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DISTRIBUTION OF FOUR DOLPHINS (*Stenella* spp. and *Delphinus delphis*) IN THE EASTERN TROPICAL PACIFIC, WITH AN ANNOTATED CATALOG OF DATA SOURCES

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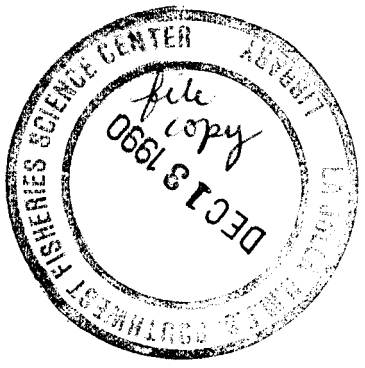

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U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
National Marine Fisheries Service
Southwest Fisheries Center

NOAA Technical Memorandum NMFS

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ABSTRACT

This paper presents distributional data on the primary dolphin species affected by the tuna purse-seine fishery in the eastern tropical Pacific (ETP). The distributional plots presented at the 1979 Status of Porpoise Stocks (SOPS) Workshop for the spotted dolphin (Stenella attenuata), spinner dolphin (S. longirostris), striped dolphin (S. coeruleoalba), and common dolphin (Delphinus delphis) are updated. Past literature is reviewed and the available sources of sighting data from the ETP are listed and described. Approximately 30,000 sightings of S. attenuata, 16,000 sightings of S. longirostris, 2,000 sightings of S. coeruleoalba, and 9,000 sightings of D. delphis have been included in the plots. The bulk of these sightings were made aboard tuna purse-seiners by observers employed by the National Marine Fisheries Service and the Inter-American Tropical Tuna Commission. A plot of sighting effort for these observed trips is also included. The NMFS observer data collection and editing program is described in detail, as are the computer programs used in this analysis.

The "SOPS '79" distributions for all four species have been extended, particularly at the western and southern edges of the ranges. Range boundaries which are not imbedded in areas of moderate or high search effort have been marked as uncertain. The known range of S. attenuata has been extended northward to ~27°N latitude off Baja California, westward to ~158°W longitude at the western boundary, and southward along the entire southern boundary, extending to ~17°S at the southeastern corner. The known range of S. longirostris has been extended in a similar fashion. The known range of S. coeruleoalba has been extended primarily westward along the northern and western edges, as far as ~155°W at the western extreme. The known range of D. delphis has been expanded slightly along all boundaries. Populations of Stenella spp. in the Hawaiian, Christmas, Marquesas, and Society Islands have been provisionally considered to be disjunct from populations in the ETP.

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INTRODUCTION

The formal program of research at the Southwest Fisheries Center (SWFC) on the populations of dolphins involved in the purse-seine fishery for yellowfin tuna in the eastern tropical Pacific (ETP) began in 1969, and the first document issuing from the program that contained extensive information on distribution of the species in the ETP was a doctoral dissertation on spotted dolphins, Stenella attenuata, and spinner dolphins, S. longirostris, submitted to U.C.L.A. (Department of Zoology) by W. F. Perrin (1972, 1973 and 1975a). Earlier published information on the species consisted of scattered single specimen records (reviewed in Perrin, 1975a) and summaries of sightings by both lay observers and biologists (Nishiwaki, 1967 and Mörzer-Bruyns, 1971). The latter are discussed in the appended catalog of data sources (Appendix 1). The same distribution information presented by Perrin (1972) (including maps of records through 1970) appeared again in an appendix to the Report of the NOAA Tuna-Porpoise Review Committee (NOAA, 1972). The first review of the distribution of S. coeruleoalba in the ETP was published the next year (Hubbs, Perrin and Balcomb, 1973). Perrin (1974 and 1975b) presented outline maps of the distributions of S. attenuata and S. longirostris incorporating additional data, and these were used in estimating population sizes (Smith, 1975), in stock assessments (Perrin, Smith and Sakagawa; 1974, 1975, 1976 and 1982) and in a review document (Barham, 1974). The report of a workshop on stock assessment in 1976 (SWFC, 1976) included maps of expanded known distributions of S. attenuata and S. longirostris that incorporated data collected through part of 1976. It also presented a map for S. coeruleoalba based on plotted records through part of 1976 in Kimura and Perrin (1976) and a range map for Delphinus delphis based on SWFC-collected data and on material presented by Evans (1976a and b). Perrin, Sloan and Henderson (1978 and 1979) presented range maps including extensions of distribution below the equator for S. attenuata and S. longirostris. Updated maps for all four species appeared in Au, Perryman and Perrin (1979), and these were used in a 1979 assessment of the status of the populations (Smith, 1979 and 1983; Holt and Powers, 1982). The species' distributions were subsequently reviewed by Alverson (1980 and 1981) and Scott (1981), who incorporated data through 1980.

The purposes of this paper are to survey and evaluate sources of data on distribution of these species of dolphins (called "target species") in the ETP and to review the known distributions based on data available through 1982. This document does not estimate predicted total distribution (based on environmental variables) or distribution at any one time (considering seasonal and year-to-year variation), but rather only establishes the total envelope within which reliable records of the species exist.

METHODS AND MATERIALS

Sources and Treatment of Distribution Data

Tunaboat Observer Data

The primary source of data on distribution was the information collected by observers aboard commercial tuna seiners (described in Appendix 1) . The observers were employed by the U. S. National Marine Fisheries Service (NMFS) or the Inter-American Tropical Tuna Commission (IATTC). For this review, data were available for cruises carried out from 1966 to 1983 (partial). Procedures for data collection and management are described in Appendix 2.

The data were extensively reviewed through 1976 by two of us (Perrin and Au) in preparation for the stock assessment exercise reported in Smith (1979). The species boundaries used in the 1979 assessment (the "Status of Porpoise Stocks Workshop") are referred to below as the "SOPS '79" boundaries. The review focused on records lying outside boundaries delineated on the basis of earlier data. A similar review was carried out by Perrin in 1980 during the course of an administrative hearing concerned with dolphin mortality in the tuna fishery, covering NMFS data for 1977 through 1979. For the present report, we have reviewed NMFS data for all years through part of 1983 and IATTC data for 1979 through most of 1983, using procedures similar to those used previously to screen the data for processing errors (coding, keypunching, etc.) and likely misidentifications (see Appendix 2).

Factors considered in reviewing these sighting records and those from other sources discussed below include:

a. documentation of diagnostic characters (including behavior) in narrative description, sketch or photograph(s);

b. sighting distance and conditions;

c. whether or not the vessel pursued the animals to identify them or, in the case of tuna seiners, to catch them;

d. experience of the observer, including number of previous cruises, training, and professional background;

e. quality of documentation and identifications for other sightings made by the same observer;

f. in the case of commercial tuna seiners, confirmation of identification by members of the crew;

g. geographical locations, i.e., degree of anomaly with regard to previously-known distribution and oceanographic conditions such as surface temperature.

Where the observer qualified the identification with "possibly," "probably," "?," etc., we upgraded the identification from "unidentified dolphin" to a specific identification only when the diagnostic characters had been unequivocally described, sketched or photographed. In most cases we let the unidentified status stand. In some few cases, especially in the data from miscellaneous sources, where the records were in far-outlying areas and the evidence to support upgrading (or downgrading) was marginally equivocal, we included the record as "probable" but treated it in a separate category (see species accounts below).

We assumed that members of the crews of the tuna purse seiners in all cases correctly identified spotted and spinner dolphins and accepted these identifications without further documentation. We did not do this for the striped and common dolphins, because many fishermen refer to both (and in some cases Fraser's dolphin, Lagenodelphis hosei) as "whitebellies."

IATTC Logbook Data

An additional source of distribution data for S. attenuata and S. longirostris was the system of logbooks maintained by the IATTC (Source VII in Appendix 1). Logbook data are supplied voluntarily by the operators of tunaboats fishing in the eastern Pacific. Data from individual purse-seine sets are extracted by the IATTC (although the identities of individual boats are kept confidential). A computerized file of dolphin data was extracted for 1959-1982. These distribution records overlap those collected by the observers to a considerable degree. The two data sets do not coincide completely, because not all trips were accompanied by observers and because not all vessel operators made their logbook data available. For the analyses here, we considered only those records lying outside the 1979 SOPS boundaries and not represented in the observer data.

The IATTC logbook data also contain records of sets made on unidentified "porpoise." Some of these were in areas for which no sets on identified dolphins were reported. In order to ascertain the likely identity of the unidentified dolphins, we examined the dolphin-species composition of sets in 1978-82 (NMFS data) on identified dolphins by 5-degree block (Fig. 1). This analysis showed that nearly all sets in offshore peripheral areas were on spotted dolphins, although some were on spinner dolphins and a very few on striped dolphins. We accordingly consider the outlying "unidentified porpoise"-set records as "probable" spotted-dolphin records and, because of the possibility that other species were involved, we kept these records in a separate category in describing the distribution of the spotted dolphin (below).

Other Sources

Other sources of distribution data, including sources not used in this review for various reasons, are described and evaluated in Appendix 1. We also reviewed extralimital records summarized by Alverson (1980 and 1981), using the same review criteria as for the tunaboat data.

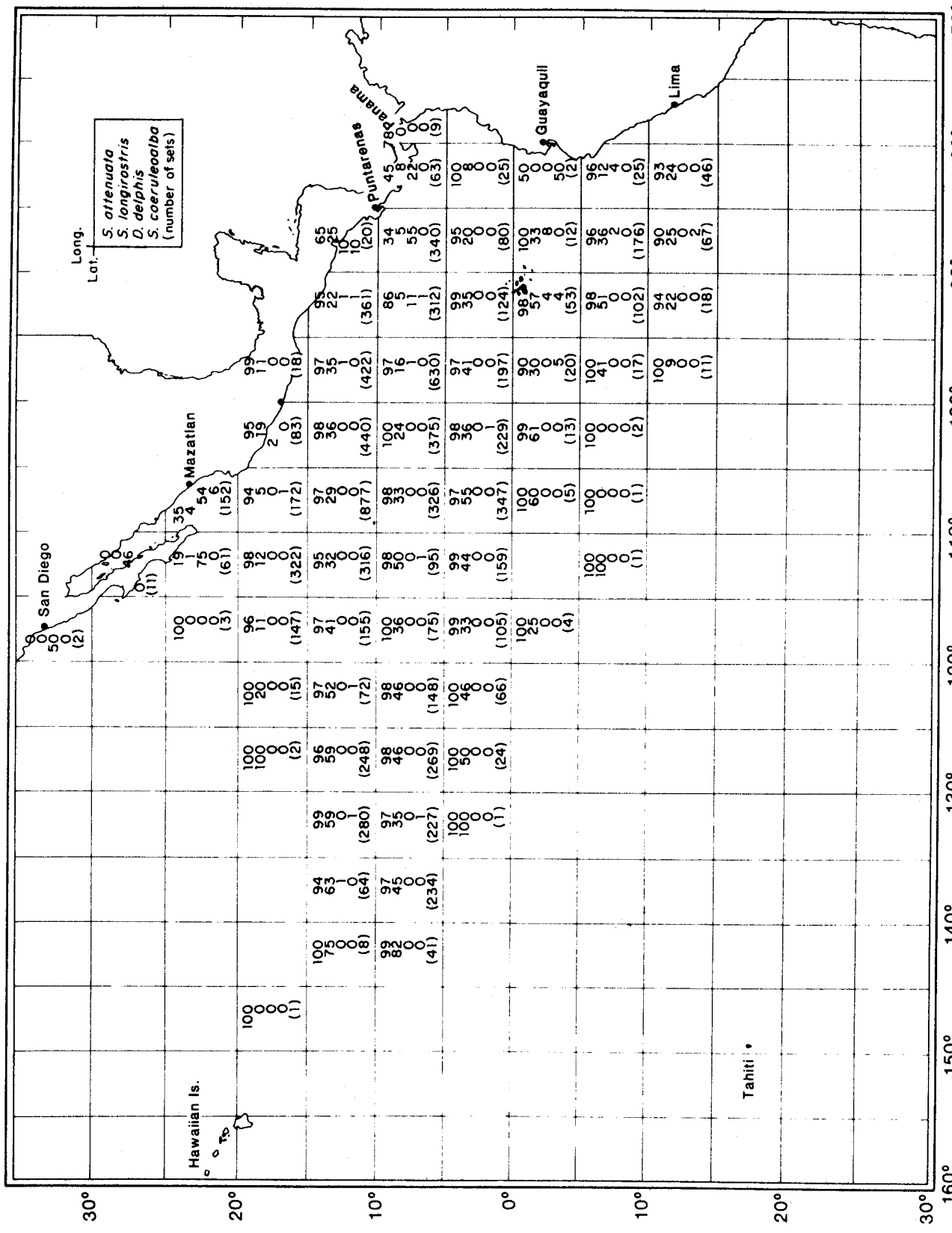

Figure 1. Species composition (%) of net sets on dolphins, 1978-1982 (NMFS data only). Sets on non-target species or on unidentified dolphins not shown but included in sample size.

We limited this review to the eastern Pacific (from 35°N latitude to 20°S latitude) and the eastern portions of the Central Pacific and South Pacific (to 160°W longitude). All four species occur around the world in the tropics. Distribution in the central, southern and western Pacific was reviewed by Hubbs et al. (1973), Perrin (1975a) and Alverson (1980 and 1981).

Data on Sighting Effort

The main source of effort data was again the tunaboat observer programs. Details of data collection and management are presented in Appendix 2. Data were available for the NMFS observer program for 1971-1982 and for the IATTC program for 1980-1982. Effort data were also available for the series of marine-mammal sighting cruises carried out by the SWFC during the period 1976-1983 (Sources III and IV.A. in Appendix 1). A total of almost 3 million miles of sighting effort is represented in the available data (Figure 2). In addition to these data, we also took into account the portions of tracklines lying outside the 1-degree squares for which effort data were available from two aerial surveys (Jackson, 1980 and SWFC, 1977; included in Source VI in Appendix 1) and from three research cruises for which effort data were not collected (Figure 2).

Computer Programs

Computer programs used in plotting and analyzing the data are described in Appendix 3.

SPECIES ACCOUNTS

Stenella attenuata

There were approximately 30,000 sightings of spotted dolphins. Confirmed sightings that fell outside the SOPS '79 boundary (Fig. 3) were mainly in regions adjacent to the SOPS '79 range: in the northeastern corner near Baja California, to the west of the westernmost extension of the range at 10-15°N latitude, to the southwest between about 130° and 140°W longitude, and in the southeastern corner near South America. In addition, there are good records of the species from Hawaii and the Marquesas Islands. In the northeastern corners and in the far southeastern corner, the outlying sightings are imbedded in large areas of considerable sighting effort; therefore the edge of the species' range in these areas can be defined with some confidence. This is also true to a lesser extent for the balance of the northern boundary west from about 130°W longitude and a portion of the southern boundary between about 130° and 145°W longitude. For the far western region and most of the southern boundary, however, the outlying sightings extend to the edge of the area covered by recorded sighting effort. These sightings are not numerous, but then the effort coverage in the peripheral areas has also been light. We conclude that the western and southern extents of the continuous range in the eastern Pacific are unknown. This is lent emphasis by three "probable" records to the southwest of the western extension of the tuna seining grounds

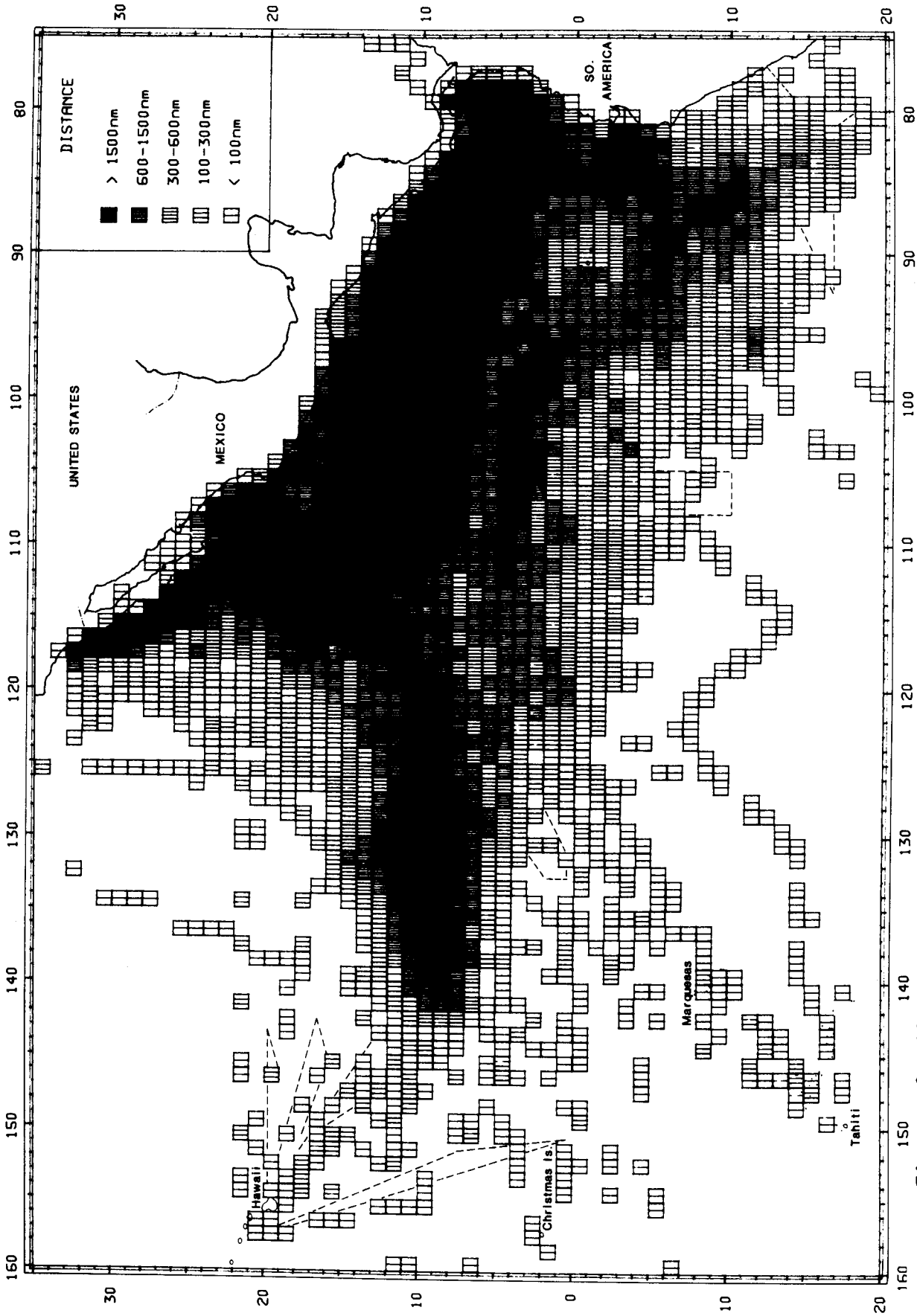

Figure 2. Sighting effort in the eastern tropical Pacific. Included are data (in nautical miles) from NMFS observer cruises in 1971-1983 and IATTC observer cruises in 1980-1982, for a total of 2,999,654 nautical miles. Also indicated (dashed lines) are outlying portions of track lines of two aerial surveys (1977 and 1979) and three research cruises for which effort data in miles was not available (SWFC cruises 126, 169, and 216).

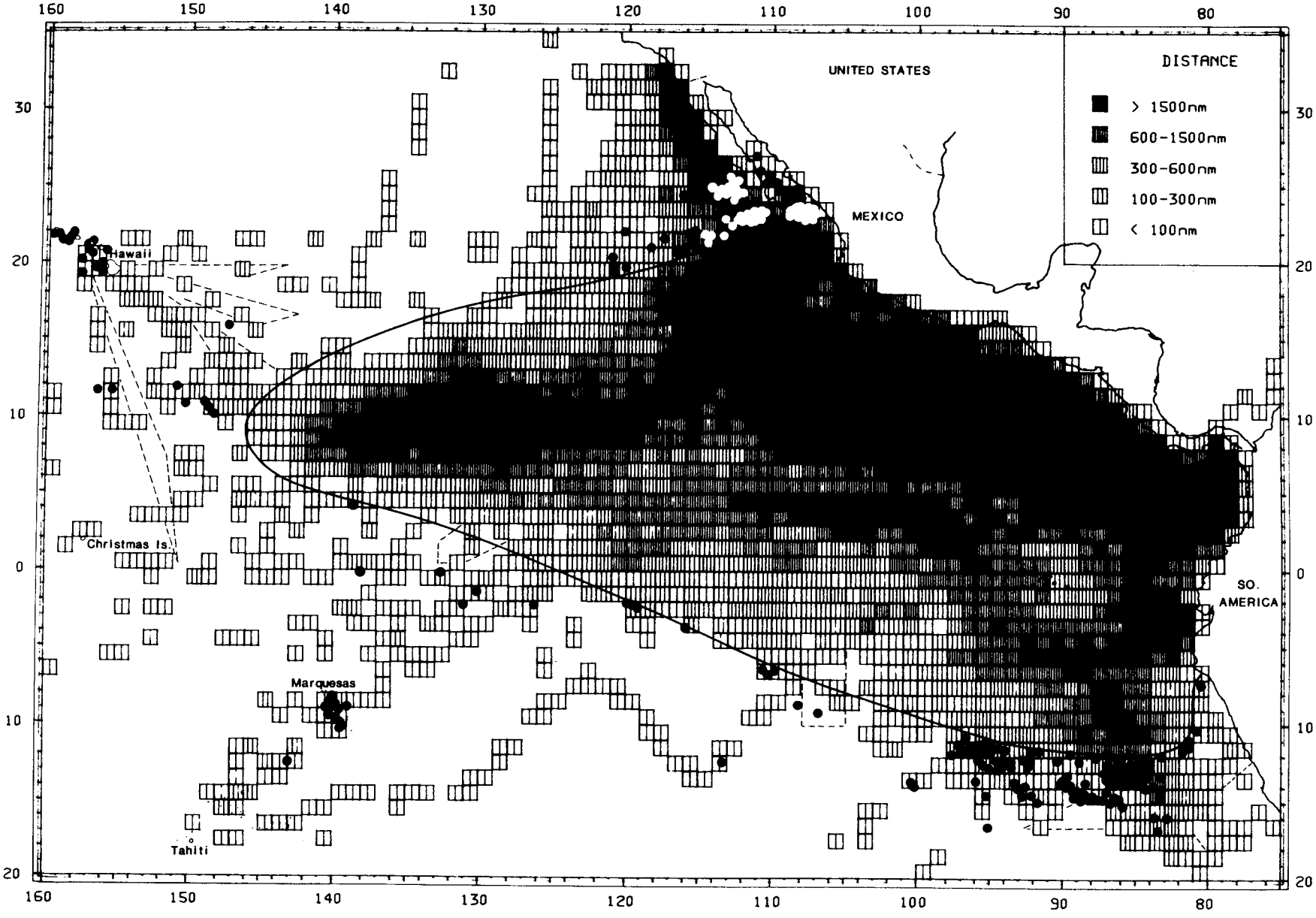

Figure 3. SOPS '79 boundary for S. attenuata, and outlying records superimposed on recorded sighting effort in nautical miles per one-degree block.

(to the north and east of Christmas Island).

In depicting the extent of the known distribution (Figure 4), we have assumed that the Hawaiian and Marquesan animals occupy disjunct ranges. We have included all other confirmed records ("probable" and "possible" not included) in a continuous envelope. We have identified those portions of the edge of the known range that are adjacent to areas of no effort with a dashed line indicating the uncertainty of the envelope. The fit of the boundary line to the data is a smoothed one, with the implication that we believe that more sighting effort would result in fewer irregularities in the edge of the swarm of points. The boundary is not as smooth as the SOPS '79 boundary, however, because such would require inclusion of very large expanses of unsurveyed ocean. Again, we emphasize that we are depicting the known distribution, not the expected distribution.

It should be noted that the envelope contains several areas that have received moderate to heavy survey effort (the two darkest symbols in Figure 3) but within which no sightings or only a few sightings have been made. One such area is the Gulf of Tehauntepec (15°N latitude, 95°W longitude). Another is an area off Costa Rica (about 8°-12°N latitude and 86°-90°W longitude). Other areas include the band just north of 5°N latitude and extending from about 95° to 125°W longitude, the area off Mexico between 15°-20°N latitude and 105°-110°W longitude, the region extending from about 12° to 16°N latitude and 118-125°W longitude, the region of the Galapagos Islands, and the eastern Panamanian Bight (off Colombia). The low-density band just above 5°N latitude may be in part an artifact related to international tuna management (the Fifth Parallel was a southern boundary of a closed fishing zone during parts of the years 1976-1979 -- IATTC, 1980), but the other gaps may well represent regions of very low density of spotted dolphins. Au et al. (1979) and Au and Perryman (MS) have examined oceanographic and ecological correlates of density of this and other species of dolphins in the ETP. They have also addressed the question of seasonal occurrence within the overall ranges. Density of dolphin schools in the peripheral portions of the ranges has been treated by Holt and Powers (1982).

S. longirostris

The pattern for this species is very similar to that for S. attenuata. Outlying records (of approximately 16,000) are for the most part from areas of minimal recorded sighting effort (Figure 5). As for S. attenuata, the outliers in the northeastern and southeastern regions are bordered by bands of sighting effort, but those in other areas run out to the edge of the recorded effort coverage and beyond. In addition to being recorded from Hawaii and the Marquesas, there are records for Tahiti and Christmas Island.

We have delineated the distribution envelope using the same criteria as for S. attenuata, and the two envelopes are very similar in extent and shape (compare Figures 6 and 4). The assumption that the island-associated populations are disjunct is less supportable than in the case of S. attenuata, because of the closer proximity of the open-ocean sightings to the Marquesas, but we retain it provisionally. The envelope does not include the two

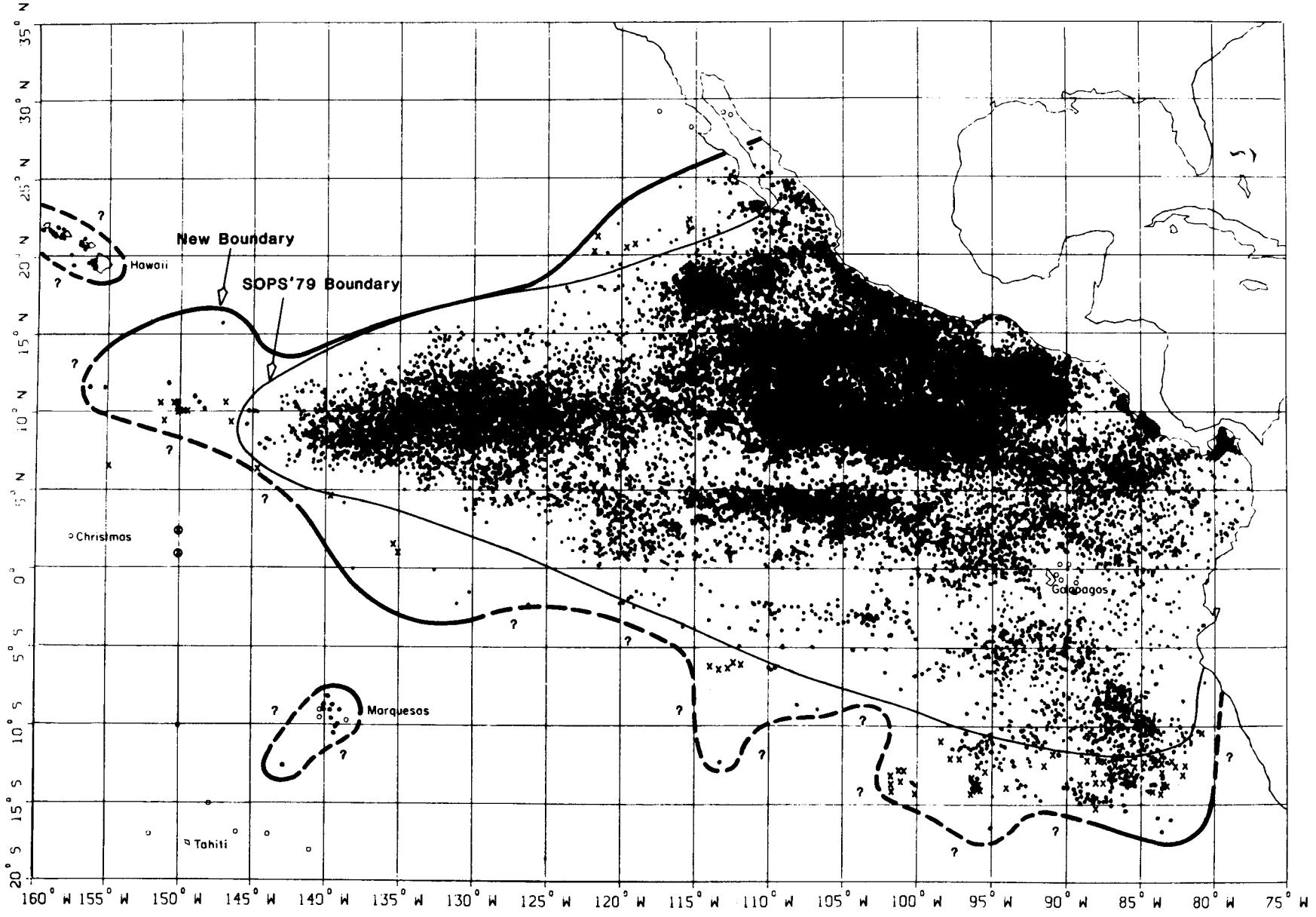

Figure 4. Known distribution of S. attenuata in the eastern Pacific. Dashed portions of new boundaries are adjacent to areas of no recorded sighting effort. Dots are confirmed records, X's are "probable" records, and circled X's are "possible" records (see text).

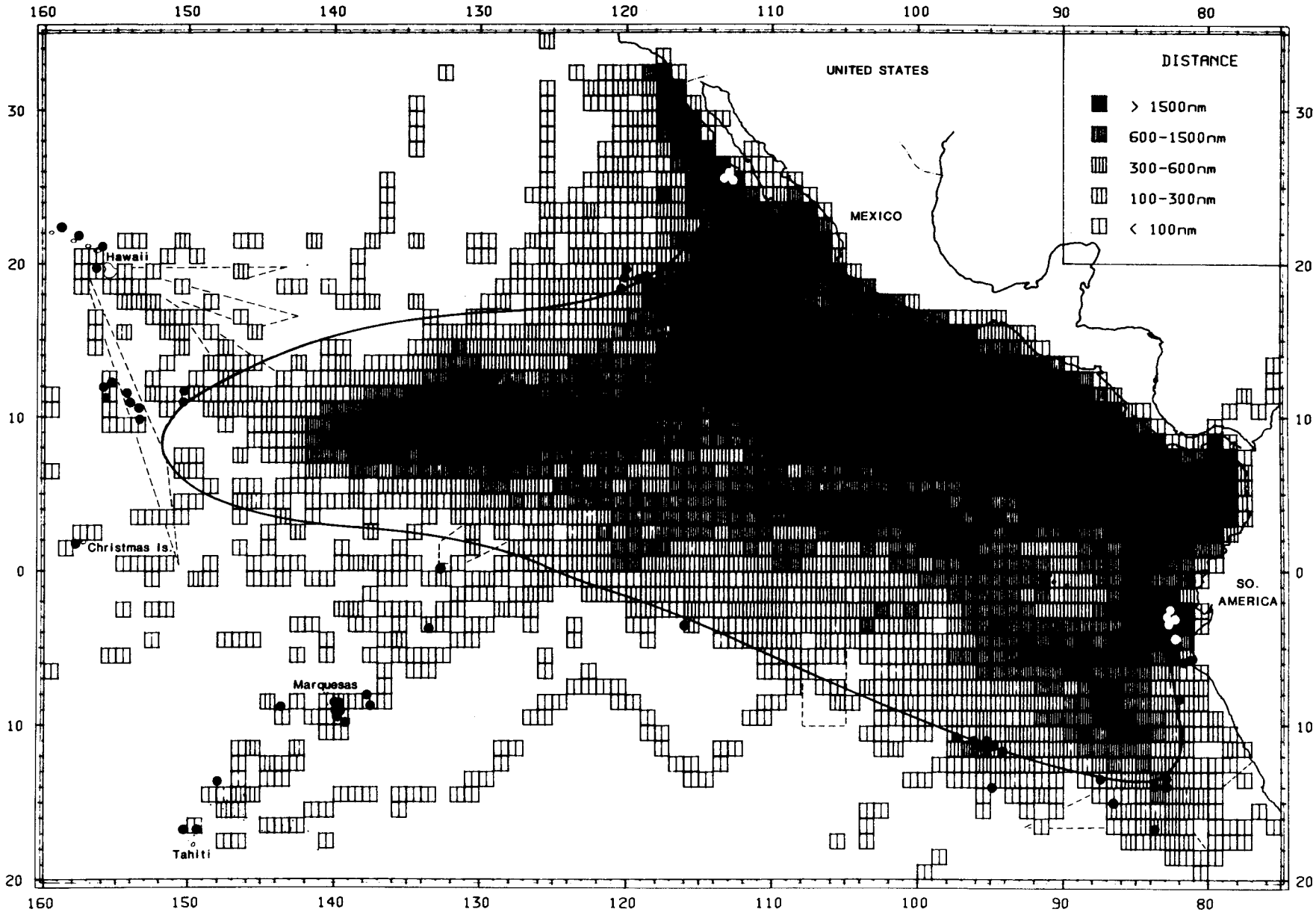

Figure 5. SOPS '79 boundary for S. longirostris, with outlying records superimposed on recorded sighting effort in nautical miles per one-degree block.

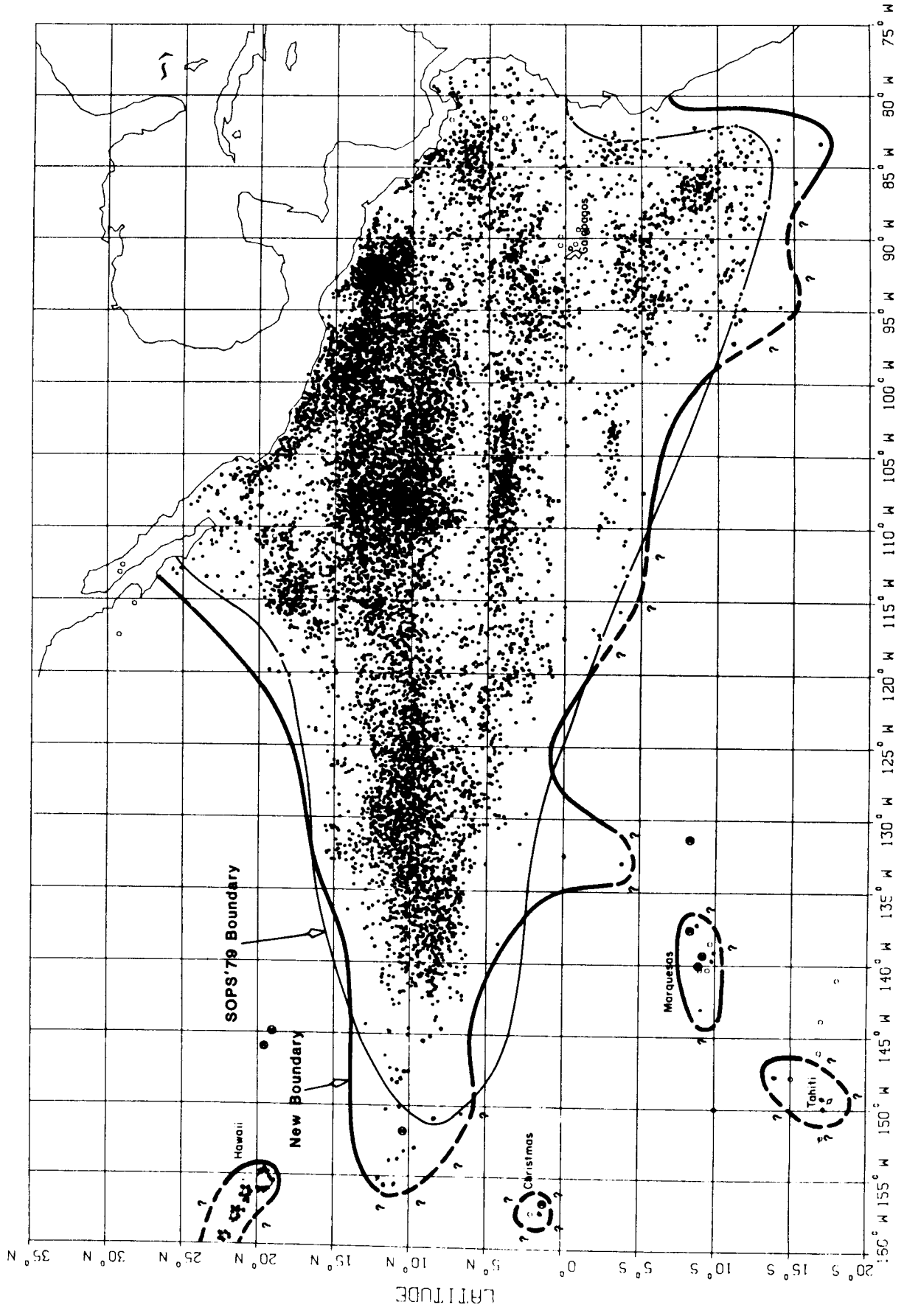

Figure 6. Known distribution of S. longirostris in the eastern Pacific. Dashed portions of new boundaries are adjacent to areas of no recorded effort. Circled X's are "possible" sightings (see text).

"possible" records to the north and one to the south in oceanic areas far outside the tuna-seining grounds.

Apparent gaps within the envelope are of the same nature and in the same areas as for S. attenuata. Comparison of the distribution of S. longirostris with that of S. attenuata (Figure 3), however, suggests that the former may be the more restricted to tropical conditions. In the northeastern and southeastern corners of the common range, water temperature can be assumed to be a direct or indirect factor limiting distribution. In these areas, S. attenuata sightings are relatively more numerous than those of S. longirostris, to a greater degree than would be predicted by the overall relative sighting ratio (about 2:1). In the south, there are several records of S. attenuata south of the southernmost record of S. longirostris.

S. coeruleoalba

There are records of the striped dolphin from northern temperate waters in the eastern Pacific (Hubbs et al., 1973), and the sightings considered here do extend north beyond the recorded sighting effort (Figure 7). The southernmost sightings in the southeastern corner of the ETP fall well within the recorded effort, however. The species occurs in Hawaiian waters, but the present data do not include any sightings from northeastern Polynesia (the Marquesas, Tuamotus, and Society Islands). In the south and west, the sightings extend to the edge of the recorded effort.

Because the record from about 34°N latitude and 138°W longitude is so far distant from the nearest records, we have treated it as disjunct in delineating the known distribution (Figure 8). As for the previous two species considered, large segments of the western and southern boundaries of the distribution are unknown. The bilobed structure of the envelope as known previously remains in this updated version.

The boundary for the striped dolphin must be treated as more tentative than those for S. attenuata and S. longirostris because of the apparent rareness of the animal relative to the other two species (only about 2,000 records, as opposed to about 30,000 and about 16,000 for S. attenuata and S. longirostris, respectively). The apparent absence from some of the peripheral portions of the area of recorded effort (e.g., in the Marquesas, off Peru and in the invagination between the two western lobes) may be an artifact of inadequate sampling.

Delphinus delphis

The distribution of outlying records (45 out of about 9,000 sightings) is not as far-flung as for the other three species, and except in the north, all lie well within areas of recorded sighting effort (Fig. 9). As in the case of S. coeruleoalba, the distribution is continuous with a temperate-water distribution to the north. This may be true for the south as well; the sighting effort to the south has been minimal. The species has not been

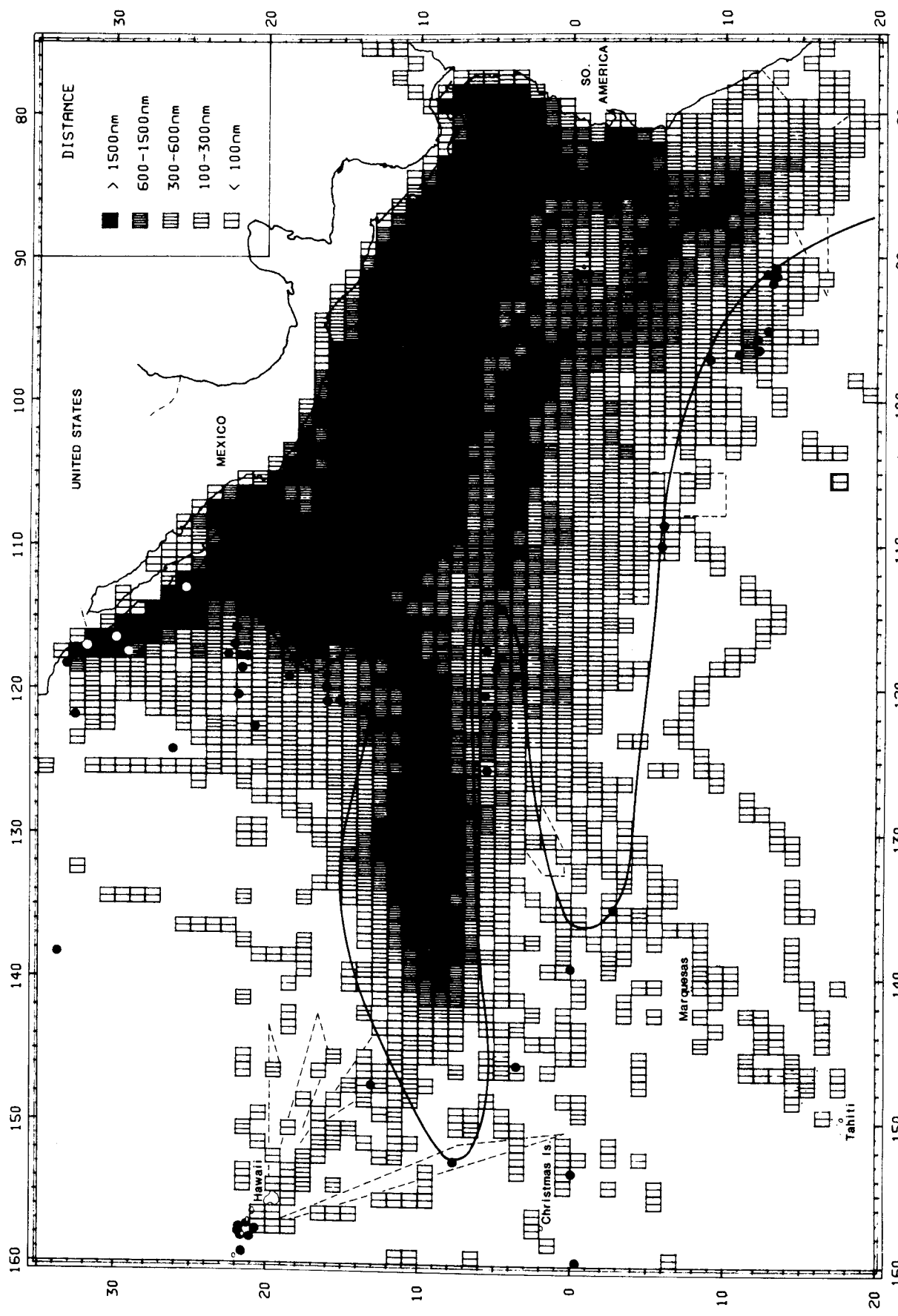

Figure 7. SOPS '79 boundary for S. coeruleoalba, with outlying records superimposed on recorded sighting effort in nautical miles by one-degree block.

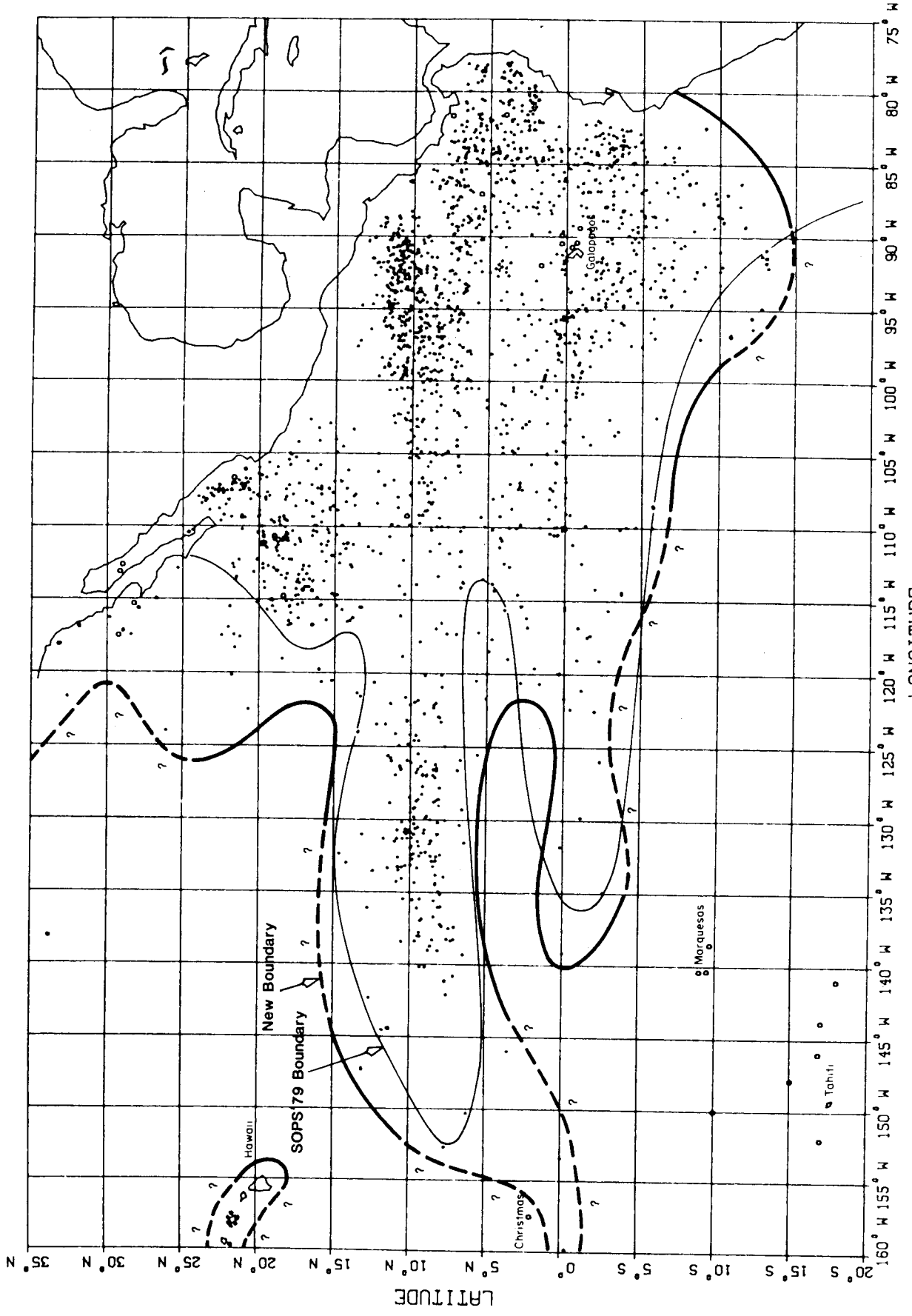

Figure 8. Known distribution of S. coeruleoalba in the eastern tropical Pacific. Dashed portions of new boundaries are adjacent to areas of no recorded effort.

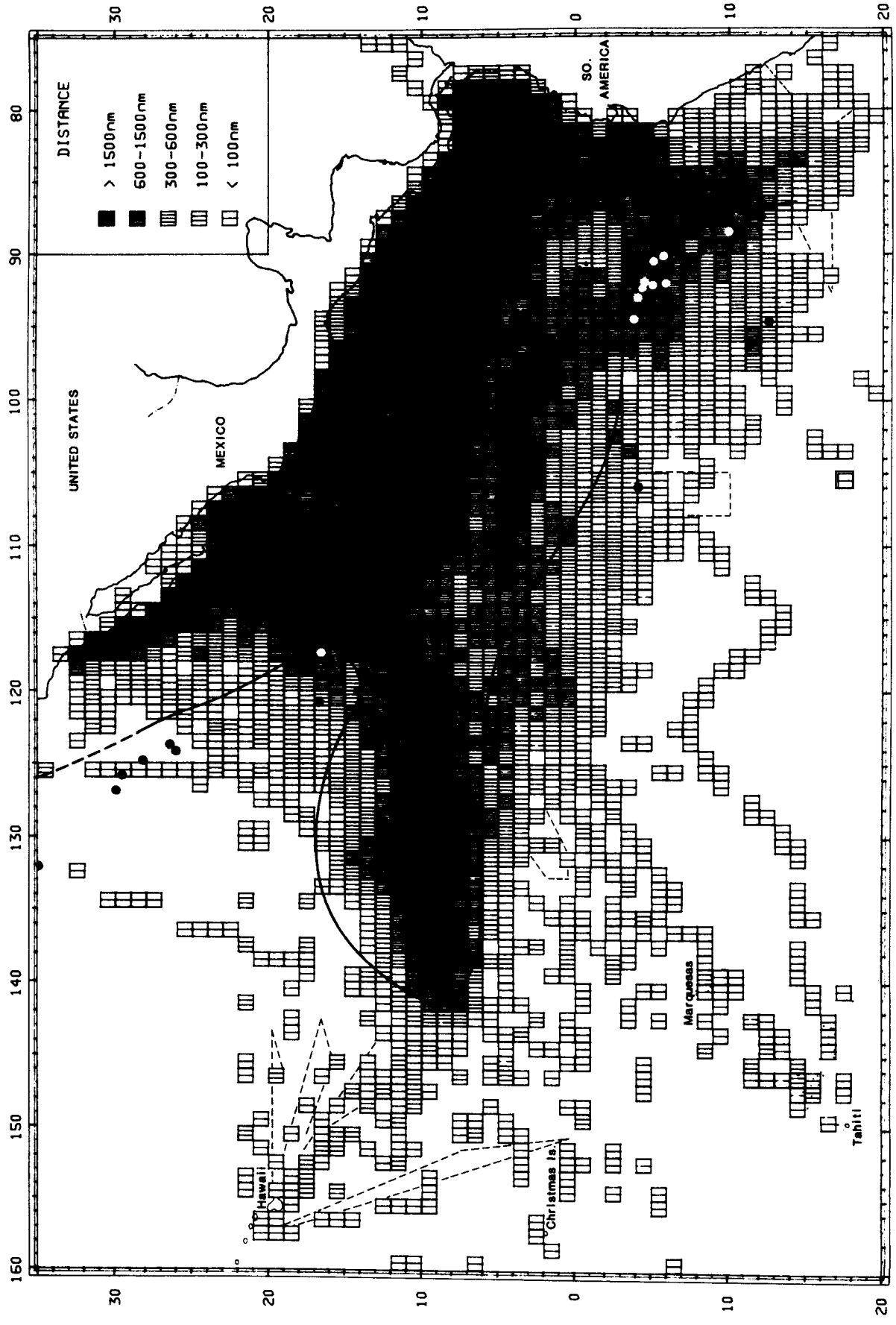

Figure 9. SOPS '79 boundary for Delphinus delphis, with outlying records superimposed on recorded effort in nautical miles by one-degree block.

recorded from Polynesia or from the open ocean in the Central Pacific.

Inclusion of the outlying records expands the known distribution in the eastern tropical Pacific only slightly (Figure 10). It can be said that the distribution of this species in the region is now known with some certitude.

The common dolphin exhibits more regional variation in apparent abundance within the envelope than do the other three species. The relatively high number of sightings and the very high levels of recorded sighting effort in the regions of apparent low density suggest that the distributional gaps are real. Furthermore, the gaps and the areas of apparent high abundance for this species complement those for the two strictly tropical species S. attenuata and S. longirostris. Regions in which apparent relative abundance of Delphinus delphis is high and that of S. attenuata and S. longirostris low include the areas around the tip of Baja California (about 20-23°N latitude), off Central America (about 10°N latitude), in the eastern Panamanian Bight (about 5°N latitude), off the Gulf of Guayaquil (about 3°S latitude) and around the Galapagos Islands. The ecological correlates and implications of this complementarity are treated in detail by Au and Perryman (MS).

DISCUSSION AND RECOMMENDATIONS

Alverson (1980 and 1981) made a point not directly addressed in the present study: that the three species of Stenella have trans-Pacific distributions, i.e., they occur in the central, southern and western Pacific. This has been established elsewhere by several workers (Perrin, 1975a; Hubbs et al., 1973; and others); the primary subject of the present study was the distribution of the four species in the eastern Pacific and immediately adjacent Central Pacific only.

In using the range estimates developed here in any extrapolation of density to total population size, it should be kept in mind that abundance in areas between the regions of apparent high population density may be very low. Also, comparative morphological studies, e.g., Perrin (1975a and b), Evans (1976a) and Perrin, Scott, Walker and Cass (in press), indicate that exchange among such regions can be low.

More surveys should be done at various times of the year along the southern edges of the known distribution, contemporaneously with surveys of adjacent high-density areas. This would allow definition of seasonal and year-to-year variation in the extent and structure of the continuous distribution.

More effort should be given to examination of the regions between the known continuous distribution in the ETP and the island groups to the northwest, west and southwest. Given the levels of effort to date, the apparent discontinuities may be artifacts, i.e. the apparent island-related distributions may not be disjunct. The internal cruise reports and data records of NMFS cruises out of Hawaii contain many records of large schools of mostly unidentified dolphins. While these schools cannot be assumed to be of

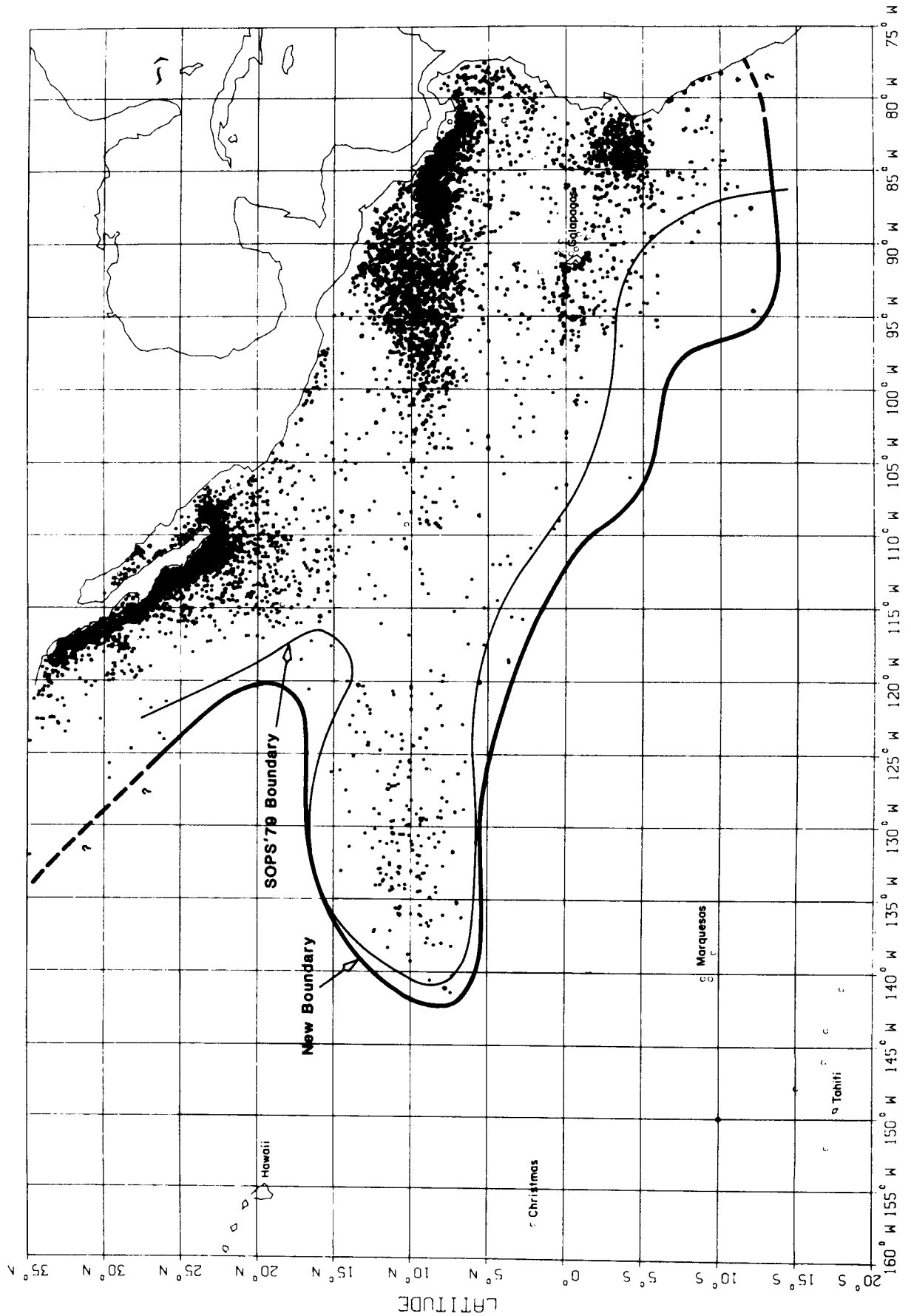

Figure 10. Known distribution of Delphinus delphis in the eastern Pacific. Dashed portions of new boundaries are adjacent to areas of no recorded sighting effort.

Stenella spp. (because other small cetaceans known to inhabit the Central Pacific, such as *Lagenodelphis hosei* and *Peponocephala electra*, also form large schools), some of them probably were. Although our review of a subsample of these volumnious data files did not yield any records of sufficient detail and reliability to merit inclusion in the distribution maps (see Catalog), at some point the entire files should be searched for possible useful information. In addition, an effort could be made on future cruises out of Hawaii to collect adequately documented sightings identified to species (some training of observers may be necessary).

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APPENDIX 1. Catalog of sources of data on the distribution of dolphins in the eastern tropical Pacific.*

*I. NMFS Tuna Purse-Seiner Observer Data

Since 1965, the NMFS observers have been placed on tunaboats in order to gather biological data on dolphins and to monitor dolphin mortality associated with the U. S. purse-seine fishery for tropical tunas. The area covered by observed trips is within the ETP (see Text Figure 1). The numbers of trips made annually are given in Appendix Table 1-1.

The fishermen use 25X binoculars and helicopters to search for dolphin schools and bird flocks that are associated with tuna. The ship typically alters course to identify schools of dolphins, but small schools or non-target species are usually not approached very closely. The observer's ability to identify the species sighted is greatly influenced by whether the ship approaches, chases and captures a school.

NMFS observers are trained in species identification prior to making their first trip (see Appendix 2). Field experience, however, is the key factor in making accurate identification of species, and since experience varies amongst observers, data from first-time observers have been treated more cautiously than data from those with more experience.

The NMFS sighting and set record forms have changed in format and information collected over the years (see Appendix 2). The observer is currently required to record the following distributional information: 1) sighting location, 2) species identification and composition by both observer and crew, 3) the closest distance to the dolphin school, 4) a sketch by the observer depicting the key characteristics observed, and 5) a written description of these characteristics. Observers occasionally bring back photographs and specimens from animals that are killed during the sets, allowing further confirmation of identifications.

The combination of observer training, crew and observer experience, and editorial review makes this a reliable data source. This body of data, and that of the IATTC observer data (Source II), together are the most extensive of all the sources and comprise the bulk of the distributional data available.

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*Sources used in the present study are marked with an asterisk.

Appendix Table 1-1. Number of trips and sightings made by NMFS and IATTC observers, 1965-1982 sightings made by NMFS observers in 1983 are included in the 1982 data base. Only a portion of the 1983 IATTC data has been included.

	NMFS		IATTC	
Year	No. trips	No. sightings (of all species)	No. trips	No. sightings (of all species)
1965	1	9		
1966	1	49		
1967	1	0		
1968	1	25		
1971	6	511		
1972	13	820		
1973	25	2,706		
1974	41	3,482		
1975	32	4,418		
1976	75	7,516		
1977	109	13,241		
1978	119	14,031		
1979	78	10,696	46	2,133
1980	45	5,548	63	6,925
1981	37	4,444	59	7,495
1982	33	6,139	48	5,864
1983	0	0	25	2,711
Total	617	73,635	241	25,128

*II. IATTC Tuna Purse-Seiner Observer Data

An observer program similar to that of the NMFS was begun in 1979 by the IATTC and was designed to sample the international fleet. The area covered in the ETP by boats sampled by the IATTC program is similar to that covered by NMFS-observed boats. The number of trips made annually is given in Appendix Table 1-1. Countries that have participated in this program have included Canada, Cayman Islands, Costa Rica, Mexico, New Zealand, Nicaragua, Panama, United States and Venezuela. Biologists are seconded by a participating country to the IATTC to serve as observers aboard vessels registered in that particular country.

IATTC observers are given similar training to that of NMFS observers. U.S. observers are given both NMFS and IATTC training, while non-U.S. observers are given only IATTC training. Information collected by the IATTC program differs somewhat from that collected by NMFS program (see Appendix 2), but it includes the same distributional information listed above. The debriefing procedures and the reliability of the data are also comparable to those of the NMFS program.

*III. NMFS Dolphin-Distribution Research Cruises

From 1974 to the present, 15 cruises have been made to the ETP to study dolphin distribution (Appendix Table 1-2). Some of these studies were designed to determine the southern and western edges of the ETP dolphin populations. The ships were diverted off trackline in order to identify dolphin schools. Typically, experienced NMFS observers were on watch using 20X or 25X binoculars.

A total of 2,911 cetacean sightings was made during these cruises. The information collected and the editing procedures were the same as for the tunaboat observer data. These data are considered reliable because of the observer experience, editorial review, and, particularly, the ability to closely approach dolphin schools for identification.

Appendix Table 1-2. NMFS dolphin-distribution research cruises.

Year	Vessel	Dolphin Research Cruise number
1974	R/V David Starr Jordan	84
1976	R/V Townsend Cromwell	168
1976	R/V David Starr Jordan	169
1976	R/V David Starr Jordan	207
1976	R/V Surveyer	212
1977	R/V David Starr Jordan	213
1977	R/V Townsend Cromwell	214
1977	R/V David Starr Jordan	319
1979	R/V David Starr Jordan	463
1979	R/V Townsend Cromwell	464
1980	R/V David Starr Jordan	598
1980	R/V Townsend Cromwell	599
1982	R/V David Starr Jordan	801
1983	R/V David Starr Jordan	843
1983	R/V Surveyor	852

IV. Other NOAA Research Cruises

*A. With Experienced Observers

Since 1969, trained observers have made dolphin sightings in the ETP aboard NOAA ships involved in non-marine mammal research (Appendix Table 1-3). Since dolphin studies were a secondary objective of these cruises, the ships did not divert from the trackline to identify dolphin schools. Sightings were made by one or more experienced observers. From 1976 on, observers were equipped with 20X or 25X binoculars with which to watch specifically for dolphin schools.

A total of 1046 sightings was made on these cruises. These data are considered reliable because of the experience of the observers.

Appendix Table 1-3. NOAA non-marine-mammal research cruises with experienced observers aboard.

Year	Vessel	(Dolphin Research) Cruise Number
1969	R/V Miss Behavior	-
1976	R/V Oceanographer	216
1977	R/V Oceanographer	232
1977	R/V Oceanographer	310
1980	R/V Oceanographer	642
1980	R/V Researcher	648
1981	R/V Oceanographer	687
1981	R/V Oceanographer	716

*B. With Inexperienced Observers

Marine mammal sighting data were available for ten cruises made in the ETP aboard NOAA ships involved in non-marine mammal research from 1967 through 1980 (Table 1-4). Observers recorded cetacean sightings but lacked experience at species identification. Sightings were made with 7X binoculars or the naked eye. The ships did not divert to approach dolphin schools.

This data base is considered less reliable than Source IV.A. due to the inexperience of the observers. These sightings have been reviewed, and 40 sightings of target species have been included in this report.

Appendix Table 1-4. NOAA research cruises with inexperienced observers aboard.

Year	Vessel
1967	R/V David Starr Jordan
1967	R/V David Starr Jordan
1967	R/V Undaunted
1970	R/V David Starr Jordan
1971	R/V David Starr Jordan
1971	R/V David Starr Jordan
1973	R/V David Starr Jordan
1979	R/V Oceanographer
1980	R/V Oceanographer
1981	R/V Oceanographer

*V. Non-NOAA Research Cruises With Experienced Observers

From 1972 through 1982, NMFS technicians were placed aboard vessels conducting non-marine mammal research in the ETP. Most of these vessels were chartered commercial albacore boats, but one was a Scripps Institution of Oceanography research vessel. The technicians' primary duties were not concerned with marine mammals, but some were experienced as marine mammal observers and kept detailed logs of sightings. The cruises for which marine mammal data are available are listed in Table 1-5. Identifications were made with 7X binoculars or the naked eye. The ships did not routinely divert from the tracklines to approach cetacean schools, although this may have occurred on occasion.

A total of 29 sightings of target species was recorded by these technicians. The data are considered reliable due to the observers' experience.

Appendix Table 1-5. Non-NOAA research cruises with experienced observers aboard.

Year	Vessel
1972	M/V Jinita (albacore research cruise)
1974	M/V Deep Six (albacore research cruise)

Appendix Table 1-5. Continued

Year	Vessel
1975	M/V Kamchatka (albacore research cruise)
1975	M/V Sun Dance (albacore research cruise)
1975	M/V Lady Olga (albacore research cruise)
1975	R/V Agassiz (Scripps Institution of Oceanography research vessel)
1976	M/V Sunrise (albacore research cruise)
1976	M/V Lusty (albacore research cruise)

*VI. Aerial Survey Data

NMFS has conducted four series of aerial surveys since 1974 to study dolphin densities in the ETP (Appendix Table 1-6). The IATTC also conducted an aerial photographic study in 1980. In the NMFS studies, species identification was a secondary objective, particularly for small schools and probable non-target species. In the IATTC study, only those schools that were photographed, mainly large schools, were recorded. Species identification for these schools, however, was a prime objective.

Passes over the schools for identification purposes were usually at an altitude of 180 m or lower. Experienced cetologists used handheld binoculars or the naked eye to identify the schools. For all of the IATTC sightings and some of the NMFS sightings, large-format photographs were taken that could confirm species identification.

A total of 1414 sightings were recorded on these surveys. This data base is considered to be reliable.

Appendix Table 1-6. NMFS and IATTC aerial surveys.

Year	
1974	NMFS aerial survey (unpub. NMFS data)
1977	NMFS aerial survey (SWFC, 1977)
1979	NMFS aerial survey (Jackson, 1980)
1981	NMFS aerial survey (Holt, 1983)
1980	IATTC aerial photography study (unpub. IATTC data)

*VII. IATTC Tunaboat Logbook Data

Many tunaboat captains fishing in the eastern Pacific have allowed the IATTC to extract data from their logbooks. Often the set information from these logbooks include whether dolphins were set upon and the species of the dolphins. Identifications are usually made by the captain or navigator, who are typically experienced at identification of target species, particularly spotted dolphins, Stenella attenuata, and spinner dolphins, S. longirostris. Species are listed in the IATTC data base as either 1) spotted dolphins, 2) spinner dolphins, 3) mixed spotter and spinner dolphins, 4) unidentified dolphins, 5) "whitebelly" dolphins (either common dolphins, D. delphis, striped dolphins, S. coeruleoalba, or Fraser's dolphins, Lagenodelphis hosei), or 6) probable dolphin set. Only the spotted and spinner dolphin sets have been used for the distribution plots, although dolphins classified as "unidentified" or "whitebelly" dolphins are probably of a target species, since a set was made on them.

Usually no species characteristics are listed by the skippers, and errors in identification cannot be checked. Since the dolphins have been captured, identifications are likely to be reliable. Set locations occasionally have been reported incorrectly for various reasons, however, and such errors may be present in the data base.

Perrin (1975a) has previously reviewed IATTC logbook data from 1963-1970, and 1970-1979 data have been partially plotted by Alverson (1981). This data base has been extensively edited since these reviews, however, and the revised data from 1959-1982 were examined in this study. A total of 321 S. attenuata and S. longirostris sets which were outside the 1979 SOPS boundaries were plotted. Additionally, outlying unidentified dolphin sets were plotted as "probable" S. attenuata sightings.

*VIII. IATTC Tuna-Tagging Cruises

The IATTC has conducted tagging cruises aboard tuna purse-seiners and baitboats since 1955 for the purpose of estimating the abundance of tunas. During 100 cruises to the eastern and central Pacific, marine mammal sightings have occasionally been recorded. Experience of the IATTC observers varied, but sightings were sometimes confirmed by the skippers and crews who presumably were experienced at identifying spotted and spinner dolphins.

A total of 1,924 cetacean sightings were recorded, of which 364 were identified as of target species. Of the remainder, a large number were unidentified-dolphin sightings, many of which were set upon by purse-seiners. These data are likely to be reliable, as most of the identified sightings were made by experienced observers and could be confirmed by the crews.

*IX. Pacific Tuna Development Foundation (PTDF) Cruises

Exploratory cruises by tuna purse-seiners have been made to the central and western Pacific since 1976 (Appendix Table 1-7) under the auspices of the PTDF (Alverson, 1981). The crews aboard these boats were experienced at identifying dolphins associated with tuna in the ETP. PTDF observers, often former NMFS observers, were also aboard to record cetacean sightings. Sighting methods were similar to those of other tuna seiners except that dolphins were not set upon, because they are not usually associated with tuna in the western Pacific. A total of 299 cetacean sightings were made during these cruises. Three sightings were made in the ETP, two were made in the Marquesas Islands, and two were made in the Hawaiian Islands. The rest were from the western Pacific and thus out of the scope of the present study. Of the seven sightings included in this analysis, all were of target species, and they are considered reliable.

Appendix Table 1-7. PTDF exploratory cruises.

Year	Vessel	Areas of Sightings
1974	M/V Sea Treasure	Marquesas Islands
1976	M/V Mary Elizabeth	New Guinea, Marshall, Caroline, Solomon and Gilbert Islands, ETP
1976	M/V Zapata Pathfinder	New Guinea, Caroline, Solomon and Gilbert Islands, ETP
1976	M/V Apollo	S. of Indonesia, ETP
1977-78	M/V Jeanette C.	New Guinea
1979	M/V Bold Venture	Guam

Appendix Table 1-7. Continued

Year	Vessel	Areas of Sightings
1979	M/V Island Princess	Marshall, Caroline, Gilbert and Solomon Islands; Nauru Atoll
1979	M/V Jeanette C.	Hawaii, NW of Midway Island; E of Japan; Philippines, Solomon Islands
1980	M/V White Star	Well N. of Wake Island, Wake, Hawaiian and Caroline Islands.
1980	M/V Island Princess	N. of New Guinea
1981	M/V Island Princess	No sighting data available.
1982	M/V Western Pacific	SW of Japan, Caroline and Gilbert Islands

*X. Naval Ocean Systems Center (NOSC) Cruises

Sightings data gathered during NOSC studies on cetaceans have been provided by W. E. Evans and S. Leatherwood to the NMFS. These data include sightings made aboard the U. S. Saluda, U. S. Sea See and other naval vessels and aircraft. Methods of sighting and identification are not known, but the observers were experienced cetologists and the data were reviewed by NMFS personnel in the 1970s. The raw data were not available for this review.

A total of 109 sightings of target species was considered reliable and used in the report.

*XI. U. S. Whale-Tagging Cruises

In the mid-to-late 1960s several whale-tagging cruises to the ETP were conducted by the U. S. National Marine Mammal Laboratory (now under NOAA/NMFS) in Seattle, Washington (Appendix Table 1-8). The vessels were mainly chartered commercial whale catchers, and the chief scientists were marine mammalogists experienced at identification at sea.

A total of 551 cetacean sightings was recorded. These data are considered reliable due to the experience of the observers.

Appendix Table 1-8. U. S. whale-tagging cruises.

Year	Vessel
1965	M/V Lynn Ann
1965	M/V Sioux City
1965	M/V Graciela
1966	M/V Sioux City
1967	M/V Sioux City
1967	R/V Washington
1968	M/V Allen B. Cody
1968	R/V Washington
1969	M/V Sioux City

*XII. U.S.S.R. - U.S. Cooperative Whale-Tagging Cruises

Two cooperative whale-tagging cruises were made aboard Soviet whaling ships, with experienced cetologists from both the U.S.S.R. and the U.S. aboard. Observers aboard the Vnushitel'nyi made sightings in 1975 in the ETP, particularly south of the equator. The Zharkyi did not operate in the ETP, but searched near the islands of Fiji, New Caledonia and Tonga in 1977. The ships apparently diverted from the trackline to identify schools.

A total of 166 cetacean sightings was made during the cruise of the Vnushitel'nyi. These sighting data are considered reliable due to the observers' experience and the ability to closely approach the schools for identification.

XIII. Published Literature Containing Original Sighting Data (full citations in Literature Cited)

*A. Wells, R. S., B. G. Wursig, and K. S. Norris (1981) A survey of marine mammals of the upper Gulf of California, Mexico, with an assessment of the status of Phocoena sinus.

A 1981 survey was funded by the Marine Mammal Commission to locate and identify cetacean species present in the northern Gulf of California. The status of the Gulf of California porpoise, Phocoena sinus, was of particular interest. The observers were all experienced marine mammalogists aboard an 8-m powerboat. Sightings were made with 7X binoculars or the naked eye, and sighted schools were approached for identification. A total of 138 sightings was made. However, of the target species, only Delphinus (70 sightings) was seen. The data are considered reliable due to the observers' experience and the high priority and effort given to

identification of sightings.

B. W. F. J. Mörzer-Bruyns. (1971) Field Guide of Whales and Dolphins.

Mörzer-Bruyns, a sea captain and amateur zoologist, spent 40 years at sea, and 18 years sketching dolphins at sea. He made 15 trips across the ETP and many more across the Pacific Ocean. He presented distribution envelopes comprised of his own sightings and a few from the literature, but did not distinguish between the two sources. Few, if any, individual sightings are presented. His sighting data are given as the total number of all species sighted in each 10° square. One can construct a crude estimate of effort from his data ("crossings"/10° square). The distributions are often stretched by linking widely separated sightings, although he may not have visited or seen anything in the intervening squares (particularly true of the "longbeaked dolphin" - a spinner in the South Equatorial Current). However, he showed a very limited distribution in the ETP for spotted, spinner, and common dolphins despite several trips out of Mexico. For these and other reasons, we do not have confidence in his published distribution maps and did not include them in this study.

*C. F. Alverson (1981). Comments on the distribution of spotted, spinner, common and striped dolphin in the tropical Pacific Ocean.

Alverson presented a 1981 review of dolphin distributions in the ETP. The sighting sources included a previously unpublished sighting of S. attenuata by T. Tafoya, an experienced tuna seiner captain. The sighting by T. Tafoya is likely to be reliable due to the captain's experience at identifying target species.

D. M. Nishiwaki (1967). Distribution and migration of marine mammals in the north Pacific area.

Nishiwaki reviewed sightings made by "fishermen, whalers, and scientists," mainly in the North Pacific. No information is available to determine the observer experience or the methods of sighting and identifying animals. Nishiwaki informed one of us (Perrin) that the data collection was retrospective, that is, the fishermen were asked to recall what they had seen and where. Nishiwaki also indicated (to Perrin) that the distribution envelopes were based on oceanic current patterns as well as on sightings data. The distributional envelopes for S. attenuata and S. longirostris were presumed to be the same. No individual sightings or species breakdown are given. Due to the lack of data necessary to evaluate the basis of these distributions, they have not been included in the present analysis.

E. EASTROPAC Cruises

A series of cruises was conducted during 1967-1968 to collect data on oceanographic and biological features of the ETP (Love, 1982). Incidental sightings of marine mammals were recorded on some of these cruises by inexperienced observers. The sightings were classified as 1) porpoise, 2) pilot whales, 3) other whales or 4) unidentified cetaceans. These data were not included in this study because of the lack of species identifications.

*F. Fitch, J. E. and R. L. Brownell, Jr. (1968). Fish otoliths in fish stomachs and their importance in interpreting feeding habits.

As part of a study on dolphin feeding habits, the authors used 8 Stenella specimens (5 spinner and 3 spotted dolphins) that had been captured by tuna purse-seiners in 1967-1968. The capture locations were recorded. Since the specimens were identified by experienced cetologists, the data are considered reliable.

*G. Norris, K. S. and T. P. Dohl. (1980). Behavior of the Hawaiian spinner dolphin, Stenella longirostris.

The authors summarized sightings of spinner dolphins in the Hawaiian Islands. Surveys were conducted by experienced catalogists from the brigantine Westwood, the motor sailers R/V Hikino and R/V Inua, the U.S. Coast Guard vessel Buttonwood and small fixed-wing aircraft. Locations of spinner dolphin captures made by Sea Life Park personnel were also recorded. A total of 59 sightings were plotted east of 160°W.

These sightings were considered reliable due to the experience of the observers.

*H. Shallenberger, E. W. (1981). The status of Hawaiian cetaceans.

The author reviewed sighting and stranding locations of Hawaiian cetaceans from both published and unpublished sources. The unpublished sources included sightings made by Sea Life Park collecting crews. A total of 86 sighting or stranding locations (E. of 160°W) of Stenella spp. were used in this report. The data are considered reliable.

*I. Norris, K. S., B. Würsig, R. S. Wells, M. Würsig, S. M. Brownlee, C. Johnson, and J. Solow (1982). The behavior of the Hawaiian spinner dolphin, Stenella longirostris.

The authors conducted boat and aerial surveys around the Island of Hawaii. They presented radio-tracking and natural-mark sightings data which indicate that the nearshore S. longirostris population are permanent residents of the Island. The report presents only their aerial sightings of S. longirostris-- a total of 98 sightings. The data are considered reliable due to experience of the observers.

*J. Other published sources which reported only one or a few records are included in the analysis and listed in the Literature Cited (Van Gelder, 1960; Mullen, 1977, Scott and Wussow, 1983).

*XIV. Dolphin Tag Returns

Since 1969, the NMFS has conducted a dolphin-tagging program in the ETP. Tags were recovered from dolphins brought aboard ship during captures by tuna purse-seiners. The tags were returned to SWFC by fishermen and by observers aboard the tunaboats. When positions could be accurately assigned to a tag return, the information was included in this data base. All tag

returns were reviewed by NMFS personnel. A total of 55 tag-return localities were considered reliable and non-overlapping with other data sources.

XV. Sightings From Private Vessels

*A. With Experienced Observers

A single S. coeruleoalba sighting in 1979 was reported off the coast of Baja California by C. Peters, a former NMFS observer.

A single S. longirostris sighting in 1981 was recorded by naturalists aboard the M/V Lindblad Explorer. Sighting methods for this cruise are not known. The sighting is considered a "possible" record due to this and the inexperience of the observers.

A cruise was conducted in 1970-1971 aboard the R/V Westward, a brigantine operated by the Oceanic Institute of Hawaii (Norris, Perrin, Castello and Bryant, unpub. MS). Two experienced observers were aboard to collect cetacean sightings. Fourteen sightings were recorded near the Marquesas, Tuamotu and Austral Islands. Additionally, several dolphins were captured for taxonomic examinations.

Sightings made by experienced observers during marine mammal surveys in 1978-1979 by the R/V Regina Maris are also available (Balcomb, Villa and Nichols, 1979; Nicholas and Payne, 1979; Balcomb, 1979; Balcomb, Miller, Wells and Würsig, 1979; also unpublished data provided by K. Balcomb, P. Ross and P. Major). A total of 522 sightings, including 144 target-species sightings were made in the Gulf of California, the west coast of Baja California and between Central America and the Galapagos Islands (Expeditions Nos. 9-14, 17). An additional three sightings made by B. Villa, a Mexican cetologist, in 1976 are also reported. A total of 7 cetacean sightings, including one sighting of D. delphis, was made in 1983 by experienced observers aboard the sailing vessel R/V Ragtime (unpub. data provided by J. Barlow, A. Hohn and M. Scott).

*B. With Inexperienced Observers

In 1975 and 1976, sightings were reported to the NMFS by the crew of the S/V Serenity, a private yacht. The sightings were made off the Marquesas Islands and off Panama. Members of the crew were inexperienced observers but were attempting to tag dolphins, which involved closely approaching schools. Standard NMFS sighting forms were filled out by the crew, but the methods of sighting and identification are not known. These have been plotted as "possible" records due to the inexperience of the observers and the lack of information needed to evaluate the identification.

*XVI. Museum Specimens

Location records associated with museum specimens have been used in this report. Specimens have been collected by harpooning or from tuna purse-seine kills. We have data on specimens in the collections of the U. S. National Museum, Los Angeles County Museum, San Diego Natural History Museum,

National Marine Mammal Laboratory and the Southwest Fishery Center (NMFS). A total of 88 location records have been considered reliable.

XVII. SWFC Honolulu Laboratory Research Cruises

Research cruises in the central Pacific were conducted between 1952 and 1982 by the Honolulu Laboratory of the NMFS Southwest Fisheries Center. Cetaceans for the most part were sighted and recorded as either 1) whales, 2) porpoises or 3) seals. Search methods are not known and the observers were apparently not experienced cetologists. Published reports for some of the cruises include Sherman and Brown, 1961 and 1962; Austin, 1957; Wilson et al., 1958; and Wilson and Rinkel, 1957. We examined a subsample of internal cruise reports and new data. We did not use the data in this report because of the questionable reliability of the (very few) species identification that were recorded. However, see DISCUSSION AND RECOMMENDATIONS.

*XIX Pacific Ocean Biological Survey Program Cruises

An unpublished body of data which was gathered between 1963 and 1969 during a series of cruises made in the Central Pacific by the Pacific Ocean Biological Survey Program of the Smithsonian Institution National Museum of Natural History was examined. These cruises were primarily to survey seabird populations, but cetacean sightings were also made. Sightings were made by both experienced and inexperienced marine mammal observers. On at least some of these cruises a bridge watch was maintained while at sea to record bird and cetacean sightings. It is not known how the observers searched or whether the ship diverted from the track to identify cetaceans. In some cases, identification could be confirmed from photographs or by collecting an animal. Seventeen certain and nine probable sightings of target species have been extracted from the data, but only two (one certain, one probable) sightings were within the ETP boundaries used in this report.

XX. California Cooperative Oceanic Fisheries Investigations (CALCOFI) Cruises

Since 1950, surveys have been conducted to sample fisheries resources within the California Current System by CALCOFI, a research consortium of several federal, state, university, and Mexican agencies. Data reports on the results of these cruises have been published since 1965 (California Cooperative Oceanic Fisheries Investigations Data Report, Vols. 1-31). A large array of vessels have been used since 1950 to survey off the California coast, but some surveys covered the west coast of southern Baja California. Incidental sightings of marine mammals were recorded in some cases, but the observers were inexperienced at cetacean identification. It is not known how searches were conducted or whether cetacean schools were approached. This data base was not included in this report due to the inexperience of the observers and the inability to evaluate individual sighting data.

APPENDIX 2. Collection and management of dolphin sighting data in the NMFS tuna/dolphin observer programs.

Marine mammal sightings data have been collected since 1971 by employees of the National Marine Fisheries Service (NMFS) and are archived at the Southwest Fisheries Center (SWFC) in La Jolla, California. These data include some 77,259 separate cetacean sighting events recorded during 642 cruises. The data are also computer-accessible and are available to staff researchers in a series of twelve annual data bases.

The vast majority of these sighting records were recorded by scientific observers stationed aboard commercial tuna purse seine vessels fishing in the eastern tropical Pacific Ocean. Twenty-five cruises in the ETP were of vessels other than seiners; most of these were National Ocean Survey (NOS)/NOAA research vessels.

Observer training

The sea-going observers are employed under the job classification of Biological Technician (Fisheries). Minimum qualifications for this classification include completion of 24 college-level semester units in the sciences or equivalent experience. Most are graduates in the biological sciences from 4-year colleges. Additional training was provided for each of the observers before they go to sea. Training sessions are prepared and presented by staff of both the Southwest Fisheries Center and the Southwest Region's San Diego Branch Office. During these sessions the newly hired observers are given intensive training on correct data forms usage and on the identification of cetaceans of the eastern tropical Pacific. Special emphasis is placed on the identification of species and stocks of the family Delphinidae. Training on cetacean identification has included slide presentations of schools at sea as well as of specimens. Since 1972, the sea-going observers have been issued an illustrated field guide to cetaceans (Leatherwood, Evans and Rice, 1972).

Instructions to observers

Since 1971, tuna/dolphin observers have been instructed to stand marine mammal watch using binoculars when a vessel was underway and the environmental conditions affecting sightability were favorable. While on watch, observers are asked to position themselves on the flying bridge near the crew's high-powered binocular sighting station in order to ensure that they have a reasonably good vantage point for observations. The number of hours expended in this manner are recorded as marine-mammal watch effort. The searching technique typically used by the crew aboard tuna purse seiners relies on at least two crewmen looking for signs of fish using high-powered (20X - 25X) binoculars. The crew members scan the horizon looking for cues such as birds, splashes or surface turbulance which sometimes are an indication of marine mammals. Because of the association between schools of certain dolphins and

yellowfin tuna (Thunnus albacares), sightings of dolphins are usually investigated more closely by the crew for the presence of fish. As a result of the observers' close proximity to the crew sighting stations, his sighting effort is augmented by that of the crew. A great many of the sightings recorded by observers are first seen by the crew while looking for fish. Observers stand watch using 7X or 10X handheld binoculars. They scan the area between the horizon and the vessel, generally concentrating their attention closer to the vessel than does the crew. The combination of techniques used by the crew and the observer provide for good coverage of the vessel's search path.

Observers are required to complete a sighting record for every distinct sighting of cetaceans made by anyone aboard the vessel, regardless of whether the observer saw the animals.

The sighting record form

Since 1971, six different types of data-collection forms have been used (see Appendix Table 2-1 and forms included at the end of this appendix). Each has been used in conjunction with a particular "observer's field manual" which contains the instructions for correct forms usage. The forms have evolved from the non-coded, loosely standardized "marine mammal log" to the present "marine mammal sighting record." The current form utilizes stringently documented collection procedures and is composed of well-defined, coded data elements. Each of the six forms contains a unique combination of data elements. This evolution of forms content has taken place in response to changes in the data requirements of NMFS researchers. There is continuity, however, for certain of the central data elements from the earliest to the most recent record types. These core elements include items such as cruise number, date of sighting, time of sighting, position of sighting, estimated school size, identification of species/stocks present and estimated species/stock proportions of the school. These forms have also been used by observers aboard research vessels.

Identifications by the crew

The sighting-record forms used since 1977 contain coding fields for recording both the crew's and the observer's independent identifications. From 1971 to 1977 there were no dedicated fields on the sighting record for recording this information. Where identifications by crew exist, they generally have been for schools which were eventually the target of a net set. The identifications are transcribed from set-log data in these cases. Sighting information provided by the crew since 1977 has been routinely recorded by the observer. When the data are returned to La Jolla for processing, species/stock identification codes are assigned to the crew identifications exactly as they are recorded without regard to their probable accuracy or reliability.

Identifications by observers

Particular attention has been directed to the identifications of species/stock as recorded by the observer on the sighting records. In order

to improve the accuracy and reliability of observer identifications, each sighting record is scrutinized during a cruise processing at the SWFC in La Jolla. The recorded diagnostic criteria used by the observer in making the field identification are evaluated. The experience of the observer is considered. After weighing these and a variety of other factors such as photographs of the school, the distance away from the school, the length of observation time and the environmental factors affecting the ability to observe the school, each observer identification is assigned a species/stock identification code.

The size of the observer force grew dramatically during 1976, as the Southwest Regional Office (SWR) of NMFS became involved with the fleet-sampling effort. It became more difficult to weigh intangible coding criteria such as the observer's experience with ETP cetaceans. At this point it was recognized that for observer identifications to be better supported, more information verifying the accuracy of the observer identification was needed on the source document. During 1977, the observer training sessions began placing heavier emphasis on collection procedures requiring fully self-supported sighting records.

Assigning identification codes

The sighting record used during 1974 was the first source document formatted with coded data elements. The sightings data collected during 1974-1976 were assigned species/stock codes by senior scientists at the SWFC. This was very time-consuming for these individuals. It was believed that a standardized methodology could be developed by which the sightings could be coded for the most part by skilled technicians (data editors) familiar with pertinent taxonomic criteria and the special problems of identification. It was also believed that these individuals should have substantial experience with the field identification of ETP cetaceans. In 1977 a contract report outlining a procedure of this type was completed by S. Leatherwood. Sightings from 1977 to the present have been coded in conformance with this procedure. Additionally, sightings data from 1971-1973 which were transcribed in 1981 onto coded formats more compatible with recent sightings data have been species-coded using this particular algorithm.

The Leatherwood Guidelines

The Leatherwood algorithm is based upon a set of interrelated procedures. They include a set of guidelines for weighing recorded diagnostic information contained on each sighting record. They also provide for a method of indicating the reliability associated with assigned species/stock codes.

The Leatherwood method requires that observers become trained on the identification of ETP cetaceans. Since 1977, the San Diego branch office of the SWR has provided training on cetacean identification, using lectures and slide presentations. The observers are presented with the diagnostic characters associated with each of the cetaceans involved to any extent with the tuna fishery and tested on correct field identification techniques.

Once the sightings have been returned to the SWFC for cruise processing, data editors follow the Leatherwood guidelines in assigning species/stock codes. For unusual sightings or records where the identification of species/stocks is not straightforward, advice is obtained from senior scientists to determine appropriate identification. Data editors review each sighting, checking the recorded diagnostic information before assigning the species/stock codes. Species/stock codes are usually assigned to correspond with the observer's field identification. However, when the recorded information indicates that the observer's identification is clearly incorrect and there are sufficient characters to permit correct identification, the editor assigns a new species/stock code. Once the coding process has been completed, the data editor evaluates the observer's performance on correct procedures for recording sightings data. This provides the SWR office with a feedback mechanism to identify and retrain observers whose performance is inadequate.

Under the Leatherwood guidelines, a reliability code is assigned to each observer species/stock identification. These codes reflect the relative reliability of the identification. There are four encoded states of relative reliability: 1) that there is not a sufficient basis upon which to verify the correctness of a single assigned species/stock code, 2) there is a sufficient basis to verify the correctness of all assigned species/stock codes, 3) there is not a sufficient basis upon which to verify the correctness of all assigned species/stock codes, or 4) the observer clearly misidentified a sighting to species/stock, and the species/stock code has been corrected by the editor.

Editing of sightings data

In addition to the post-cruise processing steps described above, the sightings data have been edited in order to improve their accuracy. The editing process has evolved from relatively simple manual checks conducted in the early years (1971-1974) into a more complex, computer-assisted procedure. Until 1975, the year when formalized data editing programs using FORTRAN were first developed, the observer bore the responsibility for checking his data for accuracy and for correcting errors. No systematic data check lists were used, and guidelines in this area were loosely defined. This early editing effort relied upon loosely identified procedures. It was difficult to establish that all the data were systematically edited in a thorough or standardized manner. Although the data were edited, the kinds of error checks performed were not documented.

In 1975, FORTRAN programs were developed by computer programming staff at the SWFC according to instructions provided by the tuna/dolphin programs data manager and applied to all new data and to re-formatted data from 1971-73. The programs perform a variety of error checks on the computer-accessible sightings data. The editors use the edit program output as a method for locating potential error in the data. They correct those errors where sufficient information exists to reconcile error. It should be emphasized that the edit programs do not of themselves change data; they provide output which identifies unusual, conflicting or unexpected data.

The editors are all experienced sea-going observers familiar with marine mammal sightings data as a result of previous cruises to the ETP. Some of the information used in reconciling error is not recorded in coded format. The editors must frequently read narrative descriptions and examine other sources in order to assess the validity of data items. When the editor corrects the data, he enters his correction on the sighting form using red ink; the correction is also made on the computer disk file. All corrections made on the sighting forms are made on the computer-stored data files and vice versa.

The editing programs have evolved since 1975 in order to accommodate changes in the layout and content of the sighting forms. Additionally, these programs have become progressively better documented. In 1979, an error statement data base was developed which describes each logical check performed by the program.

The use of FORTRAN edit programs to improve the accuracy of the sightings data does not mean that this enormous set of data is error-free. Rather it means that the checks of the data have been performed in a very systematic and well-documented manner.

Presently the data are archived at the SWFC. The sighting forms are kept in locked cabinets, and procedures for gaining access to the data have been implemented in order to improve control over this data resource. Requests for access to the raw data or the computerized files are directed to the Director of the NMFS Southwest Regional Office in Terminal Island, California.

Appendix Table 2-1. Sighting forms used in the NMFS and IATTC observer programs, 1971-1983 (sample forms follow).

Form Type	Agency	Years	Cruises
I	NMFS	1971-73	44
II	"	1974	42
III	"	1975-76	113
IV	"	1977-78	235
V	"	1979-80	131
VI	"	1981-82	76
VII	IATTC	1979	46
VIII	"	1980	63
IX	"	1981-83	132

Form Type I

MARINE MAMMAL OBSERVATION LOG

Page_____ of _____

VESSEL_____ DATE _____

Observation Effort (even if nothing seen):

Time: From _____ To _____

Position: From _____ To _____

Average Speed_____ Knots or mph (circle one) _____

Weather _____

Sea State _____

Water Temp. _____

Time	Location	Kind	No.	Notes *

* Include the following when possible: sketch; photograph; size; direction of travel; behavior; associated animals (birds, fish) FEATURES USED FOR IDENTIFICATION, course changes of vessel.

Name:_____

Address:_____

Tel. No._____

Form Type II

MARINE MAMMAL LOG

VESSEL _____ Code (1-3) OBSERVER _____ Code (4-6)

Cr. No. (7-9)	Date: mo. (10-11)	day (12-13)	yr. (14-15)	Period no. (for day) (17-18)	Card (19)	Time: from (20-23)	to (24-27)

Comments:

From: Latitude (28-31)	N/S (32)	Longitude (33-37)	E/W (38)	To: Latitude (39-42)	N/S (43)	Longitude (44-48)	E/W (49)	Avg. speed (kts, & 10ths) (50-52)
° '		° '		° '		° '		

True Course (53-55)	Maximum sight. dist. (mi. & 10ths) (56-58)	Chop ht. (ft. & 10ths) (59-60)	Wind (kts) (61-62)
°			

Start new period if course, sighting distance, chop, or wind changes

Effort in period: hrs. (63-64)	min. (65-66)	Sightings in period (no.) (67-68)

(69-80 blank)

SIGHTINGS (numbered serially for period; one for each species in mixed school):

	Card (19)	Time (20-23)	Latitude (24-27)	N/S (28)	Longitude (29-33)	E/W (34)	Bearing from ship (35-37)	Distance from ship (mi. & 10ths) (38-40)	Direction of travel of school (41-43)	Data code (44)	Loc. code (45)	Sight. code (46)
#1	2		° '		° '		°		°			

SPECIES _____ Code (47-48) Main sp. in school _____ Code (49-50)

No. in school (of this sp.) (51-55)	± error (56-59)	Total in school (of all spp.) (60-64)	± error (65-68)	Est. code (69)

Other species in school: Code (70-71)

(1) _____ Code (72-73)

(2) _____ Code (74-75)

(3) _____

(76-80 blank)

Notes (size, shape, color, how identified, sketch):

Photos: roll_____frames_____(If more than one sighting in period, go to continuation sheet)

Form Type II
(Continuation sheet)

MARINE MAMMAL LOG (Continuation Sheet)

Vess_____ Obs._____ Cr._____ Date_____ Period_____

#	Card	Time	Latitude	N/S	Longitude	E/W	Bearing from ship	Dist. from ship (mi. & 10th)	Direction of travel	Data code	Loc. code	Sight. code
	19	20-23	24-27	28	29-33	34	35-37	38-40	41-43	44	45	46

SPECIES_____ Code 47-48 Main sp. in school _____ Code 49-50

No. in school (of this sp.)	± error	Total in school (all in spp.)	± error	Est. code
51-55	56-59	60-64	65-68	69

Other species in school:

(1) _____ Code 70-71

(2) _____ 72-73

(3) _____ 74-75

Notes:

(76-80 blank)

Photos: roll_____ frames_____

#	Card	Time	Latitude	N/S	Longitude	E/W	Bearing from ship	Dist. from ship (mi. & 10th)	Direction of travel	Data code	Loc. code	Sight. code
	19	20-23	24-27	28	29-33	34	35-37	38-40	41-43	44	45	46

SPECIES_____ Code 47-48 Main sp. in school _____ Code 49-50

No. in school (of this sp.)	± error	Total in school (all in spp.)	± error	Est. code
51-55	56-59	60-64	65-68	69

Other species in school:

(1) _____ Code 70-71

(2) _____ 72-73

(3) _____ 74-75

Notes:

(76-80 blank)

Photos: roll_____ frames_____

Form Type III

SHIPBOARD MAMMAL WATCH
SIGHTING RECORD

VESSEL_____

OBSERVER_____

CRUISE NO.	OBS. NO.	DATE			SERIES NO.	LEG NO.	TIME OF SIGHTING	BEARING FROM SHIP	DISTANCE MI. & 10ths	DIRECTION OF TRAVEL	SET NO.	SURFACE TEMP. °F & 10ths
		YEAR	MO.	DAY								
1	4	7	9	11	13	15	17	21	24	27	30	33

SPECIES NAMES

Sp.(1)_____ Sp.(2) _____ Sp.(3) _____

ESTIMATE OF TOTAL SCHOOL SIZE ±		SPECIES (1)		SPECIES (2)		SPECIES (3)		POSITION OF SIGHTING			
		%	SP. CODE	%	SP. CODE	%	SP. CODE	LATITUDE	N/S	LONGITUDE	E/W
36	40	44	47	49	52	54	57	59	63	64	69

NOTES (DESCRIBE AND ILLUSTRATE EVERYTHING YOU SAW):

PHOTOS: ROLL #_____ FRAME #_____

Form Type IV

NMFS FSW3-SD
1-77

1977A SHIPBOARD MAMMAL WATCH SIGHTING RECORD

NOAA - U.S. DEPT. OF COMM.

CRUISE #	OBSERVER #	DATE YEAR	DATE MONTH	DATE DAY	SERIES #	LEG #	CARD #	TIME OF INITIAL SIGHTING OF TARGET	BEARING FROM SHIP	DISTANCE (nm & 10ths.)	DIRECTION OF TRAVEL	SET #	SURFACE TEMP (°F & 10ths.)
							0,1						
1	4	7	9	11	13	15	17	19	23	26	29	32	35

POSITION LATITUDE	N/S	LONGITUDE	E/W
38	42	43	46

SIGHTING CUE (CODE TABLE 13, PART A)

49

WHO MADE INITIAL SIGHTING? (CODE TABLE 13, PART B)

50

AVERAGED CREW ESTIMATE OF SCHOOL SIZE MEAN	HIGHEST	LOWEST
51	55	59

OBSERVER ESTIMATE OF SCHOOL SIZE BEST	HIGHEST	LOWEST
63	67	71 74

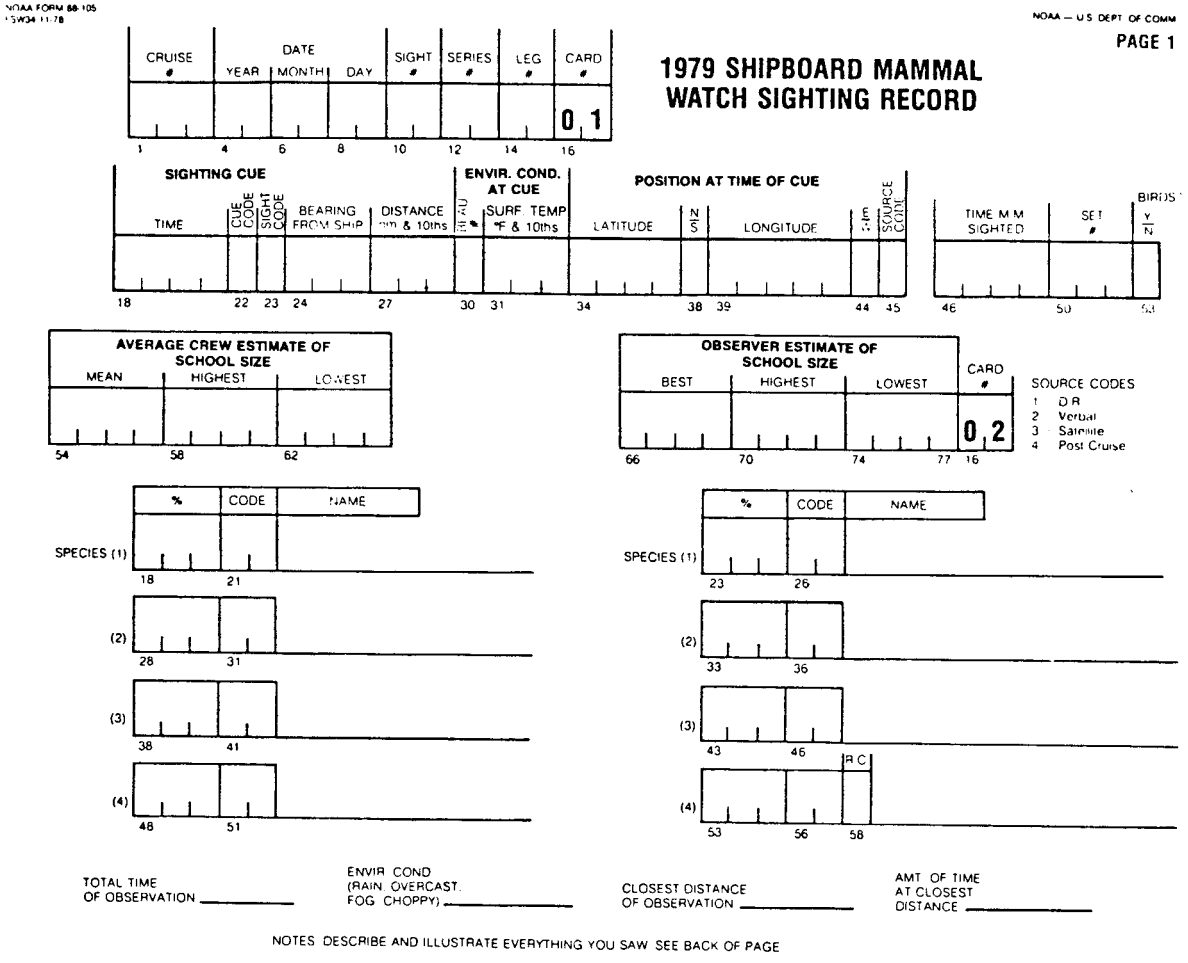
	%	CODE	NAME
SPECIES (1)			
	75	78 79	
(2)			
	24	27	
(3)			
	34	37	
(4)			
	44	47	
(5)			
	54	57	

	%	CODE	NAME
SPECIES (1)	0,2		
	17	19 22	
(2)			
	29	32	
(3)			
	39	42	
(4)			
	49	52	
(5)			
	59	62	

DESCRIBE AND ILLUSTRATE EVERYTHING YOU SAW. CONTINUE ON BACK.

PHOTOS: ROLL # _____ FRAME(S) # _____

Form Type V


NOAA FORM 88-105
(5W34 11-78)
NOAA — U.S. DEPT. OF COMM
PAGE 1
1979 SHIPBOARD MAMMAL WATCH SIGHTING RECORD
CRUISE #
DATE
YEAR
MONTH
DAY
SIGHT #
SERIES #
LEG #
CARD #
0 1
1 4 6 8 10 12 14 16
SIGHTING CUE
TIME
CUE CODE
SIGHT CODE
BEARING FROM SHIP
DISTANCE nm & 10ths
BEAU #
ENVIR. COND. AT CUE
SURF. TEMP °F & 10ths
POSITION AT TIME OF CUE
LATITUDE
N S
LONGITUDE
E W
SOURCE CODE
TIME M.M. SIGHTED
SET #
BIRDS Y N
18 22 23 24 27 30 31 34 38 39 44 45 46 50 51
AVERAGE CREW ESTIMATE OF SCHOOL SIZE
MEAN
HIGHEST
LOWEST
54 58 62
OBSERVER ESTIMATE OF SCHOOL SIZE
BEST
HIGHEST
LOWEST
CARD #
0 2
66 70 74 77 16
SOURCE CODES
1 D.R.
2 Verbal
3 Satellite
4 Post Cruise
% CODE NAME
SPECIES (1)
18 21
(2)
28 31
(3)
38 41
(4)
48 51
% CODE NAME
SPECIES (1)
23 26
(2)
33 36
(3)
43 46
R C
(4)
53 56 58
TOTAL TIME OF OBSERVATION
ENVIR. COND. (RAIN, OVERCAST, FOG, CHOPPY)
CLOSEST DISTANCE OF OBSERVATION
AMT. OF TIME AT CLOSEST DISTANCE
NOTES DESCRIBE AND ILLUSTRATE EVERYTHING YOU SAW SEE BACK OF PAGE

Form Type V
(Continued)

NOAA FORM 88-105
FSW34 11-78

NOAA — U.S. DEPT. OF COMM

1979 SHIPBOARD MAMMAL WATCH SIGHTING RECORD

SIGHTING SUMMARY

PAGE 2

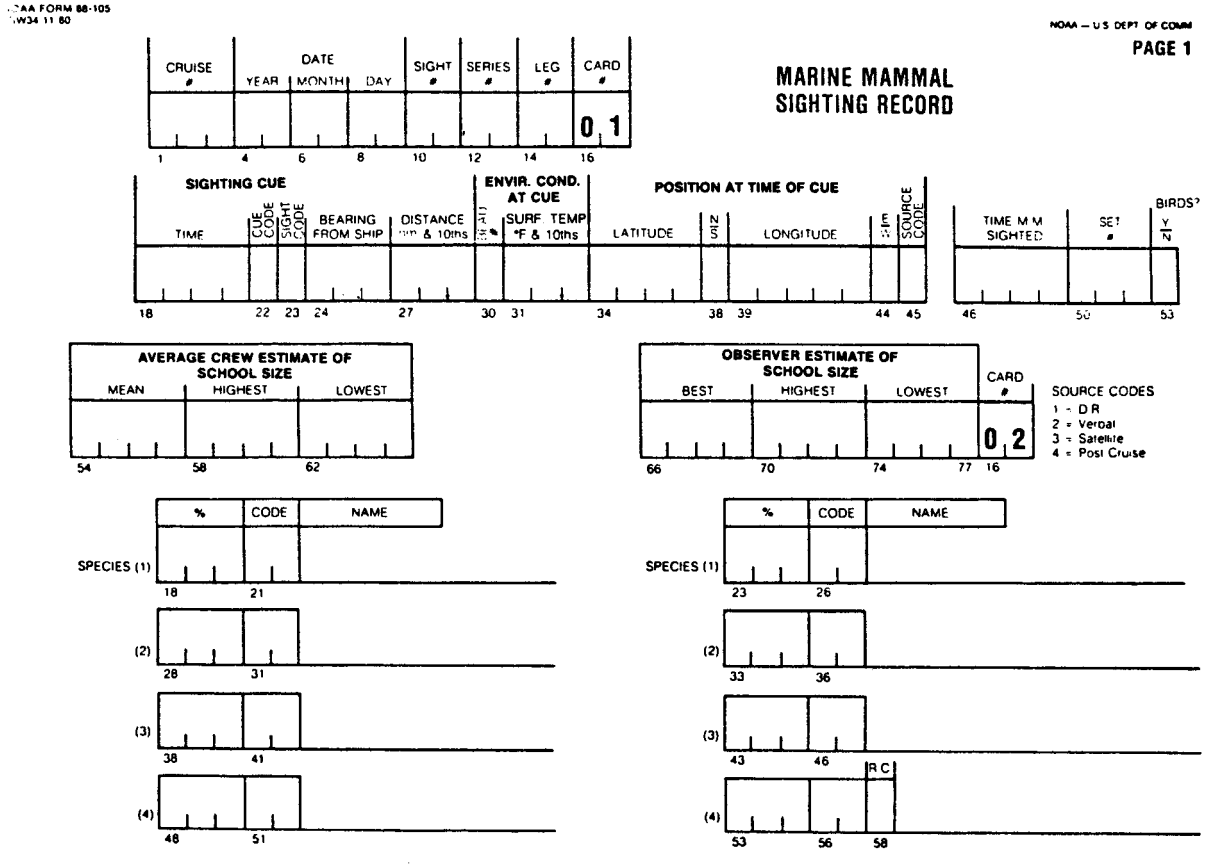
IDENTIFYING CHARACTERISTICS —

BEHAVIOR — (DESCRIBE AGGREGATION, MOVEMENT, BOW AND STERN RIDING, BLOWS, ETC.)

ASSOCIATED ANIMALS — (INCLUDE NUMBER AND SPECIES OF BIRDS)

PHOTOS ROLL#_____ FRAME(S) #_____

Form Type VI


NOAA FORM 88-105
(W34 11 80)
NOAA — U.S. DEPT. OF COMM
PAGE 1
MARINE MAMMAL
SIGHTING RECORD
CRUISE #
DATE
YEAR
MONTH
DAY
SIGHT #
SERIES #
LEG #
CARD #
0 1
1 4 6 8 10 12 14 16
SIGHTING CUE
TIME
CUE CODE
SIGHT CODE
BEARING FROM SHIP
DISTANCE
ENVIR. COND. AT CUE
SURF TEMP °F & 10ths
POSITION AT TIME OF CUE
LATITUDE
N S
LONGITUDE
E W
SOURCE CODE
TIME M M SIGHTED
SET #
BIRDS? Y N
18 22 23 24 27 30 31 34 38 39 44 45 46 50 53
AVERAGE CREW ESTIMATE OF SCHOOL SIZE
MEAN
HIGHEST
LOWEST
54 58 62
OBSERVER ESTIMATE OF SCHOOL SIZE
BEST
HIGHEST
LOWEST
CARD #
0 2
66 70 74 77 16
SOURCE CODES
1 = D.R.
2 = Verbal
3 = Satellite
4 = Post Cruise
% CODE NAME
SPECIES (1)
(2)
(3)
(4)
18 21
28 31
38 41
48 51
23 26
33 36
43 46
53 56
RC
58
TOTAL TIME OF OBSERVATION
ENVIR. COND. (RAIN, OVERCAST, FOG, CHOPPY)
CLOSEST DISTANCE OF OBSERVATION
AMT. OF TIME AT CLOSEST DISTANCE
TAGS ASSOCIATED W/SIGHTING
METHOD OF OBSERVATION (EYE, 7x, 10x, 20x)
NARRATIVE: DISCUSS EVENTS DURING THIS SIGHTING

Form Type VI
(Continued)

NOAA FORM 88-105
FSW34 11/80

NOAA — U.S. DEPT. OF COMM

MARINE MAMMAL
SIGHTING RECORD

SIGHTING SUMMARY

PAGE

LIST ALL DIAGNOSTIC FEATURES OBSERVED
(INCLUDE ESTIMATED BODY LENGTH)

SKETCH FEATURES OF ANIMALS SIGHTED

BEHAVIOR — (DESCRIBE AGGREGATION, MOVEMENT, BOW AND STERN RIDING, BLOWS, ETC.)

ASSOCIATED ANIMALS — (INCLUDE NUMBER AND SPECIES OF BIRDS)

PHOTOS: ROLL#_____ FRAME(S):#_____

Form Type VII

PORPOISE SIGHTING AND SET RECORD

DATE _____ CRUISE NO. _____ TIME PORPOISE SIGHTED _____ SIGHTING NO. _____ SET NO. _____

PAGE 1

1. ESTIMATE OF NUMBER AND SPECIES COMPOSITION OF ENTIRE PORPOISE SCHOOL

DESCRIBE AND ILLUSTRATE ON BACK OF PAGE EVERYTHING YOU SAW

	TOTAL NUMBER	% SPOTTED	% EASTERN SPINNER	% WHITE-BELLY SPINNER	% UNIDENT. SPINNERS	% OTHER SPECIES (1)	% OTHER SPECIES (2)	SPOTTED STOCK	OTHER SPECIES/STOCK (1)	OTHER SPECIES/STOCK (2)
TECHNICIAN :								NAME	NAME	NAME
CREW :								NAME	NAME	NAME
AERIAL :								NAME	NAME	NAME

2. ESTIMATE OF NUMBER OF PORPOISE THAT EVADED THE SET

	APPROX.#	MAJOR SPECIES / STOCK
EVADED CHASE / HERDING :		
EVADED ENCIRCLEMENT :		
DELIBERATELY CUT OUT :		
EVADED CAPTURE :		

3. CHASE AND SET TIMES

CHASE START	CHASE CALLED OFF OR SET ABORTED	REASON	LET GO	RINGS UP	BACKDOWN START	BACKDOWN FINISH	SKIFF ABOARD
TIME	TIME		TIME	TIME	TIME	TIME	TIME

4. ESTIMATE OF NUMBER AND SPECIES COMPOSITION OF PORPOISE CAPTURED

	TOTAL NUMBER	% SPOTTED	% EASTERN SPINNER	% WHITE-BELLY SPINNER	% UNIDENT. SPINNERS	% OTHER SPECIES (1)	% OTHER SPECIES (2)	SPOTTED STOCK	OTHER SPECIES/STOCK (1)	OTHER SPECIES/STOCK (2)
TECHNICIAN :								NAME	NAME	NAME
CREW :								NAME	NAME	NAME

5. LIVE PORPOISE RELEASED AND/OR ESCAPED AFTER RINGS UP

(a) PRIOR TO BACKDOWN [IF NO BACKDOWN GO TO ITEM (d)]			(b) BY BACKING DOWN		(c) DURING BACKDOWN BY OTHER METHODS [DOES NOT INCLUDE THOSE ANIMALS BACKED OUT]		# LIVE PORPOISE LEFT IN NET AFTER BACKDOWN	(d) FOLLOWING BACKDOWN, OR IF NO BACKDOWN		
NO. RELEASED	METHODS	NO. ESCAPED	NO. BACKED OUT	FISH LOST (TONS)	NO. RELEASED	METHODS		NO. RELEASED	METHODS	NO. ESCAPED

IATTC TUNA-PORPOISE FORM 3 10/78

Form Type VII
(Continued)

PORPOISE SIGHTING AND SET RECORD

CRUISE NO. _____
SET NO. _____

PAGE 2

6. OBSERVATIONS

(a) CHARACTERISTICS USED TO IDENTIFY PORPOISE

(b) NOTES ON PORPOISE BEHAVIOR WHEN SIGHTED, DURING CHASE AND DURING SET

(c) NOTES ON RESCUE EFFORTS AND BACKDOWN

Form Type VIII

MARINE MAMMAL SIGHTING
AND SET RECORD

DATE _____ CRUISE NO. ____ TIME MARINE MAMMALS SIGHTED____ SIGHTING NO.___ SET NO. ___ PAGE 1

1. INITIAL ESTIMATE OF NUMBER AND SPECIES COMPOSITION OF ENTIRE SCHOOL

	TOTAL NUMBER	% SPOTTED	% EASTERN SPINNER	% WHITE BELLY SPINNER	% UNIDENTIFIED SPINNERS	% OTHER SPECIES (1)	% OTHER SPECIES (2)	SPOTTED STOCK	OTHER SPECIES/STOCK (1)	OTHER SPECIES/STOCK (2)
TECHNICIAN:										
CREW :										
AERIAL :								NAME	NAME	NAME

2. MARINE MAMMAL EVASION AND ESCAPE BEHAVIOR

	SPECIES NO. 1 ACTIVITY	SPECIES NO. 1 HERDING	SPECIES NO. 1 NUMBER	SPECIES NO. 2 ACTIVITY	SPECIES NO. 2 HERDING	SPECIES NO. 2 NUMBER	SPECIES NO. 3 ACTIVITY	SPECIES NO. 3 HERDING	SPECIES NO. 3 NUMBER
BEFORE CHASE	:			:			:		
DURING CHASE	:			:			:		
AFTER LET GO	:			:			:		
DELIBERATELY CUT OUT			:			:			:
DIVED UNDER NET			:			:			:
SWAM OVER NET			:			:			:
TOTAL NUMBER OF MARINE MAMMALS NOT CAPTURED									:

3. CHASE AND SET TIMES

CHASE START	NO. OF SPBTS	CHASE CALLED OFF OR SET ABORTED	REASON	LET GO	RINGS UP	BACKDOWN START	BACKDOWN FINISH	SKIFF ABOARD	IF EVENING SET INDICATE TIME OF SUN DOWN	DESCRIBE AND ILLUSTRATE ON BACK OF PAGE EVERYTHING YOU OBSERVED
TIME		TIME		TIME	TIME	TIME	TIME	TIME	TIME	

IATTC Tuna-Propoise
Form 3 4/80

Form Type VIII
(Continued)

MARINE MAMMAL SIGHTING
AND SET RECORD

CRUISE NO._____SET NO._____ PAGE 2

4. OBSERVATIONS

(a) CHARACTERISTICS USED TO IDENTIFY MARINE MAMMALS. DESCRIBE ONLY THOSE CHARACTERISTICS ACTUALLY SEEN. MAKE A DRAWING OF AN INDIVIDUAL TO SUPPLEMENT YOUR DESCRIPTION. BE SURE TO TRY TO DISTINGUISH THE FOLLOWING: 1. SHAPE AND SIZE OF DORSAL FIN (INDICATE DIRECTION OF CANT); 2. SIZE OF SNOUT OR, IF NO SNOUT, SHAPE OF HEAD; 3. SHAPE OF BODY AND APPROXIMATE LENGTH; 4. MARKINGS, CAPE DEFINITION, AND COLOR PATTERN OF FINS AND BODY.

INDICATE THE CLOSEST DISTANCE THE MAMMALS WERE OBSERVED:_____

(b) DETAILED NOTES ON MARINE MAMMAL EVASION BEHAVIOR DURING CHASE (IF YOU ARE RECORDING A SIGHTING ONLY, USE THIS SPACE TO NARRATE BEHAVIOR OF MAMMALS SIGHTED AND ACTION TAKEN BY VESSEL, HELICOPTER, ETC.)

CREW'S ESTIMATE OF TOTAL NUMBER & % SPECIES COMPOSITION

	BEFORE LET GO				CAPTURED			
	TOTAL NO.	% SPECIES COMPOSITION			TOTAL NO.	% SPECIES COMPOSITION		
1)					1)			
2)					2)			
3)					3)			

Form Type IX

MARINE MAMMAL SIGHTING
AND SET RECORD

DATE_____ CRUISE NO. ____ TIME MARINE MAMMALS SIGHTED ____ SIGHTING NO. ____ SET NO. ____ PAGE 1

1. INITIAL ESTIMATE OF NUMBER AND SPECIES COMPOSITION OF ENTIRE SCHOOL

	TOTAL NUMBER	% SPOTTED	% E-SPIN	% WB-SPIN	% UNIDSPIN	% COMMON	% OTHER SPECIES (1)	% OTHER SPECIES (2)	SPOTTED STOCK	OTHER SPECIES/ STOCK (1)	OTHER SPECIES/ STOCK (2)
TECHNICIAN :											
CREW :											
AERIAL :											
									NAME	NAME	NAME

2. CHARACTERISTICS USED TO IDENTIFY MARINE MAMMALS. DESCRIBE CHARACTERISTICS ACTUALLY SEEN AND MAKE A DRAWING OF AN INDIVIDUAL.

CREW'S ESTIMATE

	TOTAL NO.	% COMPOSITION		
1)				
2)				
3)				

INDICATE CLOSEST DISTANCE MAMMALS WERE SIGHTED _____

IATTC Tuna-Dolphin
Form 3 10/81

Form Type IX
(Continued)

MARINE MAMMAL SIGHTING
AND SET RECORD

3. MARINE MAMMAL EVASION AND ESCAPE BEHAVIOR

PAGE 2

	SCHOOL HERDING CODE	SP. NO. 1 ACTIVITY CODE	NO. ESCAPED, CUT OUT OR EVADED	SP. NO. 2 ACTIVITY CODE	NO. ESCAPED, CUT OUT OR EVADED	SP. NO. 3 ACTIVITY CODE	NO. ESCAPED, CUT OUT OR EVADED	SP. NO. 4 ACTIVITY CODE	NO. ESCAPED, CUT OUT OR EVADED	TOTAL BY SPECIES THAT EVADED, ESCAPED OR WERE CUT OUT
BEFORE CHASE	___	___		___		___		___		
DURING CHASE	___	___	___ ___ ___ ___	___	___ ___ ___ ___	___	___ ___ ___ ___	___	___ ___ ___ ___	___ ___ ___ ___
DURING ENCIRCLEMENT	___	___	___ ___ ___ ___	___	___ ___ ___ ___	___	___ ___ ___ ___	___	___ ___ ___ ___	___ ___ ___ ___
DELIBERATELY CUT OUT			___ ___ ___ ___		___ ___ ___ ___		___ ___ ___ ___		___ ___ ___ ___	___ ___ ___ ___
EVADED UNDER NET			___ ___ ___ ___		___ ___ ___ ___		___ ___ ___ ___		___ ___ ___ ___	___ ___ ___ ___
ESCAPED OVER NET			___ ___ ___ ___		___ ___ ___ ___		___ ___ ___ ___		___ ___ ___ ___	___ ___ ___ ___
									GRAND TOTAL:	___ ___ ___ ___

4. CHASE AND SET TIMES

CHASE START	NO. SPBTS	CHASE CALLED OFF	REASON CHASE CALLED OFF	LET GO	REASON SET ABORTED	RINGS UP	BACKDOWN START	BACKDOWN FINISH	SKIFF ABOARD	IF EVENING SET INDICATE TIME OF SUNDOWN
___ ___ ___ TIME	___	___ ___ ___ TIME	___	___ ___ ___ TIME	___	___ ___ ___ TIME	___ ___ ___ TIME	___ ___ ___ TIME	___ ___ ___ TIME	___ ___ ___ TIME

5. OBSERVATIONS

a.) DETAILED NOTES ON MARINE MAMMAL EVASION BEHAVIOR DURING CHASE

b.) DESCRIBE MARINE MAMMAL EVASION AND ESCAPE BEHAVIOR DURING ENCIRCLEMENT AND THROUGH REMAINDER OF SET

APPENDIX 3. Computer analysis of the distribution and effort data.

Distribution Data

The computer system set up to aid in the analysis of these data involved 4 tasks:

Task 1 The data bases of sightings covering the period 1966 to 1982 have over 20 million bytes of information. To reduce storage space and make data manipulation easier, new data bases of reduced size were made which consisted only of a sighting identification code (cruise number, date, sighting number), the species stock code, and the geographic position.

Task 2 Plots were produced showing the distribution of sightings for each of the four species.

Task 3 Sightings outside of the SOPS '79 range boundaries were identified.

Task 4 A report was produced showing the number of sets for each species group by locality (i.e. 5-degree square).

A brief description of each task follows (refer to the schematic diagram):

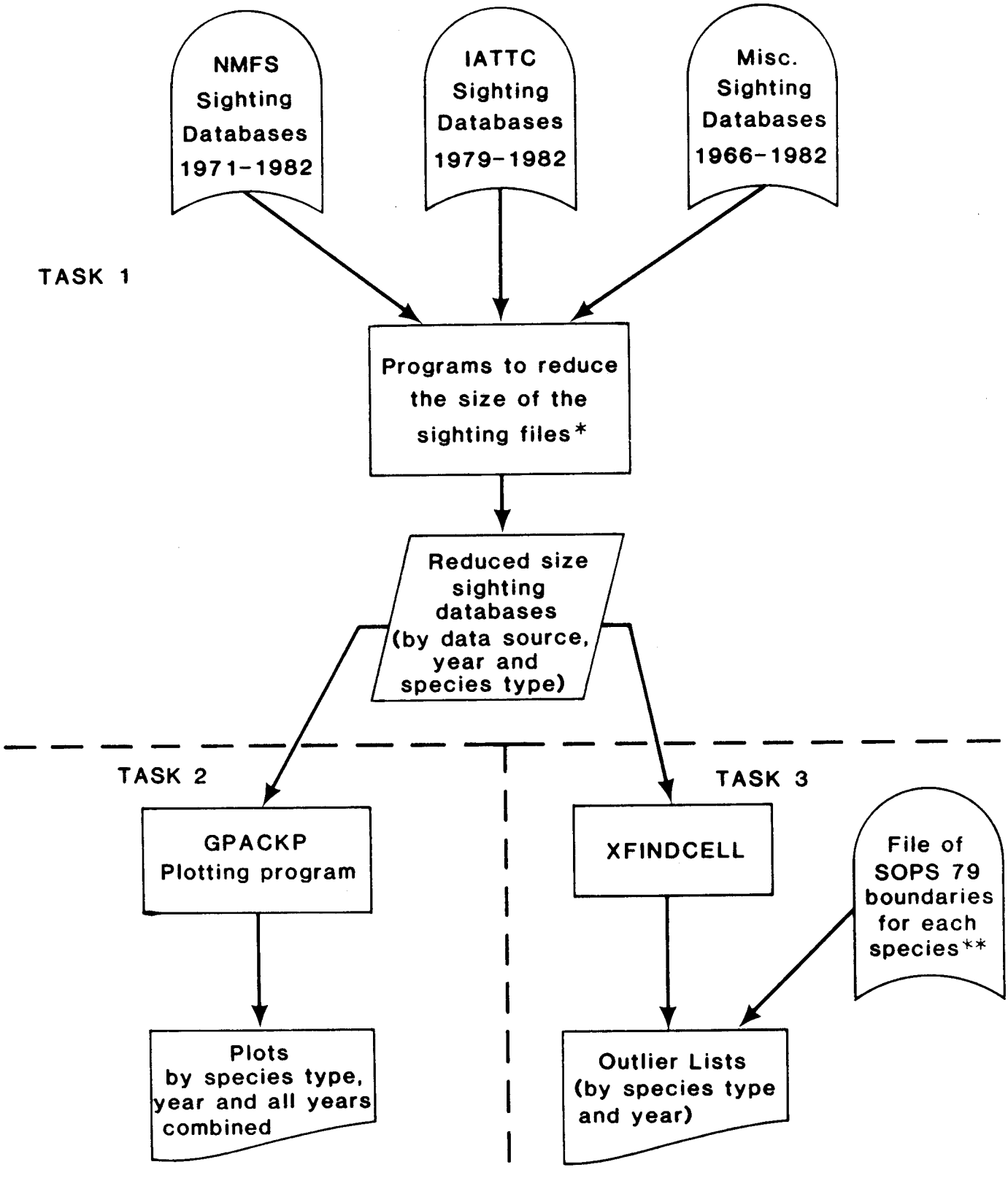
Task 1 Data sources for the sightings are the National Marine Fisheries Service Cruises from 1971 to 1983, Inter-American Tropical Tuna Commission Cruises for 1979 to 1983 (partial), and other miscellaneous sightings from 1966 to 1982. Programs were written for each type of data source to produce a data base of sighting records of reduced size. Separate data bases were produced for each data source (NMFS, IATTC and MISCELL), by species and year.

Task 2 The Southwest Fisheries Center has a general plotting program called GPACK which utilizes a commercial plotting package called DISSPLA. A slightly modified version of GPACK called GPACKP was used to produce the plots for this system. Plots were produced by species for each year and for all years combined.

Task 3 Southwest Fisheries Center has a program called FINDACELL which determines if a geographic position is located in a user-defined cell. XFINDCELL is a modification of FINDACELL which takes a polygon, in this case the SOPS '79 boundary for a species, and determines if a point, or sighting, lies inside or outside of the polygon. Points lying outside of the polygon were written to an outlier list. The original data sources for these sightings were then examined to determine their reliability.

Task 4 The program SLSUMENC was written to determine the species composition of each set at the time of capture and to count the number of sets by species group in each 5-degree square. This program was run for each year from 1977 to 1982 using the set-log databases. The data was then summarized into a final report using the SLENCREP program.

ANALYSIS OF SIGHTING DATA BY SPECIES

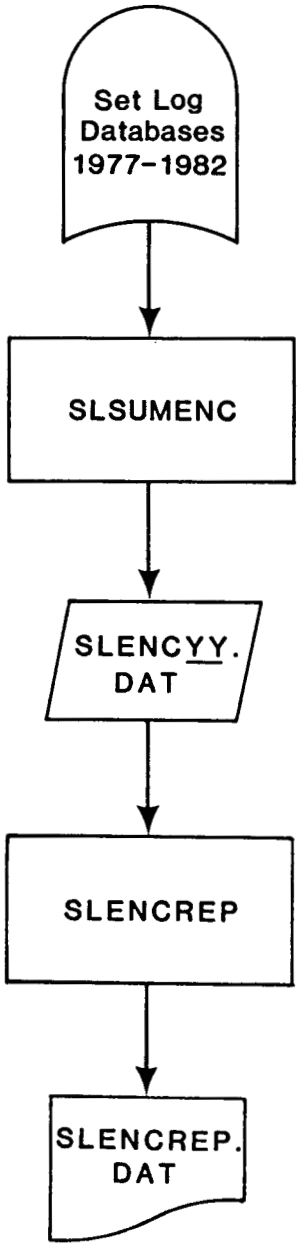


*Includes: RDCNMFS, RDCNMFS 79, YRDIFF, SPSPLIT, RDCTUNA, MISCYEAR, RDMISC

**Includes: ATTNPOLY, LONGPOLY, DELPOLY, COEPOLY

ANALYSIS OF SIGHTING DATA BY SPECIES

TASK 4



Effort Data

The computer system set up to aid in the analysis of this data involved 3 tasks.

Task 1 Computing the nautical miles of effort from the National Marine Fisheries Service (NMFS) cruises and Inter-American Tropical Tuna Commission (IATTC) cruises for each year and summarizing the data by 1-degree square.

Task 2 Merging the effort summaries for the NMFS and IATTC cruises for each year and for all years combined.

Task 3 Producing plots of effort for each year and for all years combined.

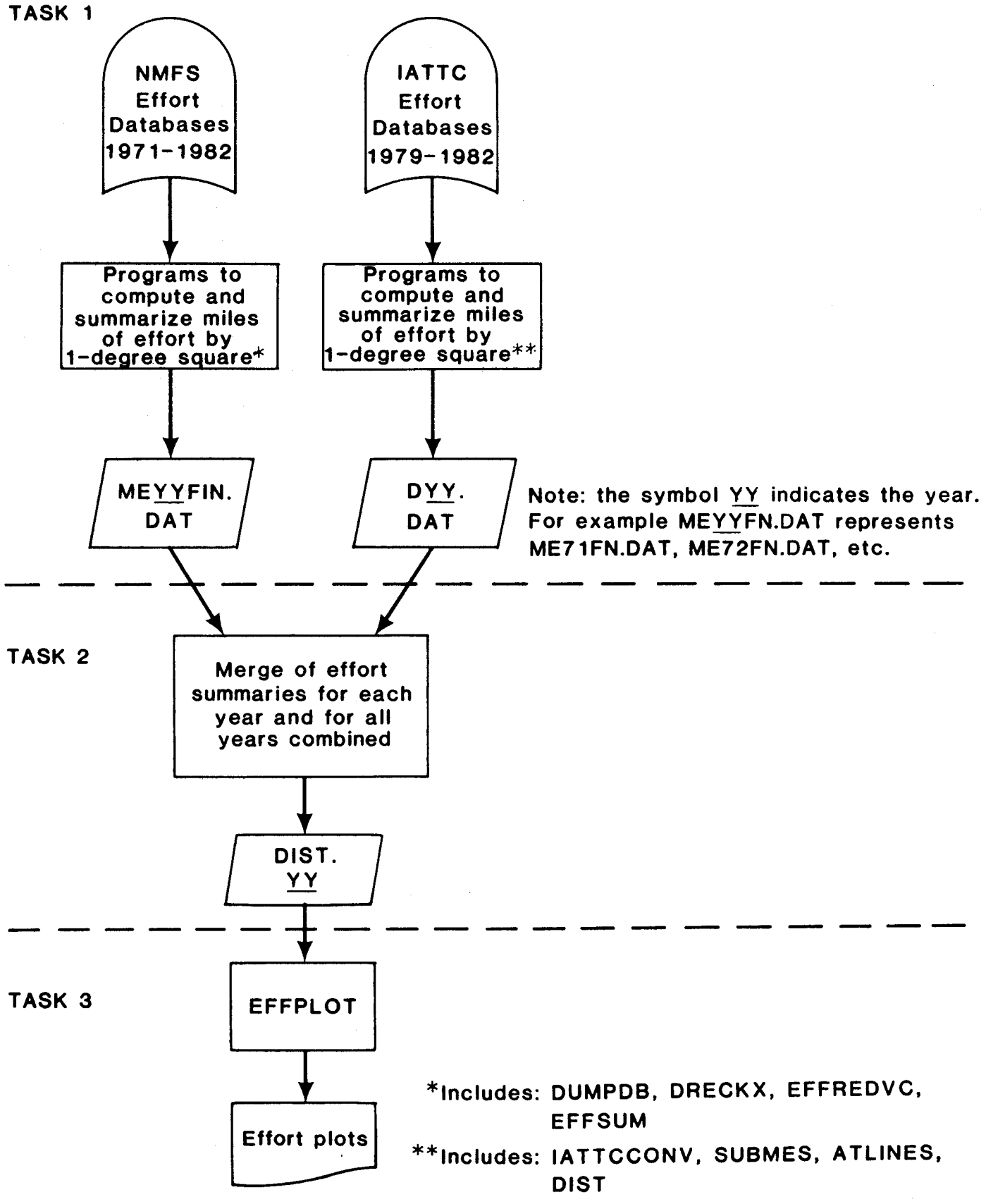
Following is a schematic diagram and a brief description of each task:

Task 1 Data sources for the effort were the NMFS cruises from 1971 to 1980 and the IATTC cruises for 1980 through 1982. Programs were written to compute the starting and ending position for each leg of effort, determine the nautical miles covered and determine which 1-degree square(s) the effort took place in. The data were then summarized for each 1-degree square. Separate sets of programs were written for the NMFS and IATTC effort, since the data are stored on different computer systems. The series of programs was run on the effort data for each year separately.

Task 2 The final effort summaries were put in compatible form and merged for each year and for all years combined.

Task 3 The plots were produced by a plotting program called EFFPLOT, which is a modification of the AMP plotting program. The program allows the user to show effort density by using amounts of shading in each 1-degree square.

ANALYSIS OF EFFORT DATA



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(February 1983)

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R. S. HOLT
(March 1983)

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