. *testudinaria* (Hubbs notes). San Diego Museum of Natural History herpetology collection No. 49853.

Sighting No. L9
Lepidochelys olivacea

Spring 1971 Sea Temp. Normal Spring/Cold Year

37°53'18"N, 122°30'00"W [less than 2 fathoms]
4 miles N of Golden Gate at Strawberry Point Lagoon, San Francisco Bay, California

This turtle was found in a lethargic and emaciated condition with mud and growth covering its carapace. Photographs were taken and the animal released. Susan E. Smith of the National Marine Fisheries Service, Tiburon Lab, submitted a series of her photographs which were then examined by Thomas Fritts, U.S. Fish and Wildlife biologist incharge of various sea turtle projects.

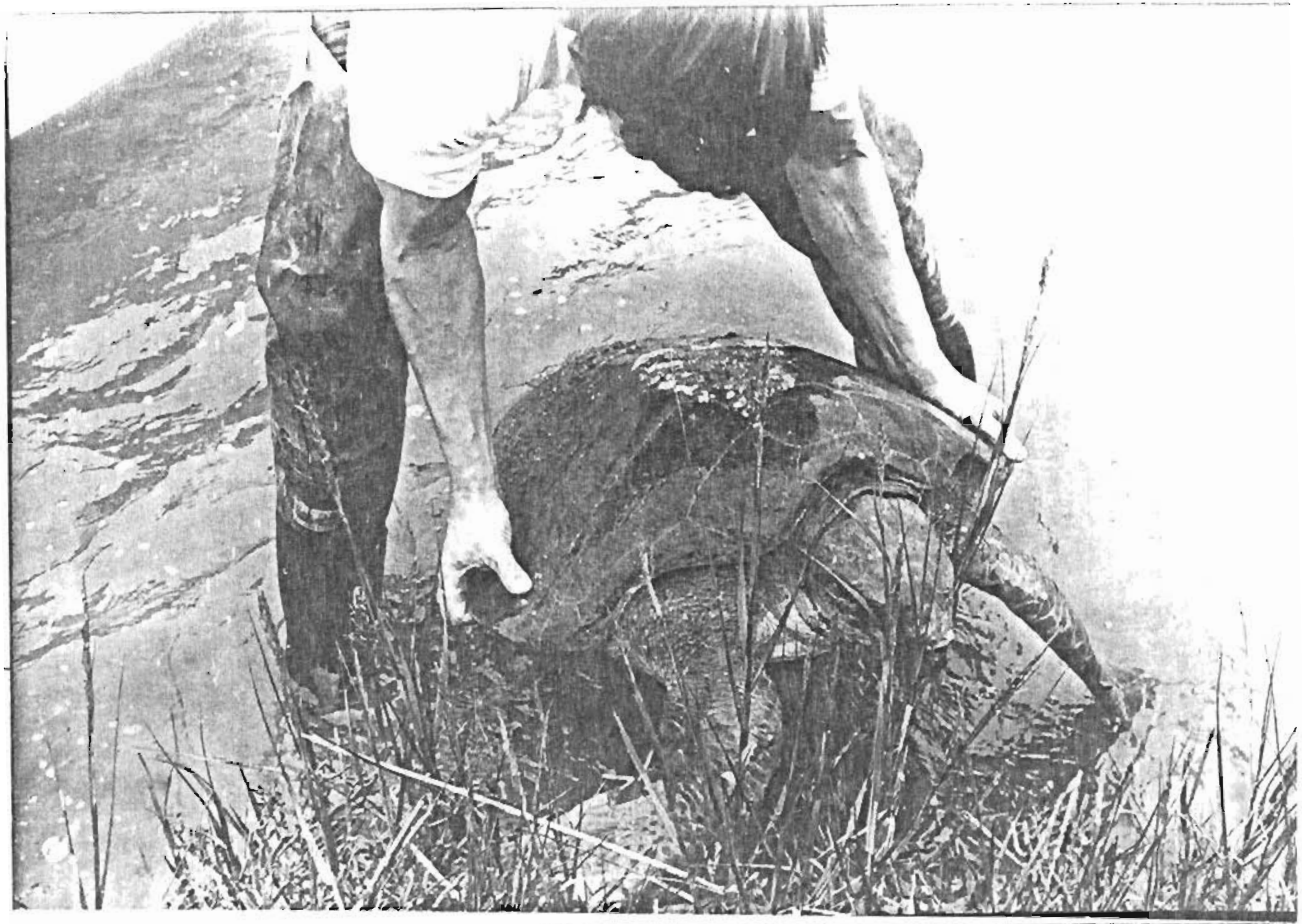


Figure 57. A Pacific ridley sea turtle brought ashore in an emaciated, lethargic condition from Strawberry Point Lagoon in San Francisco Bay (Sighting No. L9). Photograph by Susan Smith, NMFS Tiburon Lab.

Figure 58. A Pacific ridley sea turtle brought ashore from Strawberry Point Lagoon in San Francisco Bay (Sighting No. L9; Figures 57-61). The turtle's emaciated condition and the fact that its carapace was covered with mud and growth suggests that it had been burrowed in the lagoon's mud floor, possibly in response to cold spring temperatures. Photograph by Susan Smith, NMFS Tiburon Lab.

Figure 59. A Pacific ridley sea turtle brought ashore from Strawberry Point Lagoon in San Francisco Bay (Sighting No. L9; Figures 57-61). Carapace covered with mud from the lagoon's floor. Photograph by Susan Smith, NMFS Tiburon Lab.

Figure 60. Plastron view of a Pacific ridley sea turtle brought ashore from Strawberry Point Lagoon in San Francisco Bay (Sighting No. L9; Figures 57–61). Photograph by Susan Smith, NMFS Tiburon Lab.

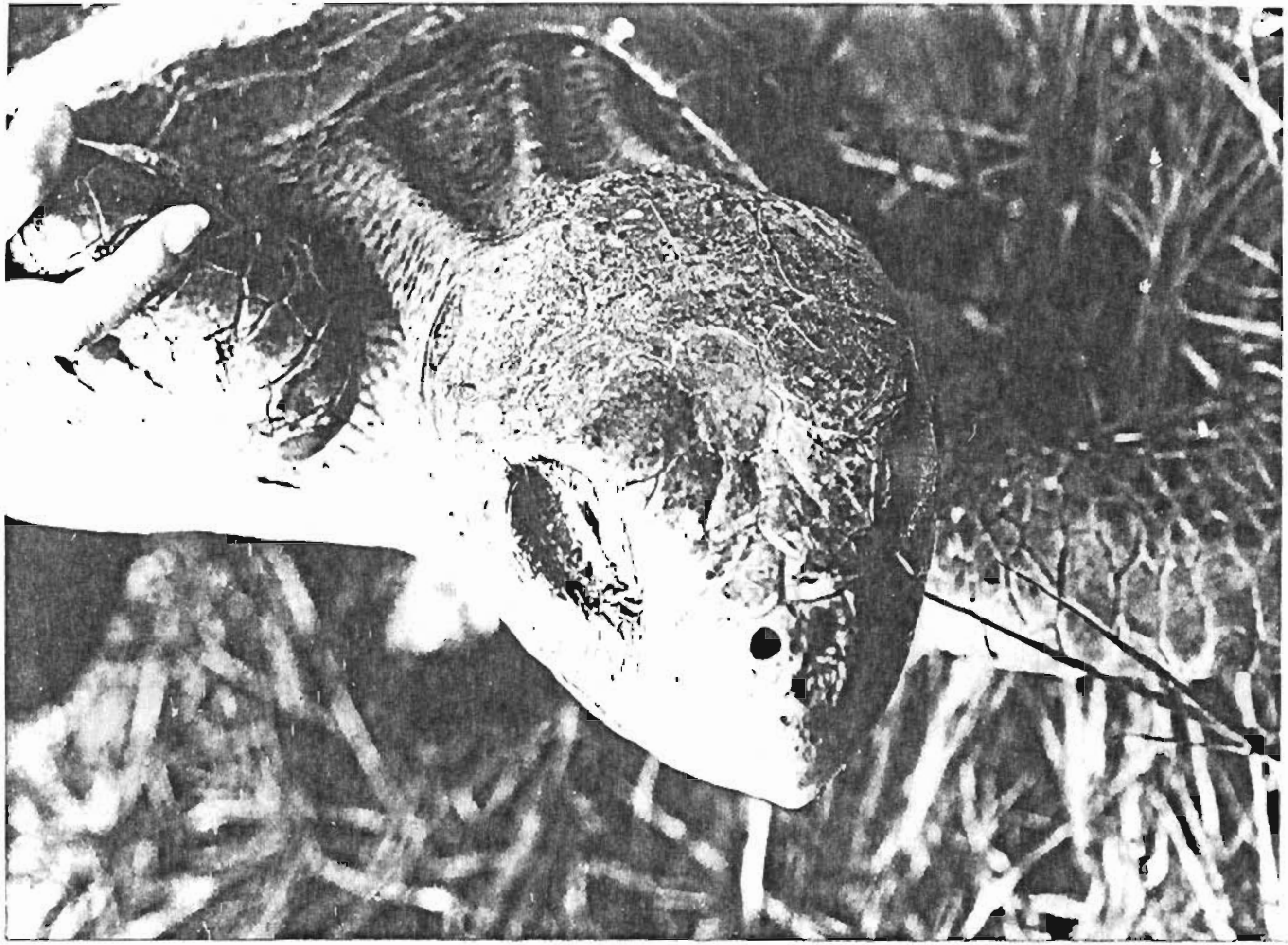


Figure 61. Head view of a Pacific ridley sea turtle brought ashore from Strawberry Point Lagoon in San Francisco Bay (Sighting No. L9; Figures 57-61). Photograph by Susan Smith, NMFS Tiburon Lab.

Sighting No. L10
<u>Lepidochelys olivacea</u>

21 October 1972 Sea Temp. Normal Month/Normal Year

32°36'18"N, 117°19'39"W [62 fms]
6 miles SW of Point Loma, San Diego, California

"Female ridley, collected by R.A. Johnson. Skeleton donated to the San Diego Museum of Natural History Herpetology collection" (Carl Hubbs notes).

Sighting No. L11 Pair of Turtles
<u>Lepidochelys olivacea</u>

29 August 1973 Sea Temp. Normal Month/Normal Year

32°50'57"N, 117°16'48"W [5 fms]
Scripps Institute of Ocenaography pier, La Jolla, California

Hubbs (1977) describes the first record of a pair of ridleys (or of any species of sea turtle) mating in Californian waters. But he does not discuss the significance of this northern mating and that sea turtles generally copulate off beaches used for nesting.

Sighting No. L12
<u>Lepidochelys olivacea</u>

16 September 1975 Sea Temp. Normal Month/Normal Year

44°20'45"N, 124°05'45"W [stranded]
2 miles N of Yachats, Waldport, Oregon

According to Mr. Darrel Demory (Oregon Department of Fish and Wildlife), this female ridley was lethargic when discovered on the beach. The turtle made little effort to move and refused fresh herring fish. The turtle was placed in a holding tank which contained circulating unheated sea water.

"The following morning no movement could be detected and the turtle was placed in the sun for warming. After an hour we decided that the turtle was dead and placed her in a freezer." The taxidermist removed a .22 bullet which had entered the animal through the top part of the right rear leg, passed through the juncture of the large and small intestine and had become lodged in the carapace. The wound was gangrenous. The digestive tract was not checked for contents and the stomach was empty. Weight 31.3 kg [69 lbs]; carapace length 61 cm; carapace width 56 cm. This female had 21 yolked eggs which measured 20-24 mm. The specimen is on display in Oregon's Department of Fish and Wildlife Newport Marine Lab (letters from Mr. Demory and notes from Dr. Carl Hubbs).

Sighting No. L13
Lepidochelys olivacea

29 August 1980 Sea Temp. Normal Month/Normal Year

30°35'00"N, 116°32'00"W [820 fms]
20 miles W of Isla San Martin, Baja California del Norte, Mexico

A sea turtle described as having a flattened, almost round light brown shell (carapace length 2½ ft [76 cm], width 2 ft [61 cm]; approximate weight 50 lbs [22.7 kg] was sighted by Captain Dennis and Candy Kruetel of the Polaris Deluxe (Fisherman's Landing, San Diego) while fishing a small school of skipjack tuna. Ocean temperature was 70°F (21°C), sighting made at 1750 hours.

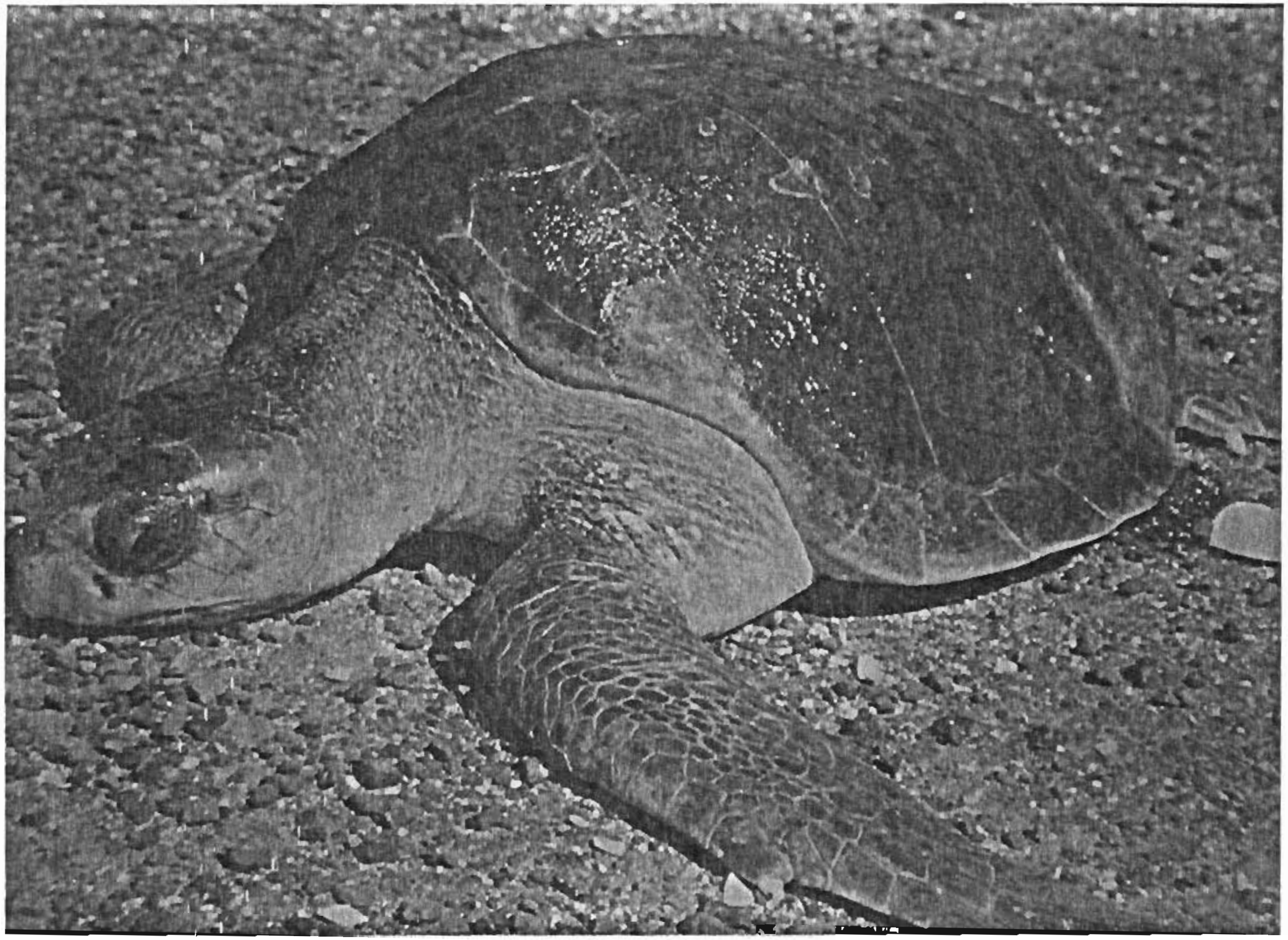


Figure 62. Pacific ridley sea turtle found alive, but in a lethargic condition 2 miles north of Yachats, Waldport, Oregon (Sighting No. L12). The turtle later died from a gangrenous bullet wound. Photograph provided by Darrel Demory, Oregon Department of Fish and Wildlife.

Sighting No. L14
Lepidochelys olivacea

16 December 1981 Sea Temp. Normal/Hot Year

41°03'N, estimated long. 124°20'W [? fms]
ocean near Trinidad, Humboldt County, California

Smith and Houck (1984) report that this female ridley was found "floating alive, but motionless, in the ocean near Trinidad, Humboldt County. Weighed 12.4 kg; total length 59.0 cm; carapace length 45.9 cm; maximum carapace width 45.1 cm; head length 11.1 cm; head width 8.6 cm; tail length 5.0 cm; length from cloaca to tip of tail 2.4 cm.

Sighting No. L15
Lepidochelys olivacea

16 March 1983 Sea Temp. Hot Month/Hot Year

30°41'45"N, 116°26'30"W [320 fms]
20 miles (296°) from Isla San Martin, Baja California del Norte, Mexico

Captain Ed McEwen aboard the *Pacific Queen* (Fisherman's Landing, San Diego) sighted a young ridley floating on the surface. Using a dip net the turtle was lifted aboard for photographs and measurements and then released at the same spot. Margie Stinson was aboard and examined the turtle. It appeared to be having bouyancy problems. When released it did not dive but floated with its posterior carapace raised. Bouyancy problems can be caused by temperatures being too low (Schwartz, 1978). But surface temperatures were 60-62°F (15.5-16.7°C) and are warm enough for this species to remain in healthy condition.

APPENDIX H

DESCRIPTION OF SIGHTINGS OF SEA TURTLES FOR WHICH THE SPECIES COULD NOT BE IDENTIFIED

Sighting No. U1
Unidentified Species

10 February 1872

32°40'30"N, 117°12'30"W [1859 map] [6 fms]
32°40'35"N, 117°13'20"W [1977 map]
near the head of San Diego Bay, San Diego, California

"Three turtles caught near the head of bay by Captain Handbury's surveying party; combined weight about 550 pounds [250 kg]; some years ago Captain Bogart turned loose about 200 in the bay and more recently several more were thrown overboard here; turtles were brought here from Baja California" (San Diego Herald. 1872 Feb. 10: 3 (col. 1)).

Sighting No. U2
Unidentified Species

March 1872

32°40'N, 117°08'W [1 fm]
San Diego Bay, San Diego, California

"Number in bay increasing; not rare to find one weighing 200 pounds; Chinese have found several lately; sold them to restaurants and hotels" (San Diego Herald. 1872 Mar. 23: 3 (col. 2)). These may have been Chelonia since Captain Bogart did release a number of greens into the bay in 1857.

Sighting No. U3
Unidentified Species

about 13 October 1872 [on Friday last]

32°39'N, 117°15'30"W [8 fms]
kelpbeds off Point Loma, San Diego, California

"A Big Turtle Captured in the Kelp. Captain Niles, while cruising around on Friday last, spied in the kelp a monster trying to disengage itself from the kelp in which it was tangled. He made sail for the spot with the intention of helping the sea tortoise out of the difficulty by taking it aboard the yacht. He found however, that he had no small job on hand, for the animal—it is as much flesh as fish—weighed about 600 pounds [272 kg]. After effecting the capture, the Captain made his way to Culverwell and Jorres' wharf with his prize, where he has moored it until the steamer Orizaba sails from San Francisco (San Diego Herald. 1872 Oct. 13: 3 (col. 2)).

Sighting No. U4
Unidentified Species

18 August 1884

32°40'N, 117°07'W [1859 map] [1 fm]
San Diego Bay, San Diego, California

"The largest turtle we have seen for a long time was shipped on the Orizaba last night. It was four feet [122 cm] in length and weighed over three hundred pounds [136 kg]. It was caught by Chinese fishermen" (San Diego Herald. 1884 Aug. 14: 3 (col. 1)).

Sighting No. U5
Unidentified Species

March 1888

32°40'N, 117°07'W [1 fm]
San Diego Bay, National City, California

"Turtles weighing 200 pounds [91 kg] had been caught from the first wharf [Railroad Wharf in National City] but the 70 pounder [32 kg] caught in March 1888 was thought to be the last of its kind. It meant good money for someone" (Phillips, 1960).

Sighting No. U6
Unidentified Species

July 1888

32°40'N, 117°06'W [1 fm]
San Diego Bay, San Diego, California

"News Notes from National and Coronado. Many turtles in the bay. Anglers report that many turtles are daily sighted from the wharf, but none have ever been killed or captured. The difficulty lies in the fact that the only way of catching these elusive reptiles is by shooting them, and the discharge of firearms from the wharf is prohibited" (San Diego Herald. 1888 July 12: 5 (col. 5)).

Sighting No. U7
Unidentified Species

8 January 1889

32°40'N, 117°14'W [5 fms]
San Diego, California

"A turtle weighing 500 pounds [227 kg] was exhibited on the Playa yesterday. The monster was caught by a fishing crew by means of a harpoon or gig. It attracted a great deal of attention yesterday and surprized many, when touched, by showing that it still had sufficient life to move" (San Diego Union and Daily Bee. 1889 Jan. 9: 8 (col. 1)).

Sighting No. U8
Unidentified Species

June 1890

32°40'N, 117°06'W [1859 map] [1 fm]
32°40'N, 117°07'W [1977 map]
San Diego Bay, National City, California

"National (City). Turtles of large dimensions are reported numerous around the wharves, and are quite annoying to anglers" (San Diego Union and Daily Bee. 1890 June 6: 6 (col. 2)).

Sighting No. U9
Unidentified Species

June 1890

32°46'25"N, 117°12'30"W [1859 map] [3 fms]
32°46'25"N, 117°13'30"W [1977 map]
False [Mission] Bay, San Diego, California

"A Profitable Business, Ninety-eight Delivered a Week in Catching Turtles in False Bay. At this time of year there are numerous sea turtles in False Bay, and during last week two men who make a business of catching the monsters were quite successful, clearing $98 for the week's work. The turtles delivered in the city are worth four cents per pound at the restaurants" (San Diego Union and Daily Bee. 1890 June 17: 1 (col. 6)).

Sighting No. U10
Unidentified Species

10 July 1890

32°46'30"N, 117°12'30"W [1859 map] [1 fm]
32°46'30"N, 117°13'30"W [1977 map]
False [Mission] Bay, San Diego, California

"Some very large turtles were brought from Mission Bay yesterday by the Chinamen. One weighed 250 pounds [113 kg] and was all two of them could carry swung by shoulder poles" (San Diego Union and Daily Bee. 1890 July 11: 8 (col. 4)).

Sighting No. U11
Unidentified Species

22 July 1892

32°49'N, 117°17'18"W [7 fms]
kelpbeds. La Jolla, California

"An Immense Turtle. P.M. Johnson, R.M. Mills and Anson Mills, while fishing off La Jolla Saturday, captured a large turtle in the kelp, weighing 150 pounds [68 kg]. They stole a march on it by catching it by the flippers and towed it to shore with a heavy shark line. For the past few days the residents of that locality have been reveling in turtle steaks and soups. This, in the memory of the oldest inhabitant, is the first of the kind caught in that vicinity" (San Diego Union and Daily Bee. 1892 July 27: 5 (col. 2)).

Sighting No. U12
Unidentified Species

23 May 1903

32°39'N, 117°07'W [1 fm]
San Diego Bay, San Diego, California

"Caught Fourteen Turtles. Peter Stanovitch, a fisherman, yesterday brought in fourteen large turtles which he had caught during the night, the largest one weighing 500 pounds [227 kg]. The turtles were captured in the shallow water of the mud flats where they breed at this time of the year" (San Diego Union and Daily Bee. 1903 May 24: 5 (col. 2)). We have no evidence that turtles ever nested or even copulated in San Diego Bay. While they might, on occasion, have copulated, sea turtles do not nest on mud substrate consequently it is extremely doubtful that they ever nested on San Diego's mud flats as this newspaper article implies.

Sighting No. U13
Unidentified Species

7 July 1905

31°46'30"N, 116°48'W
in vicinity of Todos Santos Island and Punta Banda, Baja California del Norte, Mexico

Recorded in Slevin's (1931) log of voyage to the Galapagos Islands as ... "sighted our first turtle this morning".

Sighting No. U14
Unidentified Species

9 December 1907

38°00'N, 122°25'W [? fms]
San Francisco Bay, California

See next entry (No. U15).

Sighting No. U15
Unidentified Species

11 January 1908

37°48'N, 122°16'W [estuary shallows]
East Oakland Harbor, San Francisco Bay, California

"THREE MEN BATTLE WITH BIG TURTLE. When Lassooed in Water it Starts on Journey, Towing His Excited Captors. Unusual Scene is Witnessed by Many Persons from an Oakland Wharf. OAKLAND, Jan. 11.— Three men in a boat with a giant turtle that had been lassooed, and which fought with all its great strength to free itself from its captors, were participants in a sensational struggle in the estuary near the Webster street bridge this afternoon. The battle was watched by many persons from the Franklin street wharf, who were at first at a loss to know what kind of a marine monster had been roped. When the turtle finally was exhausted and dragged up a gang-way by six men, a metal tag was discovered fastened with a chain to the left front flipper. The plate was stamped with Chinese characaters, and when translated gave a Chinese date corresponding to December 9, 1907. The monster weighed 400 pounds [181 kg].

The stranger was first observed by Jack Forest, a longshoreman, while it was swimming leisurely in the estuary and exploring Oakland Harbor. As the big turtle's back bobbed up and down in the water, Forest was at a loss to make out what the object was, and imagined at one time that it might be a submarine boat. He called Fred Kohler and Gus Olsen, two other longshoremen, who were in the vicinity of the Franklin street whart, to see the sight. The three decided to make a capture, and securing a boat and a rope, they pulled out into the channel.

When within range Forest swung his lasso as the turtle shoved its head above the surface. The noose settled fast about the creature's neck, and the next instant Forest was jerked off his feet to the bottom of the boat, almost capsizing the craft. Olsen and Kohler grabbed the line, and both clung to it while the turtle started his tow for East Oakland. The live tug pulled the boat for 50 yards, but tired as the rope choked it. Forest, Kohler and Olsen then rowed to the wharf, towing their catch.

Because of the fact that the turtle wore a metal tag bearing Chinese characters it is supposed that the animal may have escaped from Chinese fishermen on the San Francisco side of the bay.

Sighting No. U16
Unidentified Species

September 1942 Sea Temp. Normal Month/Normal Year

According to newspaper reports, specimens were sighted by fishermen off the Pacific coast from California to Vancouver Island during September, 1942 (Carl, 1944; 1947).

Sighting No. U17
Unidentified Species

March 1945 Sea Temp. Cold Month/Normal Year

32°45'30"N, 117°15'12"W [2 fms]
Mission Bay, San Diego, California

Dr. Robert Wisner (Scripps Institute of Oceanography) recalls seeing a "good sized turtle coming in with the tide under the Old Mission Bay Bridge. He estimated it to weigh between 150 and 200 pounds, it appeared to be about 2° feet [61 cm] wide and was longer than wide. An old fisherman, also seeing the turtle, was not too surprized to see it saying that he saw them 'every once in a while'."

Sighting No. U18 Several Sightings
Unidentified Species

September 1957 Sea Temp. Normal Month/Normal Year

37°40'-50'N, 122°55' - 123°10'W [? fms]
near the Farallon Islands, California

"Several other turtles were seen by albacore fishermen around the Farallon Islands, with no definite indication as to whether these were green turtles or loggerheads" (memo from Dr. Carl Hubbs, SIO, to Chuck Shaw, San Diego Zoo, dated 3 December 1957).

Sighting No. U19 Multiple Sightings
Unidentified Species

April and May 1958 Sea Temp. Hot Months/Hot Year

49°30'N, 126°40'W [27 fms]
near Nootka Sound, Vancouver Island, British Columbia, Canada

Reported in Radovich (1961).

Sighting No. U20
Unidentified Species

17 September 1962 Sea Temp. Normal Month/Cold Year

32°49'05"N, 117°16'24"W [2 fms]
La Jolla Cove, La Jolla, California

Several sea turtles were apparently taken at La Jolla in the fall of 1962, despite cool temperatures (Carl Hubbs' notes). The San Diego Union reported that "A sea turtle was speared off La Jolla...The turtle, a 31-pounder [14 kg], an infrequent visitor in these parts, was found swimming through the kelp at the Cove by Tony Sanchez, a National City skindiver. He shot it, lugged it ashore and treated his diving pals to turtle soup" (San Diego Union. 1962 Sept. 18: Outdoor Column by Rolla Williams). The Skindiver comments that "Both Mick Church and Tony Sanchez have added turtle to theri seafood menu, a la La Jolla Cove" (1962 Oct.& Nov.: 2 (col. 5)).

Sighting No. U21
Unidentified Species

June 1963 Sea Temp. Normal Month/Normal Year

32°47'47"N, 117°12'45"W [½ fm]
De Anza Cove, Mission Bay, San Diego, California

Mike Mills, a member of the San Diego Herpetological Society, reports seeing a sea turtle at the surface in De Anza Cove. He was able to get a good look at the turtle before it dove in the fairly warm water. It had an orangish carapace about 3 feet [91 cm] in length.

Sighting No. U22
Unidentified Species

September 1963 Sea Temp. Normal Month/Normal Year

32°12'30"N, 119°12'35"W [810 fms]
about 15 miles S of the Cortez Bank (S of San Clemente Island), California

Carl Hubbs' notes.

Sighting No. U23
Unidentified Species cf. *Chelonia mydas*

Summer 1969 Sea Temp. Normal Months/Normal Year

32°47'42"N, 117°12'48"W [1-2 fms]
Bahia Motel, Mission Bay, San Diego, California

Mr. Denny Schrader (Fisherman's Landing) watched a small dark olive-green colored turtle swimming on the surface of the bay before it came ashore on the beach at the Bahia Motel. He picked up the turtle, examined its flippers and plastron for any markings--it had none--and then released it back into the bay waters. Its carapace was about 14 inches [36 cm] in diameter, a little larger than the size of a dinner plate.

Sighting No. U24 9 Sightings
Unidentified Species

1975 - 1978

32°30' - 34°30'N, 118° - 120°30'W [? fms]
Southern California Bight area, Channel Islands, California

"Between 1975 and 1978, Bureau of Land Management Cetacean survey personnel incidentally reported nine sightings of sea turtles in the Southern California Bight area. During these surveys, the turtles were only briefly observed and pursuit for identification was impractical. Most of these BLM reports came from the vicinity of the Channel Islands and along underwater ridges and escarpments" (Guess, 1981). Robert Guess has maintained a log of these sightings but it has not been made available to this study.

Sighting No. U25
Unidentified Species

July or August 1975 Sea Temp. July Normal Month/Cold Year
August Cold Month/Cold Year
33°11'42"N, 117°26'30"W [20 fms]
2¼ miles off Los Flores, Camp Pendelton, just N of Oceanside, California

Joe Cacciola, Captain of the Matt Walsh (Ports O' Call

Sportfishing, San Pedro) reports that "the turtle was near the surface but dove quickly as we passed by. The turtle was good sized, perhaps a green sea turtle, but I could not be sure of an accurate identification. This was a late morning or early afternoon sighting."

Sighting No. U26
Unidentified Species

14 August 1976 Sea Temp. Normal Month/Normal Year

33°42'N, 118°18'W [stranded]
Cabrillo Beach, San Pedro, California

A freshly dead turtle washed in at Cabrillo Beach. Its approximate measurements were 125 pounds [57 kg]; length (not known if this refers to total or carapace length) 40 inches [101 cm]. The turtle was placed in a freezer and then stored at Marineland. Unfortunately, it was sent to a rendering plant and destroyed before photographs were taken and the species identified. According to a letter from Mr. John Heyning, Cabrillo Beach Marine Museum, there appears to be some argument as to whether it was a ridley (*Lepidochelys olivacea*) or green sea turtle (*Chelonia mydas*).

Sighting No. U27
Unidentified Species

July 1977 Sea Temp. Cold Month/Normal Year

48°04'N, 126°14'W [900 fms]
62 miles (280°) from Cape Flattery, Washington

Pat Rutten, National Marine Fisheries Service biologist aboard the NOAA vessel *Miller Freeman*, sighted a 2-3 ft [61-91 cm] green colored turtle near the water's surface. Pods of porpoise were also observed and albacore boats were working that area.

Sighting No. U28
Unidentified Species

30 June 1978 Sea Temp. Normal Month/Hot Year

32°46'14"N, 117°14'W [2 fms]
Mission Bay, San Diego, California

Bill Garska, herpetology graduate student at UCLA, saw a sea turtle beneath the Islandia Bridge in Mission Bay during the evening's incoming high tide.

Sighting No. U29
Unidentified Species

August 1978 Sea Temp. Normal Month/Hot Year

32°50' - 33°20'N, 118°20'W [400-600 fms]
between east end of Santa Catalina Island and the east end of San Clemente Island, Channel Islands, California

According to the _Cucamongan_'s log, Herb and Ida Buehler observed a small sea turtle on the surface.

Sighting No. U30
Unidentified Species

31 August 1978 Sea Temp. Normal Month/Hot Year

33°25'N, 118°17'W [461 fms]
out of Avalon, Santa Catalina Island, Channel Islands, California

Ida and Herb Buehler aboard the _Cucamongan_ (Newport Beach) record their sighting of a large sea turtle out of Avalon.

Sighting No. U31
Unidentified Species

13 September 1978 Sea Temp. Hot Month/Normal Year

48°23'N, 123°09'W [35 fms]
6 miles off San Juan Island, Washington

Commercial fisherman JohnReid, reports that the seiner Snow Cloud brought aboard a live turtle, predominately brown in color. While contacting the National Marine Fisheries Service, the crew released the turtle.

Sighting No. U32
Unidentified Species

May - June 1979 Sea Temp. May Cold Month; June Normal Month/Normal Year
33°08'03"N, 117°20'03"W [entrained]
SDG & E Co. Encina power facility, Carlsbad, California

A turtle, whose shell measured 48 in [122 cm] across and about 12 in [31 cm] in height, was removed from the bar racks at the San Diego Gas and Electric Company power generating facility at Agua Hedionda Lagoon, Carlsbad. The bar racks filter costal water which is drawn into the facility for cooling machinery. Many barnacles and green algae were found on the turtle's carapace. The animal was immediately released (pers. comm. with Elaine Carlin, Lockheed Corporation fisheries technician at the facility).

Sighting No. U33
Unidentified Species

6 June 1979 Sea Temp. Normal Month/Normal Year

33°28'15"N, 117°56'50"W [277 fms]
between Newport Beach and Lausen Knoll (14 mile bank), Channel Islands, California (193° from Newport Beach)

Commercial fisherman Bill Vas and David Maze of the Newport Beach Harbor Patrol, sighted a small sea turtle (less than 18 inches [46 cm] long) at 1050 hours.

Sighting No. U34
Unidentified Species

July 1979 Sea Temp. Normal Month/Normal Year

32°51'46"N, 118°24'55"W [2½ fms]
lee side of Mesquite Point, San Clemente Island, Channel Islands, California

Bob Fletcher, owner of the Cat Special (Fisherman's Landing, San Diego) reports seeing a 150-200 lb [68-91 kg] turtle. Ocean temperatures were 65-68°F (18-20°C) in the area at the time.

Sighting No. U35
Unidentified Species

21 July 1979 Sea Temp. Normal Month/Normal Year

32°44'15"N, 117°37'30"W [570 fms]
21 miles W of Point Loma, San Diego, California

..."He estimated that the turtle weighed at least 50 to 60 pounds [23-27 kg] and was 2½ feet [76 cm] in length (letter from Mary MacKenson, describing a report from her son-in-law).

Sighting No. U36
Unidentified Species

19 August 1979 Sea Temp. Normal Month/Normal Year

33°08'03"N, 117°20'03"W [entrained]
SDG & E Encina power facility, Carlsbad, California

A live turtle, estimated to weigh 50 pounds [23 kg] with a shell 14-18 inches [36-46 cm] wide, was removed from the bar racks at the San Diego Gas and Electric Company power facility at the Agua

Hedionda Lagoon, Carlsbad. A metal identification tag was found attached to each foreflipper. The employee examining the turtle has not been able to find his notes recording the tag numbers (pers. comm. with Elaine Carlin, Lockheed Corp. fisheries technician at the facility).

Sighting No. U37
Unidentified Species

September/October 1979 Sea Temp. Normal Months/Normal Year

33°08'23"N, 117°20'18"W [1 fm]
Agua Hedionda Lagoon, Carlsbad, California

While fishing with rod and reel, from the south side of the jetty on the south shore of Agua Hedionda Lagoon, John Bunting (of Oceanside) hooked a turtle too large to land and his line snapped releasing the turtle. The general consensus among those fishing in Agua Hedionda is that a turtle is frequently seen along the south jetty where the warm effluent is released from the San Diego Gas and Electric Company's power generating facility (pers. comm. with John Bunting).

Sighting No. U38
Unidentified Species

1 October 1979 Sea Temp. Normal Month/Normal Year

33°08'03"N, 117°20'03"W [entrained]
SDG & E Company Encina power facility, Carlsbad, California

A small turtle, estimated to weigh about 30 pounds [14 kg] was removed from the bar racks at the San Diego Gas and Electric Company power facility at Agua Hedionda Lagoon, Carlsbad. It was released immediately into the surf off the facility (pers. comm. with

Elaine Carlin, Lockheed Corporation fisheries technician at the facility).

Mr. Dave Rogers, maintenance supervisor for the facility, explained that turles are usually seen during the fall months and then typically at night. Turtles are seen offshore the facility during winter months (Elaine Carlin). Mr. William Hubbard, of the San Diego Sheriff's Astrea Search and Rescue Helicopter Squad, reports that on several occasions during summer months (when water clarity was exceptionally clear) he saw turtles (generally 1-3 individuals at a time) about one half to one mile offshore the power facility.

Sighting No. U39 2 Turtles
Unidentified Species

25 February 1980 Sea Temp. Normal Month/Normal Year

34°43'N, 121°00'W [250 fms]
20 nautical miles W of Point Arguello, California

Listed in Dohl (1980).

Sighting No. U40
Unidentified Species

9 May 1980 Sea Temp. Normal Month/Normal Year

33°20'33"N, 117°19'09"W [stranded]
Lover's Cove, Santa Catalina Island, Channel Islands, California

George Hart, operator of the Catalina Island glassbottom boat, reports finding a dead sea turtle in Lover's Cove, just south of Avalon.

Sighting No. U41
Unidentified Species

10 May 1980 Sea Temp. Normal Month/Normal Year

captured 33°08'30"N, 117°23'W [60 fms]
Carlsbad Canyon, offshore of Carlsbad, California

released 33°01'N, 117°17'W [surf]
Cardiff-by-the-Sea, California

Commercial fisherman Joel Hughes (Oceanside) caught a live sea turtle in his rock cod gillnet. He took it home for dinner, but a friend objected so strongly that they released it that evening into the surf at Cardiff-by-the-Sea. After the incident Joel began having an interest in sea turtles earning him the nick-name "Turtle Boy".

Sighting No. U42 3 Turtles
Unidentified Species

13 May 1980 Sea Temp. Normal Month/Normal Year

32°31'30"N, 118°15'45"W [423 fms]
15 miles (195°) from the east end of Long Beach breakwater, Los Angeles Harbor, Long Beach, California

Commercial fisherman Mike Frame reports seeing a group of three small hardshell sea turtles eating jellyfish on the water's surface. The turtles were all less than 30" [76 cm] long.

Sighting No. U43
Unidentified Species

26 May 1980 Sea Temp. Normal Month/Normal Year

33°29'15"N, 118°02'30"W [270 fms]
10 miles (220°) from Newport Beach, California

Small hardshelled sea turtle observed by commercial fisherman Gary Schniepp (vessel Jo Ann, Newport Beach).

Sighting No. U44
Unidentified Species

2nd Week June 1980 Sea Temp. Cold Month/Normal Year

32°59'N, 117°16'30"W [stranded]
beach at north end of Del Mar race track between Via de la Valle, Del Mar and Seaside in Solana Beach, California

The Ed Bentz family, members of the San Diego Turtle and Tortoise Society, report seeing "a hatchling sea turtle tumbling about in the tide. They walked it out to where the water was calm and then released it. The hatchling had flippers, a long tail, dark green-pink belly and a dark green back. It was less than 2 inches [5 cm] across."

Sighting No. U45 3 Hardshelled Turtles cf. Caretta
Unidentified Species

July 1980 Sea Temp. Cold Month/Normal Year

33°09'N, 117°22'45"W [25 fms]
3/4 mile off the SDG & E Co. Encina power facility and the military academy, Carlsbad, California

While pulling his halibut gillnet set in 25 fathoms, off the San Diego Gas and Electric Comapny's bouys, commercial fisherman Dan West observed three very large sea turtles ("not leatherbacks") eating a brown and white striped jellyfish. Upon pulling the net he discovered that almost all of his catch of bonito (Sarda chilensis) was destroyed. There was a single triangular piece missing from the gut area of each of the 15 or 20 bonito fish. Mr. West is accoustomed to harassment by various types of sharks and the California sea lion but these predators do not have a triangular shaped bite. The bites removed a four inch [10 cm] section of the stomach area of each fish. The muscle and fillet area of the fish were not affected but still the fish could not be marketed. Mr. West was not angry because this was the first time he had encountered this type of mutilation and he did get to watch the turtles feeding on the surface jellyfish. This indicates that these turtles are capable of diving to 25 fathoms [150 feet] where the net was set. Ocean temperature 61°F (16°C).

Sighting No. U46
Unidentified Species cf. Caretta

3 July 1980 Sea Temp. Cold Month/Normal Year

33°28'24"N, 117°53'06"W [316 fms]
7 miles (170°) from Newport Beach, California

Commercial fisherman Bill Vas (Newport Beach) observed a reddish turtle (carapace length less than 3 ft; 91 cm). The turtle was not swimming in any apparent direction. Mr. Vas did not notice any barnacles or algae growing on the turtle's shell. Observed at 1155 hours. The ocean had been 69°F (20.5°C) for a week.

Sighting No. U47
Unidentified Species cf. *Chelonia mydas*

15 July 1980 Sea Temp. Cold Month/Normal Year

31°44'07"N, 117°17'30"W [600 fms]
above the 295 bank, 55 miles (170°) from San Diego, California

John Stratton, deckhand on the sportfisher *Fortune* (Fisherman's Landing, San Diego) observed a greenish turtle swimming on the water's surface. He estimates the turtle to have weighed at least 200 pounds [91 kg] and to have a carapace 3½ feet [107 cm] in length and 3 feet [91 cm] in width.

Sighting No. U48
Unidentified Species

July or August 1980 — Sea Temp. Coos Bay: July Cold, August Normal/Normal Year; Neah Bay: July and August Normal Months/Normal Year

45°33'40"N, ? longitude
in the tuna fishing grounds off Garibaldi, Oregon

A fisherman reports seeing a large sea turtle on the tuna grounds west of Garibaldi. He called Mr. Dale Snow (Oregon Department of Fish and Wildlife) to ask if it was legal to catch the beast. Over the years tuna fishermen have told Mr. Snow of various instances of seeing turtles off the Oregon coast. Unfortunately, these records were not kept.

Dr. Raymond Gilmore of the San Diego Museum of Natural History records the following ..."Turtles—off the Columbia River, Oregon. Bud Newton said that he had seen turtles in the ocean off the Columbia River while he was catching albacore in the warm water. The North Pacific Drift or Japanese Current must be very warm in some years off Oregon."

Sighting No. U49
Unidentified Species cf. _Dermochelys coriacea_

1 September 1980 — Sea Temp. Normal Month/Normal Year

33°22'22"N, 117°52'30"W [341 fms]approximately 10 miles SW of Dana Point Harbor, California

Larry Litivinoff, aboard the _Lundy Tours_ (Newport Beach, Balboa Angling Club), reports seeing briefly a green/brown turtle floating in the water with its front flippers slowly moving. He describes the turtle's shell as being approximately 4½ feet [137 cm] and 2 feet [61 cm] wide. The shell was ridged and he suggested that it might be a leatherback. [Typically leatherbacks are black with white or yellow speckles but they conceivably could appear green/brown if they have a light layer of algae on the shell or if the water is dirty (see Dermochelys Sighting No. D96). The ocean was calm, blue/green and no other sea life was observed in the vicinity (1330 hours sighting). This is Mr. Litivinoff's first sighting of a turtle in these seas in six years.

Sighting No. U50
Unidentified Species

6 September 1980 Sea Temp. Normal Month/Normal Year

33°23'10"N, 118°01'W [300+ fms]
Lausen Knoll, near the 14 mile bank (195°) from Newport Beach, San Pedro Channel, Channel Islands, California

Bill Hastings, aboard the Belle Isle (Newport Beach), observed a small yellow brown turtle feeding on a floating kelp paddy. He estimates the turtle as having a shell approximately 24 inches [61 cm] in length, 10 inches [25 cm] in width and its body weight as 25 pounds [11 kg]. The turtle had at least seven "limpet" shells [probably barnacles] on its carapace. Ocean temperature 66°F (18.9°C); 1300 hours.

Sighting No. U51
Unidentified Species

10 September 1980 Sea Temp. Normal Month/Normal Year

33°35'50"N, 117°54'W [1-4 fms]
underneath the Balboa pier, Newport Beach, California

Mr. Bud Racker, owner of Baldy's Tackle store on the Balboa peninsula of Newport Beach, reports that a boy hooked a turtle off the Balboa pier. The turtle snapped the line and escaped. Water temperature 67°F (19.4°C).

Sighting No. U52
Unidentified Species cf. Lepidochelys olivacea

14 September 1980 Sea Temp. Normal Month/Normal Year

33°34'45"N, 117°59'30"W [26 fms]
3½ miles off the Santa Ana River jetty, Newport Beach, California

Commercial fisherman Bill Vas observed a light green, white and brown colored sea turtle at 1000 hours. He estimated its shell to have been about 2½ feet [76 cm] in width.

Sighting No. U53
Unidentified Species

19 October 1980 Sea Temp. Normal Month/Normal Year

33°44'44"N, 118°06'45"W [1 fm]
jetty at mouth of the San Gabriel River, Seal Beach, California

While fishing from the Seal Beach jetty at the mouth of the San Gabriel River, Michelle and Gary Shannon saw a sea turtle approximately 30-40 inches [76-102 cm] in length. "Last year at approximately the same time (October) a turtle was spotted in this same area. Both were about the same size. Both observations were during the early morning high tide. The temperature of the river is usually warmer than the outer water because of the large power generating facilities upriver. In both instances, the sea turtles were cruising along the surface with their heads elevated."

Sighting No. U54
Unidentified Species

21 February 1981 Sea Temp. Normal Month/Hot Year

32°39'00"N, 117°15'15"W [10 fms]
off the kelpbeds and green tank, Point Loma, San Diego, California

Ross Talner aboard the sportfisher Coral Sea (Point Loma Sportfishing Assoc., San Diego) observed a turtle swimming on the surface about 50 feet from the boat at 1030 hours. He estimates that the turtle weighed 25 pounds [11 kg] and that its shell was approximately 28 inches [71 cm] long and 18 inches [46 cm] wide. The turtle was not captured. Ocean temperature 59°F (15°C).

Sighting No. U55
Unidentified Species

15 March 1981 Sea Temp. Normal Month/Hot Year

32°39'27"N, 117°21'48"W [119 fms]
7 miles (260°) off Point Loma, San Diego, California

Don Latham, editor of the San Diguieto Citizen, reported seeing a very small dark brown sea turtle travelling north in 58°F (14.4°C) water. Because the turtle had a vertebral ridge he tentatively identified the tuıtle as a loggerhead (Caretta), but there is some question because small ridleys (Lepidochelys) also have this ridge.

Sighting No. U56 2 Turtles Together
Unidentified Species

17 July 1981 Sea Temp. Cold Month/Hot Year

45°37'N, 123°59'W [15-20 fms]
off Rockaway Beach, between Twin Rocks (N of Tillamook Bay) and the Nehalem River, Oregon

Larry Hoffmiller, a commercial fisherman aboard the Molly Jo (Garibaldi, Oregon), informed Dale Snow (Oregon Department of Fish and Wildlife) that while trolling for salmon he spotted two small dark green turtles. They were about 18 inches [46 cm] in total length. There were thousands of wind sailor jellyfish (Velella) on the water's surface and many porpoise and some whales were in the area. Water temperatures were in the mid-40's to 52°F (7-11°C).

Sighting No. U57
Unidentified Species

1 August 1981 Sea Temp. Normal Month/Hot Year

32°05'N, 118°14'W [53 fms]
60 mile bank (220°) from San Diego, California

Garry Black, skipper of the Conquest (Fisherman's Landing, San Diego) reports seeing a 2½ ft [76 cm] turtle in a kelp paddy. The turtle was dark brown--the same color as the kelp. Mr. Black thought the turtle was a green sea turtle. Kelp paddies are typically copper-rust in color and if the turtle was the same color as the kelp this would suggest a loggerhead (Caretta). The turtle dove as the vessel approached for a second time for photographs. Ocean temperature 69°F (20.6°C).

Sighting No. U58
Unidentified Species

2 August 1981 Sea Temp. Normal Month/Hot Year

32°38'35"N, 117°16'58"W [38 fms]
3 miles off Point Loma (240°), San Diego, California

Dean Adams, skipped of the sportfisher Cortez (Fisherman's Landing, San Diego) observed a small sea turtle (carapace length

2 feet or 61 cm) in an area popular for fishing Pacific bonito (*Sarda chilensis*). The turtle's shell was covered almost entirely with "moss" (algae). The surface ocean temperature was 72°F (22°C); afternoon sighting.

Sighting No. U59
Unidentified Species

mid-August 1981 Sea Temp. Normal Month/Hot Year

31°44'07"N, 117°1'30"W [295 fms]
on the 295 fathom bank, 55 miles (170°) from San Diego, California

Garry Black, skipper of the sportfisher *Conquest* (Fisherman's Landing, San Diego) observed a small sea turtle--the size of a serving plate.

Sighting No. U60
Unidentified Species

14 September 1981 Sea Temp. Normal Month/Hot Year

32°26'15"N, 117°12'45"W [18 fms]
2 miles NE of South Coronado Island, Baja California del Norte, Mexico

Buz Brizzendine, skipper of the sportfisher *Prowler* (Fisherman's Landing, San Diego) sighted a small sea turtle having a 2 ft [61 cm] shell. Surface ocean temperatures were in the mid-60's (18°C).

Sighting No. U61
Unidentified Species

15 September 1981 Sea Temp. Normal Month/Hot Year

47°49'09"N, 125°12'02"W [225 fms]40 miles (187°) from Cape Flattery, Washington

Sarah Hinckley, National Marine Fisheries Service biologist aboard the Cobb, sighted a turtle first from a distance of 200 feet [61 m] astern. The Cobb was stationary in the water or moving slightly forward setting a string of sablefish traps. Almost 15 minutes after the first sighting, the turtle surfaced about 50 feet [15 m] off the port beam. It remained at the surface for about 20-25 seconds. Its back was visible and its head was lifted above the water. The shell appeared to be about 4 feet long [122 cm]. No other distinctive physical characteristics or behaviors were observed. The animal submerged and did not reappear. The water temperature was 60-65°F (15.5-18°C) at the surface and was approximately 5-7°C warmer than is normal for this area at this time of the year. This was consistently true in the area the Cobb was working (40-60 miles off the Washington coast).

Sighting No. U62
Unidentified Species

22 September 1981 Sea Temp. Normal Month/Hot Year

46°00'N, 123°58'30"W [10 fms]
2 miles W of Seaside, Oregon

Sarah Hinckley, NMFS, reports that a biologist (from the Washington Department of Fish and Game) working aboard the salmon troller Beloit II sighted a hardshelled sea turtle (estimated length 4 ft; 122 cm).

Sighting No. U63
Unidentified Species

24 October 1981 Sea Temp. Normal Month/Normal Year

37°43'10"N, 122°55'10"W [30 fms]
3.9 miles (56°) from Southeast Farallon Island, California

During a Sierra Club trip returning from the Farallon Islands, a sea turtle was sighted. According to Yvonne McHugh (Berkeley) its length was approximately 3 feet [91 cm] and its head looked to be that of a green sea turtle. Jellyfish of different types were abundant on the surface. Some of the jellyfish were yellow, others were puce or green; some had beautiful pigment designs and hundreds of the coelenterates were about 12" [30.5 cm] in diameter. A great white shark, one subfish and a number of whales were seen during the day. Kelp paddies were in the area of the turtle sighting; 1530-1600 observation.

Sighting No. U64
Unidentified Species

early November 1981 Sea Temp. Normal Month/Normal Year

33°40'N, 118°30'W [450 fms]
10 miles off Point Fermin, Los Angeles, California

Bob Bose, aboard the commercial albacore jigboat Ataloa (San Diego), sighted a small sea turtle 10 miles off Point Fermin.

Sighting No. U65 3 Turtles
Unidentified Species

every day 9 - 13 August 1982 Sea Temp. Hot Month/Hot Year

33°27'39"N, 118°05'54"W [1½ fms]
2 miles up the San Gabriel River (at Westminster Blvd), Seal Beach, California

Terry Howe (Whittier) reports seeing three turtles approximately 2 miles up the San Gabriel River at Westminster Blvd where two power generating facilities discharge warm water into the river. Two of the turtles had carapaces 2½-3 feet [76-91 cm] in length and the third turtle was smaller having a shell approximately 12 inches [31 cm] in diameter. All were dark brown. Turtles were seen every day in the area between August 9th and 13th.

Sighting No. U66
Unidentified Species

6 November 1982 Sea Temp. Normal Month/Normal Year

31°11'00"N, 117°05'30"W [500 fms]
90 miles (175°) from Point Loma, San Diego, California (208° from Punta Banda, Baja California del Norte, Mexico)

Garry Black, skipper of the sportfisher Conquest (Fisherman's Landing, San Diego) spotted a small sea turtle in a kelp paddy.

Sighting No. U67
Unidentified Species

12 December 1982 Sea Temp. Hot Month/Hot Year

33°27'31"N, 118°06'20"W [1-2 fms]inland from the Pacific Coast highway bridge, in the San Gabriel River, Seal Beach, California

Norm and Matthew Vas (Newport Beach) sighted a turtle in the San Gabriel River just inland of the Pacific Coast highway bridge. Its head was the size of a softball.

Sighting No. U68
Unidentified Species

11 January 1983 Sea Temp. Hot Month/Hot Year

32°52'52"N, 118°25'05"W [1-8 fms]
between White Rock and Purse Seiner Point, San Clemente Island, Channel Islands, California

Peter Haaker, of the California State Fisheries Laboratory in Long Beach, momentarily observed a sea turtle between White Rock and Purse Seiner Point. He could not see it long enough to describe it.

Sighting No. U69
Unidentified Species

19 February 1983 Sea Temp. Hot Month/Hot Year

30°08'40"N, 116°01'30"W [59-72 fms]
10 miles S of Bahia San Quintin, Baja California del Norte, Mexico
13 miles offshore

A small hard-shelled sea turtle was observed by Captain Steve Loomis of the Royal Polaris (Fisherman's Landing, San Diego). Its species was not identified.

Sighting No. U70
Unidentified Species

5 March 1983 Sea Temp. Hot Month/Hot Year

31°27'40"N, 116°48'30"W [258 fms]
10 miles (270°) off Punta San Jose, Baja California del Norte, Mexico

A small hard-shelled sea turtle (species unknown) was observed on the surface by Captain Ed McEwen of the Pacific Queen (Fisherman's Landing, San Diego).

Sighting No. U71
Unidentified Species

4 June 1983 Sea Temp. Hot Month/Hot Year

32°34'48"N, 117°14'36"W [25 fms]
5 miles (180°) S of Point Loma, North of Coronado Islands, California; 5 miles offshore

This turtle was observed actively swimming NW on the surface. Its shell was estimated to be 2-2½ feet [61-76 cm] in diameter, beige-brown in color with barnacles. Observed by Craig

Shugert (El Cajon).

Sighting No. U72
Unidentified Species

29 June 1983 Sea Temp. Hot Month/Hot Year

32°00'N, 117°13'30"W [610 fms]
40 miles (180°) S of San Diego, California;
28½ miles (301°) from Cabo Punta Banda, Baja California del Norte, Mexico

A small red-yellow turtle was observed by Captain Nick Cates of the Fish 'n Fool (Fisherman's Landing, San Diego) in 62°F (16.67°C) water.

Sighting No. U73
Unidentified Sighting cf. Chelonia mydas

4 October 1983 Sea Temp. Hot Month/Hot Year

32°51'18"N, 117°18'18"W [26 fms]
kelpbeds off Point La Jolla, La Jolla, California

Tom Taylor (Escondido, California) observed a large turtle at the surface in a kelpbed. The turtle's shell was about the size of a man's encircled arms and was black with tinges of green. This probably was a green sea turtle (Chelonia mydas).

Sighting No. U74
Unidentified Species

6 November 1983 Sea Temp. Hot Month/Hot Year

32°26'36"N, 117°22'48"W [606 fms]
4 miles (270°) W of North Coronado Island, Baja California del Norte, Mexico

Tim Barnett of the Scripps Institute of Oceanography reports a "small brown turtle was seen by two boats about 4 miles west of North Coronado Island on 6 November 1983".

Sighting No. U75
Unidentified Species

9 November 1983 Sea Temp. Hot Month/Hot Year

32°49'14"N, 118°20'45"W [$2\frac{1}{2}$ fms]
reef off Pyramid Head, San Clemente Island, Channel Islands, California

Terry Garrett aboard the Sand Dollar dive boat (Point Loma Sportfishing, Assoc., San Diego) reports that this turtle "seemed to be travelling on a southward course. The shell was approximately $2\frac{1}{2}$ feet [76 cm] in length, $1\frac{1}{2}$ feet [46 cm] in width, mottled brown and green. It appeared that a few barnacles had broken off the shell. There was an upwelling of cooler water that day."

APPENDIX I

APPENDIX J

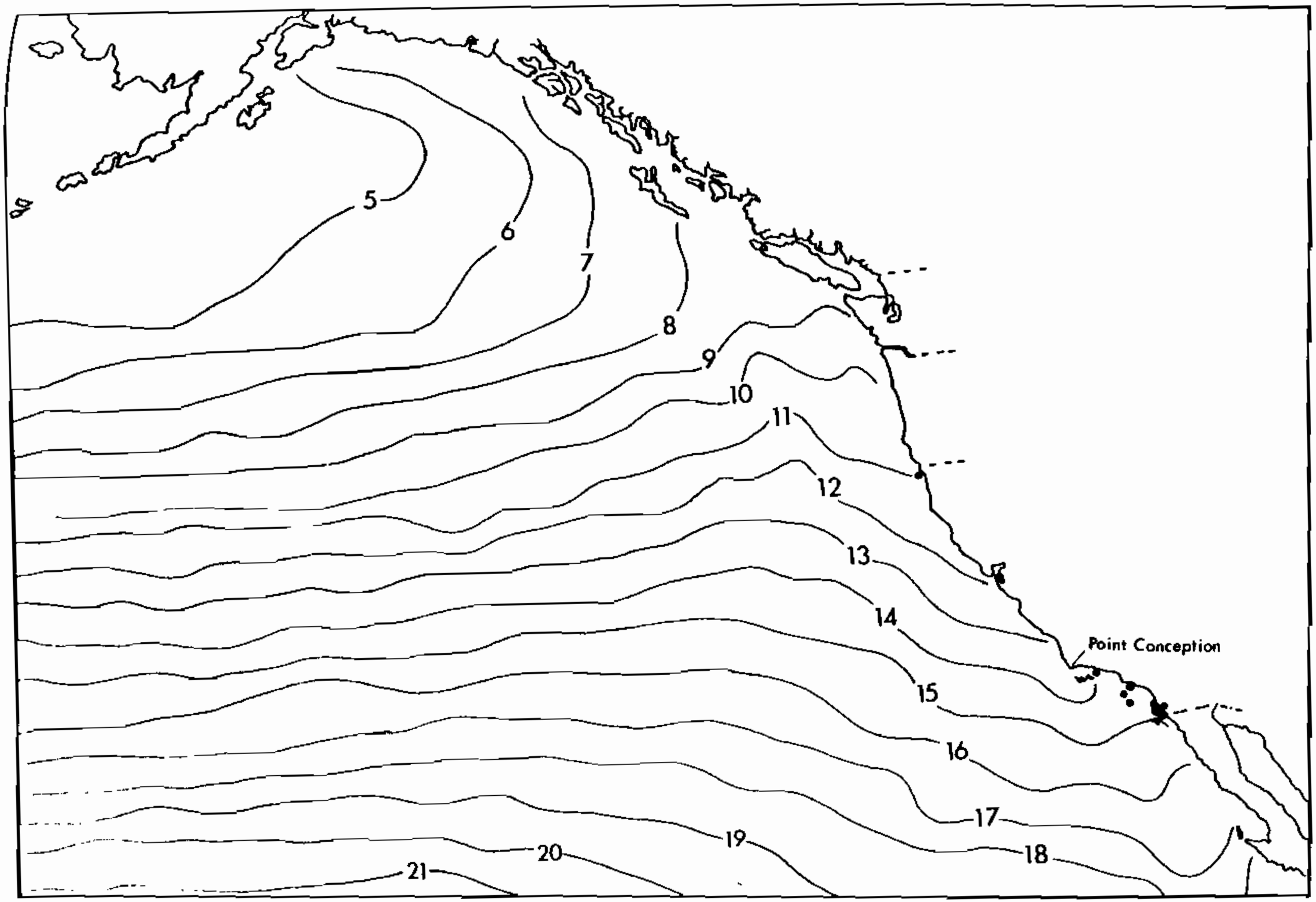


Figure 67. January distribution of sea turtle sightings in the northeastern Pacific as related to the position of surface isotherms.

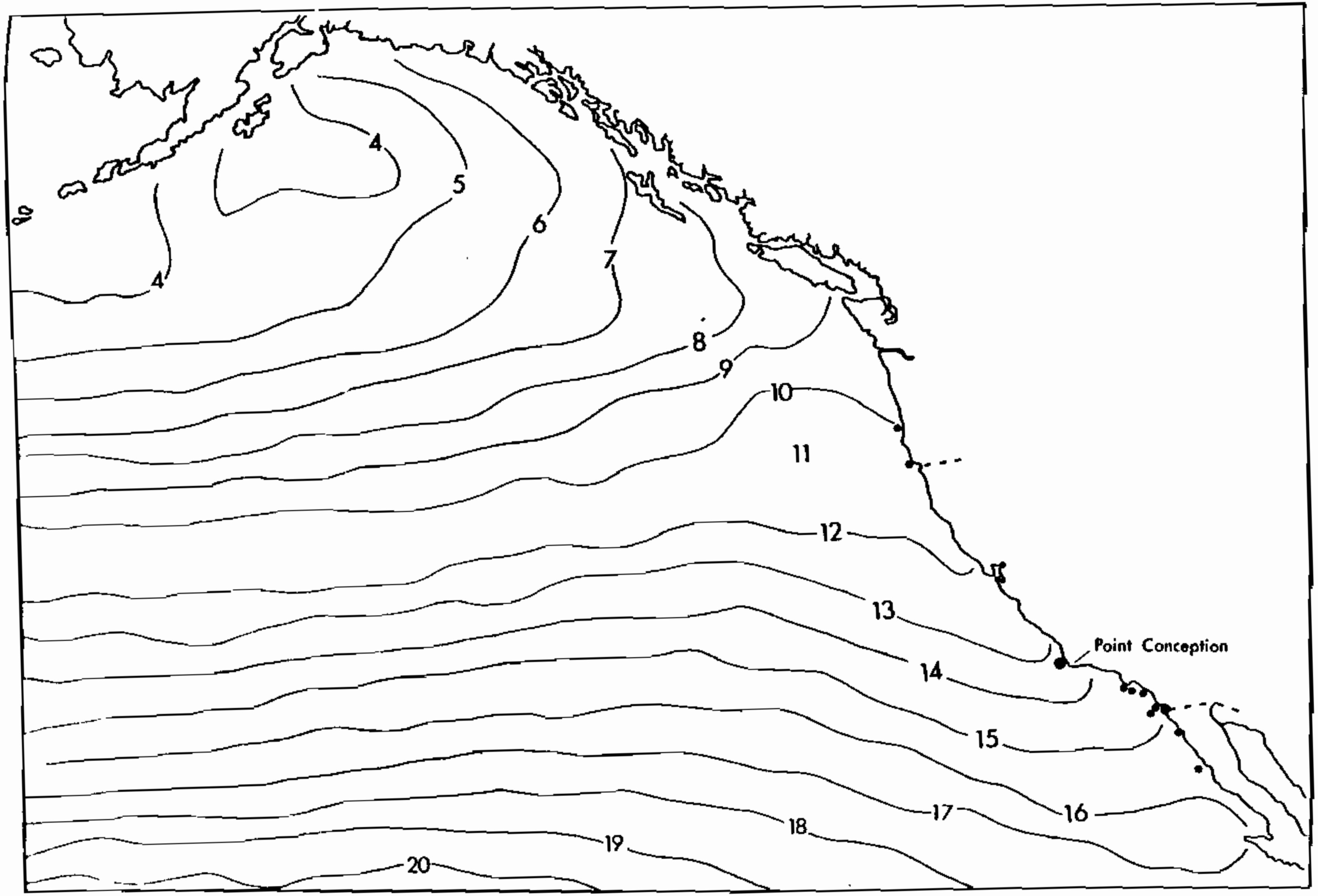


Figure 68. February distribution of sea turtle sightings in the northeastern Pacific as related to the position of surface isotherms.

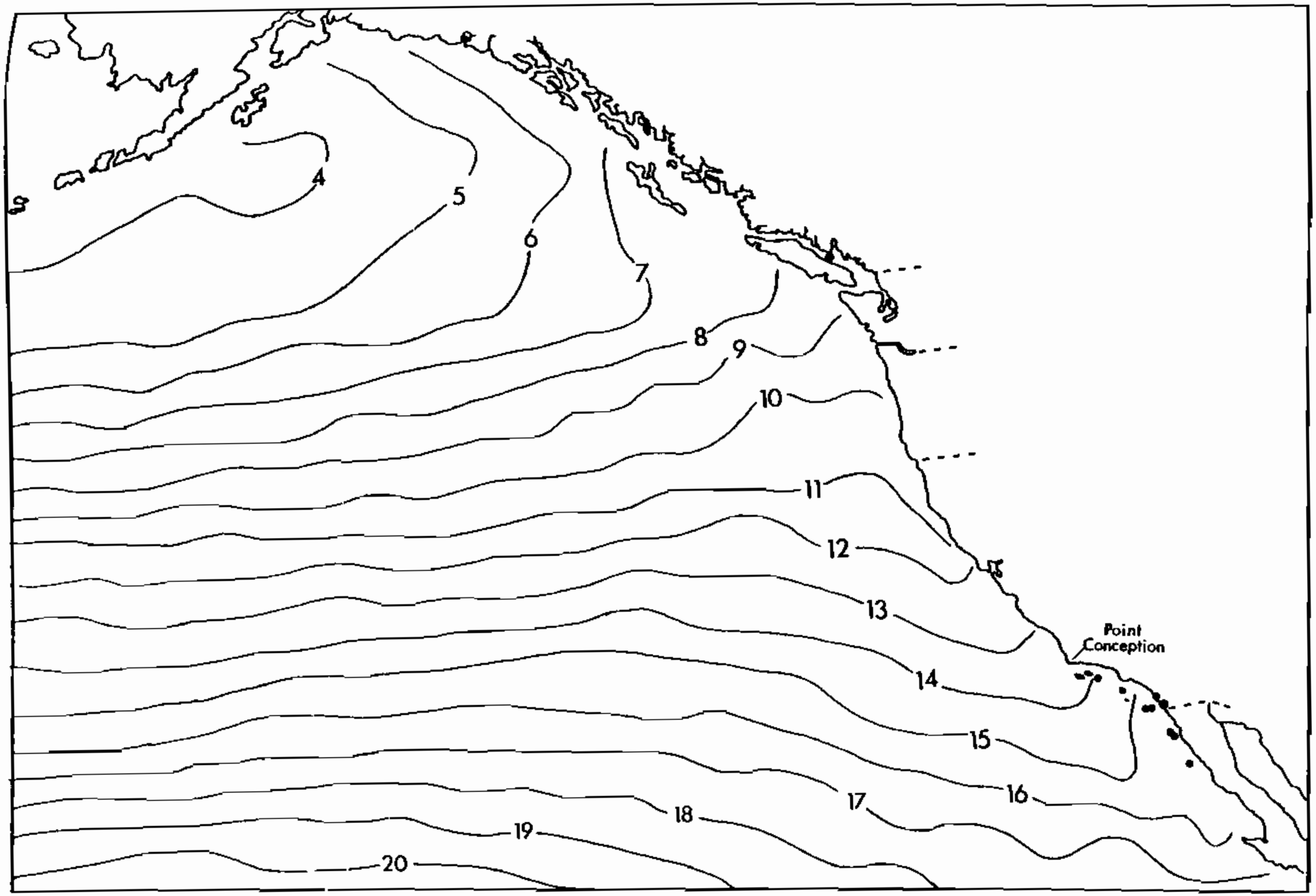


Figure 69. March distribution of sea turtle sightings in the northeastern Pacific as related to the position of surface isotherms.

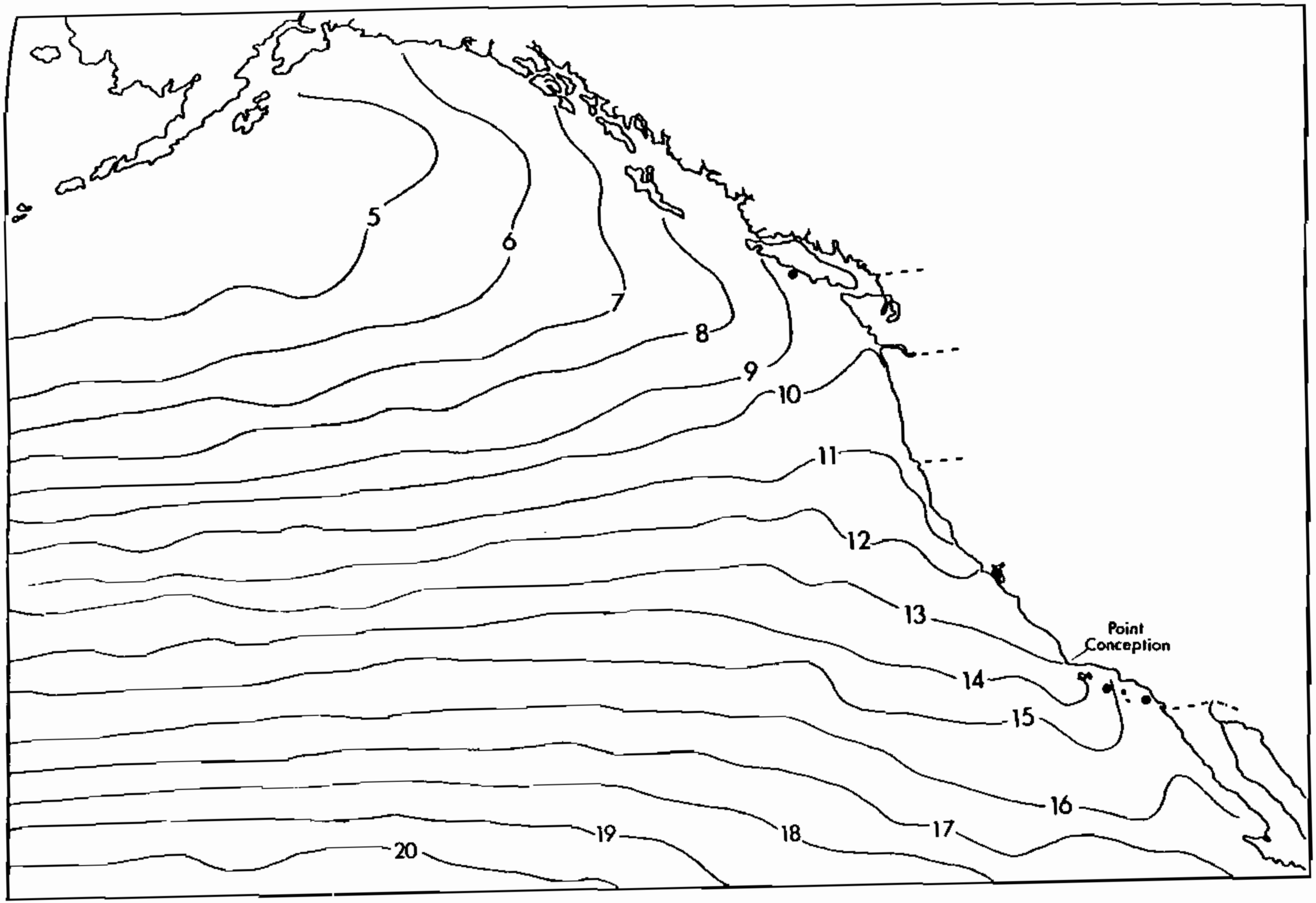


Figure 70. April distribution of sea turtle sightings in the northeastern Pacific as related to the position of surface isotherms.

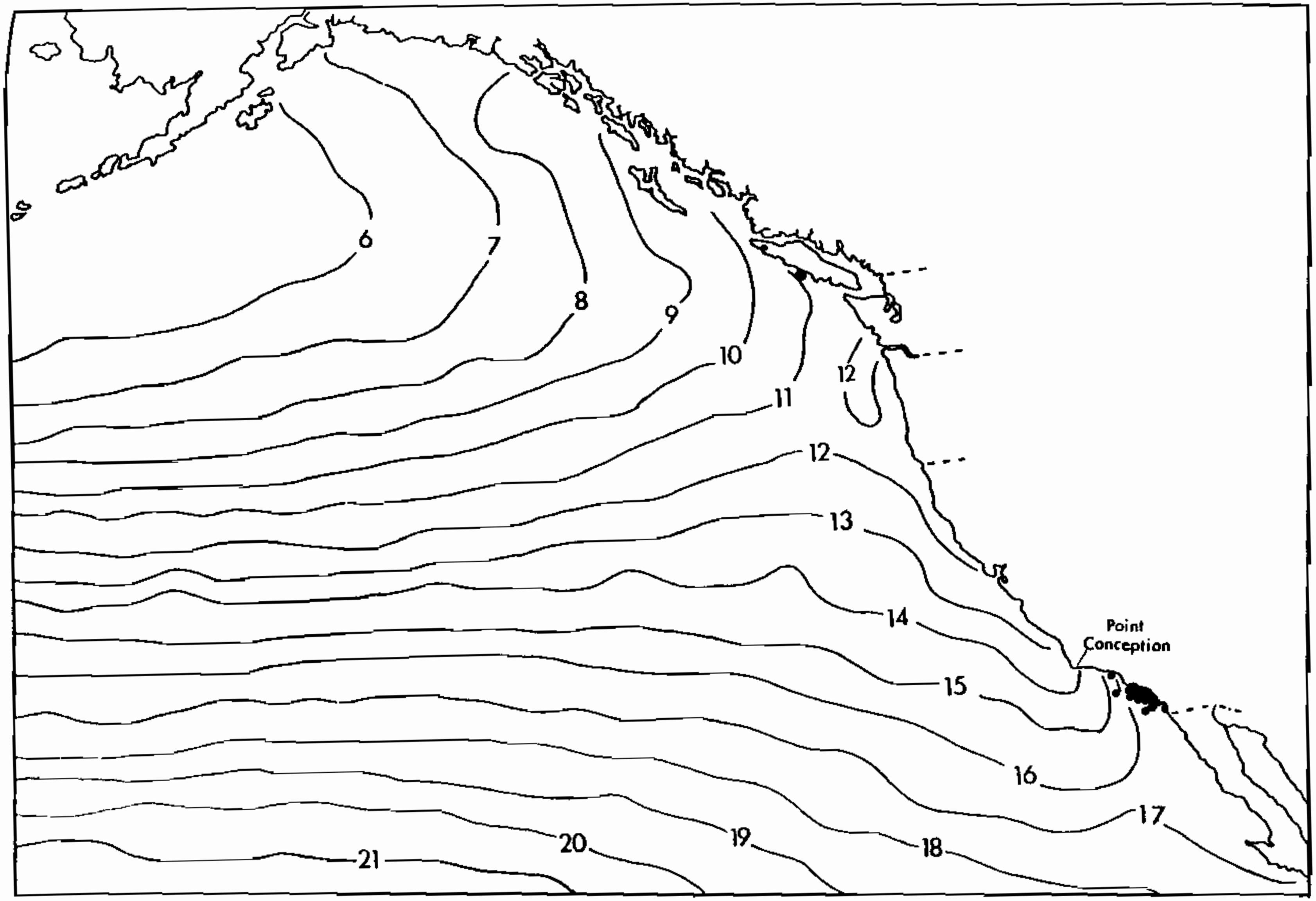


Figure 71. May distribution of sea turtle sightings in the northeastern Pacific as related to the position of surface isotherms.

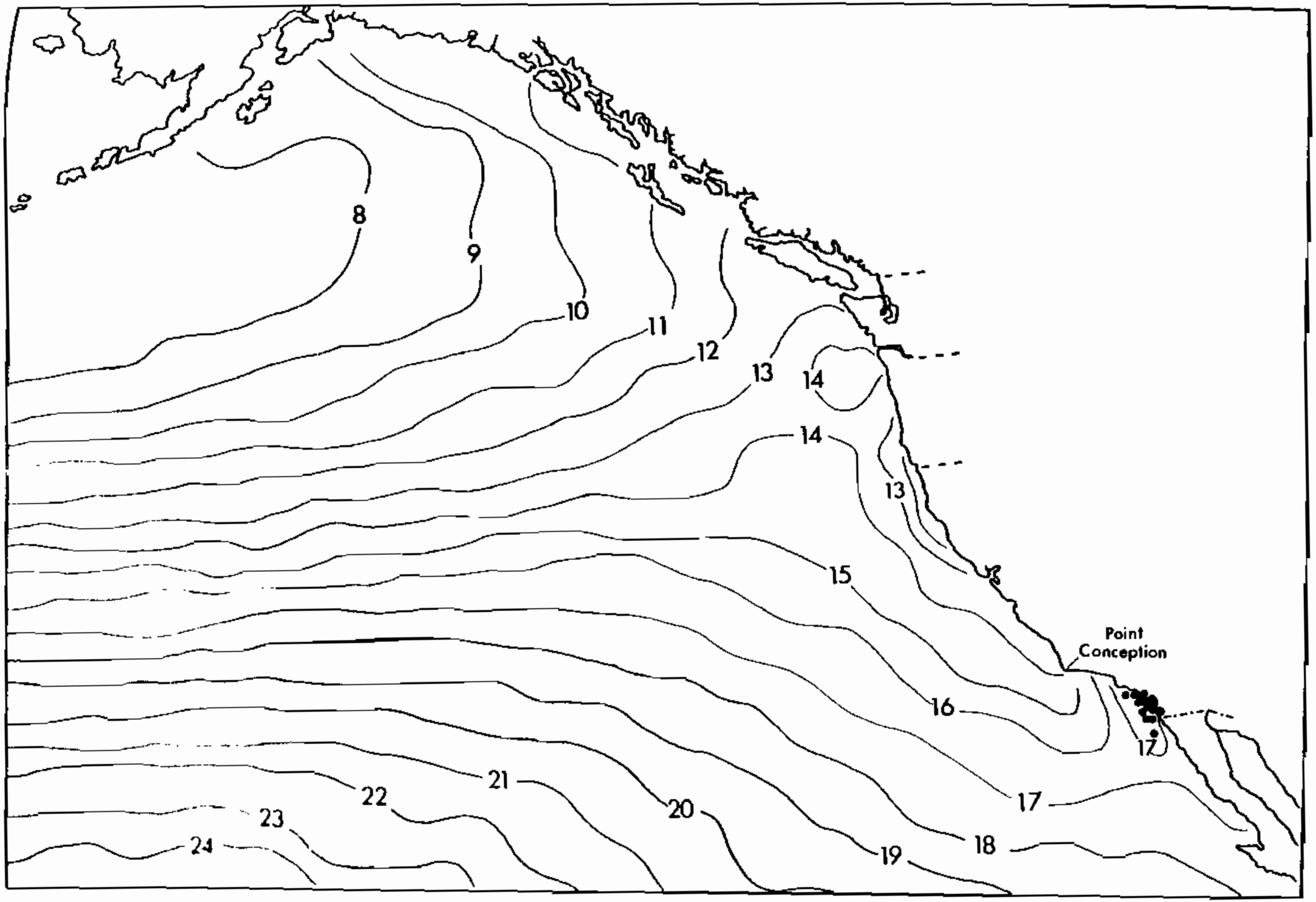


Figure 72. June distribution of sea turtle sightings in the northeastern Pacific as related to the position of surface isotherms.

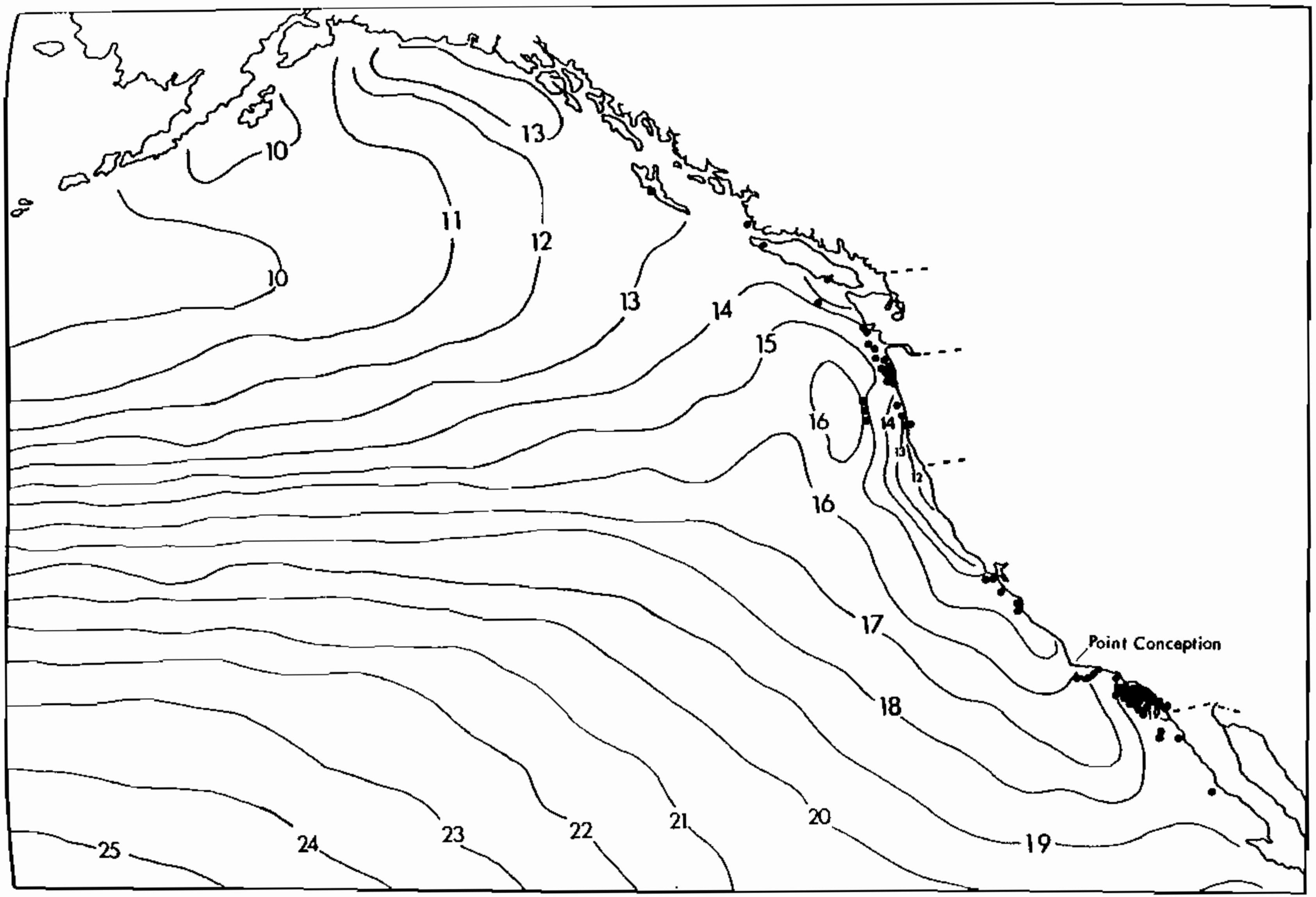


Figure 73. July distribution of sea turtle sightings in the northeastern Pacific as related to the position of surface isotherms.

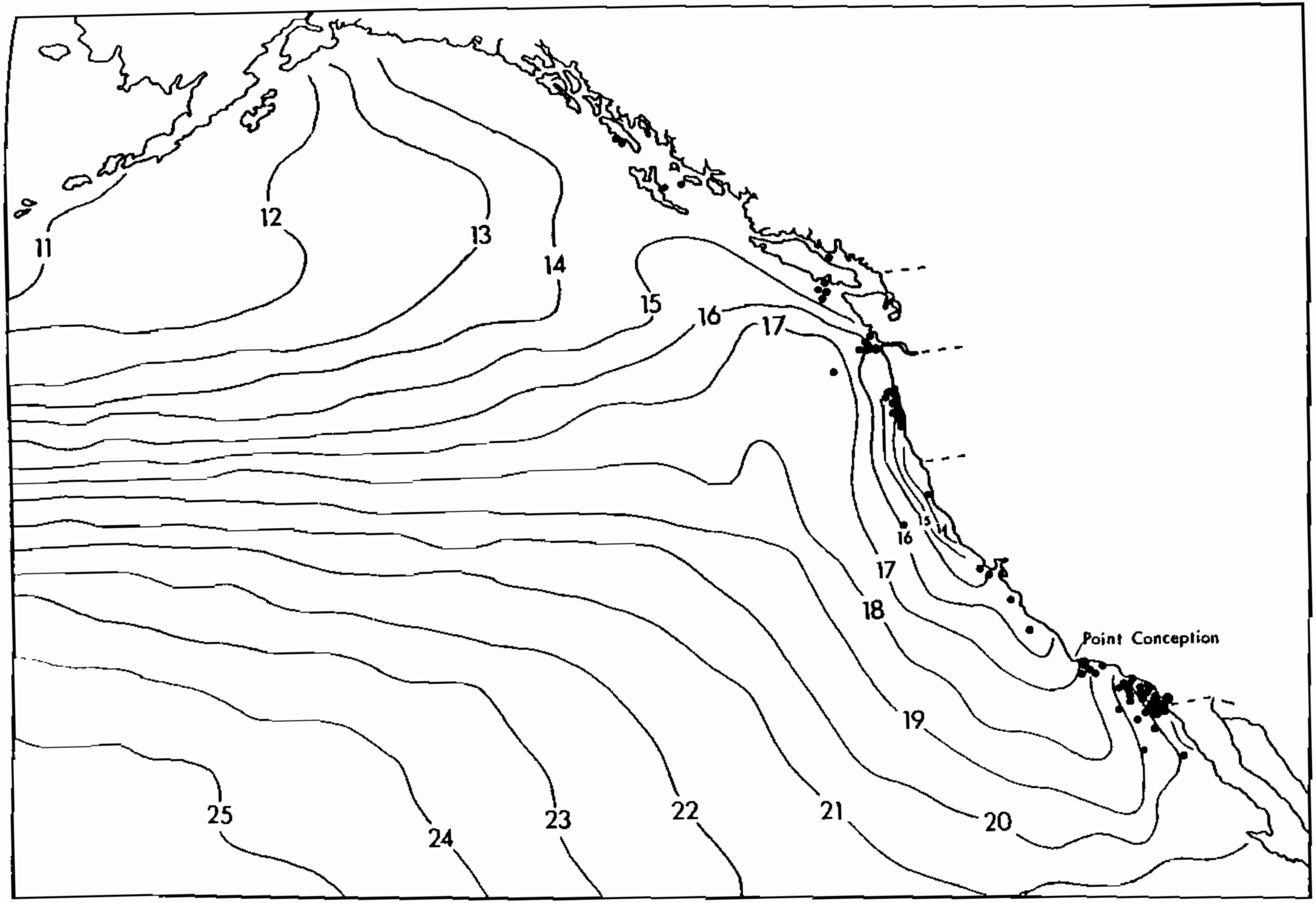


Figure 74. August distribution of sea turtle sightings in the northeastern Pacific as related to the position of surface isotherms.

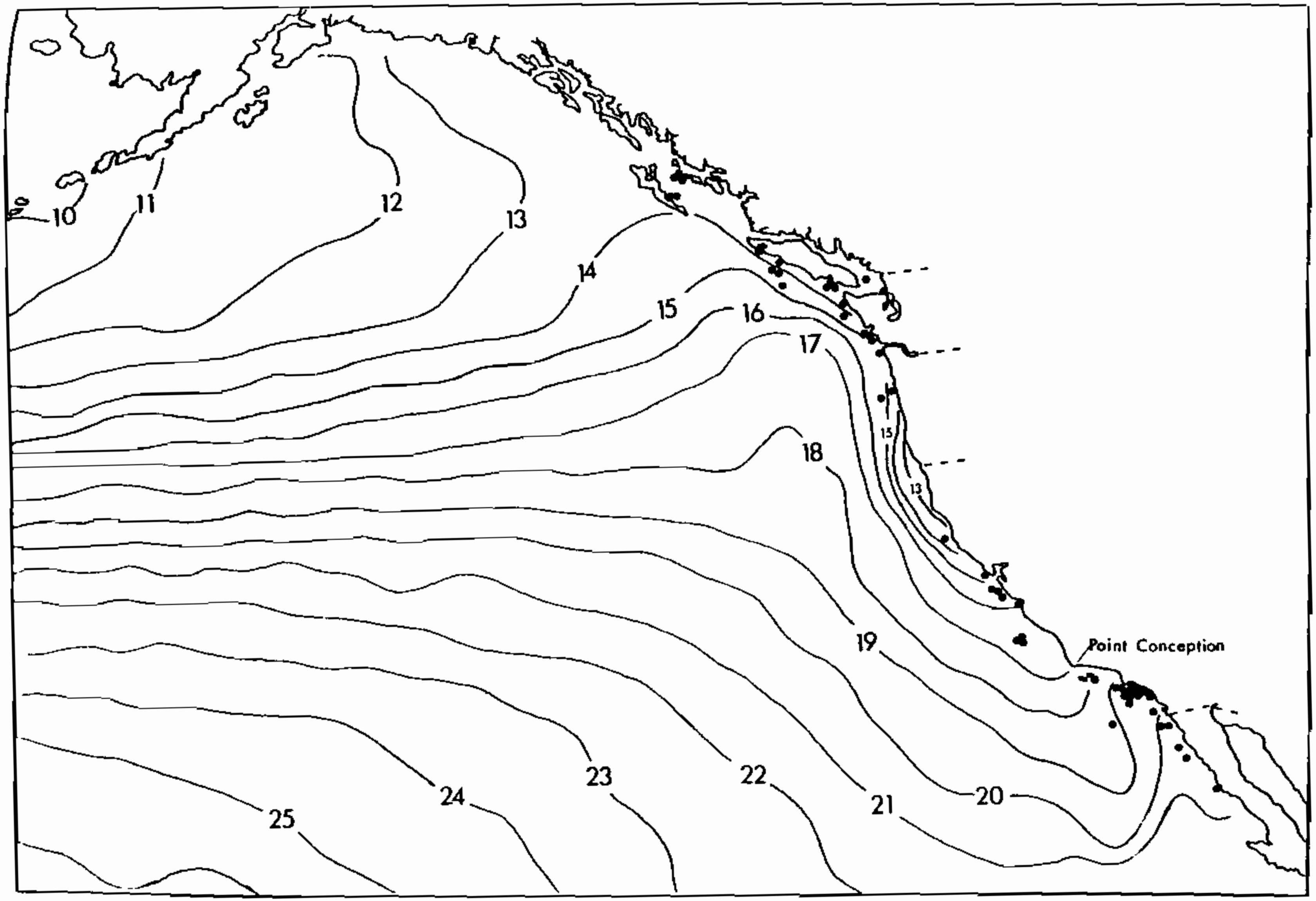


Figure 75. September distribution of sea turtle sightings in the northeastern Pacific as related to the position of surface isotherms.

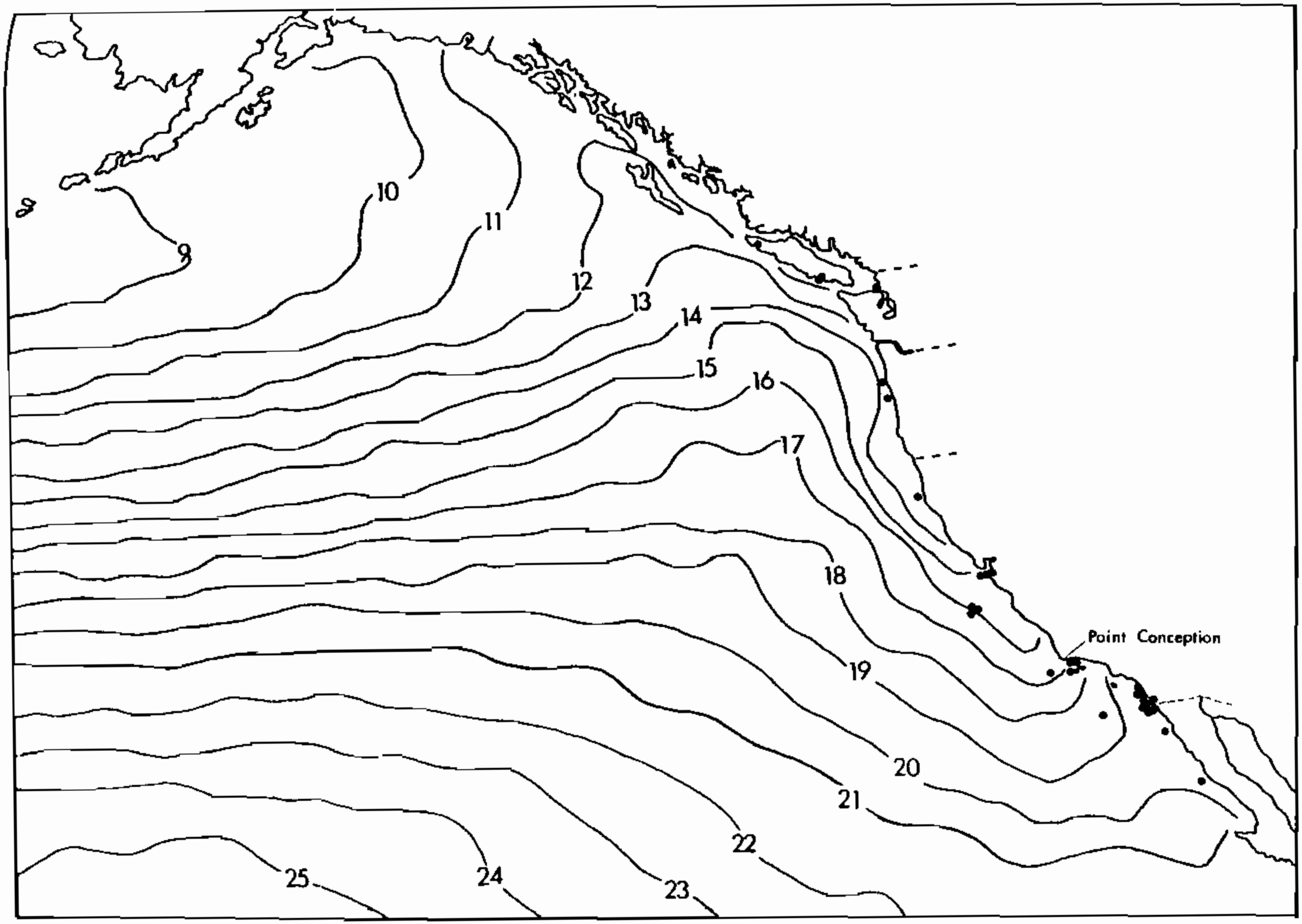


Figure 76. October distribution of sea turtle sightings in the northeastern Pacific as related to the position of surface isotherms.

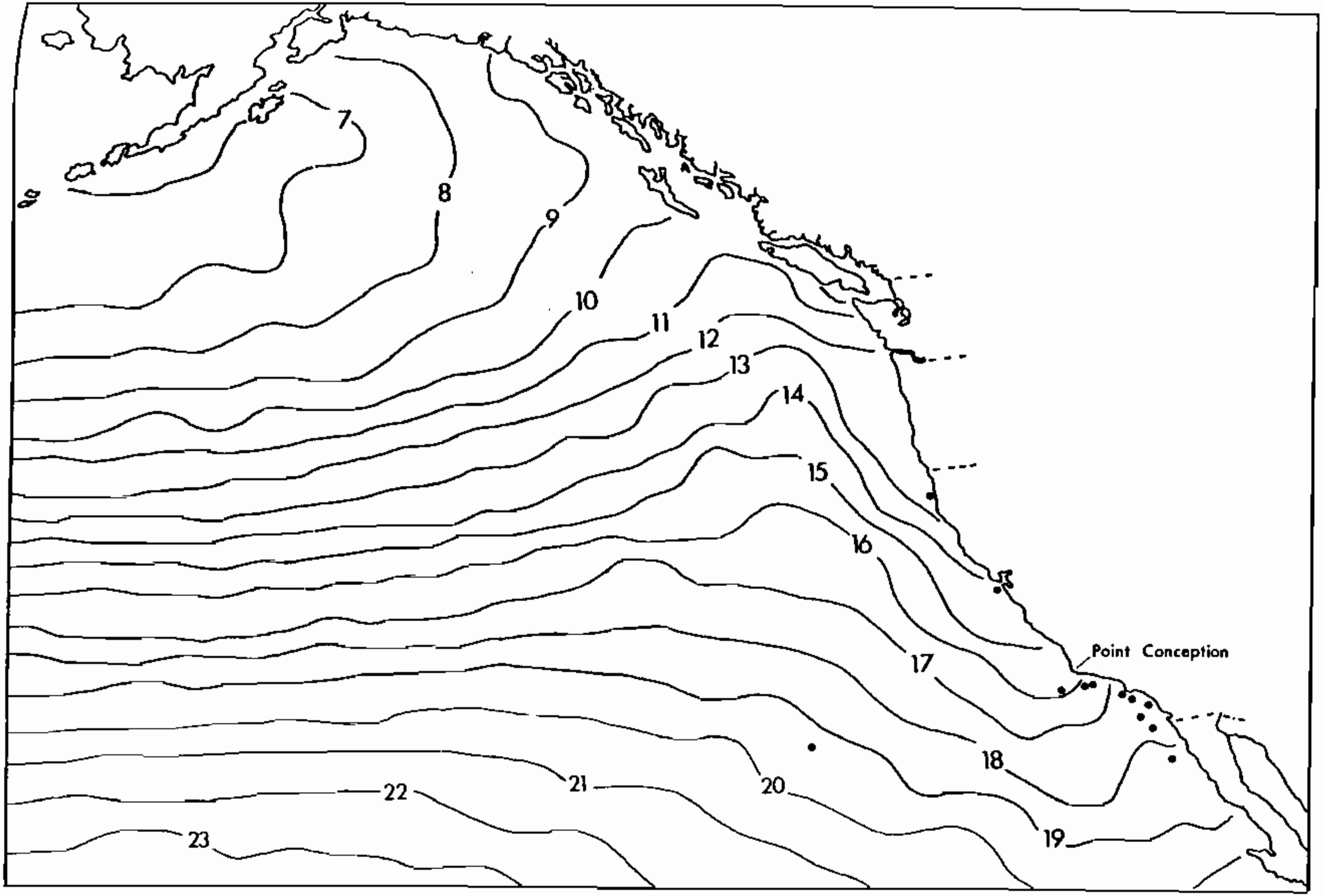


Figure 77. November distribution of sea turtle sightings in the northeastern Pacific as related to the position of surface isotherms.

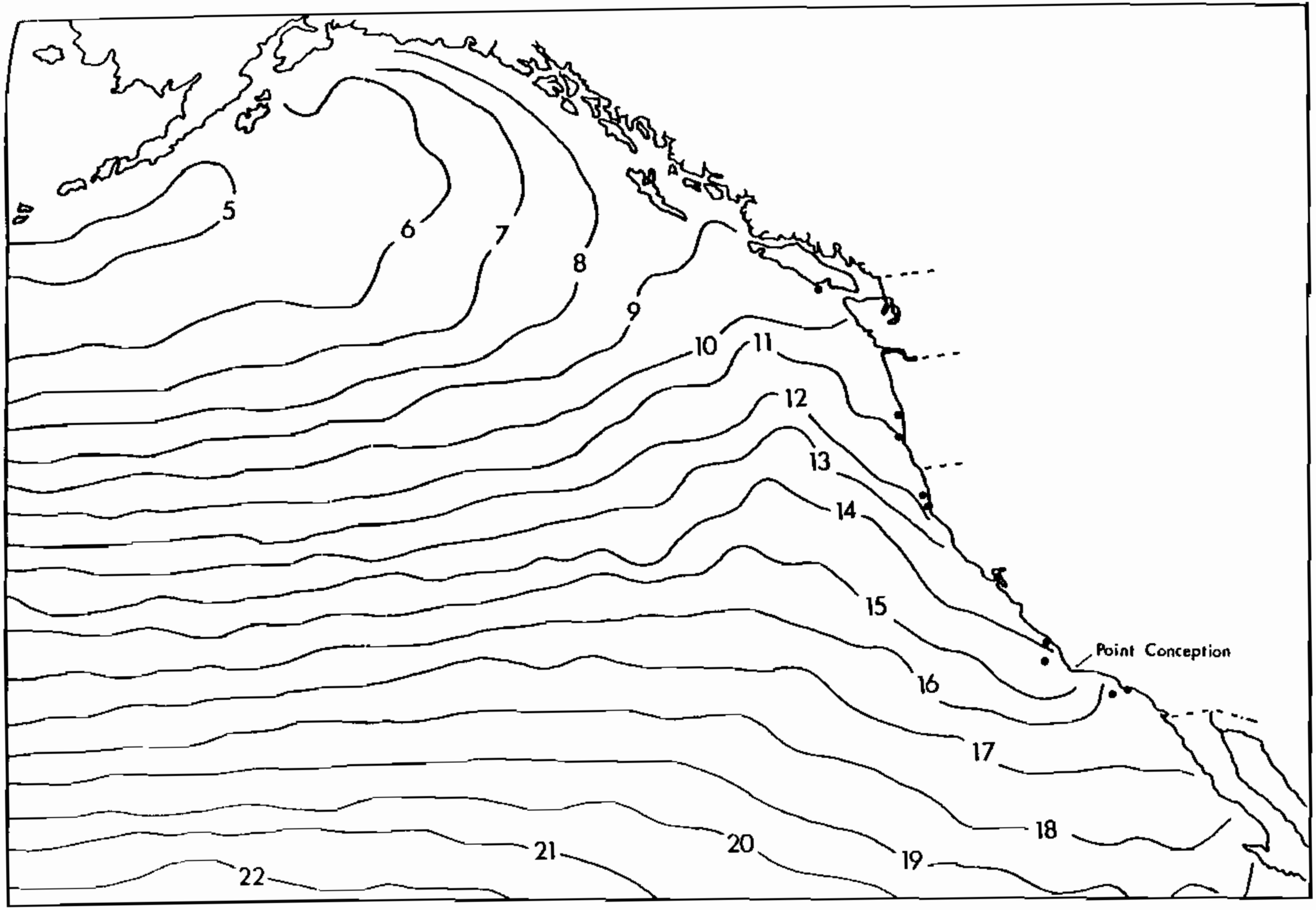


Figure 78. December distribution of sea turtle sightings in the northeastern Pacific as related to the position of surface isotherms.

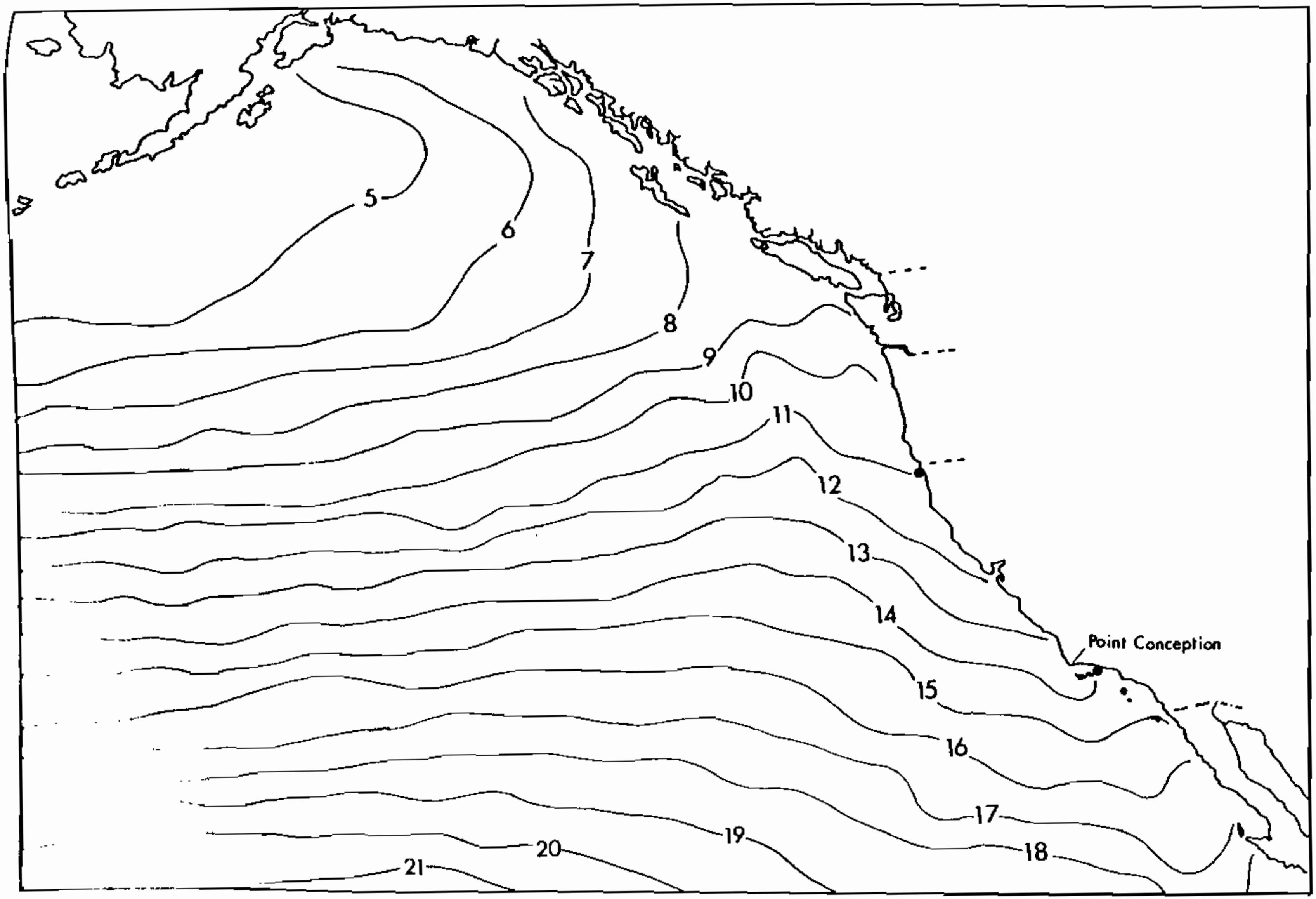


Figure [illegible] [illegible] distribution of leatherback sightings in the northeastern Pacific as related to [illegible] [illegible]ition of surface isotherms. There were no February sightings.

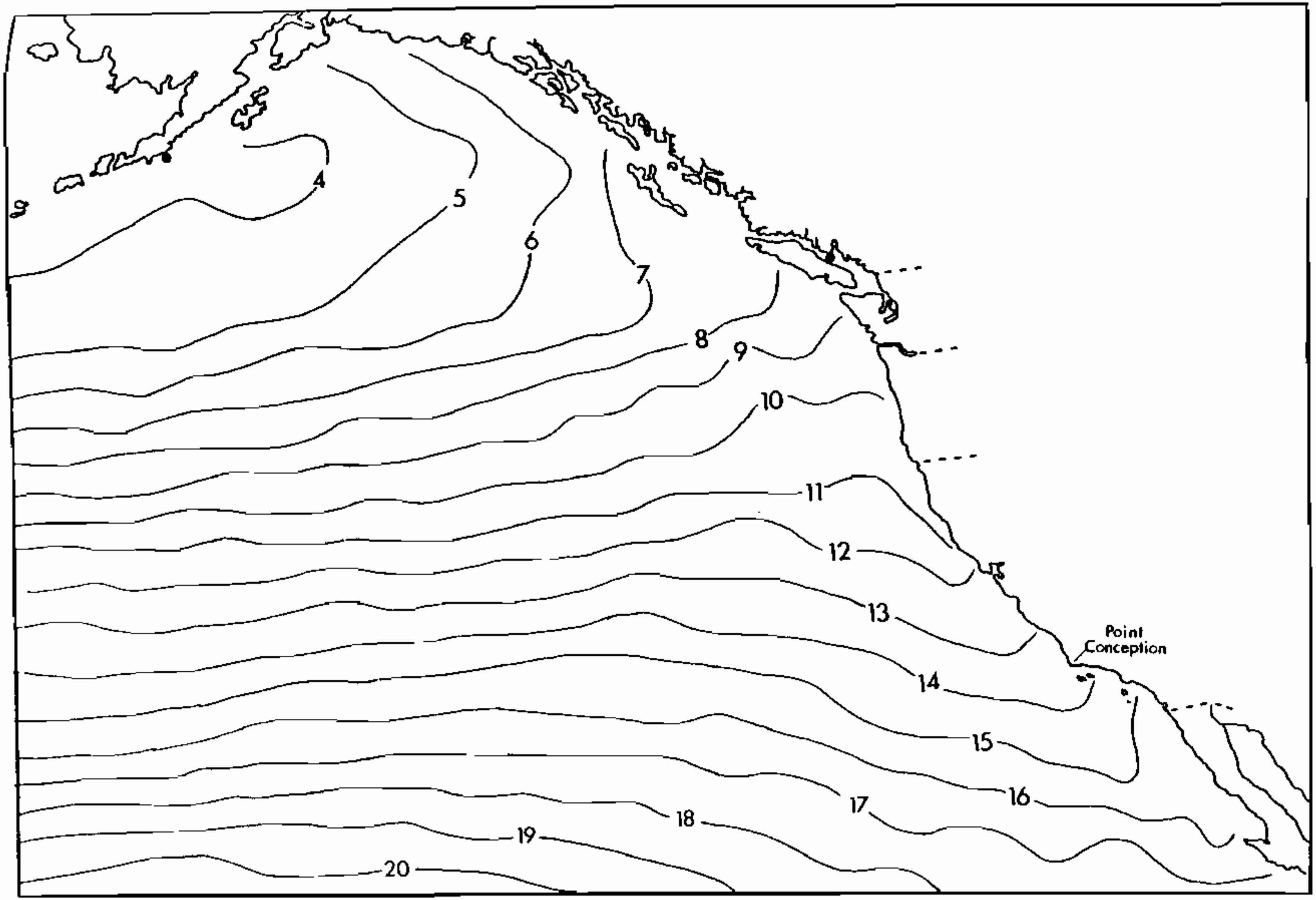


Figure 80. March distribution of leatherback sightings in the northeastern Pacific as related to the position of surface isotherms. The only April sightings were reported as from "central California" and were not plotted.

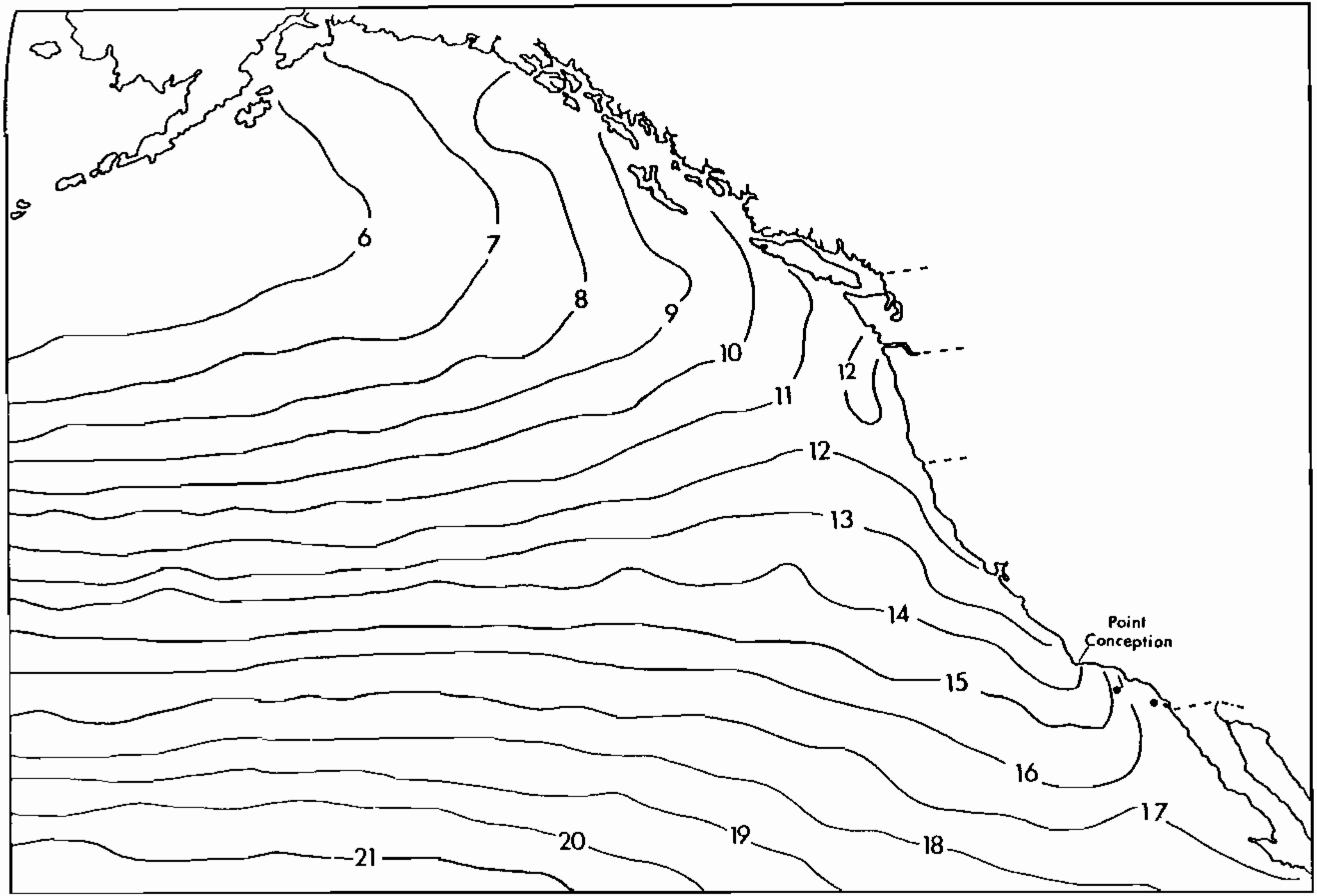


Figure 81. May distribution of leatherback sightings in the northeastern Pacific as related to the position of surface isotherms.

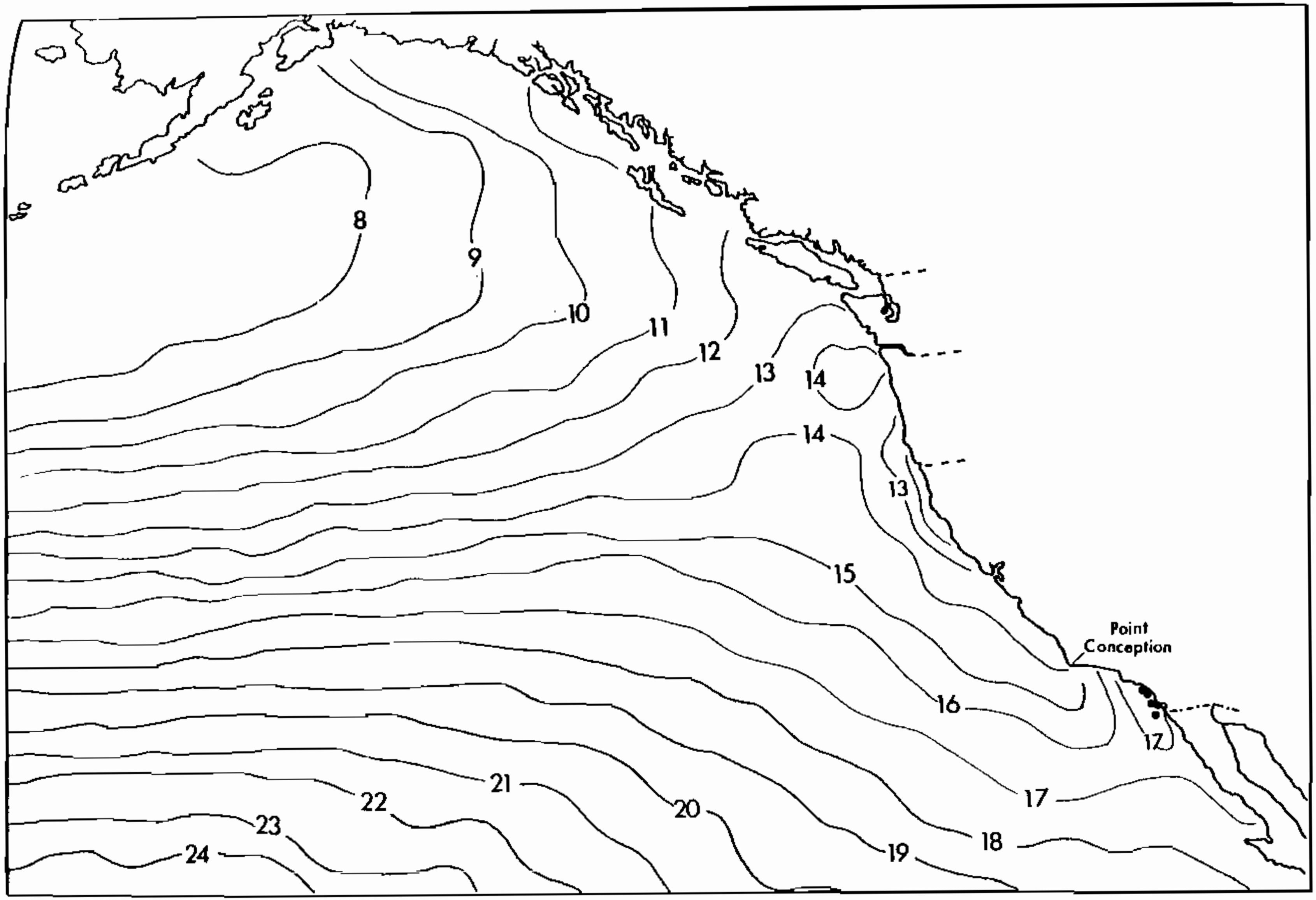


Figure 82. June distribution of leatherback sightings in the northeastern Pacific as related to the position of surface isotherms.

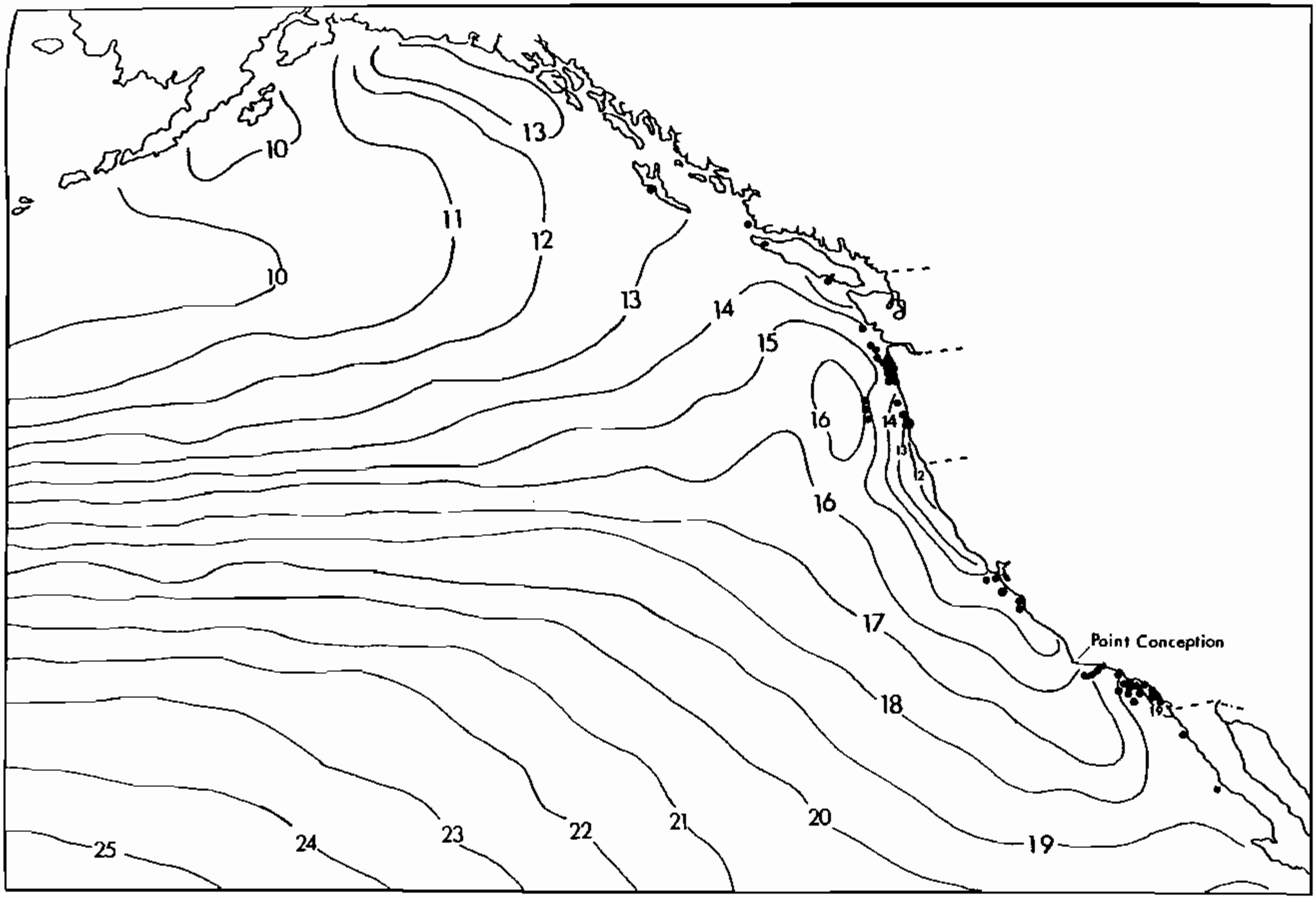


Figure 83. July distribution of leatherback sightings in the northeastern Pacific as related to the position of surface isotherms.

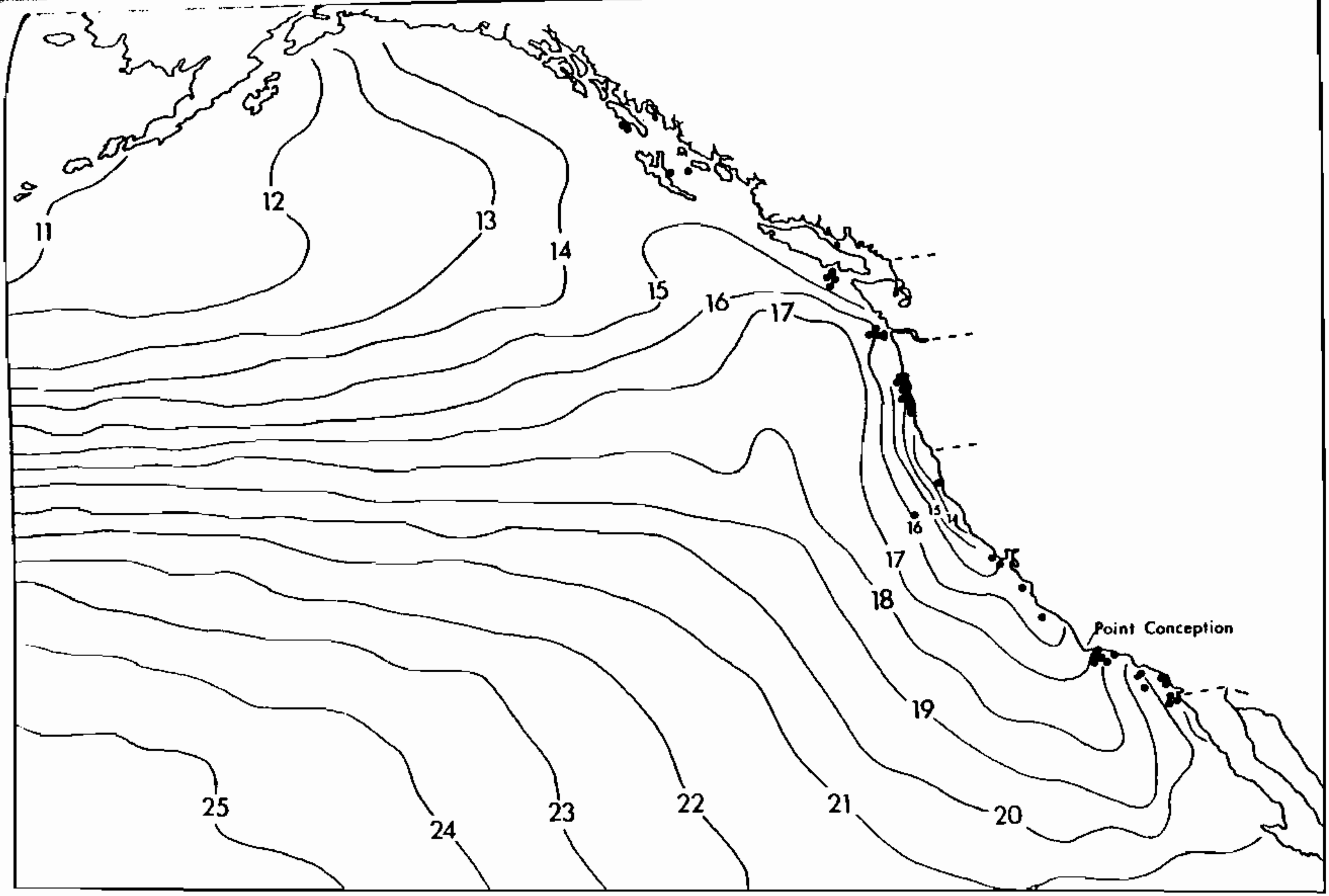


Figure 84. August distribution of leatherback sightings in the northeastern Pacific as related to the position of surface isotherms.

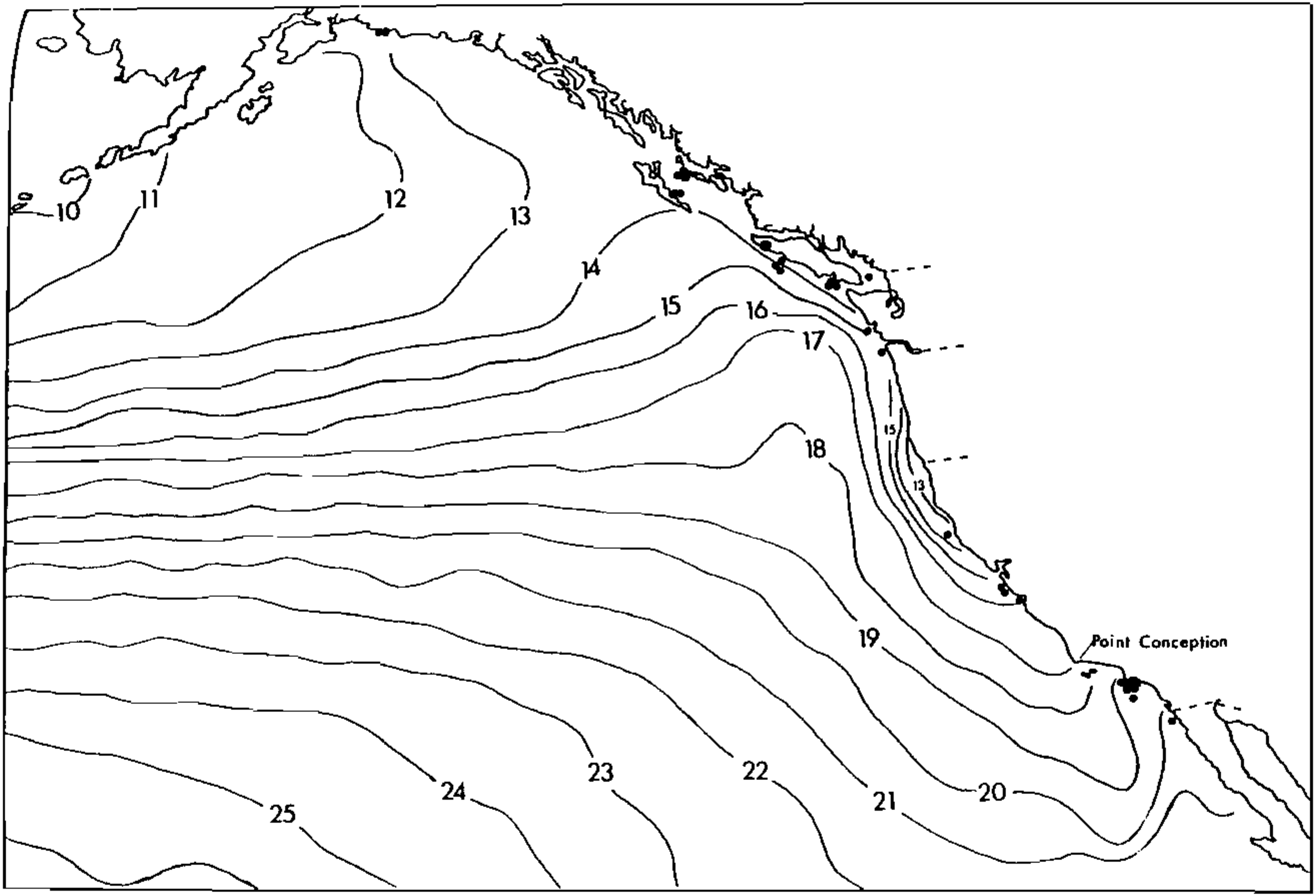


Figure 85. September distribution of leatherback sightings in the northeastern Pacific as related to the position of surface isotherms.

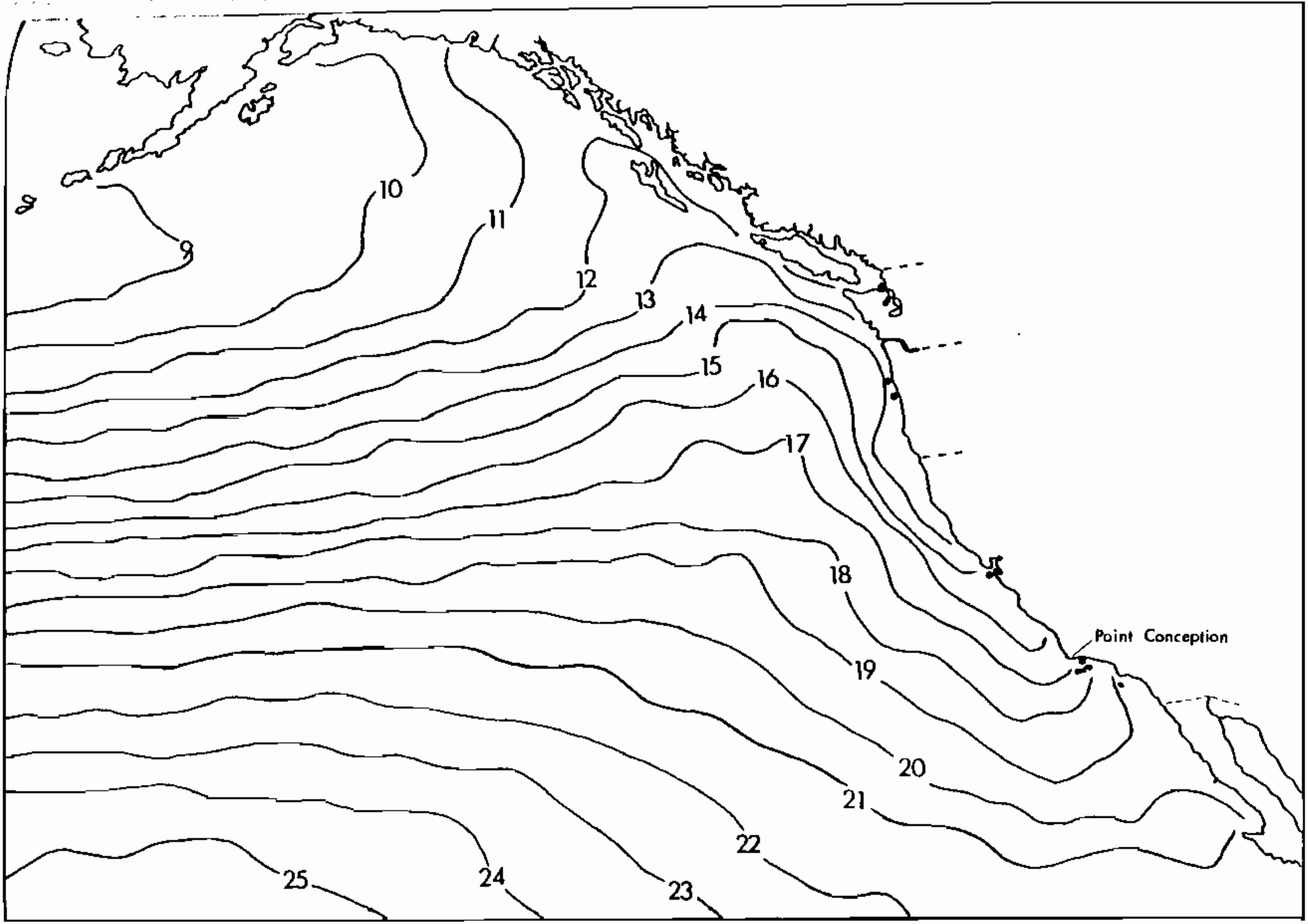


Figure 86. October distribution of leatherback sightings in the northeastern Pacific as related to the position of surface isotherms.

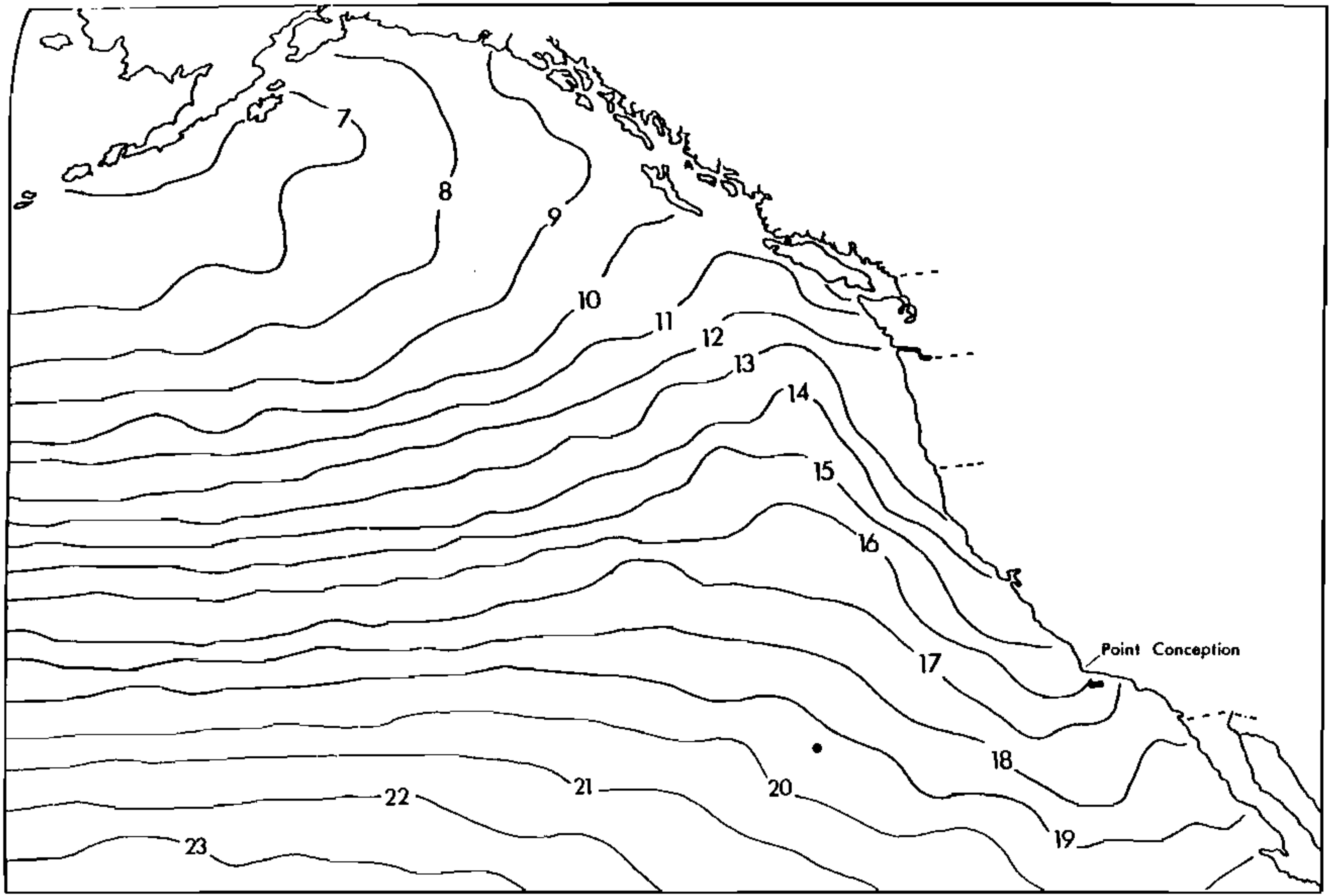


Figure 87. November distribution of leatherback sightings in the northeastern Pacific as related to the position of surface isotherms.

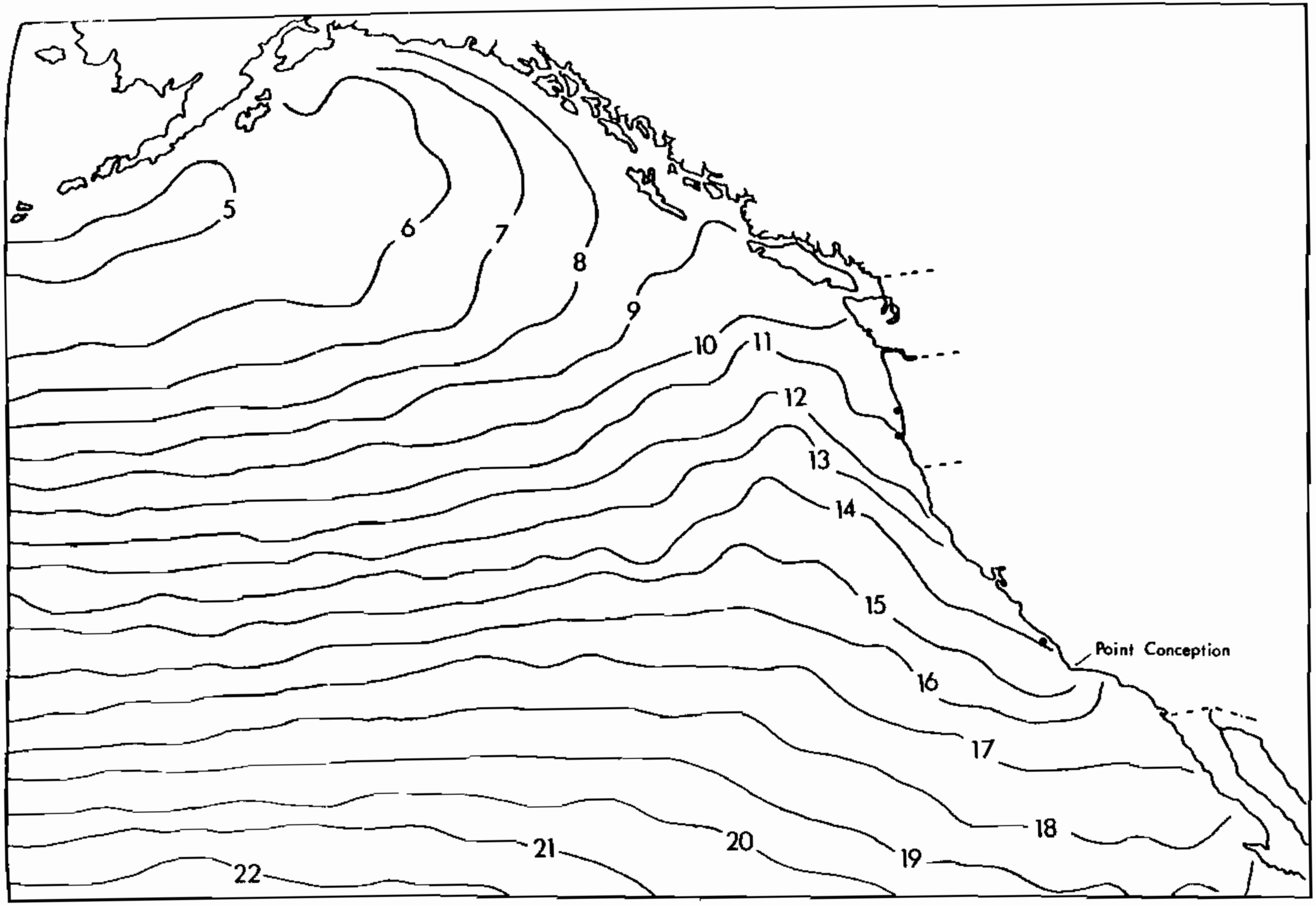


Figure 88. December distribution of leatherback sightings in the northeastern Pacific as related to the position of surface isotherms.

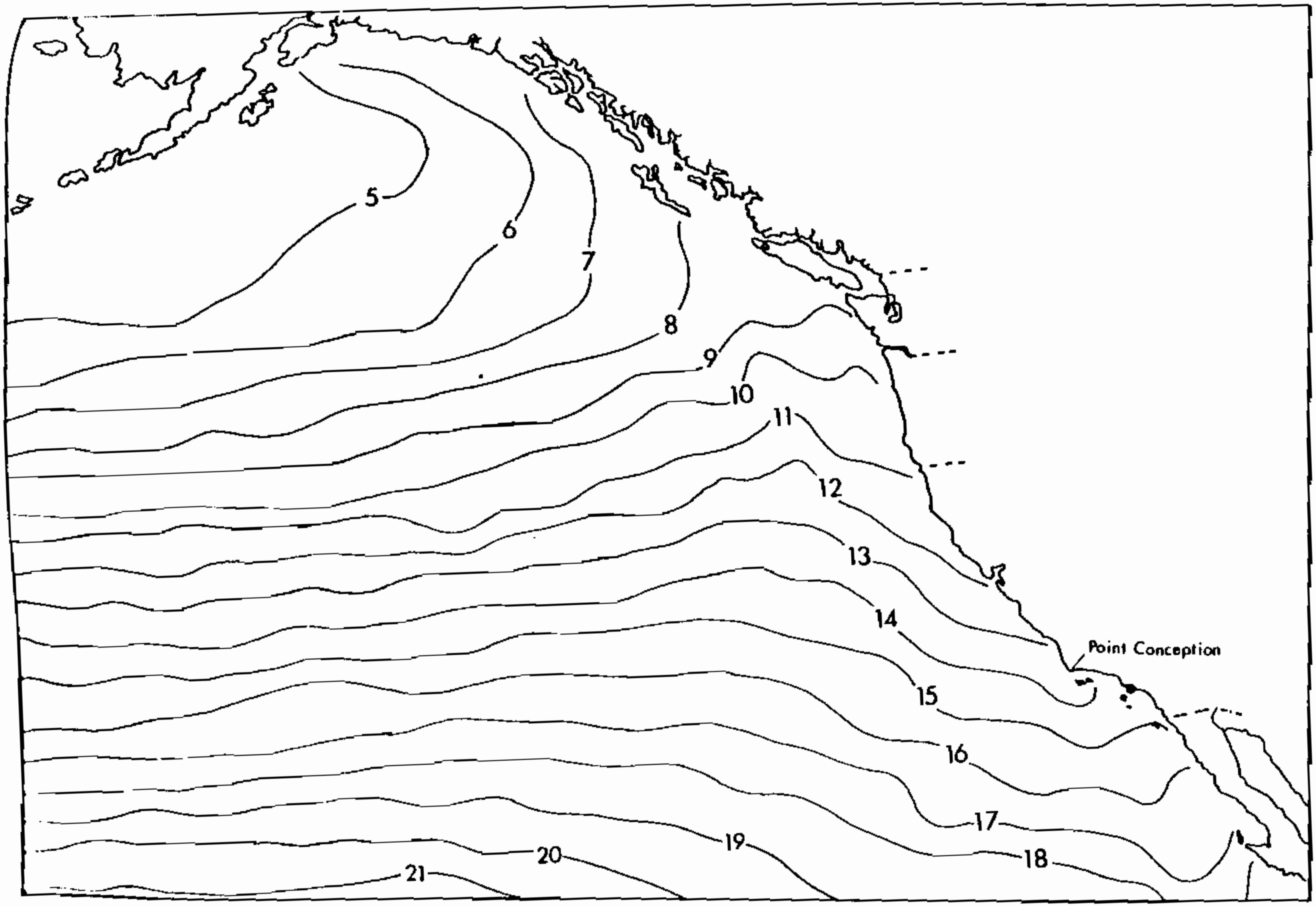


Figure 89. January distribution of sightings of green sea turtles in the northeastern Pacific as related to the position of surface isotherms.

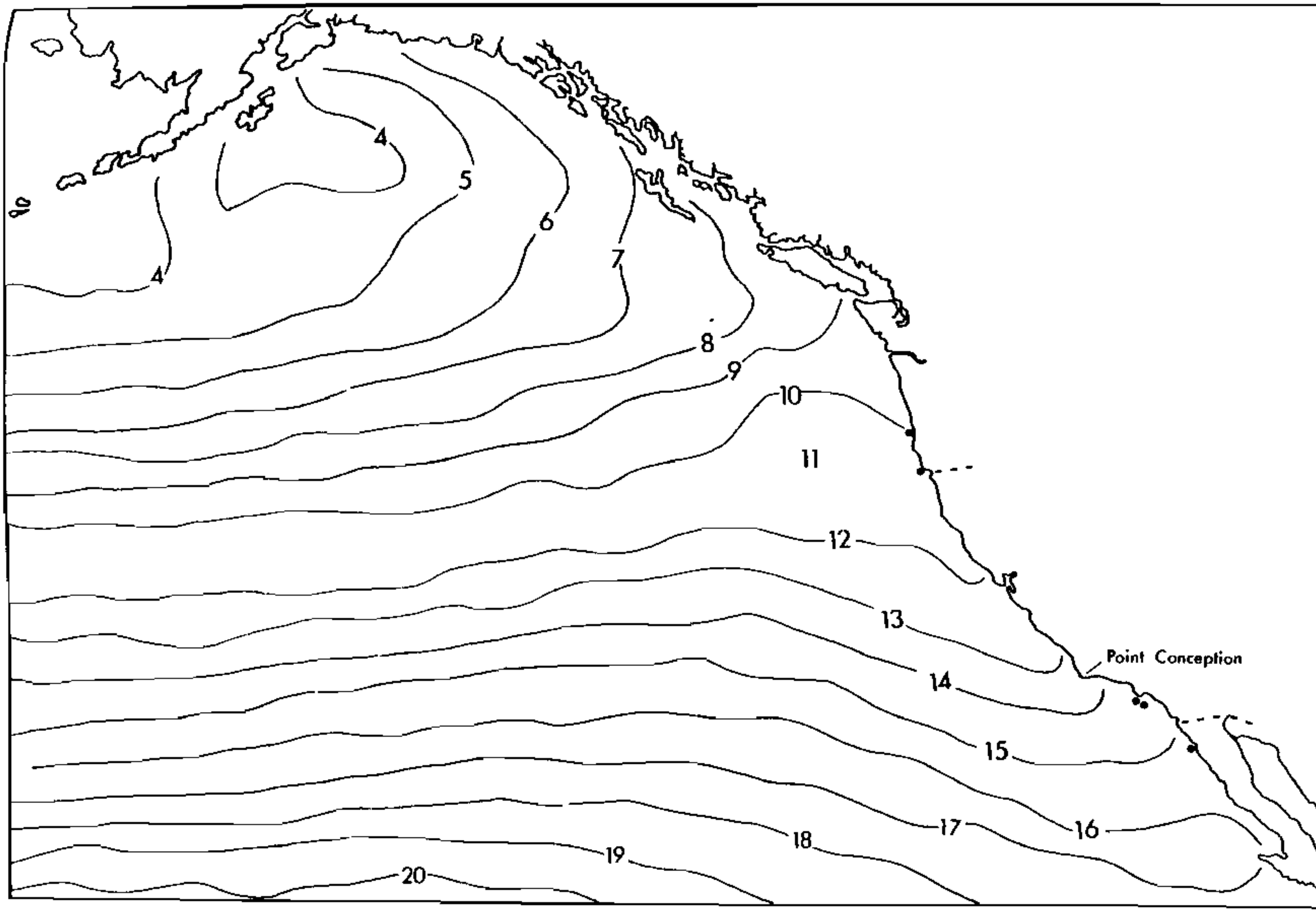


Figure 90. February distribution of sightings of green sea turtles in the northeastern Pacific as related to the position of surface isotherms.

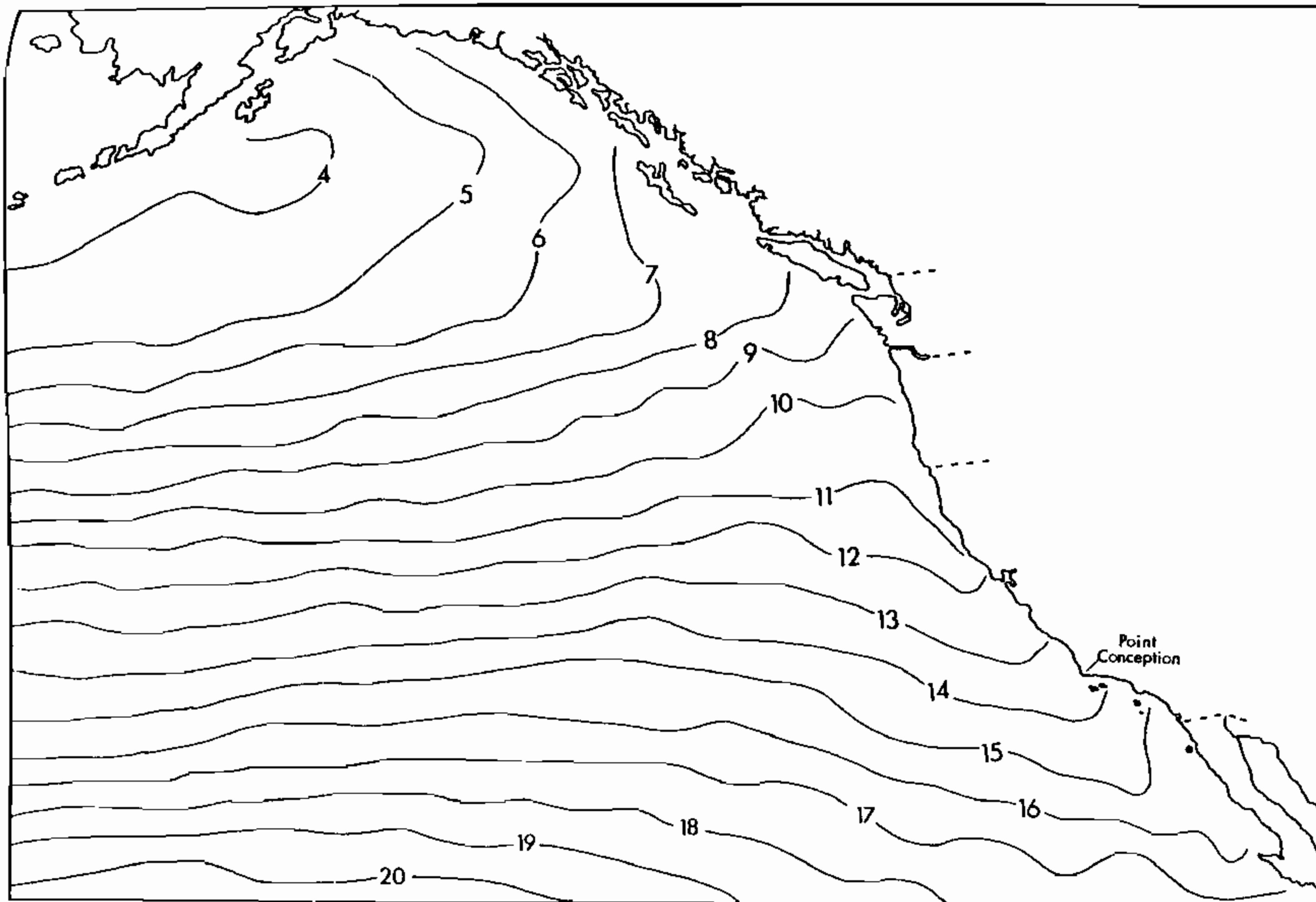


Figure 91. March distribution of sightings of green sea turtles in the northeastern Pacific as related to the position of surface isotherms.

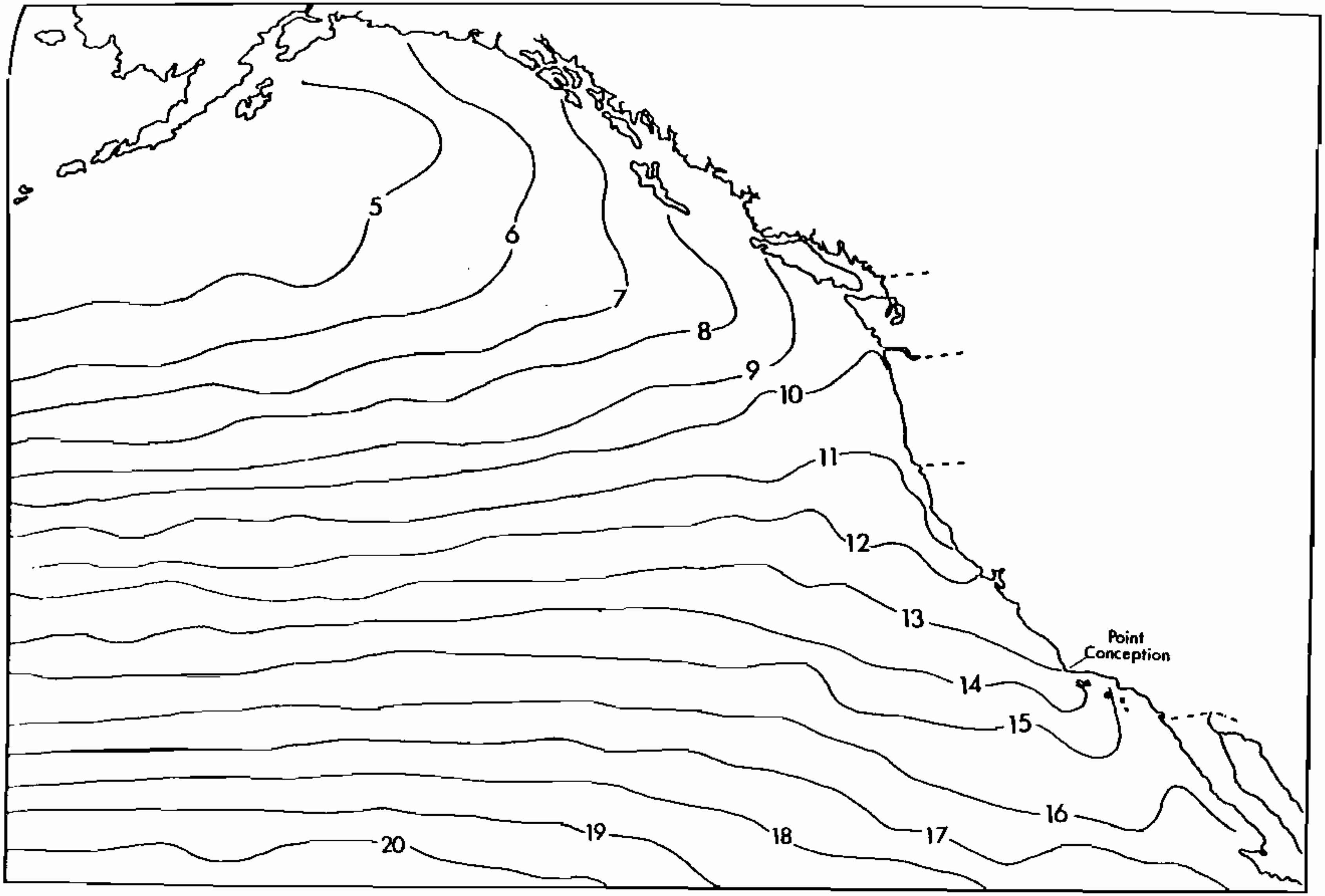


Figure 92. April distribution of sightings of green sea turtles in the northeastern Pacific as related to the position of surface isotherms.

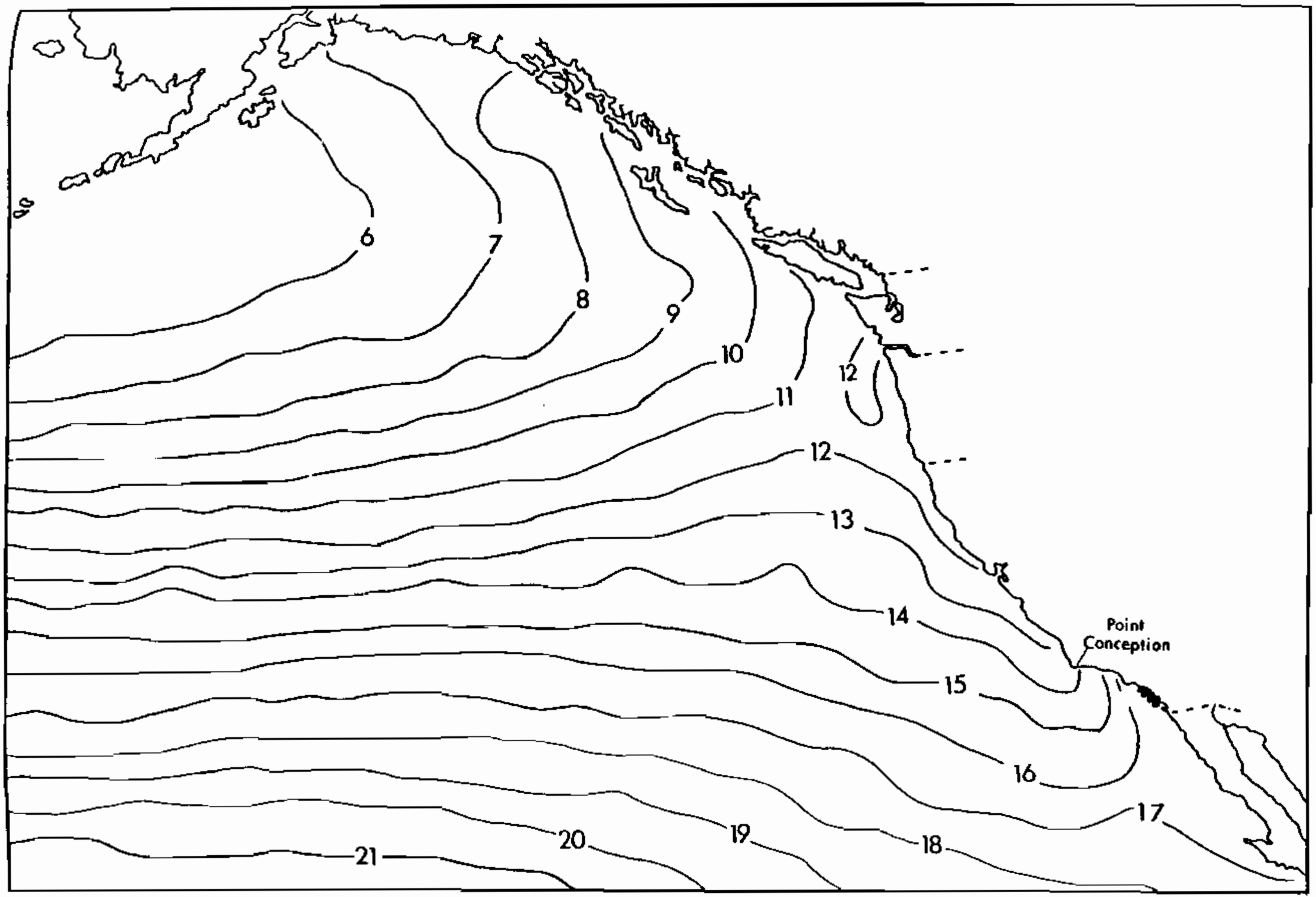


Figure 93. May distribution of sightings of green sea turtles in the northeastern Pacific as related to the position of surface isotherms. No June sightings were reported.

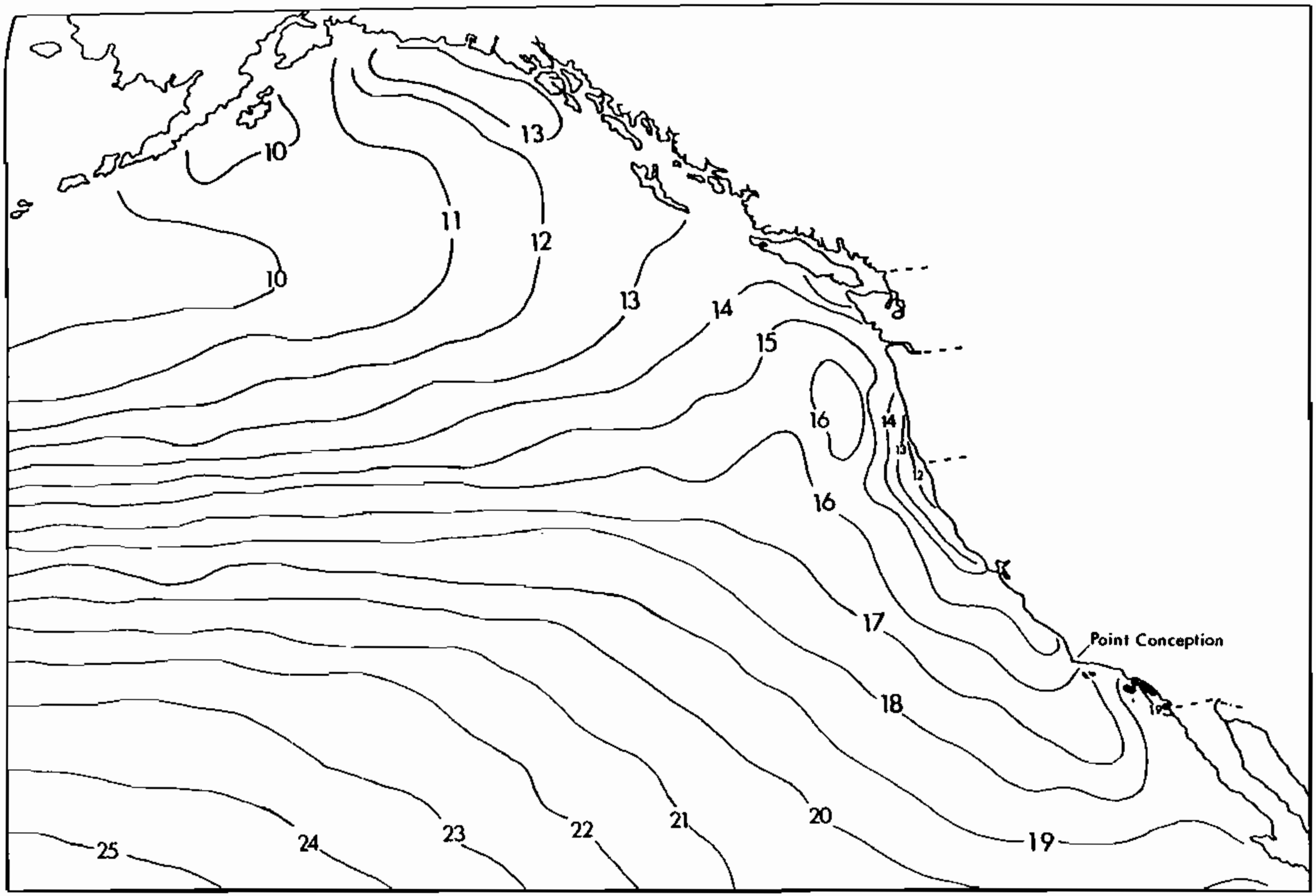


Figure 94. July distribution of sightings of green sea turtles in the northeastern Pacific as related to the position of surface isotherms.

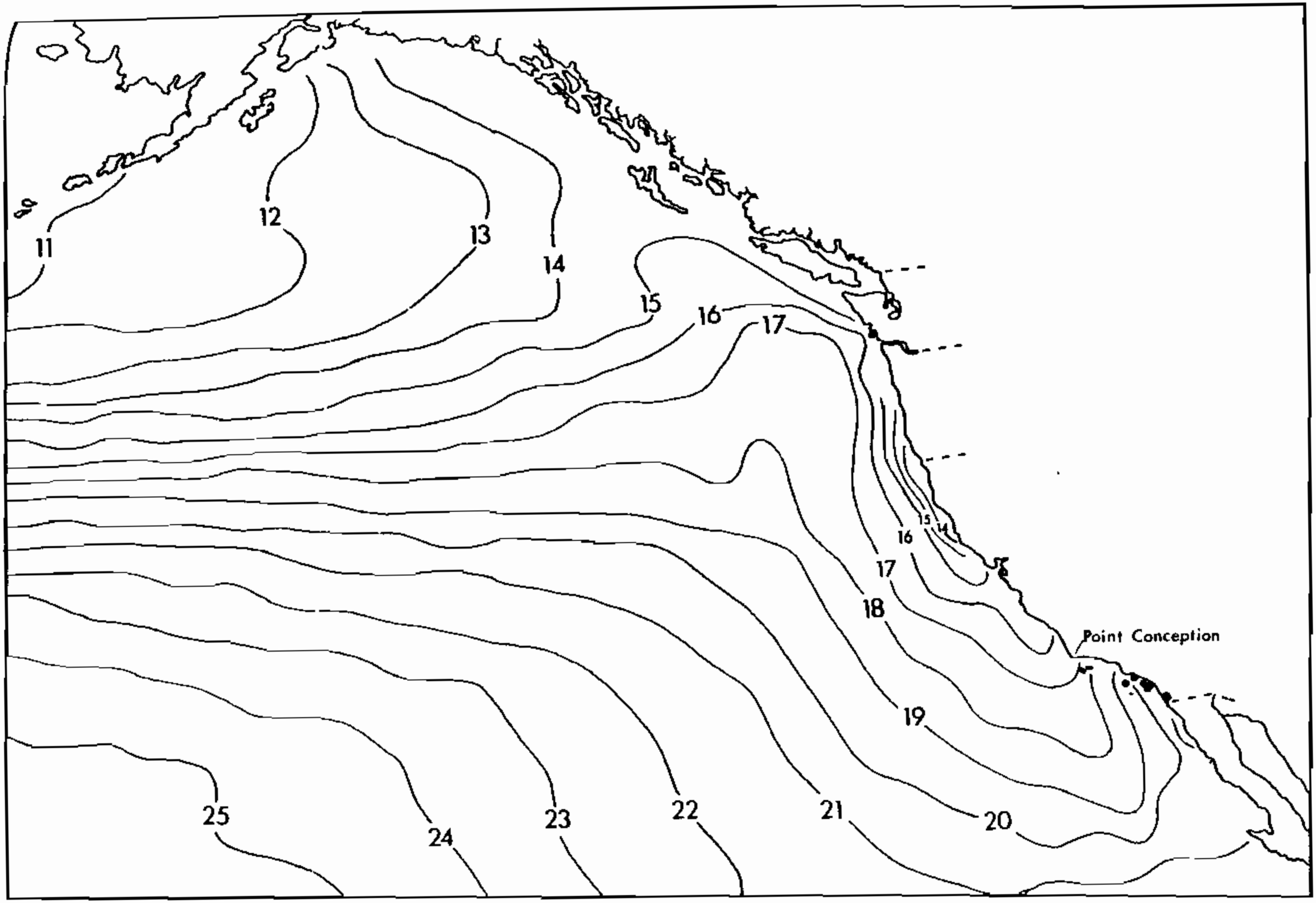


Figure 95. August distribution of sightings of green sea turtles in the northeastern Pacific as related to the position of surface isotherms.

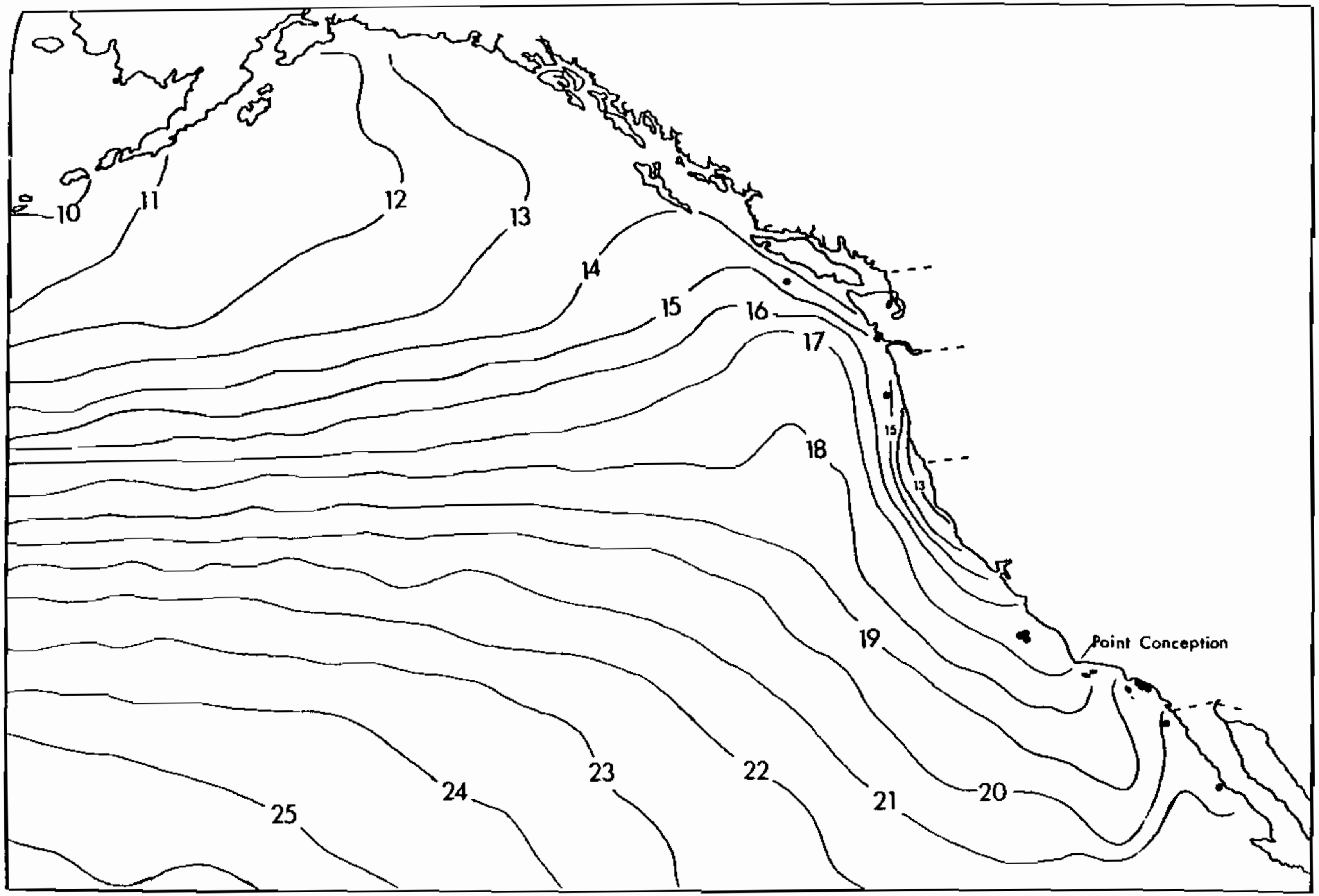


Figure 96. September distribution of sightings of green sea turtles in the northeastern Pacific as related to the position of surface isotherms.

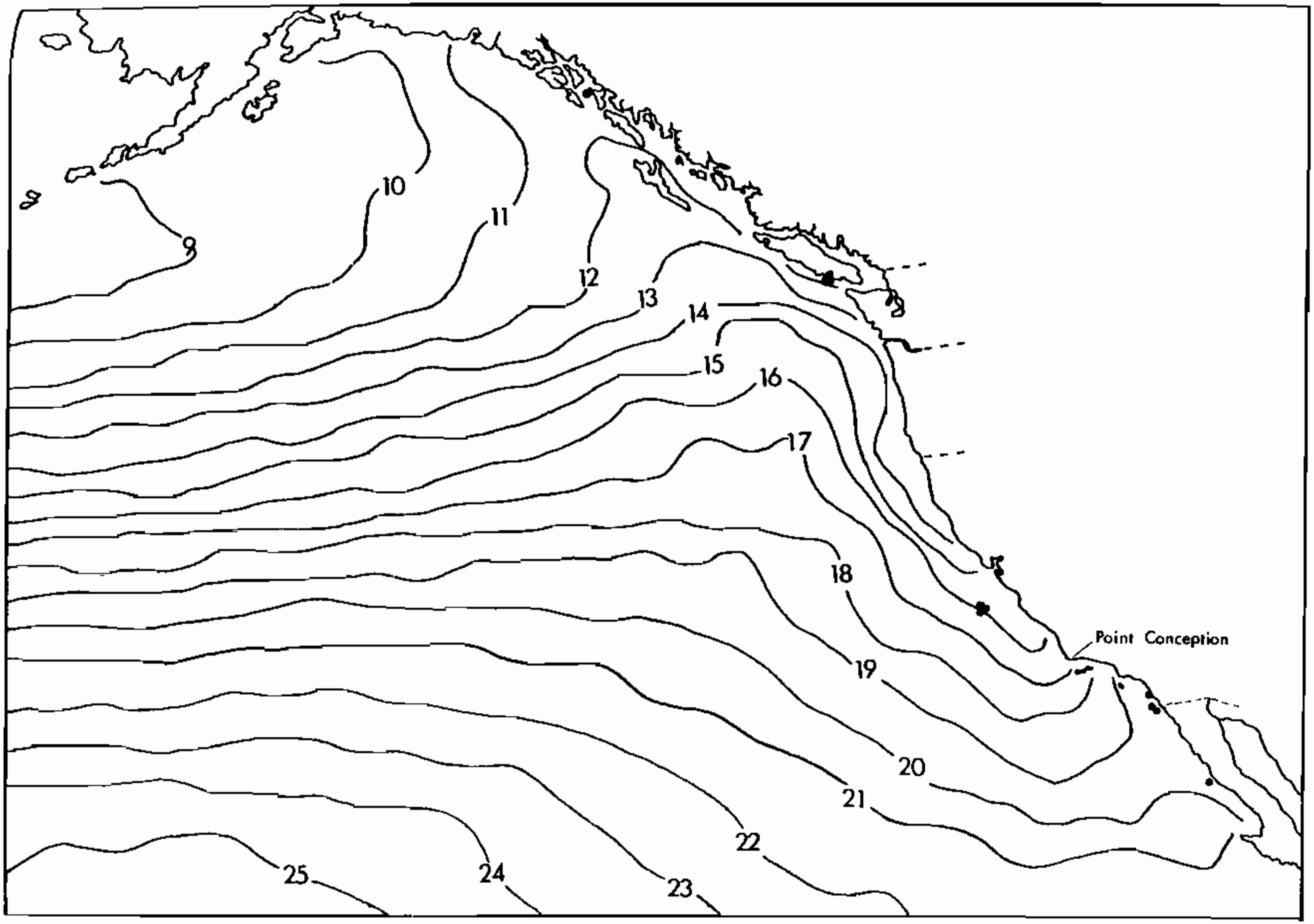


Figure 97. October distribution of sightings of green sea turtles in the northeastern Pacific as related to the position of surface isotherms.

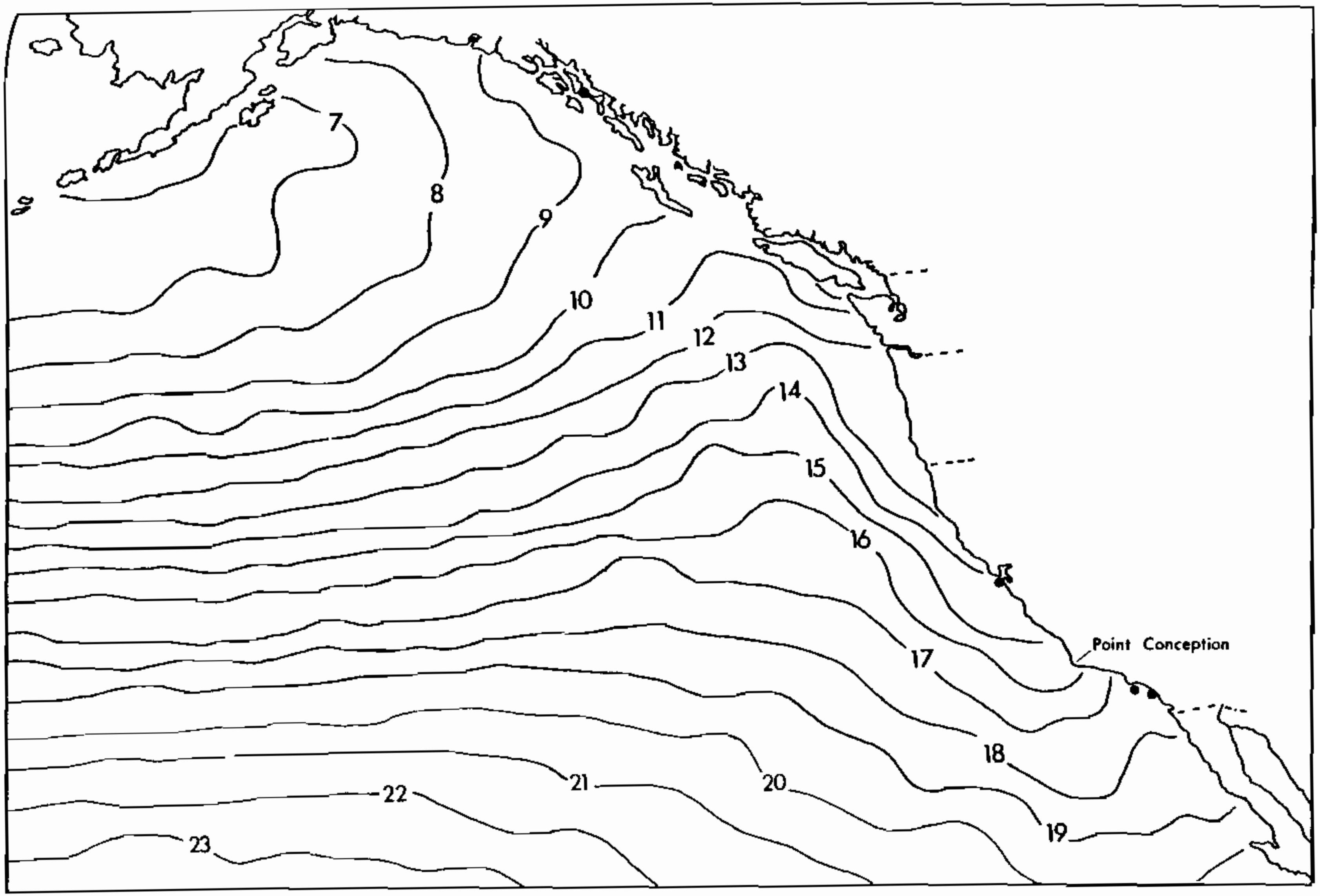


Figure 98. November distribution of sightings of green sea turtles in the northeastern Pacific as related to the position of surface isotherms.

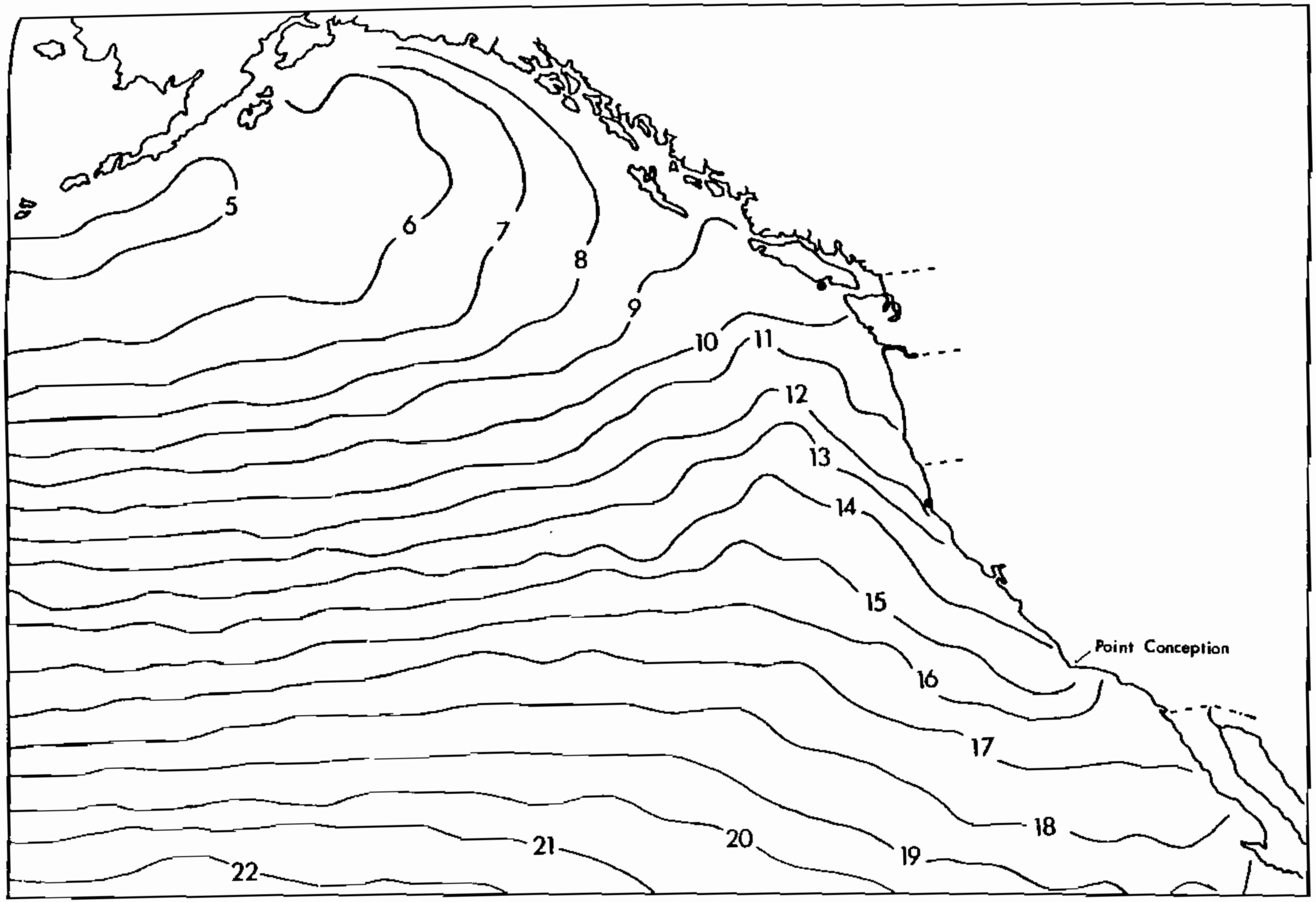


Figure 99. December distribution of sightings of green sea turtles in the northeastern Pacific as related to the position of surface isotherms.

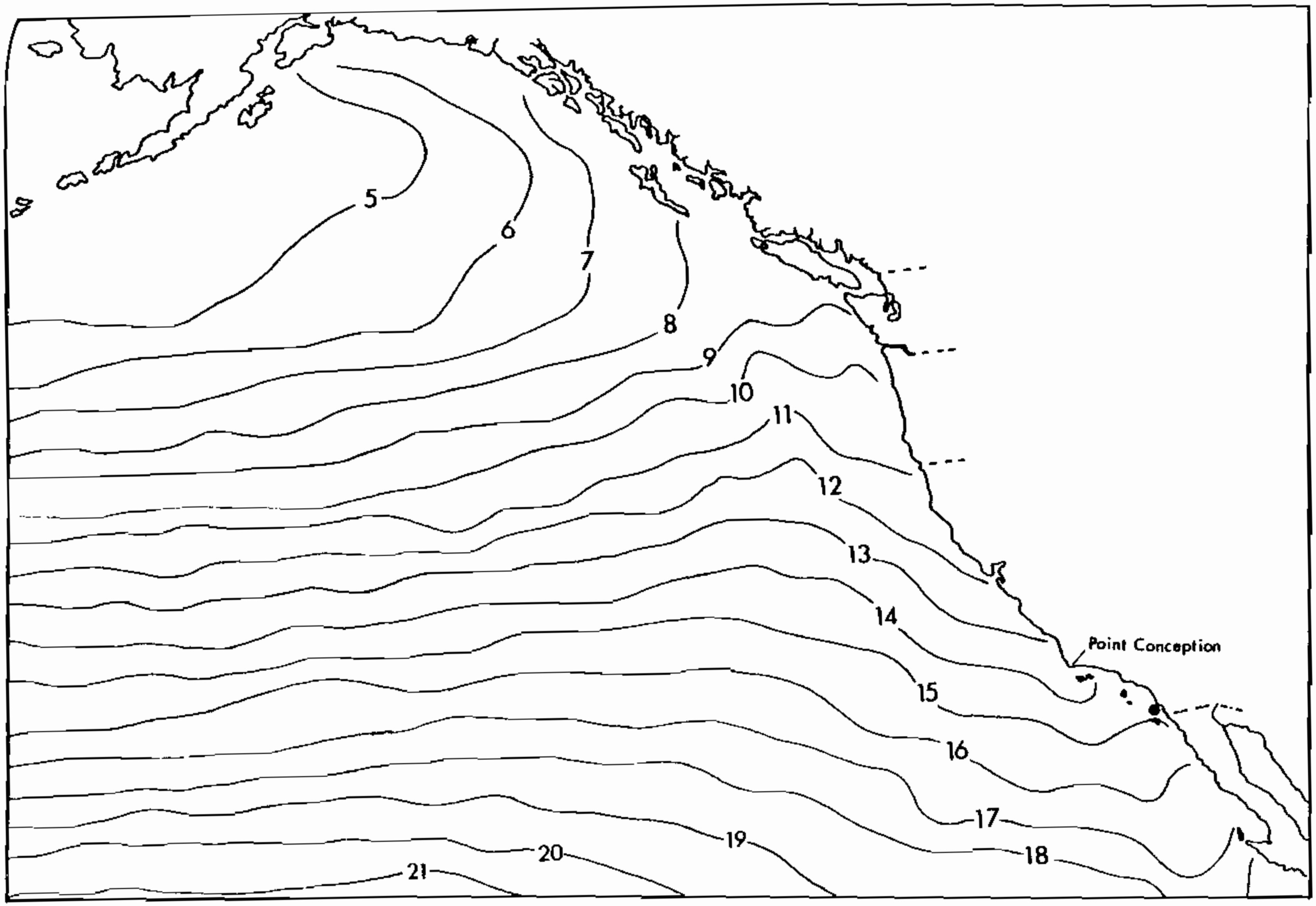


Figure 100. January distribution of sightings of loggerhead sea turtles in the northeastern Pacific as related to the position of surface isotherms.

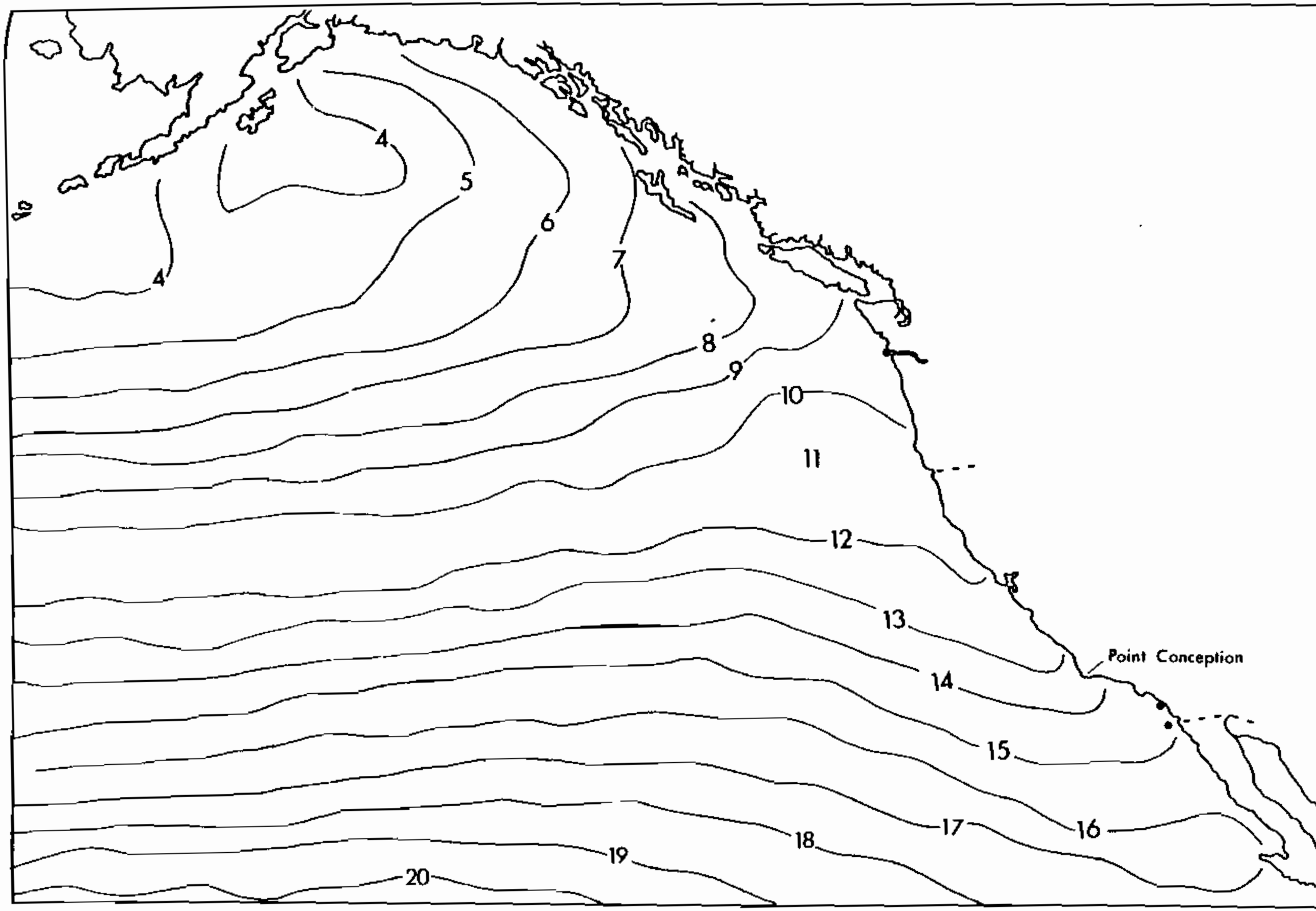


Figure 101. February distribution of sightings of loggerhead sea turtles in the northeastern Pacific as related to the position of surface isotherms.

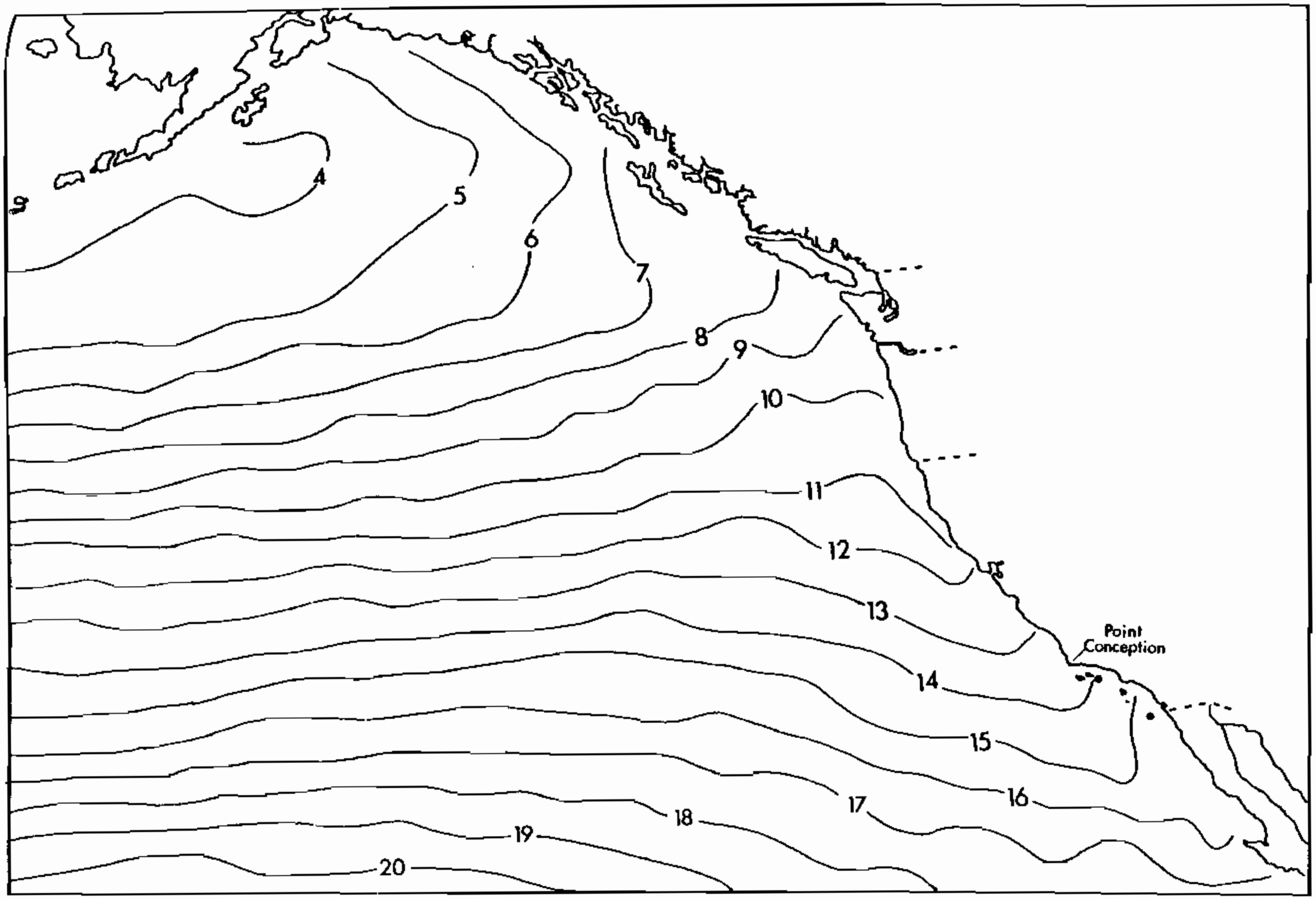


Figure 102. March distribution of sightings of loggerhead sea turtles in the northeastern Pacific as related to the position of surface isotherms. No April sightings were reported.

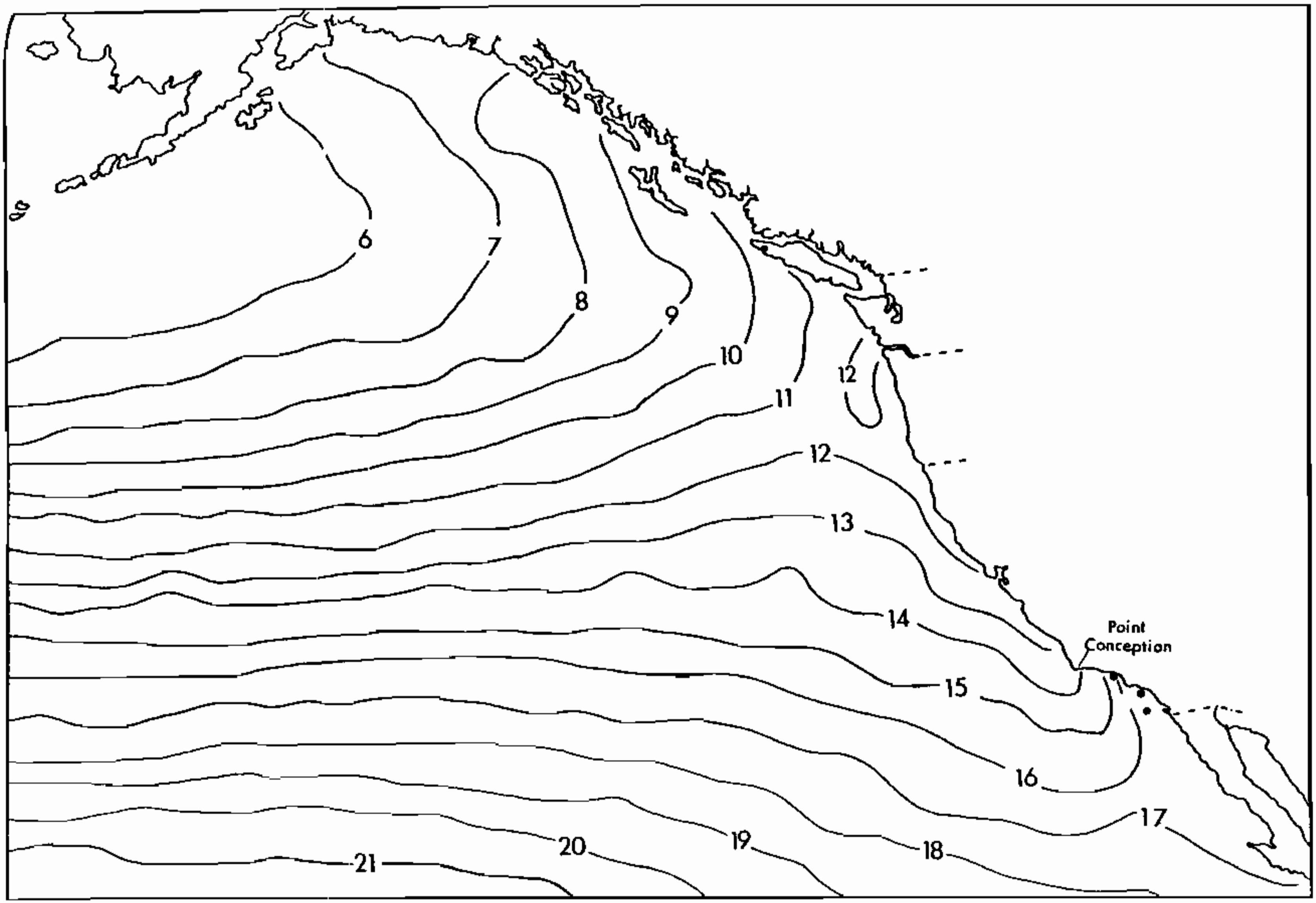


Figure 103. May distribution of sightings of loggerhead sea turtles in the northeastern Pacific as related to the position of surface isotherms. No June sightings were reported.

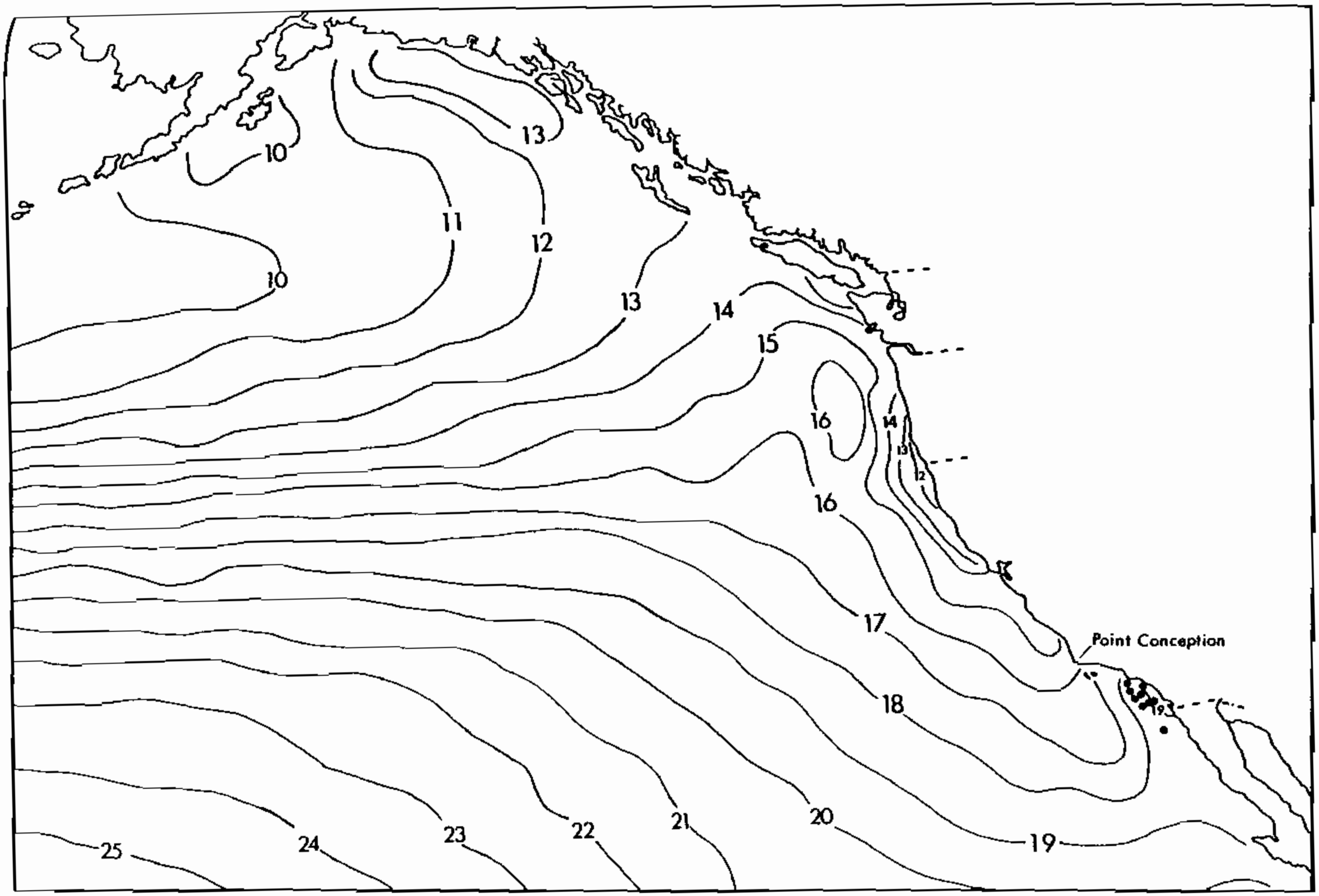


Figure 104. July distribution of sightings of loggerhead sea turtles in the northeastern Pacific as related to the position of surface isotherms.

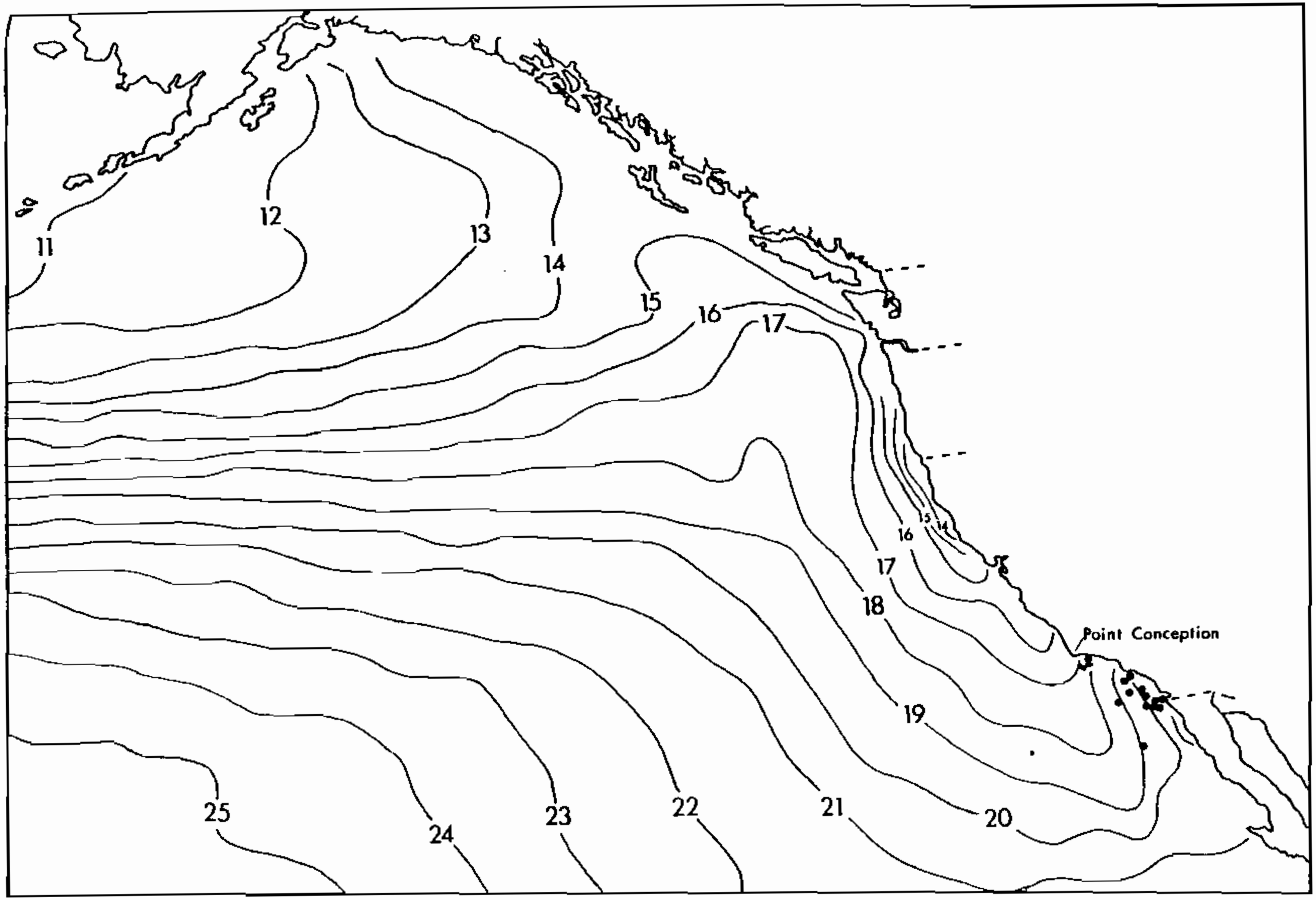


Figure 105. August distribution of sightings of loggerhead sea turtles in the northeastern Pacific as related to the position of surface isotherms.

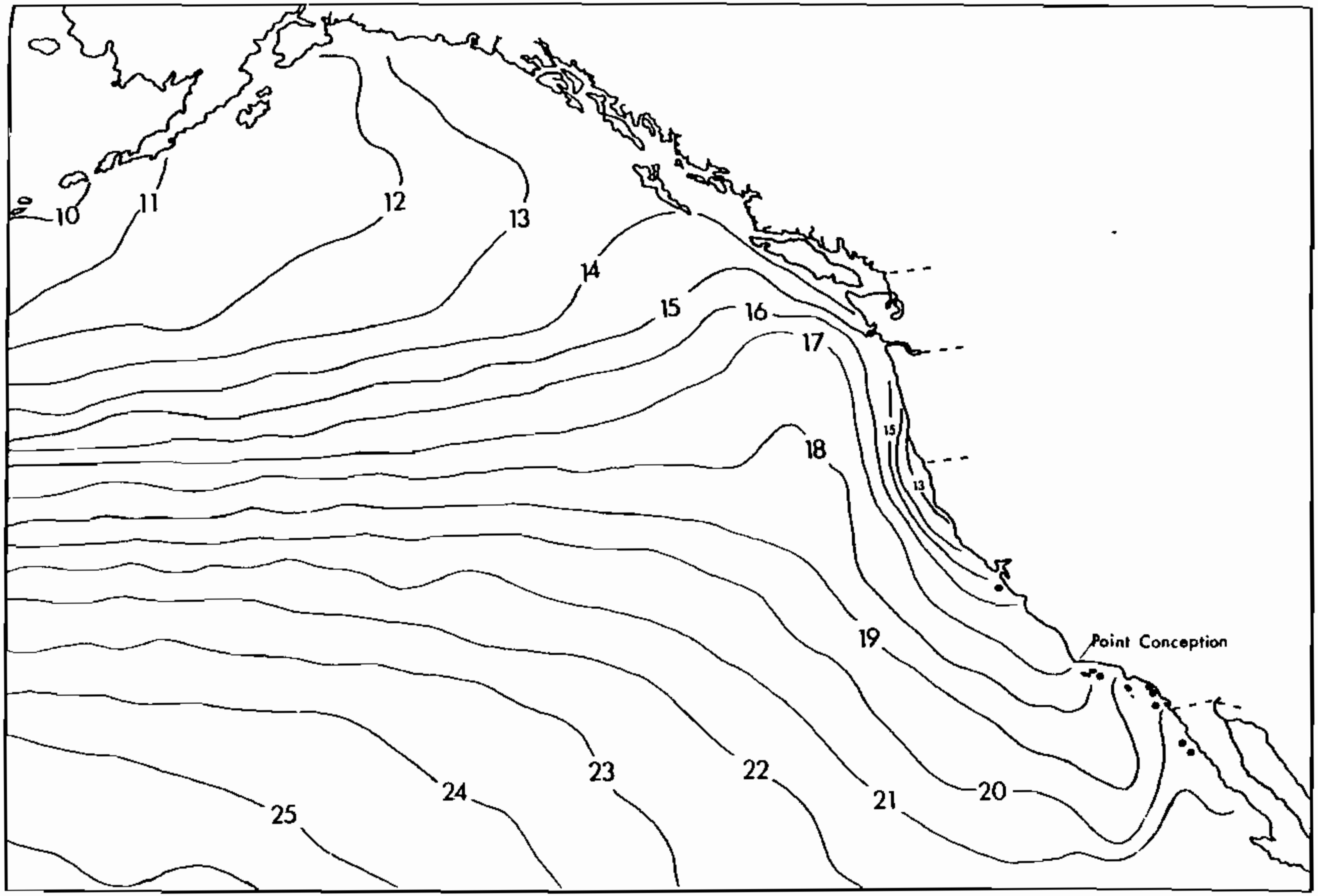


Figure 106. September distribution of sightings of loggerhead sea turtles in the northeastern Pacific as related to the position of surface isotherms.

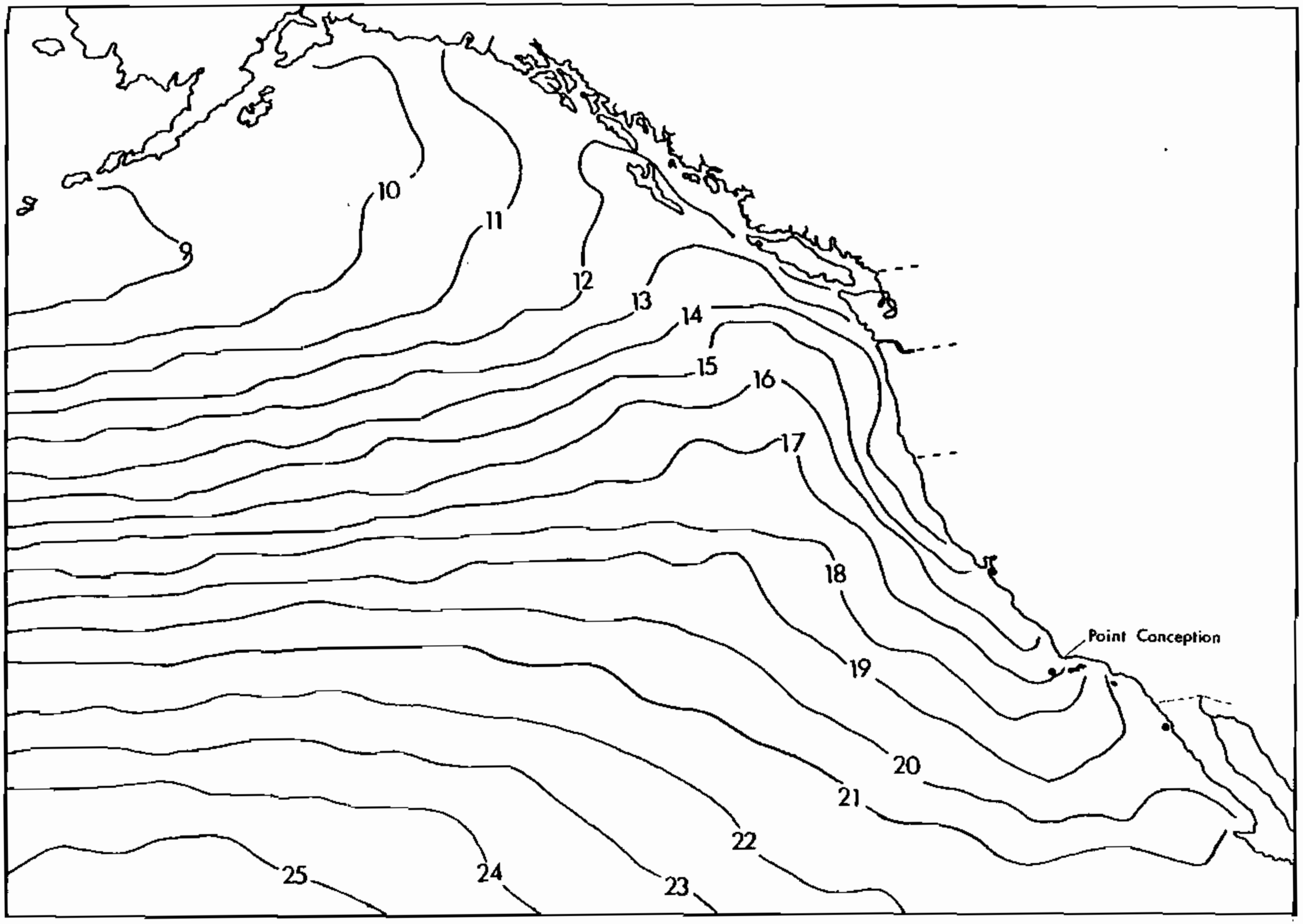


Figure 107. October distribution of sightings of loggerhead sea turtles in the northeastern Pacific as related to the position of surface isotherms.

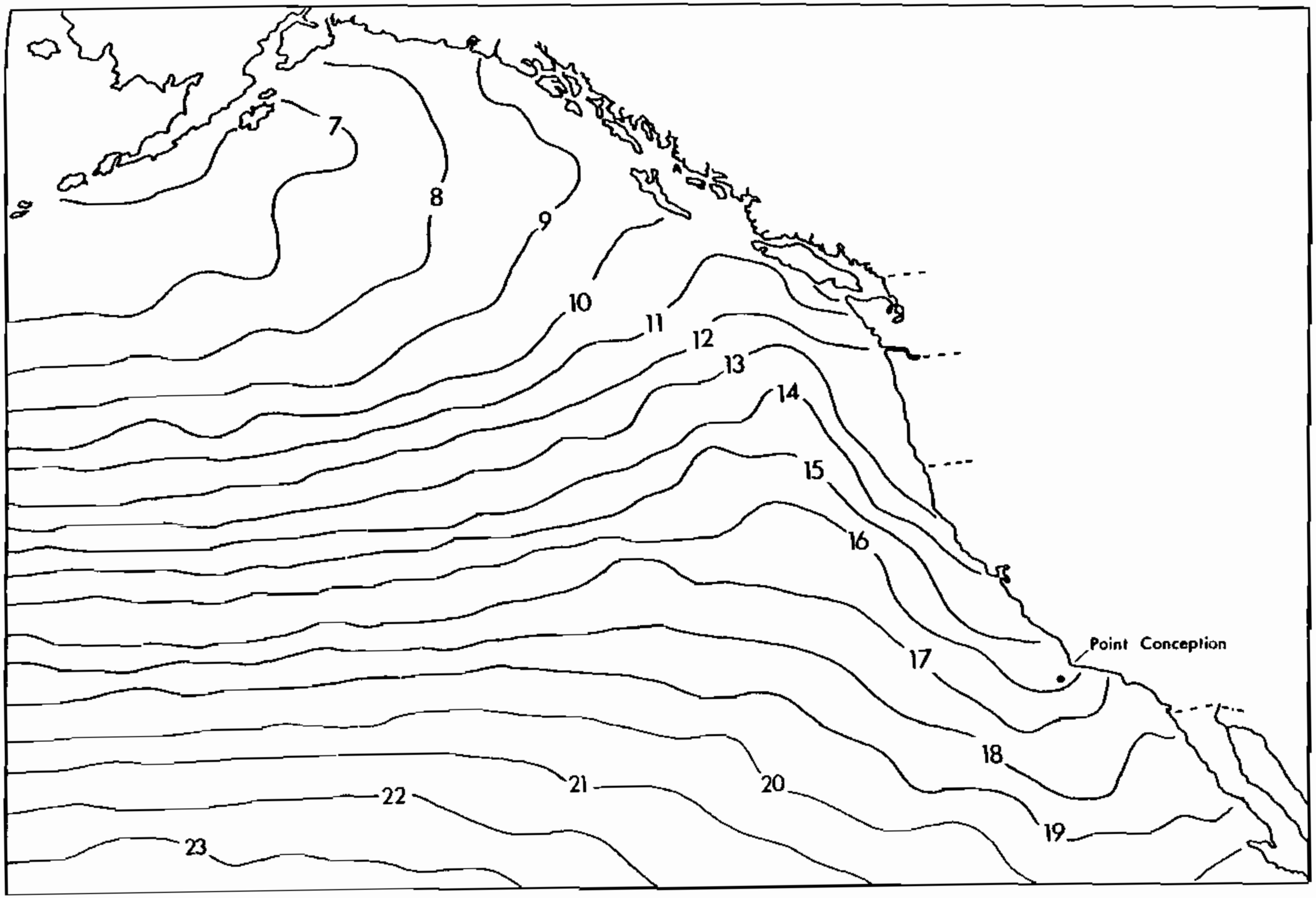


Figure 108. November distribution of sightings of loggerhead sea turtles in the northeastern Pacific as related to the position of surface isotherms.

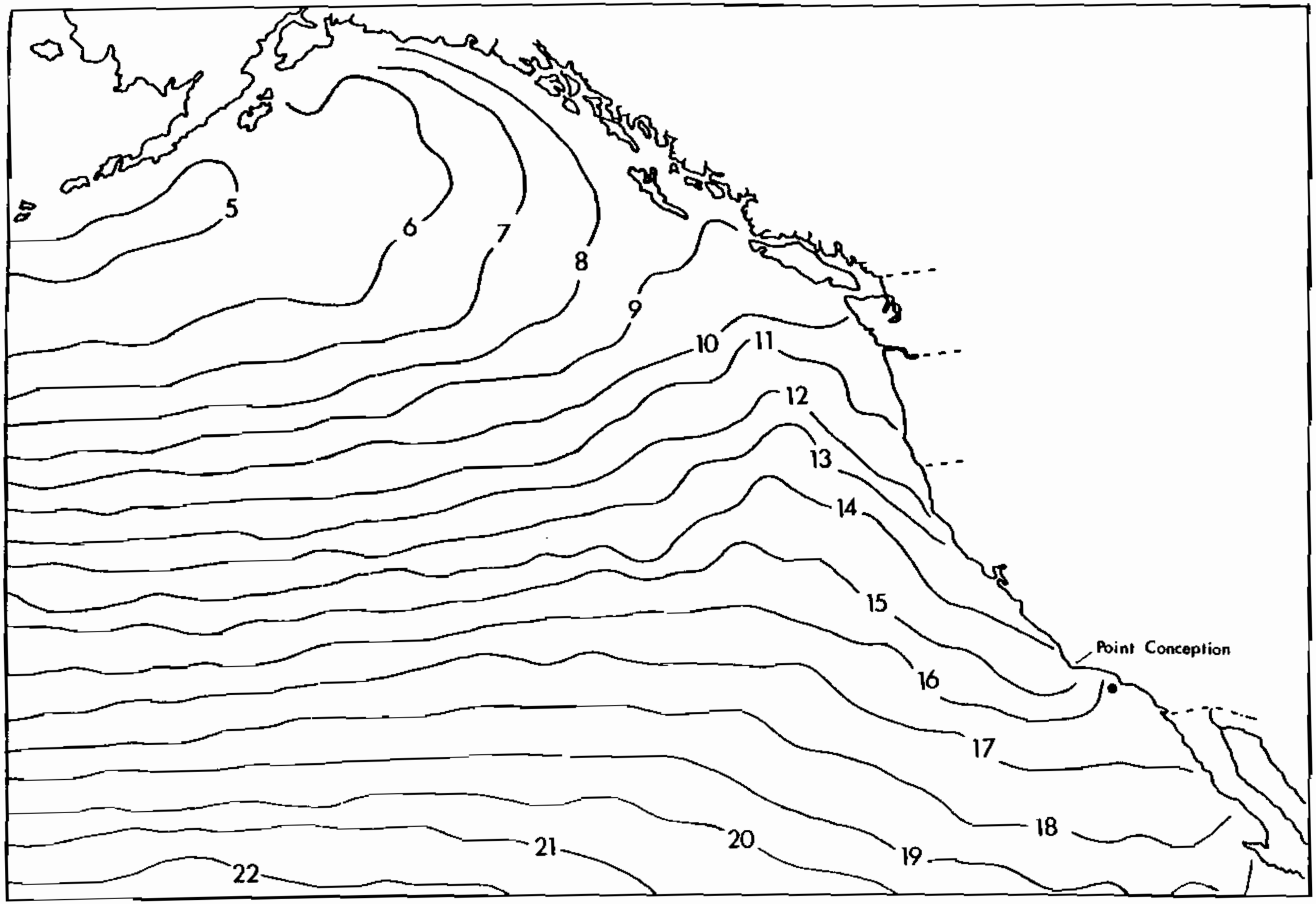


Figure 109. December distribution of sightings of loggerhead sea turtles in the northeastern Pacific as related to the position of surface isotherms.

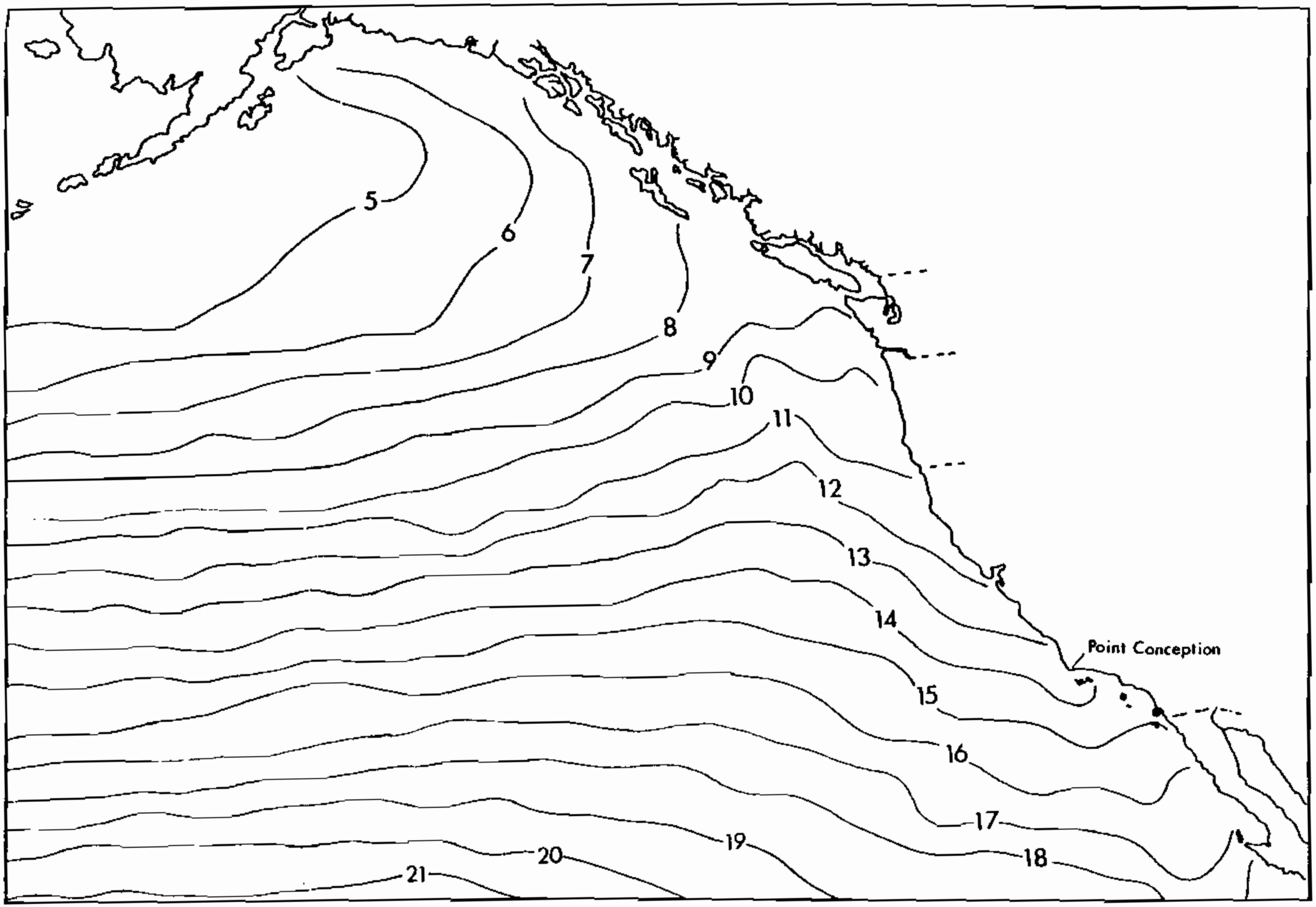


Figure 110. January distribution of sightings of Pacific (olive) ridley sea turtles in the northeastern Pacific as related to the position of surface isotherms. There were no sightings reported for ridleys during February.

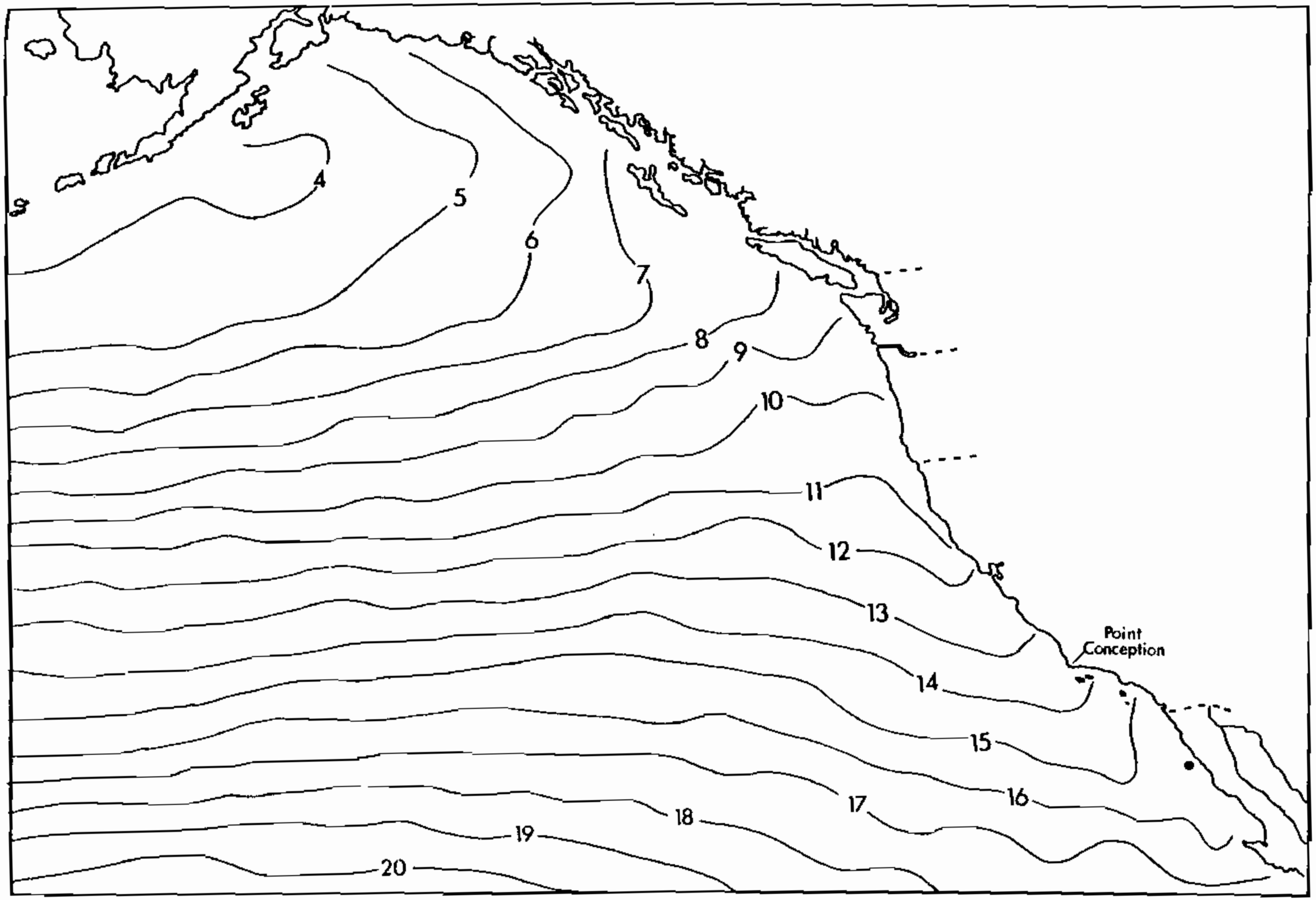


Figure 111. March distribution of sightings of Pacific (olive) ridley sea turtles in the northeastern Pacific as related to the position of surface isotherms.

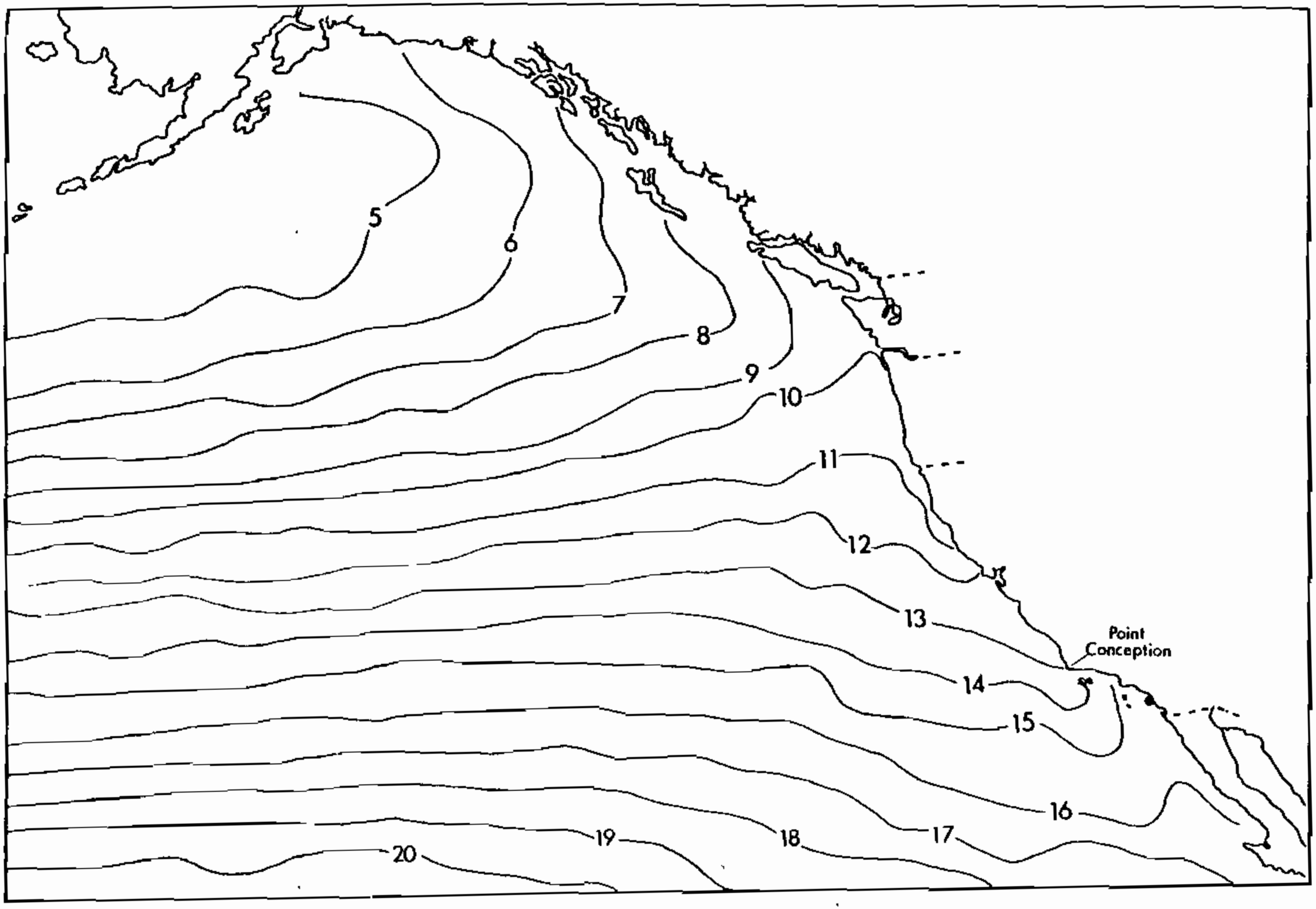


Figure 112. April distribution of sightings of Pacific (olive) ridley sea turtles in the northeastern Pacific as related to the position of surface isotherms. There were no sightings reported for ridleys during the months of May, June or July.

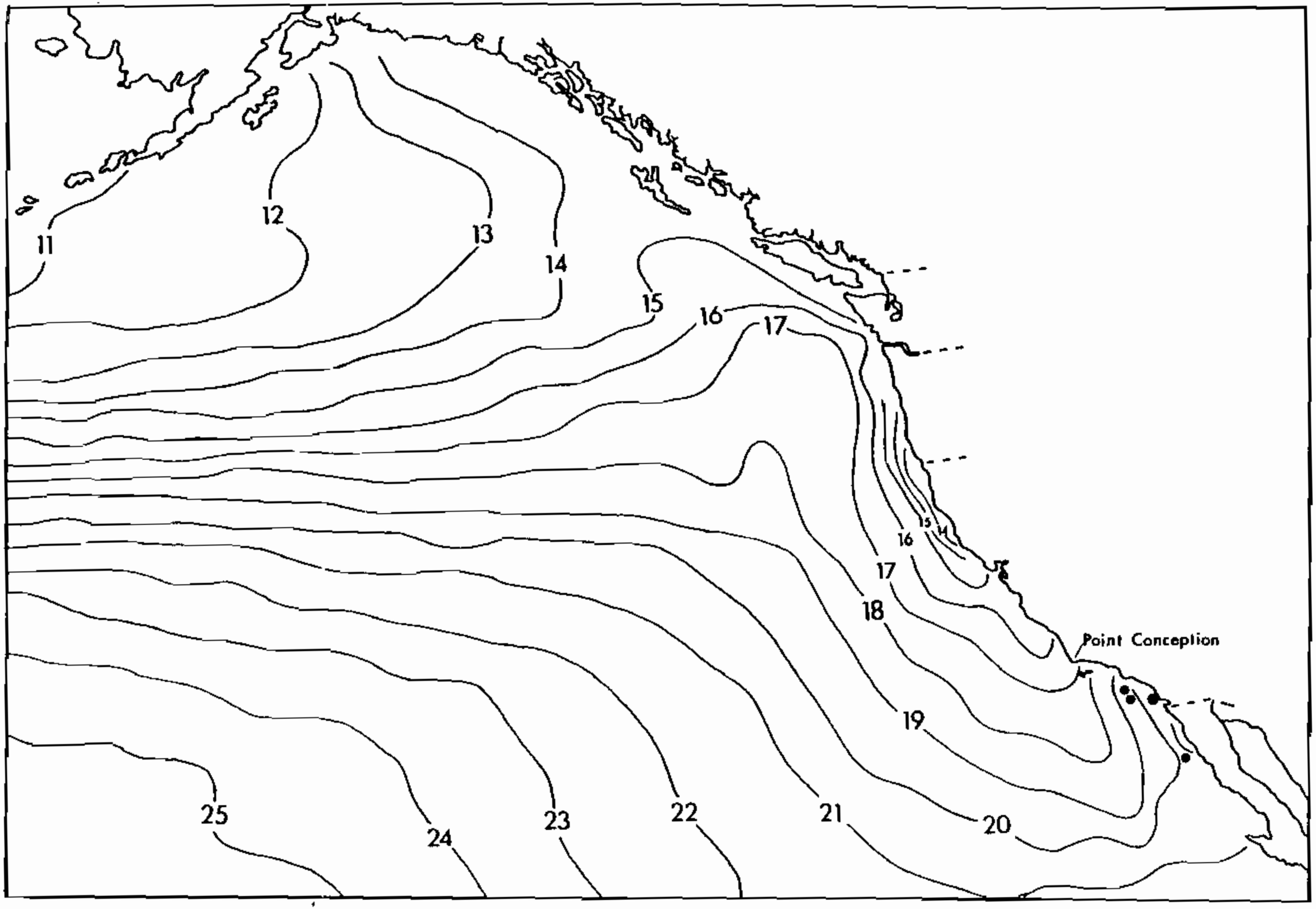


Figure 113. August distribution of sightings of Pacific (olive) ridley sea turtles in the northeastern Pacific as related to the position of surface isotherms.

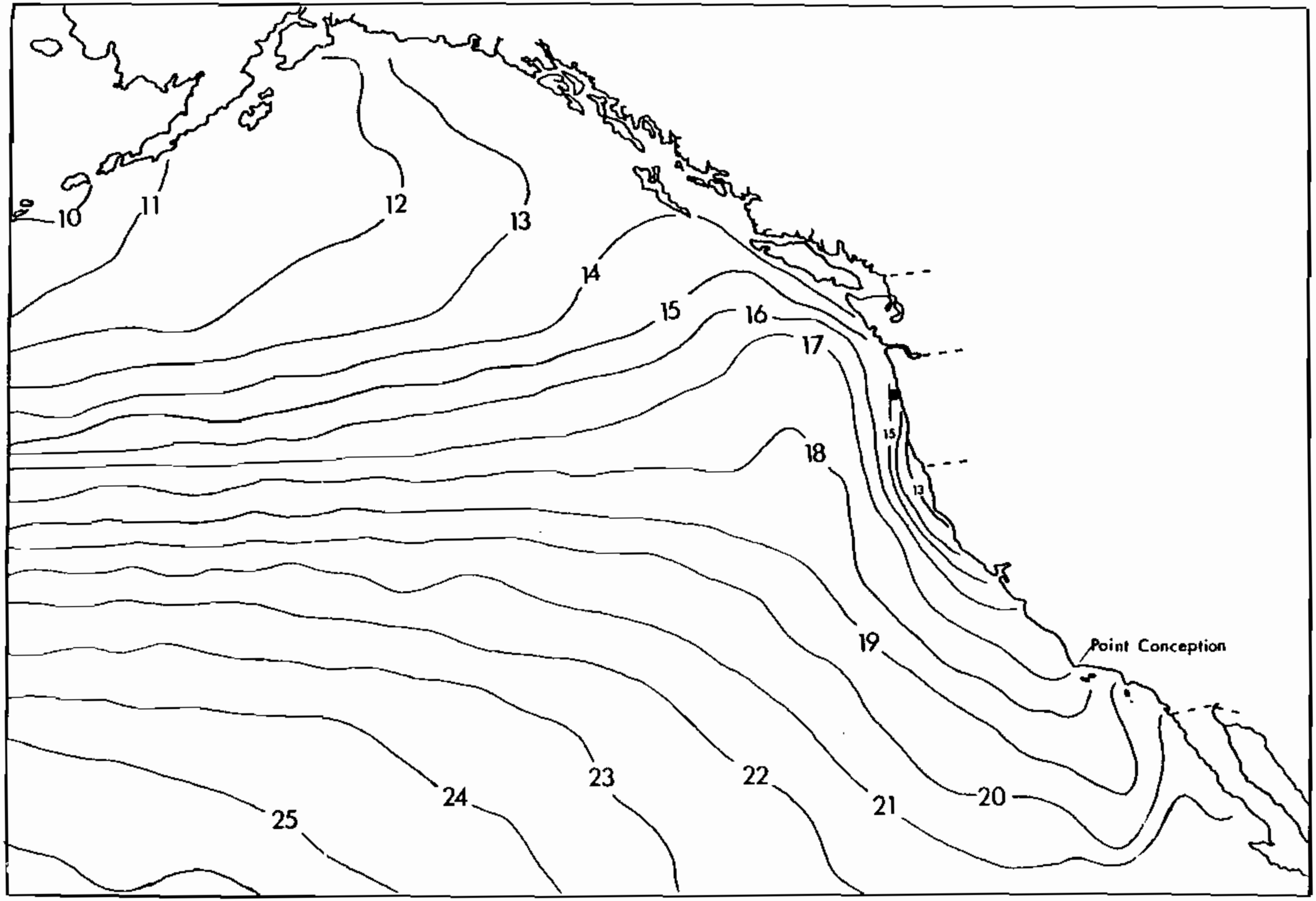


Figure 114. September distribution of sightings of Pacific (olive) ridley sea turtles in the northeastern Pacific as related to the position of surface isotherms.

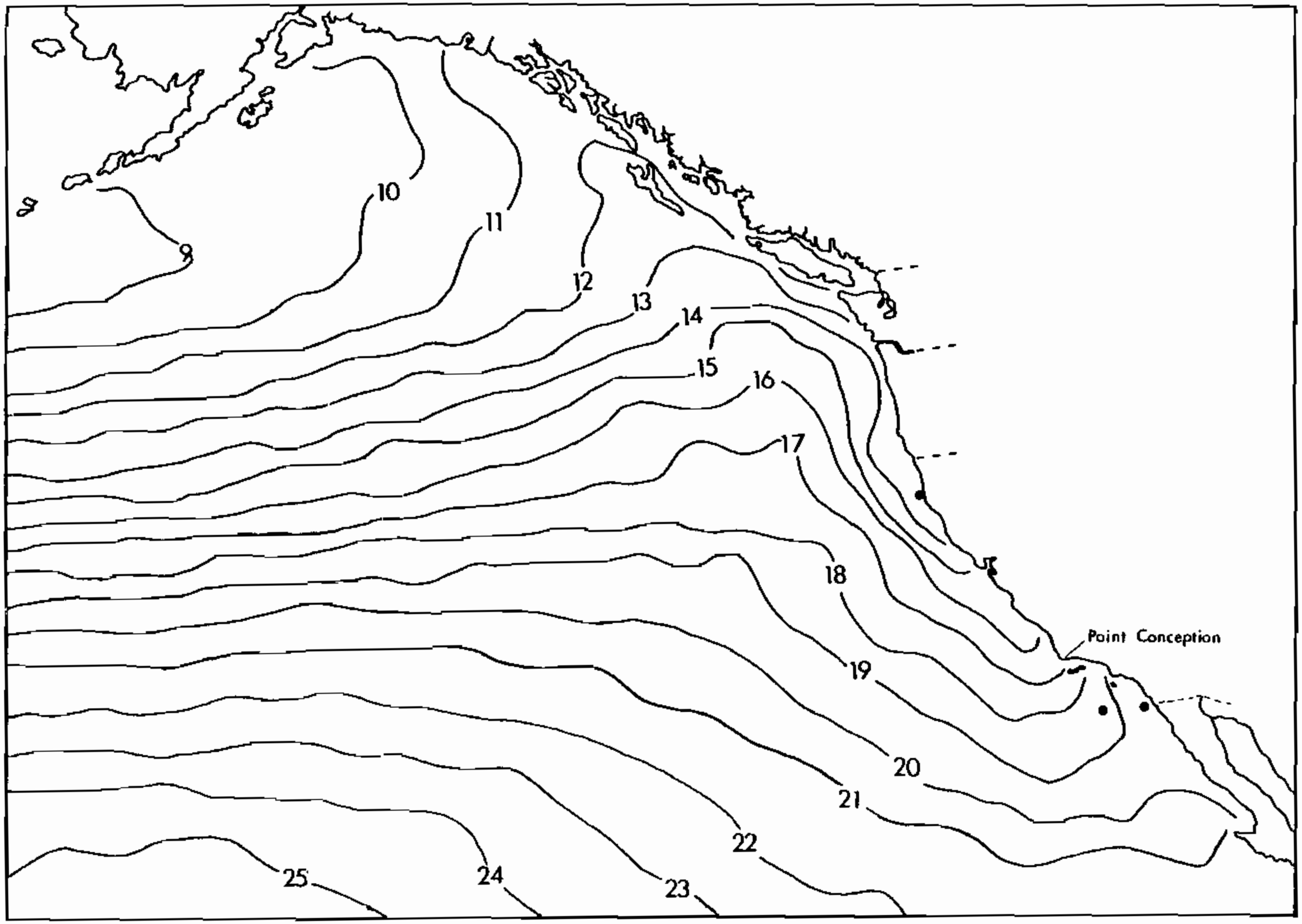


Figure 115. October distribution of sightings of Pacific (olive) ridley sea turtles in the northeastern Pacific as related to the position of surface isotherms.

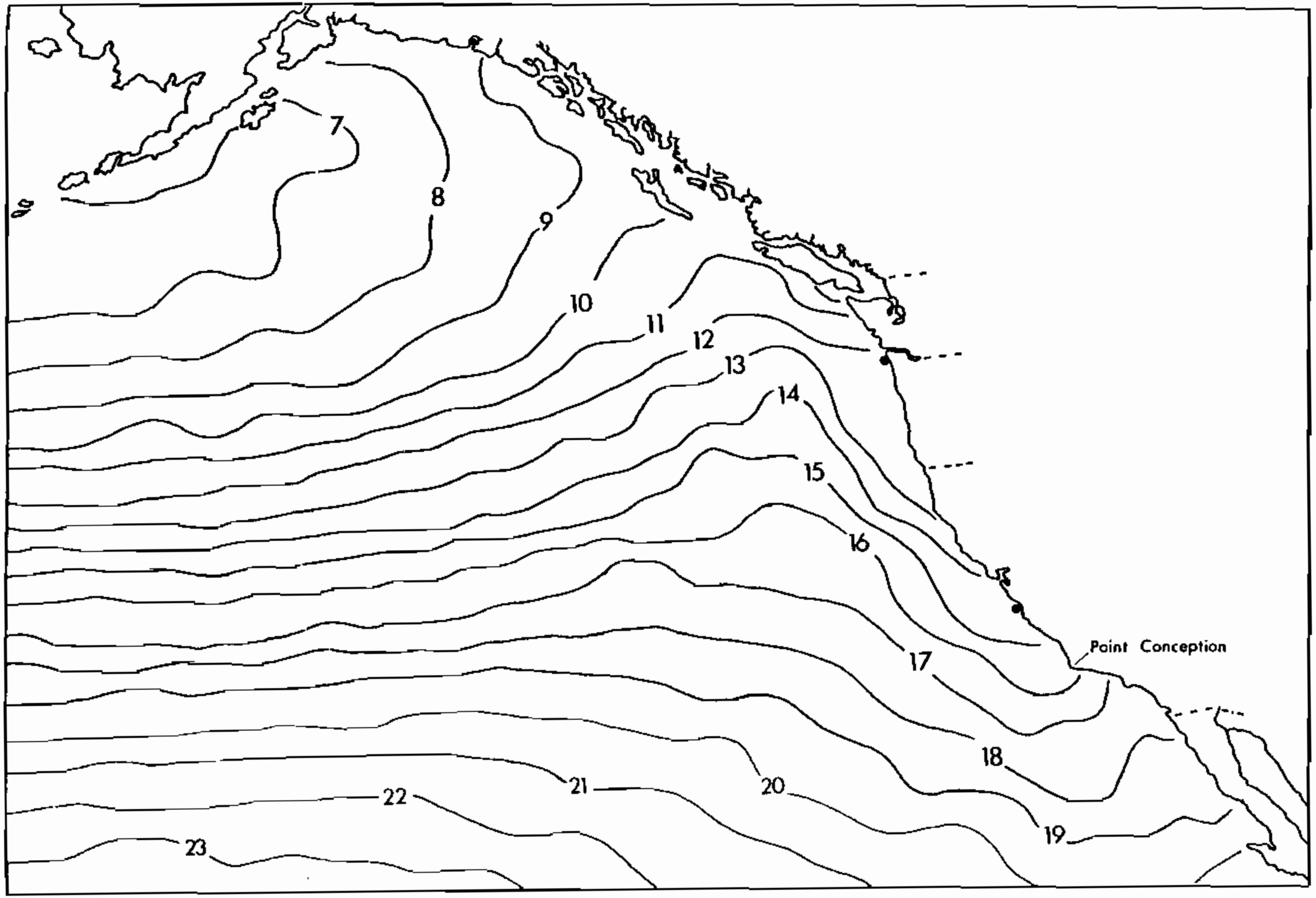


Figure 116. November distribution of sightings of Pacific (olive) ridley sea turtles in the north-eastern Pacific as related to the position of surface isotherms.

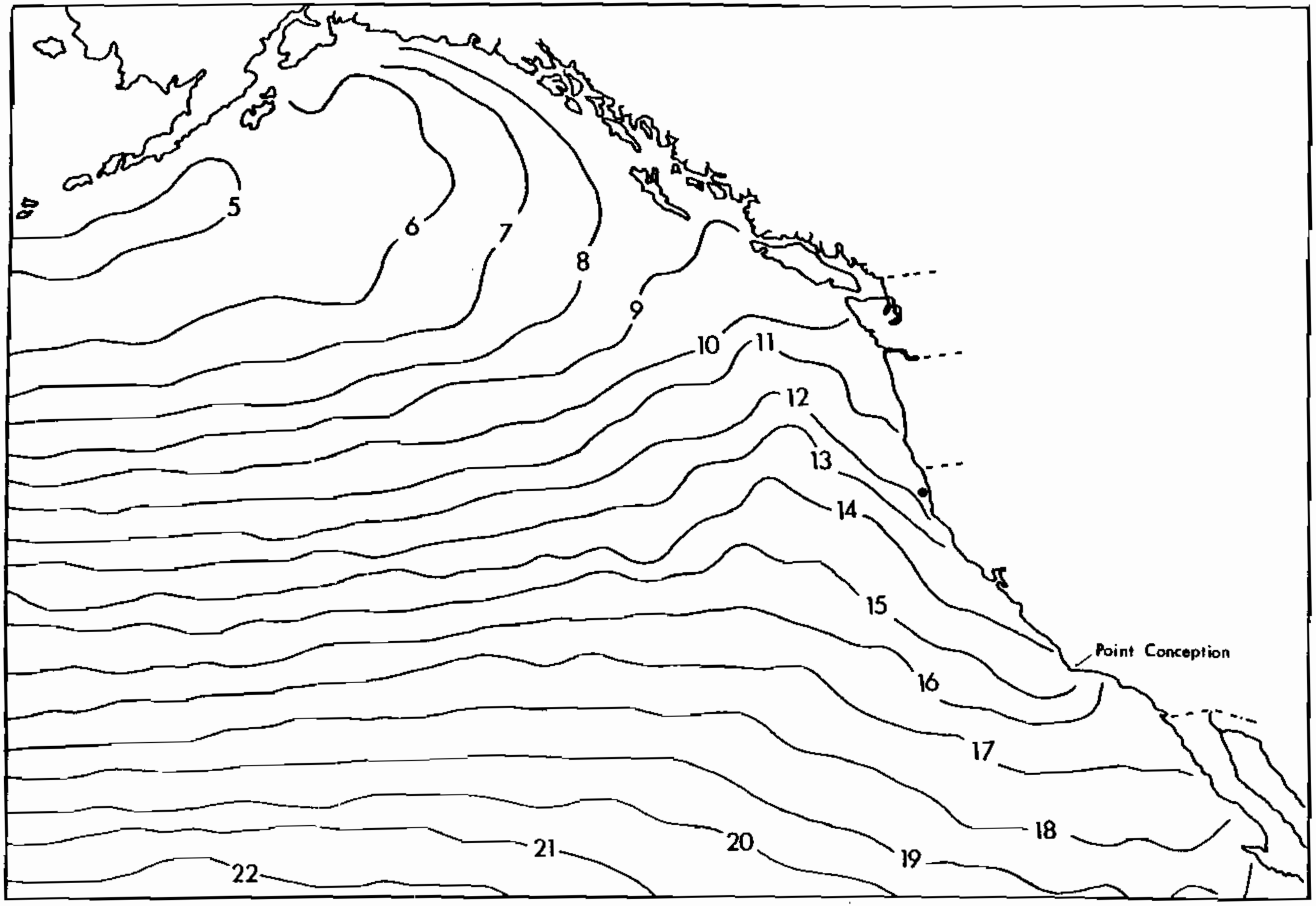


Figure 117. December distribution of sightings of Pacific (olive) ridley sea turtles in the northeastern Pacific as related to the position of surface isotherms.

ABSTRACT

ABSTRACT

A small population of green sea turtles (Chelonia mydas) migrate seasonally to San Diego Bay, California spending November - April in the warmest part of the bay, in and near the warm-water discharge channel of the San Diego Gas and Electric Company's South Bay facility.

Six turtles (1 juvenile, 3 adult males and 2 adult females) were captured in February and March 1979 and tracked using ultrasonic temperature-sensing telemetry to study their thermal biology as well as their daily and seasonal behavior. A transmitter was attached to each turtle's carapace to monitor ambient temperature. In addition, with the exception of one female, each was fed a miniature transmitter to monitor body temperatures.

Their body temperatures ranged from 15.6-27.75°C (in 15.3 to 30.0°C water) but typically were 21-25°C (= eccritic temperature; 23.35°C group mean). One turtle monitored at a cool-water locale became inactive, remaining sedentary at the bay's floor when water temperatures were 15-17°C; its body temperature decreased to 15.6-16.7°C. This turtle alternated days of inactivity at this cool-water locale with days when it re-entered the warm channel and was seen actively swimming and its body temperatures increased accordingly.

Tidal phase, rather than time of day, was of greater importance to turtle activity and travel within the channel. Turtles were active during night hours, as well as during days; one turtle

was tracked on five occasions on what appeared to be nocturnal feeding sojurns through eelgrass beds outside the channel.

Their diving behavior consists, generally, of a long dive of 15-25 minutes followed by a single breath or several short dives (30-90 seconds) before resubmerging for a long dive. Dives as long as 40-45 minutes were common; average length of dives increased with body weight. Synchronous (group) surfacing was observed in 8 of 17 periods.

Records of sightings of sea turtles in the northeastern Pacific (north of 29°45'N latitude) were collected and analyzed to determine the geographic and seasonal distribution of Dermochelys coriacea (leatherback), Chelonia mydas (green), Caretta caretta (loggerhead) and Lepidochelys olivacea (Pacific ridley) sea turtles.

A significantly greater number of turtles were reported when surface ocean temperatures were unusually hot and fewer during periods when temperatures were anomalously cold. But the greatest number of sightings occurred during July, August and September regardless of periods of unusual ocean temperatures indicating a turtle season.

Hard shelled species occur south of Point Conception, California, all year but are most common during July-September when they can range considerably further north.

Leatherbacks appear south of Point Conception only during July-September when temperatures are 16-20°C and probably migrate along the coast from southern Baja California. North of Point Conception they first appear in Oregon in July, when 13-15°C isotherms are pushed against the Orgeon coast. As the season continues they disperse north in the Alaskan Gyral (following the movement of 13-15°C currents) and south in the California Current.

The association of these sea turtles with other species and habitats, their tolerance to low ocean temperatures, bathymetry and their level of contact with man was also reviewed.

United States Department of the Interior
FISH AND WILDLIFE SERVICE

Branch of Ecology
Museum of Southwestern Biology
University of New Mexico
Albuquerque, New Mexico 87131

505:766-3903

22 April 1986

Dr. George H. Balazs
National Marine Fisheries Service
Honolulu Laboratory
P.O. Box 3830
Honolulu, Hawaii 96812

Dear George:

I have had the best of intentions of sending the enclosed samples of Margery Stinson's thesis to you for a couple of months. Even though the thesis was approved in 1984, I only recently received a final copy due to delays in producing the photographs, extra copies, and other details. It is a monumental work and has a wealth of details, history, documentation, and analyses that constitute a valuable resource to those of us working with sea turtles. I'm aware that some boiling could be done to reduce its size but I would like to see the vast majority of the documentation and discussion published in one or two major publications. I have talked to Woody about some help with publication costs and he might be able to help somewhat. Your ideas on whether the NMFS might be able to help or want to sponsor it in one of their publication outlets would be greatly appreciated. As you can see the northeastern Pacific analysis is based on 316 sights for which date and locale were known and 132 of which were from north of Point Conception. Forty-two percent of all sightings were leatherbacks but green and loggerhead turtles formed a significant part of the data base. Certainly the information has relevance to the recovery team even though it does not focus on the Hawaiian area.

I would be glad to discuss publication alternatives with you after you have had a chance to ponder the size and scope of the thesis.

I appreciated your comments on the narration of the sea turtle audiovisual program and will certainly consider them in the final revision.

Sincerely,

Tom

Thomas H. Fritts
Leader, Herpetological Studies Project

Enclosure