Abstract.–During 1986, the National Marine Fisheries Service began conducting long-term research vessel surveys to determine trends in population size of dolphin stocks taken incidentally by tuna purse seiners in the eastern tropical Pacific. Line transect methodology was used by observers aboard two vessels for 120 days each. We assumed the variability associated with the abundance estimates would be relatively constant during the sampling period and investigated (1) annual changes in population size of the northern offshore spotted stock that could be detected within a 5-year (six survey) sampling period, and (2) the number of years required to detect a 10% annual decline with α and β error levels of 10%. The abundance estimate of the northern offshore spotted dolphin stock using the first year's data was 929,000 animals. After 5 years, a minimum 17.6% annual decline could be detected during which 62% of the stock would decrease. A 10% annual decline can be detected in a minimum of 8 years. Data from subsequent surveys will be investigated that may improve our ability to detect smaller annual declines.

Manuscript accepted 21 September 1989.
Fishery Bulletin, U.S. 88:105-111.

Monitoring Trends in Dolphin Abundance in the Eastern Tropical Pacific Using Research Vessels Over a Long Sampling Period: Analyses of 1986 Data, The First Year

Rennie S. Holt
Stephanie N. Sexton
Southwest Fisheries Center
National Marine Fisheries Service, NOAA
La Jolla, California 92038

The National Marine Fisheries Service (NMFS) is responsible for assessing the status of dolphins taken incidentally by tuna purse seiners in the eastern tropical Pacific (ETP) (Richey 1976). The status of spotted dolphins *Stenella attenuata* is of special concern because it is the major species taken by the fishery (Smith 1979). Of the three stocks of spotted dolphins, the northern offshore stock has been fished more frequently than any other stock. The four stocks of spinner dolphins *S. longirostris*, and the four stocks of common dolphin *Delphinus delphis*, are also taken. The four stocks of striped dolphin *S. coeruleoalba* and the Fraser's dolphin *Lagenodelphis hosei* are occasionally caught (Holt and Powers 1982). These five species are herein grouped and termed target species.

NMFS conducted assessments of target populations in 1976 (SWFC 1976) and again in 1979 (Smith 1979) using absolute stock abundance. The validity of the absolute estimates depended on several assumptions (i.e., all schools located directly on the trackline were detected, schools did not respond to the ship before being detected, etc.). Unfortunately, not all of these underlying assumptions were met (Holt and Cologne 1987, Holt 1987). Therefore, in 1984 Congress amended the Marine Mammal Protection Act and mandated that an alternative approach for assessing stocks be used that was less sensitive to biases. By using consecutive population estimates and establishing the first estimate as a base to which all subsequent estimates would be relative, we can detect trends in stock sizes over a long sampling period. These relative estimates can provide an assessment of stock condition if the biases in the abundance estimates are consistent over the sampling period.

In 1986, NMFS initiated a research program to monitor dolphin populations in the ETP which would utilize two research vessels for at least 5 years during which six surveys would be conducted. The research design (Holt et al. 1987) indicated that a 10% annual rate of decrease in northern offshore spotted dolphins could be detected (a total 41% decrease over six surveys). Herein, we present the population estimates for the first year's survey data. We also discuss effects of several factors on these base estimates, and, assuming data for subsequent surveys will have the same level of precision (coefficient of variation levels) as the first year, examine changes in population sizes that can be detected in 5 years or, conversely, the number of years required to detect various levels of change.

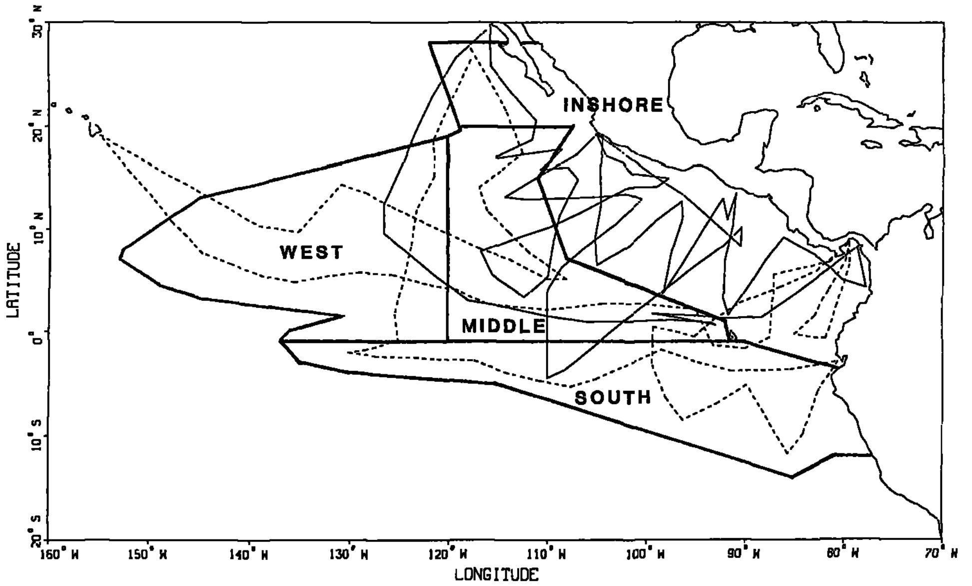

Figure 1
Tracklines traversed by the NOAA RV *David Starr Jordan* (solid) and *McArthur* (dash) during the 1986 dolphin survey, eastern tropical Pacific. Tracklines generated using noontime positions.

Materials and methods

Study area and survey coverage

The study area was described by Au et al. (1979) (Fig. 1). We partitioned the area into four strata: inshore, middle, and west located north of 1°S, and a south stratum. These strata were selected based upon preliminary examinations of historical distributions of dolphin stocks and oceanographic features.

The NOAA research vessels *David Starr Jordan* and *McArthur* traversed predetermined tracklines in the ETP during 29 July–5 December and 6 December, respectively (Fig. 1). Each vessel spent approximately 120 days at sea. Detailed operations, survey procedures and preliminary data summaries for each vessel are presented elsewhere (Holt and Sexton 1987, Holt and Jackson 1987).

On each ship, two observers used 25× binoculars located on each side of the ship to search from directly ahead to abeam of their respective sides of the ship. A third observer served as data recorder and searched directly ahead of the ship when not recording data. Two teams of three observers each alternately occupied the three duty stations. Each team was on duty for 2-hour shifts. During each shift, members spent approximately equal time occupying each duty station. Whenever possible, schools were approached and observers recorded independent "best" estimates of school size. If an observer could not obtain a best estimate, a "minimum" estimate was made. Independent estimates were averaged to obtain mean minimum and best estimates.

Abundance estimation

Estimates of population abundance of the target species (N_{ij}) are computed as (Holt and Powers 1982):

$$N_{ij} = \sum_{k=1}^{4} [D_k\, S_{tk}\, P_{tk}\, P_{ik}\, A_k/A_{ik}]\, [A_{ijk} + P'_{ij}\, A'_{ijk}],$$

where

- D_k = estimate of density of all dolphin schools, both identified and unidentified to species, in area k,
- S_{tk} = estimate of mean size of target schools in area k,
- P_{tk} = estimate of proportion of dolphin schools which are target schools in area k,
- P_{ik} = estimate of proportion of individuals of species i in target schools in area k,
- P'_{ij} = estimate of proportion of individuals of stock j of species i in target schools in overlap region containing two stocks of species i (overlap region discussed in text),
- A_k = total area inhabited by the target species in area k,
- A_{ik} = area inhabited by species i in area k,
- A_{ijk} = area inhabited by species i, stock j, in area k, and
- A'_{ijk} = area inhabited by species i, stock j, in overlap region of area k.

The variance of N_{ij} was calculated using bootstrapped methods. For each stratum, the number of legs (segment of time during which all sighting conditions were consistent) of searching effort was tabulated, and then effort legs equal to that number were randomly selected with replacement. This effort and the associated sightings were used to calculate school density, school size, species proportions, and finally estimates of N_{ij}. This process was repeated 100 times. The bootstrapped variance of N_{ij} for each stock was calculated using these 100 estimates.

Formulae used to estimate school density are from Burnham et al. (1980), Holt (1985, 1987), and Hayes and Buckland (1983). The Fourier series (Crain et al. 1979) and hazard rate (Hayes and Buckland 1983, Buckland 1985) models both provided adequate fits to the perpendicular (sighting) distance data; however, the hazard rate model was used because, unlike the Fourier series model, it does not require subjective selection of the number of terms in the model and, therefore, could be used in the bootstrapped procedures. Of schools containing both target and non-target species, only the proportion of individuals of the target species was used in the school size estimates. Estimates of the proportion of all dolphin schools that were target schools (P_{tk}) were calculated using formulae from Holt and Powers (1982). Formulae to estimate the proportions (P_{ik}) of the number of individuals for each species of all target individuals are given by Barlow and Holt (1986).

All species of dolphins encountered in the study area were included in the density analyses. Estimates were calculated using only schools containing 15 or more animals. Smaller schools were not used because we believe small schools both on and off the ships' tracklines may be difficult to detect, especially during rough weather and may have been missed at a variable rate depending on prevailing weather conditions (Holt and Powers 1982).

Schools detected at increasing distances from the trackline tend to include disproportionately more large schools because there is a direct correlation between the size of a school and the probability of it being detected (Drummer 1985). This biases school size estimates upward and species proportions toward species which tend to occur in large schools. We attempted to adjust for this bias by weighting school size and species-proportion estimates by the inverse of the logarithm of school size (Holt and Powers 1982). Schools for which there were no "best" estimates of size were not used in the school-size or species-proportions calculations.

Because a 3.7 km (2.0 nm) truncation point provided the best fit of the hazard model to the data, only schools detected within 3.7 km perpendicular distance of the trackline were used to estimate school density. Schools detected greater than 3.7 km have little affect on the density estimates, and the perpendicular distance distributions of schools at greater distances were "spiked". These spikes are a result of the observers' tendency to round-off estimates of radial distances and sighting angles of schools detected at large distances from the vessel in multiples of 0.5 nm or 5°, respectively.

Some stocks of the same species have overlapping ranges (A'_{ijk}). These overlapping stocks include (1) coastal and northern spotted, (2) eastern and whitebelly spinner, and (3) Baja Neritic and northern common dolphins (Perrin et al. 1984). The relative number of dolphins of each overlapping stock (P'_{ij}) was calculated for data pooled over the range and, if applicable, over strata. The relative proportions of coastal and northern spotted, and of eastern and whitebelly spinner stocks, within their respective areas of overlap, were calculated as the average of their relative abundances (percent occurrence). Few data were available to determine relative proportions of the overlapping Baja Neritic and northern common dolphins. Therefore, population estimates for Baja Neritic were combined with northern common dolphins.

The area inhabited by each target species (A_{ik}) and each stock (A_{ijk}) used to calculate the population abundance estimates were those defined by Au et al. (1979) and Perrin et al. (1984). The size of each stratum (A_k) and the size of the area occupied by each stock in each stratum were calculated by counting the number of 1° quadrilateral squares in the stratum at each degree of latitude; partial squares were approximated. Next, the number of 1° squares was multiplied by the area in a 1° square for that latitude as described by Holt and Powers (1982).

Detecting trends in abundance

The variability associated with the population abundance estimates of northern offshore spotted dolphins during this first survey was examined to determine changes which may be detected from subsequent surveys using methods presented by Holt et al. (1987) and Gerrodette (1987). For Type I (α) and Type II (β) error levels of 0.10, we computed the number of years required to detect a minimum annual decrease of 0.10 and the minimum annual decrease in northern offshore spotted dolphins which could be detected at the end of the planned 5-year (6-survey) period. In addition, we calculated the total population decrease that would occur over the 5-year period given that annual level of decrease.

Results

During the entire survey, observers aboard both vessels searched 30,339 km and detected 1150 marine mammal schools. Dolphins were present in 749 of these

Table 1

Summary of 1986 dolphin survey in eastern tropical Pacific. Data were truncated at 3.7 km perpendicular distance. Schools with less than 15 animals were omitted from analyses. School sizes and species proportions weighted by inverse of logarithm of school size. Effort collected during sea states 0–5 were included in analyses. Data summed for both vessels. Total estimates calculated using effort summed over all four strata.

	Inshore	Middle	West	South	Total
Survey area (1000 km^2)	5,693	3,798	5,298	4,359	19,148
Percent of total survey area	30	20	28	22	100
Trackline searched (km)	11,889	7,846	3,877	4,056	27,669
Percent of searching effort	43	28	14	15	100
Dolphin schools					
Density (D_k) (schools/1000 km^2)	3.62	2.56	1.89	2.32	2.89
Number detected[1]	165	77	28	36	306
Mean target-species school size (S_{tk})	89.41	83.97	104.55	179.04	99.13
Number target schools[2]	126	71	25	27	249
Proportion target schools (P_{tk})	0.790	0.906	0.897	0.744	0.825
Proportion of target animals by species					
Spotted	0.239	0.378	0.347	0.170	0.266
Spinner	0.293	0.242	0.351	0.054	0.235
Common	0.296	0.108	0.008	0.661	0.305
Striped	0.163	0.272	0.126	0.056	0.160
Fraser's	0.009	0.000	0.168	0.059	0.035
Proportion of animals in overlap area					
Coastal spotted					0.395
Offshore spotted					0.605
Eastern spinner					0.703
Whitebelly spinner					0.297
Number of schools in overlap area					
Spotted					29
Spinner					96

[1]Includes unidentified dolphin schools.
[2]Includes schools identified as target species but for which a best estimate of school size was not made.

schools. While searching in the study area (Fig. 1), observers on both vessels searched 27,669 km and detected 306 dolphin schools containing 15 or more animals located within 3.7 km perpendicular distance of the trackline during Beaufort sea states of 5 and less (Table 1). The amount of effort and schools detected varied among strata; 43% of the total trackline searched and 54% of all dolphin schools detected were in the inshore area.

Abundance estimation

The estimate of $f(0)$ for data in the total area (pooled) was 0.522. Density estimates (D_k) in the four strata, calculated using the pooled $f(0)$, ranged from 1.89 to 3.62 schools/1000 km^2 (Table 1). Estimates of mean school size (S_{tk}) of target species ranged from 83.97 to 179.04 animals (Table 1). The proportion of identified dolphin schools that included target species (P_{tk}) ranged from 0.744 to 0.906 among strata (Table 1).

The proportions of individuals of all target schools that were spotted dolphins (P_{ik}) in the four strata ranged from 0.170 to 0.378 (Table 1). The proportions of the other target species among strata also varied greatly. For example, the proportion of common dolphins ranged from 0.008 to 0.661 (Table 1). Only 29 spotted dolphin schools were detected in the overlap region of the coastal and offshore spotted stocks. The proportion (P'_{ij}) of these that were offshore spotted dolphins was 0.605 (Table 1). Of 96 spinner dolphin schools detected in the area of overlap of eastern and whitebelly spinner stocks, the proportion of these that were eastern spinner dolphin individuals was 0.703.

The areas inhabited by each stock (A_{ijk}) of each target species (A_{ik}) in each stratum (A_k), and the overlapping areas (A'_{ijk}) inhabited by (1) coastal and offshore spotted dolphins and (2) eastern and whitebelly spinner dolphins, are shown in Table 2.

Relatively, common dolphins were the most abundant species (Table 3). The estimate of 929,000 northern offshore spotted dolphins represented 78% of the estimate of all stocks of spotted dolphins. The coefficient of variation (CV) of the abundance of the northern offshore spotted dolphon stock, CV(N_{ij}), was 0.255. The

Table 2
Area inhabited (km^2) by each dolphin species/stock in inshore, middle, west, and south strata, and in total survey area, eastern tropical Pacific.

Dolphin species/stock	Inshore	Middle	West	South	Total area
Spotted					
Coastal, non-overlapping	113,660			8,557	122,217
Northern offshore, non-overlapping	4,073,493	3,788,767	4,016,325		11,878,585
Coastal and northern offshore, overlapping	909,279				909,279
Southern offshore, non-overlapping				3,175,138	3,175,138
Coastal and southern offshore, overlapping				68,455	68,455
Total	5,096,432	3,788,767	4,016,325	3,252,150	16,153,674
Spinner					
Costa Rican	248,366				248,366
Northern whitebelly, non-overlapping			1,806,239		1,806,239
Eastern and northern whitebelly, overlapping	4,762,844	3,401,601	2,889,195		11,053,640
Southern whitebelly, non-overlapping	9,825	346,337	47,898	2,543,829	2,947,889
Eastern and southern whitebelly, overlapping	190,322			751,964	942,286
Total	5,211,357	3,747,938	4,743,332	3,295,793	16,998,420
Common					
Northern tropical	1,477,237	477,581			1,954,818
Western central tropical	17,886	1,273,546	2,207,221		3,498,653
Eastern central tropical	3,502,375	420,581			3,922,956
Southern tropical	829,881	847,176		1,239,588	2,916,645
Total	5,827,379	3,018,884	2,207,221	1,239,588	12,293,072
Striped					
Northern tropical	1,104,177	681,546			1,785,723
Western central tropical			2,870,874		2,870,874
Eastern central tropical	3,549,019	1,066,116			4,615,135
Southern central tropical	510,371	1,658,074	514,537	3,792,278	6,475,260
Total	5,163,567	3,405,736	3,385,411	3,792,278	15,746,992
Fraser's*	5,211,357	3,747,938	4,743,332	3,295,793	16,998,420
All species/stocks	5,848,469	3,797,734	5,298,266	4,203,366	19,147,835

*Used total spinner dolphin area.

Table 3
Estimates of base population sizes (N_{ij}) (10^3 animals) by stock for target dolphin species in total survey area, eastern tropical Pacific. Estimates weighted by size of each stratum.

Dolphin species/stock	N_{ij}	SE(N_{ij})	CV(N_{ij})
Spotted			
Coastal	36.0	8.6	0.239
Northern offshore	929.0	236.5	0.255
Southern offshore	218.5	120.3	0.551
Total	1183.5	365.4	0.309
Spinner			
Costa Rican	20.9	6.1	0.292
Eastern	579.6	192.2	0.332
Northern whitebelly	333.1	127.5	0.383
Southern whitebelly	83.1	32.9	0.396
Total	1016.7	358.7	0.353
Common			
Northern tropical	124.9	39.7	0.318
West central tropical	42.5	22.2	0.522
East central tropical	277.3	85.6	0.309
Southern tropical	943.2	388.8	0.412
Total	1387.9	536.3	0.386
Striped			
Northern tropical	92.4	20.2	0.219
West central tropical	99.9	40.7	0.407
East central tropical	230.6	48.6	0.211
Southern tropical	212.3	62.4	0.294
Total	635.2	171.9	0.271
Fraser's	247.9	202.5	0.817
Total	4471.2	1634.8	0.366

abundance estimate for eastern spinner dolphins was 579,600 animals with a CV of 0.332.

Trends in abundance

Assuming the CV(N_{ij}) for subsequent surveys will be constant during the sampling period, and with α and β errors equal to 0.10, a 10% annual decrease in abundance of offshore spotted dolphins can be detected in a minimum of 8 years. After 5 years, and assuming the CV(N_{ij}) of 0.255 will remain constant, a minimum annual decline of 17.6% may be detected during which a 62% decrease of the offshore spotted stock would have occurred.

Discussion

A biased estimate may be acceptable to detect trends in population changes if the bias is constant among annual surveys and if it results in a more precise estimate. For example, the estimate of school density that was calculated by fitting a detection function to data pooled over all strata is biased upwards because searching effort was not allocated to strata uniformly but proportionately to historical estimates of density. The inshore stratum, which historically had the largest density (Holt et al 1987), received a greater proportion of the searching effort (43% of total effort) compared with its relative size (30% of total area). However, the pooled estimate is more precise than the stratified estimate, and the bias should be consistent during subsequent years.

Our estimate of target school size (99.13 animals, Table 1) was half the estimate from aerial data collected in 1979 (199.8 animals per school) (Holt 1985). Although school size may have declined between 1979 and 1986, our estimate is similar to a previous school size estimate that used data collected 1979–83 aboard research vessels (119.9 animals per school) (Holt 1985). In addition, we used only schools detected within 3.7 km perpendicular distance of the trackline, while the previous aerial and ship studies used schools detected within 11.1 km perpendicular distance (approximate distance to horizon from ship). Our estimate using the 11.1 km perpendicular distance was 111.97 animals per school. The previous estimates from airplanes and ships may have been biased upward because large schools are more likely detected at greater distances than are small ones.

The inverse log weighting factor used to adjust biases in the school-size and species proportion estimates caused by detecting disproportionately more large schools may have over- or undercompensated by an unknown degree. Recent work by Drummer (1985) investigating size biases may be utilized during comparisons of this data and subsequent years' data.

Estimates of the relative proportions (P'_{ijk}) of coastal and offshore spotted dolphins and of eastern and whitebelly spinner stocks in their respective areas of overlap were based on data pooled over all strata and included all schools occurring within 11.1 km (6 nm) perpendicular distance from the trackline; however, they were based on small sample sizes (29 spotted and 96 spinner schools). These estimates may change with collection of additional survey data. However, the proportion of eastern spinner dolphins to whitebelly spinner dolphins in their overlap area was 0.703 during 1986 (Table 1) and was 0.714 when all research vessel data collected from 1976–86 were combined (207 schools).

Our population abundance estimates are intended to serve as the baseline estimates for relative comparisons using data collected during subsequent surveys. When our estimates of northern offshore spotted dolphins are compared with previous estimates, ours are much smaller than those made for data collected through 1979 (2,775,000 animals) (Holt and Powers 1982) and for data collected through 1984 (2,533,300 animals) (Holt 1985). Both the latter absolute and our current base estimates may be biased because they share common data collection constraints—failure to detect all trackline schools—which bias the density estimates downward. The older estimates may also contain other biases which result in relatively higher values. For example, those estimates used a combination of data collected aboard airplanes, research vessels and tuna vessels, and survey coverage was pooled over several years, seasons, and areas. However, some variables used to calculate our estimates used small data sets that may have resulted in less precise results.

Because our population estimates are intended to serve as the baseline estimate for relative comparisons using data collected during subsequent surveys, consistent bias during the sampling period will not jeopardize the results. Therefore, several options will be reviewed in analyzing subsequent years' data which may reduce variability associated with the population estimates. Sample sizes to calculate school sizes and species proportions may be increased by utilizing all schools detected at perpendicular distances from the trackline out to the horizon. We will investigate spotted dolphin abundance estimates using only schools of spotted dolphins. A computerized binocular system (Holt and Sexton 1987) may yield more precise estimates of radial distance and sighting angles to dolphin schools, and we have incorporated use of a ship-based helicopter to obtain aerial photographs of dolphin schools to calibrate observer estimates of school size. Hopefully, some or all of these factors may reduce the CV(N_{ij}) levels to around 12%, as anticipated by Holt et al. (1987) in initial survey design.

Acknowledgments

We acknowledge the biologists who collected the data: S. Benson, C. Bisbee, K. Brownell, S. Buckland, A. Dizon, W. Irwin, R. LeDuc, M. Lynn, M. Newcomer, R. Pitman, L. Robertson, D. Skordal, S. Sinclair, P. Stangl, and M. Webber. We are grateful to A. Jackson, W. Parks, and S. Reilly for directing the at-sea operations, and W. Parks and P. Stangl for their shoreside support. We thank J. Barlow, S. Buckland, K. Burnham, D. DeMaster, M. Hall, L. O'Brian, and S. Reilly for reviewing this manuscript.

Citations

Au, D., W.L. Perryman, and W. Perrin
1979 Dolphin distribution and the relationship to environmental features in the eastern tropical Pacific. Adm. Rep. LJ-79-43, Southwest Fish. Cent., Natl. Mar. Fish. Serv., NOAA, La Jolla, CA 92038, 59 p.

Barlow, J., and R.S. Holt
1986 Proportions of species of dolphins in the eastern tropical Pacific NOAA-TM-NMFS-SWFC-56, Southwest Fish. Cent., Natl. Mar. Fish. Serv., NOAA, La Jolla, CA 92038, 44 p.

Buckland, S.T.
1985 Perpendicular distance models for line transect sampling. Biometrics 41:177–195.

Burnham, K., D. Anderson, and J. Laake
1980 Estimation of density from line transect sampling of biological populations. Wildl. Monogr. 72, 202 p.

Crain, B., D. Burnham, D. Anderson, and J. Laake
1979 A Fourier series estimator of population density for line transect sampling. Utah State Univ. Press, Logan, 25 p.

Drummer, T.D.
1985 Size-bias in line transect sampling. Ph.D. Diss., Univ. Wyoming, Laramie, 143 p.

Gerrodette, T.
1987 A power analysis for detecting trends. Ecology 68: 1364–1372.

Hayes, R.J., and S.T. Buckland
1983 Radial distance models for the line transect method. Biometrics 39:29–42.

Holt, R.S.
1985. Estimates of abundance of dolphin stocks taken incidentally in the eastern tropical Pacific yellowfin tuna fishery. Adm. Rep. LJ-85-20, Southwest Fish. Cent., Natl. Mar. Fish. Serv., NOAA, La Jolla, CA 92038, 32 p.
1987 Estimating density of dolphin schools in the eastern tropical Pacific ocean by line transect methods. Fish. Bull., U.S. 85:419–434.

Holt, R.S., and J.B. Cologne
1987 Factors affecting line transect estimates of dolphin school density. J. Wildl. Manage. 51(4):836–873.

Holt, R.S., and A. Jackson
1987 Report of a marine mammal survey of the eastern tropical Pacific aboard the Research Vessel *McArthur* July 29–December 6, 1986. NOAA-TM-NMFS-SWFC-77, Southwest Fish. Cent., Natl. Mar. Fish. Serv., NOAA, La Jolla, CA 92038, 161 p.

Holt, R.S., and J.E. Powers
1982 Abundance estimation of dolphin stocks in the eastern tropical Pacific yellowfin tuna fishery determined from aerial and ship surveys to 1979. NOAA-TM-NMFS-SWFC-23, Southwest Fish. Cent., Natl. Mar. Fish. Serv., NOAA, La Jolla, CA 92038, 95 p.

Holt, R.S., and S.N. Sexton
1987 Report of a marine mammal survey of the eastern tropical Pacific aboard the Research Vessel *David Starr Jordan* July 29–December 5, 1986. NOAA-TM-NMFS-SWFC-76, Southwest Fish. Cent., Natl. Mar. Fish. Serv., NOAA, La Jolla, CA 92038, 171 p.

Holt, R.S., T. Gerrodette, and J.B. Cologne
1987 Research vessel survey design for monitoring dolphin abundance in the eastern tropical Pacific. Fish. Bull., U.S. 85:435–446.

Perrin, W.F., M.D. Scott, G.J. Walker, and V.L. Cass
1984 Review of geographical stocks of tropical dolphins (*Stenella* spp. and *Delphinus delphis*) in the eastern Pacific. Adm. Rep. LJ-87-02, Southwest Fish. Cent., Natl. Mar. Fish. Serv., NOAA, La Jolla, CA 92038, 68 p.

Richey, C.R.
1976 Memorandum of opinion. CA NO. 74-1465 and CA No. 75-0227 U.S. District Court, District of Columbia, May 11, 1976.

Smith, T.D.
1979 Report of the status of the porpoise stock workshop (August 27–31, 1979, La Jolla, CA). Adm. Rep. LJ-79-41, Southwest Fish. Cent., Natl. Mar. Fish. Serv., NOAA, La Jolla, CA 92038, 120 p.

SWFC
1976 Report of the workshop on stock assessment of porpoises involved in the eastern tropical Pacific yellowfin tuna fishery. Adm. Rep. LJ-76-29, Southwest Fish. Cent., Natl. Mar. Fish. Serv., NOAA, La Jolla, CA 92038, 60 p.