SOUTHWEST FISHERIES CENTER

NATIONAL MARINE FISHERIES SERVICE SOUTHWEST FISHERIES CENTER P.O. BOX 271 LA JOLLA, CA 92038

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TUNA VESSEL OBSERVER DATA RESEARCH PLAN FOR FY-1987 AND BEYOND

By

Stephen B. Reilly

ADMINISTRATIVE REPORT LJ-87-11

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RESEARCH PLAN FOR FY-1987 AND BEYOND

Stephen B. Reilly
Fishery-Marine Mammal Interactions Division
Southwest Fisheries Center
P.O. Box 271
La Jolla, California 92038

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INTRODUCTION

In 1986 the SWFC initiated a program to monitor annually for 5 years (1985 - 1991) the status of stocks of eastern tropical Pacific (ETP) dolphins affected by interactions with the ETP tuna purse-seine fishery. The purse-seiners capture and accidentally kill dolphins in the process of catching tuna. Because dolphins are protected under the Marine Mammal protection Act of 1972, the National Marine FIsheries Service has been charged with the task of setting quotas on this accidental kill.

This new monitoring program was initiated in response to reauthorization and revision of the Marine Mammal Protection Act in 1984. It includes three activities: 1) estimating relative abundance of dolphins, from data collected during annual sighting surveys conducted aboard NOAA research vessels, 2) monitoring biological indicators collected from dolphins killed incidental to fishing operations, potentially for use as indicators of relative abundance, and 3) determining how data collected by scientific observers placed on tuna purse-seiners can be used effectively to monitor trends in dolphin abundance over time.

The research vessel and biological monitoring activities are proceeding well. The evaluation of tuna vessel observer data (TVOD) has proceeded much more slowly, primarily because no standard methods for such evaluation exist. Considerable research and development are necessary to determine whether TVOD will be useful for monitoring dolphin abundance. The potential advantages in using TVOD are substantial enough that this research and development should be pursued.

The sighting surveys conducted aboard research vessels (Activity 1) are undeniably the best (most defensible statistically) source of data, but these surveys are very costly. Only two ships can be sent to sea each year, and only for 4 months each. Given the size of the area to survey (roughly the size of the continental U.S.) these ships can cover only a limited portion of the dolphin's range in any short period of time.

TVOD, on the other hand, are collected by observers accompanying 10 to 100 cruises per fishing year, each cruise lasting 1 to several months. Thus TVOD are more abundant and relatively much less expensive. However, there are serious uncertainties about the use of TVOD to monitor trends in abundance. The fundamental problem is that data from fishing vessels are opportunistic (nonrandom). Collections depend not on a scientifically designed survey plan but rather on the fishing strategies of the captains controlling individual vessels, and other factors including economics and environmental variation.

This document describes the Southwest Fisheries Center's research plan to evaluate potential uses of TVOD to monitor changes in abundance of eastern tropical Pacific dolphins, despite this fundamental problem of nonrandom data collection. The research conducted through this program will be directed specifically toward evaluating TVOD collected from the eastern tropical Pacific Ocean. But the general problem, and hopefully the solutions, have relevance for aquatic stock assessment procedures worldwide.

Most of the research foci described in this plan were proposed by participants in a workshop held at the SWFC on 13 November 1985 (Attachment 1). This workshop included a panel of experts on dolphin assessment and on the ETP tuna-dolphin fishery. The purpose of the workshop was to solicit the panel's advice on research projects pertinent to evaluating uses of TVOD for monitoring trends in abundance of dolphin populations.

PROGRAM OBJECTIVE

The program objective suggested by the panel at the Nov. 13 1985 workshop and adopted in this research plan is:

"Determine if, and how, tuna vessel observer data and ancillary information can be used to monitor (with acceptable accuracy and precision) trends in ETP dolphin abundance."

In particular, the goal is to identify statistically acceptable indexes (estimates) of trends in dolphin abundance. Workshop participants suggested many criteria for evaluating such indexes but agreed unanimously on only two:

1) "The precision of the index must be testable by standard statistical methods,"

and,

2) "The accuracy of the indices must be based on testable assumptions."

Choices between alternative indexes should be based primarily upon these criteria.

PROGRAM ELEMENTS

This research plan contains 5 general topics (program elements); 1) documentation and review of existing data sources and previous analyses relevant to abundance estimation using TVOD, 2) defining "searching effort", 3) model development, 4) calibration of TVOD with research survey data collected from the same time and place, and 5) investigating potential relationships between dolphin biology, stock structure, and abundance. Groupings of proposed research projects within each topic are somewhat arbitrary, because there are many interconnections between projects under different headings (Figure 1).

Research projects recommended by the workshop participants are grouped within topics 2 through 5. Topic 1 (reviews) was not suggested at the workshop, but was the obvious place to begin when it became apparent that such reviews did not yet exist.

Rationale, value, and work plans for each topic are described in greater detail below.

1. Review and Document TVOD.

The quantity of TVOD is overwhelming. Both NMFS and the Inter-American Tropical Tuna Commission (IATTC) collect TVOD. Hundreds of thousands of records exist, representing hundreds of data types collected in more or less detail since NMFS personnel first began accompanying tuna purse-seiners on routine fishing trips to the ETP in 1966. In 1974 NMFS began routinely sending large numbers of observers to sea on U.S. tuna vessels as part of a formal program to monitor dolphin mortality. In 1979 IATTC started a similar program for the foreign fleet.

There are over 20 TVOD data bases, most of which have evolved with changing data needs. Six of these are considered primary data sources in the NMFS data base: 1) Set Log, 2) Tally, 3) Marine Mammal Sightings, 4) Marine Mammal Sighting Effort, 5) Fishing Mode and 6) Cruise Specifications.

There is currently no succinct description of the logical associations between these data bases or the methods used to edit, manage and archive them. To remedy this, TVOD and procedures by which it has been utilized are being summarized and described by Oliver (in progress).

Both NMFS and IATTC have used TVOD in a variety of analyses related directly or indirectly to estimating abundance of ETP dolphins. As with the data sources, without a review it is not possible to evaluate efficiently the approaches that have been used to date, to assess their inter-relationships, to determine whether new, non-redundant approaches are feasible or desired, or to identify those new approaches with the greatest potential. To remedy this, a comprehensive review document has been completed in draft that summarizes the history of the problem, the approaches taken by NMFS and IATTC to solve it, and the data sources used (Vetter 1987).

The major positive attribute of TVOD is its abundance. However, abundance does not guarantee utility. Many real and potential problems with the collection and use of TVOD for abundance estimation, some extremely serious, others less so, have been mentioned specifically or as anecdotes in numerous reports. Perhaps the most important result of the review of existing data and past analyses is that these problems will be systematically catalogued, evaluating their extent and potential importance.

2. Define "Search Effort" by Tuna Purse-Seiners.

Many of the critical weaknesses in TVOD for indexing trends in dolphin abundance relate to uncertainties in defining searching activities of the fishing vessels. The more promising methods of estimating trends in abundance (line transect analysis (LTA), encounter rates (ER), catch-per-unit effort (CPUE) and related methods) share the common attribute of representing abundance as some function of animal occurrence (sightings, captures, etc.) and searching effort. A thorough understanding of seiner searching effort is therefore of fundamental importance. We do not now have this thorough understanding.

Purse-seiner searching strategy is apparently flexible and elaborate and deviates in important ways from the formally defined, random surveys required for most methods of abundance estimation, including those listed above (LTA, ER, CPUE). The fishermen are searching for both tunas and dolphins, sometimes predominantly one, sometimes the other. Search strategy when seeking dolphins (in "dolphin fishing" mode) apparently differs from search strategy when seeking school-fish (in "school fishing" mode). It is not always apparent from existing data which mode an individual vessel was in when the data were collected. In addition, vessels often operate in ephemeral "code groups", teams of vessels exchanging coded communication about areas of high catches and/or high density of dolphin schools.

Factors such as these changes in fishing mode and operating in code groups apparently help tuna vessels concentrate their searching in areas of higher dolphin density, rather than having to search randomly the dolphin's entire range. This leads to serious statistical problems when trying to extrapolate to areas of low density the abundance estimates derived only from data collected where dolphins were numerous. If a "key" exists to the questions, "...if, and how TVOD ... can be used...", it is likely to be found by investigating tuna purse-seiner searching effort. We plan to study searching by focusing on the following topics.

2.1 Identify Fishery Attributes.

2.1.1 Quantify fishing effort via fishery system model.

An effective way to formalize and integrate the variety of fishery attributes that may affect searching effort is through a "fishery system model". The model will allow us to formalize quantitatively our understanding, and gaps in our understanding, of "fishing effort" in the ETP tuna purse seine fishery. We want to know how dolphins affect this effort, and how variations in effort affect TVOD and its efficacy for estimation of dolphin abundance.

The potential effects of economics, social ties, code groups, vessel types, changing fleet size, flags, ports, and skippers' searching strategies will be documented in a workshop to be held in August 1987. Workshop participants will include scientific, economic and fishery experts.

2.1.2 Analyze search tracks of individual vessels.

Analyses of searching behavior of individual vessels will contribute substantially to our understanding of the process of searching and sighting. That is, by studying individual vessels rather than just aggregate statistics we hope to better define sighting effort for our abundance indices.

Work on this topic was begun by Polacheck (1983), who focused primarily on spatial clustering of net sets and secondarily on clustering of sightings. Smith and Robertson (in prep.) have extended Polacheck's work by developing a microcomputer system to display the searching tracks and set/sighting clusters for individual vessels, and by examining more sophisticated methods for defining clusters of events.

Important research reequired in this area includes: applying the clustering routines of Smith and Robertson, extending the analyses to a greater time span, considering attributes identified in the workshop (e.g. vessel characteristics, skipper characteristics, area fished, economic climate and the physical and biological conditions current at the time of the cruises.

2.2 Define effects of environment on TVOD

Characteristics and variation of the ETP environment can affect in two ways assessments derived from TVOD. First, dolphins are not uniformly abundant. Ranges, spatial distributions within ranges, and school sizes all vary both within and between years, causing real variability in TVOD-based estimates. Second, observers ability to see dolphins varies in both space and time, as environmental conditions (e.g., wave height, sun glare, fog or rain) vary, causing artifactual variability in TVOD-based estimates.

Separating real variation in dolphin distributions resulting from environmental variation, from apparent variation due simply to changes in sightability, is a critical aspect of the research program. We must have this information in order to interpret total variability in indexes of dolphin abundance.

The three activites most critical for evaluating the environmental effects on TVOD-based indexes (estimates) are described below.

2.2.1 Identify time and space scales of patchiness for tunas and dolphins.

At any point in time dolphins are not uniformly distributed within their range, but are more abundant in some areas than others. Their distribution is "patchy". The characteristics of this patchiness are important both to our ability to locate dolphin schools during our research surveys, and to the ways in which fishermen must locate dolphins to capture tunas. We plan to extend and verify preliminary work by Polacheck (1983) by quantifying the apparent patchiness of dolphin schools, and temporal changes in this patchiness. This information will be used to help interpret our research survey censuses, and any indices developed based on TVOD.

2.2.2 Define dolphin habitat.

One research project currently underway at SWFC involves quantifying the large-scale environmental attributes of dolphin distribution (based on summaries of two-degree latitude/longitude squares over the entire ETP). These distributions appear to include a temporal component which changes seasonally and inter-annually, especially coincident with El Nino conditions.

This work must be expanded to investigate variation in dolphin distribution and environmental features on smaller scales of time and space. In addition, we will be extending during the upcoming research surveys the descriptive work of Au and Perryman (1985) to quantify observed relationships between dolphin sightings and contemporaneous environmental conditions. Quantification is necessary for testing statistically the"reality" of apparent associations, and for applying these results to other elements of the research program.

2.2.3 Examine sighting biases.

Holt (1983) has shown that time of day, area, and various weather-related conditions affect observer's ability to detect dolphin schools, school size estimates, and relative sightability of different species/stocks encountered during research surveys. These factors are equally important for interpreting data collected from tuna vessels. We need a research project directed specifically toward this problem.

2.3 Examine schemes for post-stratification of TVOD.

These post-stratification schemes potentially reduce variance and generate subsets of data that meet the assumptions required by various estimation procedures. But questions have been raised about their efficacy and statistical value. We must critically evaluate these schemes in relation to analysis of TVOD.

2.3.1 Define index areas.

This project, will be directed toward identifying geographic areas fished year after year that can be used to examine variation in TVOD. These areas can be defined to consider other fishery attributes such as the predominant fishing mode at the time. Polacheck (1983) and Hammond and Laake (1983) examined this approach to stratifying TVOD. Their results suggest it is worth pursuing.

2.3.2 Identify patterns in dolphin abundance.

This project is similar to section 2.3.1 as a primarily empirical approach to decreasing the statistical noise in TVOD. Various stratification schemes will be examined, with the objective of producing relatively homogeneous data sets within strata defined on large scales of time and space. These stratified data can then be treated in a manner appropriate to each stratum. This approach is currently being pursued by the IATTC in their line transect analyses of TVOD.

2.3.3 Subsample to obtain "random" effort file.

Given the tremendous number of data available, it may be possible to select subsamples that are more random than the total data set in relation to the dolphins' distributions. The IATTC is also interested in this approach.

3. Develop and Evaluate Trend Index Models.

Indices of abundance are derived from sightings data by fitting the data to various models. The most popular models for indices of dolphin abundance, used by NMFS for research survey data and by IATTC for TVOD, have been line transect models. Because serious unanswered questions exist about the ability of TVOD to satisfy the assumptions required for line transect analysis, other models must be investigated as well. Promising alternative models, in addition to line transect, are described below.

3.1 Line transect models.

Estimates of abundance based on line transect analysis of TVOD are being aggressively investigated by Buckland and Anganuzzi (IATTC). It was the consensus opinion of the Observer Data Workshop participants that these models held the most promise for utilizing TVOD to index dolphin abundance. While the SWFC has not yet conducted research specifically on line transect model development for use with TVOD, the need may arise in subsequent years. This will depend upon results of our near-term studies (especially on searching effort), and on the directions taken by the IATTC.

3.2 Non-line transect models.

Some of the approaches described below are not likely to succeed (e.g., mark-recapture, which would be extremely expensive). Regardless, we have not dismissed any approach a priori, but will give serious consideration to any method that may be useful. If line transect methods do not prove useful, we must have feasible alternatives. If line transect methods do prove useful, it will be important to have comparative analyses to aid in interpreting assessment results. Research into these non-line transect methods will be an important aspect of our work during this and coming years.

3.2.1 Catch per unit effort (CPUE).

It may be possible to examine the TVOD in light of existing theory and methods based on fishery CPUE. As with the other models, this set of methods is critically dependent upon a clear understanding of searching effort. Assumptions may be violated to a lesser extent than for other available tools. We are giving CPUE indexes serious consideration. A workshop on CPUE models for whale assessment was held in early 1987 by the International Whaling Commission. Dr. Douglas Chapman of the University of Washington attended that workshop on behalf of the US, and is preparing a short report on potential uses of CPUE with tuna vessel data. If so indicated by Chapman's report, we will pursue this area further, in the immediate future.

3.2.2 Encounter rates.

This approach examines temporal and spatial variation in sighting rates of dolphin schools. Unlike line transect analysis, school size is not included in the estimation procedure. This simplifies the analysis and reduces the number of assumptions to be satisfied because the line transect requirements for specification of sighting models (and attendant stringent assumptions) are eliminated.

But encounter rates are the crudest index available, and results tend to be quite variable (Polacheck 1983). They are not sufficient alone to index reliably changes in dolphin abundance.

3.2.3 Species proportions.

Barlow (MS, SWFC) proposed using species proportions from TVOD to index changes in dolphin abundance. More rapid decreases in abundance of one stock of dolphins relative to others might be detectable in the relative proportions sighted. Barlow concluded initially that changes in less-abundant stocks might be detectable, but changes in the more-abundant stocks would be much more difficult to detect.

Because methods for detecting changes in the less-abundant species are especially few, it would be worthwhile to pursue this approach, even if it serves only to corroborate results from other monitoring methods.

3.2.4 Mendehlsson's spatial model(s).

Mendelssohn (of the Pacific Fisheries Environmental Group, PFEG) has for some years been developing methods to analyze multivariate spatial data in a time-series context. His analysis attempts to account for some of the common and severe limitations of fishery-related data. We asked his opinion of the problems we face in attempting to use TVOD to monitor changes in dolphin abundance. He responded that there were two areas in which his methods could potentially make a contribution (memo to Reilly, attached as Appendix 2). First, his approach might help in describing the fishing/searching process, contributing to our understanding of "searching effort". Second, his approach may help resolve some serious problems with estimating density of dolphin schools.

In either case application of these methods to TVOD will not be a simple task, if feasible at all.

3.2.5 Fishing system model: to evaluate trend indexes.

A fishing systems model provides one of only 2 possible methods for evaluating the suitability of TVOD for deriving trend indexes. The other method is direct comparison of estimates derived from TVOD with estimates derived from research survey data (RSD) collected at the same time and place.

Computer simulation of the fishery is the most cost-effective way to evaluate current or suggested methods of using TVOD to estimate abundance or trends in dolphin abundance. By testing the methods on simulated TVOD generated from a model with known inputs, the resulting estimates can be compared definitively with the actual abundance (and trends) generated by the model.

Additionally, simulation models are not restricted simply to observed conditions but can be used to test the effects of alternative scenarios.

3.2.6 Mark-recapture.

Previous efforts to design a mark-recapture experiment to estimate ETP dolphin abundance were unsuccessful because of the large number of marked animals needed to for an adequate recapture sample, and because of the expense of tagging and recapture operations. In addition, marking techniques have generally been too transient; no permanent marks have been devised. Recent developments make it worth re-considering this approach.

One new tool is a small, subcutaneous electronic tag, referred to as a "PIT" (passive integrated transponder) tag. These can be attached from a boat without having to capture and handle the animal. The subcutaneous placement may also eliminate tag loss.

Other advantages are that the tag is relatively inexpensive, and that recent increases in the fraction of the tuna fleet accompanied by observers have increased the number of dolphins available to be tagged. The basis of any such approach, if it is to be effective, would be to mark and recapture animals from tuna vessels. A preliminary analysis should be conducted to determine the number of marks that will be needed to achieve a particular level of precision, given our current understanding of population sizes and the number of animals that are inspected by observers each year.

4. Calibrate TVOD.

TVOD differs from research survey data (RSD) in at least two important ways; 1) average school size estimates from TVOD are much larger estimates from research survey data (Holt and Powers 1983) and 2) relative proportions of different dolphin species recorded are quite different in the two data sets (Barlow and Holt 1986). Analyses of existing data and (potentially) directed field experiments are required to 1) determine the sources of these differences and 2) calibrate one data set relative to the other.

Six research projects relevant to these problems are described below.

4.1 Compare existing RSD with TVOD from same time/space.

Comparison of encounter rates, school sizes, species proportions and related statistics between research vessels and nearby tuna vessels, from existing data, is an essential task in determining the properties of observer data. This is in progress at the SWFC by Holt, Whalen and Macky.

Results from this study will be important for planning at-sea verification (calibration) experiments, and for formulating more detailed plans for analyses of the existing data base.

4.2 Compare existing TVOD with other TVOD from "same" time/space.

Following the logic of section 4.1, we will also compare statistics from different tuna vessels operating in the same vicinity at the same time (definition of "same" being a key element here).

Given our understanding of patchiness in dolphin distribution, we expect to see a great deal of between-vessel variability in this study. We need to identify which fraction of this variability is due simply to differences between vessels, and which is due to actual differences in abundance of dolphins. Quantifying this difference is critical for interpreting any trends (or lack thereof) in dolphin abundance estimated from TVOD. This project will allow us to estimate between-vessel variability in areas where dolphin densities are assumed relatively invariant.

4.3 Design and conduct calibration experiments.

It may be necessary to conduct experiments to calibrate TVOD against RSD. We will gain some knowledge from analysis of existing data, and will use these results as presamples in our experimental designs. Since past and planned dolphin monitoring research cruises were not designed to allow calibration of TVOD against RSD, we cannot assume that data from the research cruises can be used for these calibrations. We need details from these ongoing analyses to construct detailed plans for focused experiments.

On May 12, 1987 the SWFC Survey Design Group discussed the rational, feasibility, and possible options for a field experiment to compare tuna vessel observer data with research vessel data. A report of that meeting is attached here as Appendix 3. The basic conclusion of the discussions was that the feasibility of such an experiment was in question, and that it was necessary to examine the topic in light of current and pending comparisons of existing comparable TVOD and RSD (section 4.1). Someone from the SWFC will conduct this analysis upon completion of 4.1.

4.4 Define observer biases & their effects on trend indexes.

Estimated values of trend indexes derived from TVOD include true dolphin abundance, random error due to various procedural and environmental factors, and non-random error (bias) due to consistent problems in estimation. For example, it is not clear if observers, on average, estimate accurately dolphin school sizes but with a wide confidence region, or if for some ranges of true school sizes observers consistently underestimate or overestimate. Similar uncertainties exist for all types of estimates made by the observers.

If such biases are constant from year to year, they should not affect our ability to detect with TVOD trends in dolphin abundance. If, however, the biases change from year to year, it will be essential to recognize them if we are to successfully monitor dolphin abundance using TVOD.

This recognition can be achieved in part by analysis of existing data. Experiments proposed in Section 4.3 may also be necessary. For example, an experiment involving a concurrent estimates of school size by observers aboard research vessels, helicopters and tuna vessels may be necessary for estimating trends in abundance.

4.5 Assess biases in school size estimates.

Preliminary analyses of TVOD by Hammond and Laake (1983) using line transect methodology indicated a downward trend in both spotted and spinner dolphin abundance during 1977 - 1981. These trends were due to decreases in estimated school size; school density did not appear to change significantly.

Obviously, school size estimation procedures must be given considerable attention in our research program. We have estimates from research vessels, tuna vessels, airplanes and helicopters using aerial photos. A comprehensive analysis including all data sources is needed. Results from this analysis can define some of the basic properties of the estimates from different platforms, indicate which problems cannot be resolved with data on hand, and suggest how to best use our controlled platforms in field experiments. Research in this area has been initiated by the Fishery Independent Assessment Program.

4.6 Evaluate statistical power of trend indexes.

Part of a comprehensive experimental design for a program to utilize TVOD to monitor trends in dolphin abundance will be explicit statistical consideration of the power of our monitoring tools, and related attributes. Power can be assessed by asking questions such as "what levels of population change can index "A" detect over various monitoring periods?", and "are these levels of change likely to occur in practice ?". Analyses of this sort were considered by Gerrodette (1985) in designing the research surveys. We propose to extend this approach to analysis of TVOD.

5. Biological Indexes and Stock Structure

The biology program of the SWFC's Marine Mammal Division uses almost exclusively data and samples collected by observers aboard U.S. tuna vessels. These data and samples are used to distinguish between different stocks of dolphins, to identify individuals to stock and species, to estimate reproductive rates and condition, and to determine age.

This information is then incorporated into population models from which management decisions, in particular quotas on incidental kill, are derived.

Aspects of the biology program directly relevant to estimating trends in dolphin abundance include 1) stock identification(s) and the effect that incorrect identifications may have on trend estimates, and 2) changes in life history parameters that may have resulted from changes in abundance due to fishing pressure, and 3) definition of "nursing" or other areas of special interest for management.

Relationships between life history parameters and abundance are suggested by preliminary results for spotted dolphins. The ratio of female-to-male calves (less than 130 cm or approximately one year of age) apparently increased with cumulative fishing effort. Current and future efforts will examine this apparent sex ratio response and others such as fetal sex ratios, age at sexual maturity, or changes in length at birth to examine whether these life history parameters may be useful as indicators of trends in population size.

Barlow and Sexton (MS in prep.) have found that certain subareas of the ETP have significantly greater than expected proportions of lactating females, suggesting that there may in fact be "nursing areas", or similar zones of specific importance for dolphin recruitment. Future studies will further pursue this possibility.

SUMMARY

A research plan comprising 5 elements is presented to derive and evaluate, from tuna vessel observer data, indexes of abundance of dolphin stocks affected by interactions with the tuna purse-seine fishery in the eastern tropical Pacific Ocean. The 5 elements include 1) review and evaluation of existing data and previous research, 2) definition of "search effort", 3) mathematical modeling, 4) calibration of TVOD with research survey data, and 5) correlation between dolphin abundance and biology.

Several research projects have been identified within each of the elements. Work has begun on some, but not all, of these projects; limited resources prevent work on the others. Valid use of TVOD for estimation of trends in dolphin abundance depends on successful completion of the research outlined here.

ACKNOWLEDGMENTS

This research plan has been prepared with the help of Doug DeMaster, Andy Dizon, Liz Vetter, Vic Thayer, and Robert Holland.

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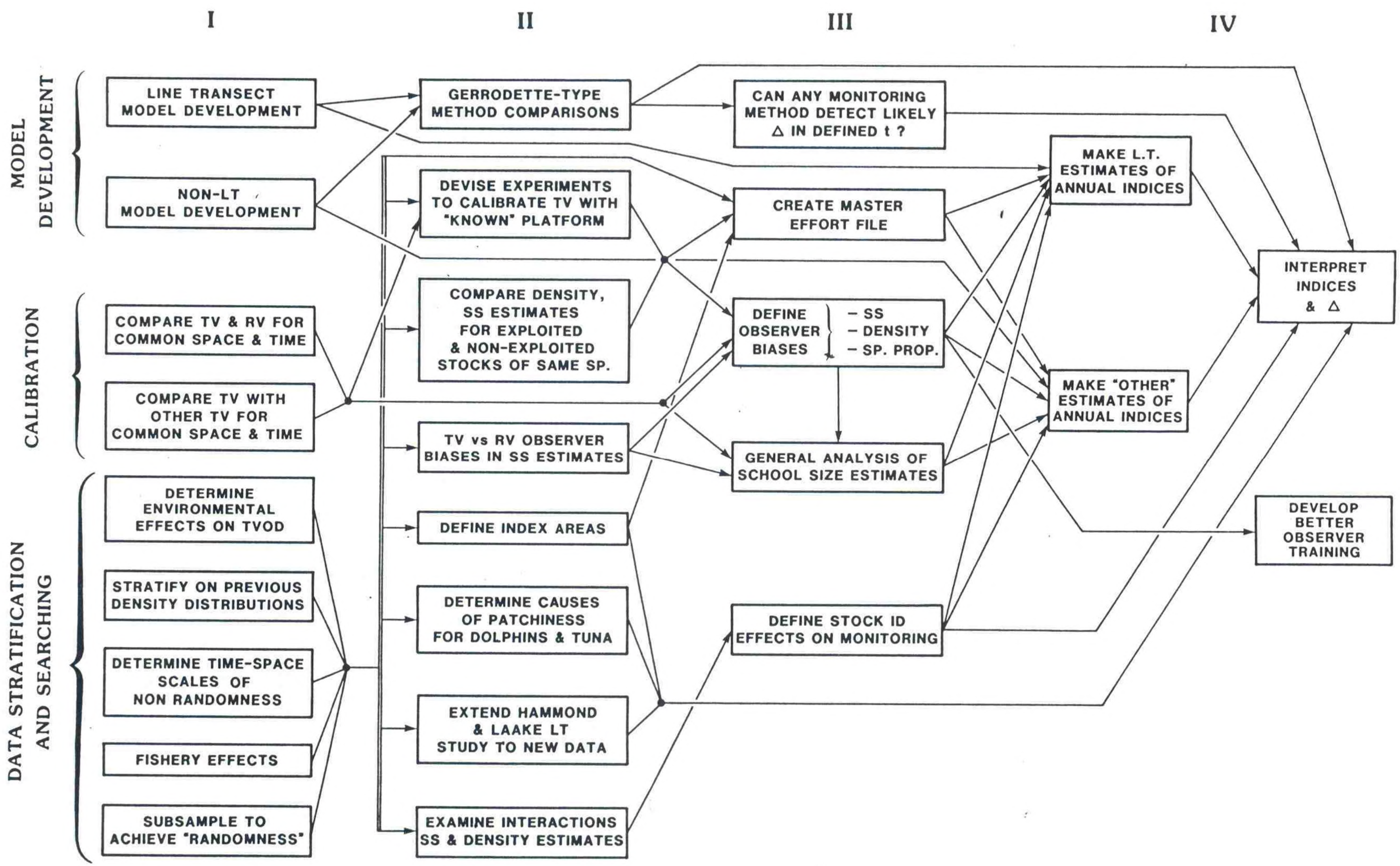
I
II
III
IV
MODEL DEVELOPMENT
CALIBRATION
DATA STRATIFICATION AND SEARCHING
LINE TRANSECT MODEL DEVELOPMENT
NON-LT MODEL DEVELOPMENT
COMPARE TV & RV FOR COMMON SPACE & TIME
COMPARE TV WITH OTHER TV FOR COMMON SPACE & TIME
DETERMINE ENVIRONMENTAL EFFECTS ON TVOD
STRATIFY ON PREVIOUS DENSITY DISTRIBUTIONS
DETERMINE TIME-SPACE SCALES OF NON RANDOMNESS
FISHERY EFFECTS
SUBSAMPLE TO ACHIEVE "RANDOMNESS"
GERRODETTE-TYPE METHOD COMPARISONS
DEVISE EXPERIMENTS TO CALIBRATE TV WITH "KNOWN" PLATFORM
COMPARE DENSITY, SS ESTIMATES FOR EXPLOITED & NON-EXPLOITED STOCKS OF SAME SP.
TV vs RV OBSERVER BIASES IN SS ESTIMATES
DEFINE INDEX AREAS
DETERMINE CAUSES OF PATCHINESS FOR DOLPHINS & TUNA
EXTEND HAMMOND & LAAKE LT STUDY TO NEW DATA
EXAMINE INTERACTIONS SS & DENSITY ESTIMATES
CAN ANY MONITORING METHOD DETECT LIKELY Δ IN DEFINED t ?
CREATE MASTER EFFORT FILE
DEFINE OBSERVER BIASES – SS – DENSITY – SP. PROP.
GENERAL ANALYSIS OF SCHOOL SIZE ESTIMATES
DEFINE STOCK ID EFFECTS ON MONITORING
MAKE L.T. ESTIMATES OF ANNUAL INDICES
MAKE "OTHER" ESTIMATES OF ANNUAL INDICES
INTERPRET INDICES & Δ
DEVELOP BETTER OBSERVER TRAINING

Figure 1.

6 December 1985
Southwest Fisheries Center, NMFS

REPORT OF PLANNING WORKSHOP ON USES OF TUNA VESSEL OBSERVER DATA TO INDEX TRENDS IN ABUNDANCE OF EASTERN TROPICAL PACIFIC DOLPHINS

The meeting was convened at 8:30 am on 13 November 1985 at the Southwest Fisheries Center (SWFC), La Jolla, California. The meeting was sponsored by the National Marine Fisheries Service to aid in planning research on potential uses of observer data to index trends in abundance of eastern tropical Pacific (ETP) dolphins. The participants in the one day workshop included:

- Mr. Franklin Alverson, Living Marine Resources (LMR), representing the U.S. Tuna Foundation.
- Dr. Jay Barlow, SWFC.
- Dr. Stephen Buckland, Inter-American Tropical Tuna Commission (IATTC).
- Dr. Douglas Chapman, University of Washington, representing the U.S. Marine Mammal Commission.
- Dr. Daniel Goodman, Montana State University, representing the U.S. Marine Mammal Commission.
- Dr. Martin Hall, IATTC.
- Dr. Rennie Holt, SWFC.
- Mr. Michael McGowan, Bumble Bee Seafoods, Inc.
- Mr. Norman Mendes, Southwest Region, NMFS
- Mr. Paul Patterson, LMR, representing Van Camp Sea Foods, Inc.
- Dr. Stephen Reilly, SWFC, Meeting Convener, author of this report.

The meeting was facilitated by Mr. David Mackett, SWFC Planning Officer.

Materials distributed to the participants prior to the workshop included a background summary, proposed agenda, definition of meeting formalities, the minutes of a previous meeting on the topic, and two relevant publications. These are attached here as Appendices 1 through 6.

1.0 Introductions

Mr. John Carr, Deputy Director of the SWFC, welcomed the participants. He opened the meeting by voicing the strong committment of the SWFC, NMFS to developing the full potential of tuna vessel observer data as a tool to monitor trends in abundance of ETP dolphins. He introduced Mr. Mackett as the meeting facilitator, and Dr. Reilly as the convener.

Mackett then briefly defined the roles to be filled by the participants, facilitator and convener.

Mr. Carr discussed the three-faceted ETP dolphin monitoring program being adopted by the SWFC, NMFS. This program includes research vessel sightings surveys, monitoring of biological indicators through study of dolphin specimens from the fishery, and (the subject of this workshop) pursuing the potential uses of tuna vessel observer data to monitor trends in dolphin abundance.

Reilly agreed to prepare this report, and mail it to the meeting participants by mid-January 1986, if at all possible. This fianl version encompasses comments made by the participants to a draft report circulated in early December 1985.

2.0 Identification of previous and current research.

Nine previous or current research projects were identified as being directly relevant to the subject of this workshop. These projects were briefly discussed. They include the following:

Smith, T.D. 1975. Estimates of sizes of two populations of porpoise (Stenella) in the eastern tropical Pacific Ocean. Southwest Fisheries Center Administrative Report No. LJ/75/67.

Holt, R.S. and J.E. Powers. 1982. Abundance estimation of dolphin stocks involved in the eastern tropical Pacific yellowfin tuna fishery determined from aerial and ship surveys to 1979. NOAA Tech. Memo. NMFS-SWFC-23: 1-95.

Hammond, P.S. and J.L. Laake. 1983. Trends in estimates of abundance of dolphins (Stenella spp. and Delphinus delphis) involved in the purse-seine fishery for tunas in the eastern Pacific Ocean, 1977-81. Rep. Int. Whal. Commn. 33: 565-588.

Polacheck, T. 1983. The relative abundance of dolphins in the eastern tropical Pacific based on encounter rates with tuna purse seiners. Ph.D. Thesis, University of Oregon. 444 pp.

Barlow, J. and R.S. Holt. 1984. Geographic distributions of species proportions for dolphins of the eastern tropical Pacific. Southwest Fisheries Center Administrative Report No. LJ-84-27: 1-44.

Barlow, J. Manuscript, 1984. Use of species proportions to monitor trends in spotted dolphin abundance, 1986-1990. Unpublished typescript, 9 pp.

Hall, M. and S. Buckland. IATTC research in progress, on mortality estimation and application of line transect models to observer data assessment.

Smith, T.D. and P. Robertson. In Preparation. Investigations of the scales of spatial and temporal clustering of eastern tropical Pacific tuna vessel effort by microcomputer displays of individual vessel patterns.

Reilly, S.B. Manuscript. Large-scale spatial and temporal patterns in the distribution of four dolphin species in the eastern tropical Pacific.

Reilly, S.B. In progress. Oceanographic patterns in the eastern tropical Pacific and large-scale variation in ETP dolphin distribution.

3.0 Discussion of objective.

After some discussion, the group reached a consensus on the specific wording for the program objective. The proposed wording (see Appendix no. 2) was modified slightly to read,

> "Determine if, and how, tuna vessel observer data and ancillary information can be used to monitor (with acceptable accuracy and precision) trends in ETP dolphin abundance."

4.0 Discussion of criteria to determine if we have met our objective.

Three potential criteria were suggested in the proposed agenda (Appendix no. 2). Other potential criteria were suggested and discussed.

From the written suggestions, and the discussion which followed, the following general points emerged. All agreed that the criteria on accuracy and precision should be adopted. While no strong attitudes were voiced regarding the specifics for the third suggested criteron from Appendix 2 ("...detect a total change of X% over a period of Y years.") it was suggested that we should use values for X and Y similar to those now in place for the planned research vessel surveys: 40% over 5 yrs. Other more demanding values were suggested as goals, but not as minimal criteria for acceptance or rejection of the potential monitoring method(s) which will use observer data. While other potential criteria were suggested and discussed, no clear consensus was reached on specific criteria other than the two regarding accuracy and precision. Appendix 7 lists the criteria suggested and discussed during this session. The SWFC will consider these suggested criteria in formally designing its research program.

The meeting adjourned for lunch from about 12:00 noon to 12:45.

5.0 Identification of major topics for future research.

In response to the question, "In the context of designing a program to meet the objective, what important ideas (subject areas, processes, etc.) do you think should be considered?" forty two research topics were suggested.

6.0 Structuring of suggested research topics.

The 42 topics were classified into the following categories: data stratification and searching processes, line transect methods, school size estimation, stock ID, method development and comparisons, inter-method and inter-platform calibration, observer effects and data collection, and economics. Appendix 8 lists the individual research topics sorted into these categories.

Prioritization of the categories was discussed, and it was agreed that all were ultimately necessary, so that it would be misleading and inappropriate to say that work on line transect methods was of higher priority than work on school size estimation, for example. It was agreed that it would be more appropriate to prioritize the individual research projects, regardless of categories.

7.0 Prioritization of research topics.

In order to obtain the advice of the non-SWFC participants on research priorities, they were asked to categorize the 42 topics into three ordinal groups: high (3), medium (2) and low (1) priority. The 42 topics are again listed in Appendix 9, this time grouped by the sum of the priority ranks. The highest priority topics are listed below with some discussion.

The two topics which received highest ranking (19) were:

> **Apply appropriate liye transect methodology to all available data.**
>
> Comments: The Hammond-Laake paper discussed above applied line transect methods to observer data for 1977-81. This can be easily extended at minimal cost to subsequent years and possibly to some years prior to 1977. There are, however, some unresolved points in their methodology including violations of line transect assumptions. Simulation studies or other approaches should be carried out to determine their effects. Also, the school size estimation problem needs to be resolved. It is suggested that the Hammond-Laake extension with various alternative assumptions to test its robustness could be carried out in the short term to estimate the number of schools while longer term investigations of (for example) school size estimation are proceeding.
>
> **Study and apply data-dependent stratification procedures.**
>
> Comments: This was suggested to encompass all other topics referring to examination of spatial and temporal heterogeneity of the searching process, fishery operations,

environmental effects, etc. It was the consensus of the group that advances in this general topic are critical to meet the program objective.

The three topics which received the second highest ranking (18) were:

Compare tuna vessel observer data and research vessel data for areas where both were collected simultaneously.

Comments: The basic purpose of this comparison would be to calibrate the data from the two types of platforms, in order to better understand how we might use observer data to index trends in dolphin population size. This suggestion encompassed comparisons of all relevant aspects of the data bases, including school size estimates, species proportion estimates, sighting frequencies and distances, etc. Two levels of comparison are implied: comparison of existing data, and of future data collected during or adjunct to the planned research vessel surveys. It may be necessary to conduct directed experiments in the future to complete the required comparisons. Work is in progress at the SWFC on comparisons of existing data. The results of these comparisons, coupled with developments in other, related research, should indicate, whether directed experiments will be necessary.

Explore randomization of existing observer data by sub-sampling.

Comments: A major problem pointed out by previous investigations of the observer data is that the seiners' search patterns do not appear to be random in relation to the distribution of dolphins in the ETP. It was suggested that given the vast amount of observer data, we may be able to subsample the data base in a manner that would result in a data sample that is randomly distributed in relation to dolphin distribution. The IATTC suggested this topic and expressed interest in pursuing it.

Examine environmental effects on abundance estimates.

Comments: This suggestion refers to the possible associations between environmental patterns and variability and the results of sightings surveys. Broadly it could refer to both research vessel and tuna vessel sightings data, but the context here was in reference to tuna vessel data. This topic encompasses, for example, possible large scale effects of an El Nino on the data collected during an entire year or more, the possible effects of seasonal rough weather in parts of the ETP, the possible effects of permanent or seasonal features of the region's oceanography, as well as smaller-scale environmental features and processes. Investigations on this topic are underway at the SWFC and are slated to continue.

The other 37 topics are listed, in descending priority groups, in Appendix 9.

8.0 Future workshops.

The idea of future workshops was posed to the group. After a short discussion, the consensus reached was that it would not be productive to attempt to plan a future workshop at this time. Rather, after more research has been done on some of the critical projects, we should schedule the next workshop(s) to review the results. The panelists felt that little could be expected from another "brainstorming" session, in the absence of new information.

9.0 Closing remarks.

The participants were asked to individually give their impressions of where we stand now in relation to potential uses of observer data for indexing trends of dolphin abundance, and (if interested) what they or the institution they represent intend to do in this area in the future. The individual responses are summarized below.

Dr. Martin Hall, IATTC. The Tuna Commission is now investigating both mortality estimation and indexing abundance using observer data. They anticipate finishing work on mortality estimation this year, and at that time will dedicate all of their tuna-dolphin program's analytic expertise to indexing abundance. They will concentrate on line transect methods, and on common dolphins during the coming months. Their current intention is to pursue some of these topics in-house for a while before soliciting help or advice from outside experts. The IATTC would like to integrate their research in this area with the SWFC as much as possible. Dr. Hall felt that this meeting may have been premature, and could possibly have been more productive some months later, after more research had been completed.

Mr. Frank Alverson, LMR. Living Marine Resources will act in an advisory role only, as requested by either the NMFS or the IATTC. They will be pleased to act as an interface with the tuna industry when possible. Mr. Alverson felt that the meeting was a good, if belated beginning. He hoped to see the NMFS follow up on the course of work suggested at the meeting.

Mr. Michael McGowan, Bumble Bee Seafoods Inc. He and Bumble Bee will participate as interested and concerned observers only in future research and development on assessment uses of observer data. They can provide us with the tuna industry's view point. Mr. McGowan felt that the day's meeting went well, and that what happened as a result would be the ultimate evaluation of the usefulness of the meeting.

Mr. Paul Patterson, LMR. He reiterated Mr. Alverson's comments, and stressed that, as stated by Mr. McGowan, how the National Marine Fisheries Service carries forth with the work identified during the meeting will provide the best evaluation of the results of the meeting, and the agency's committment.

Dr. Dan Goodman, Montana State University. He felt that during the meeting we had consolidated our understanding of the problem. The need now is to do some research on the topics identified.

Dr. Rennie Holt, SWFC. He stated that his personal involvement in the future would be in at least two areas. He will continue the comparisons of data from tuna and research vessels for common areas and times from existing data. This work has only recently begun. Also, he will possibly be involved in research on line transect methods and observer data, an area in which he is currently very involved for the research vessel surveys.

Dr. Doug Chapman, MMC. The Commission has been one of the groups pushing for this meeting, in part to see to what extent NMFS is committed to this effort. In that sense, the meeting has been a success. He felt that the SWFC needed to identify their permament program leader as soon as possible, to make timely progress in research on observer data. The MMC will continue to work with the SWFC where possible, including possible co-sponsorship of subsequent workshops. Dr. Chapman and the MMC promote interaction with the tuna fleet via the Porpoise Rescue Foundation, or similar channels.

Dr. Stephen Buckland, IATTC. Dr. Buckland felt he would certainly be investigating line transect applications for indexing dolphin populations with observer data. A particular area of interest to him is making modifications to the methods to make them more robust to the inevitable violations of assumptions. Dr. Buckland has just recently arrived at the IATTC to begin his job, which is dedicated to observer data analyses.

Dr. Stephen Reilly, SWFC. As convener, Dr. Reilly thanked the participants for their enthusiastic participation and valuable contributions toward a research plan for developing observer data as a tool to index dophin abundance. He plans to continue his present work on environmental effects on the distribution and abundance of ETP dolphins, which emphasizes the use of tuna vessel data.

Mr. John Carr, SWFC. Representing the NMFS, Mr. Carr thanked the participants for their efforts and interest. He reiterated his earlier statement of the committment of the SWFC, NMFS to pursue the full potential of the tuna vessel observer data to monitor dolphin populations in the ETP. The current and future observer data should be open to anyone interested in using it for research. The SWFC will coordinate with the IATTC in observer data analyses to the fullest possible extent. It is not now clear how we will accomplish all of our research in this area: we may contract out some parts of the work if it appears feasible and more efficient than developing new expertise in-house. In the future, the SWFC will seek further guidance from this meeting's participants.

The meeting adjourned at 4:30 pm.

APPENDEX 1

OBSERVER DATA WORKSHOP
13 NOVEMBER 1985
SOUTHWEST FISHERIES CENTER, NMFS

Background

Beginning in 1986 NMFS is conducting a new program to monitor the status of eastern tropical Pacific (ETP) dolphin populations which have been subject to mortality incidental to purse-seine fishing for tunas. This program, designed in response to the 1984 reauthorization of the Marine Mammal Protection Act, is comprised of three activities: annual visual censuses from NOAA research vessels, monitoring of biological indicators via specimens from the fishery, and investigating if (and how) data collected by scientific observers onboard tuna purse seiners can be used to monitor dolphin population trends.

Operational plans for the first two parts of the monitoring program are now well advanced. Relative to the research vessel (RV) and biological monitoring activities, considerably more research and development are needed for the monitoring use of tuna vessel observer data (TVOD). Given the potential advantages to having a monitoring tool based upon TVOD at our disposal, it is important that this research be vigorously pursued.

This workshop is the first of a series to be held during the coming year to address the potential uses of TVOD as a monitoring tool. The primary objective for this first meeting, loosely titled a 'scoping session', is to identify the major dimensions of the problem, i.e. areas requiring research to determine if and how we can monitor the status of ETP dolphins via TVOD. After some major research areas have been identified, we can discuss topic priorities, who might best conduct the research, and which topics could profitably be addressed in later, more technical workshops. We also should discuss some unambiguous criteria to evaluate the findings of the research resulting from these planning exercises.

There is no existing, brief synopsis of relevant work on tuna vessel observer data. The two most directly relevant papers available are Hammond and Laake (1983: enclosed) and Polacheck (1983: excerpts enclosed). During the introductory period of the workshop we can briefly discuss these and other past or current projects to determine what areas, in general, have been or are being addressed.

Following the second workshop to plan the NMFS research vessel surveys, held in February 1985, one day was devoted to an initial discussion of the monitoring uses of observer data. At that meeting we discussed the papers by Hammond and Laake (1983) and Polacheck (1983), which are enclosed here. The minutes of that meeting are also appended here, for your information. Hopefully, through the minutes of this previous session we can avoid some duplication of effort. As mentioned above, we should focus our discussions to clarify our objective(s), set some unequivocal criteria by which to judge our progress, and identify the major parts of the problem of using TVOD to index dolphin abundance. Some of these major pieces were identified in the previous meeting, and are listed in the minutes.

APPENDEX 2

PROPOSED AGENDA

1. Introductory Comments.

   - Welcome
   - Approval of Agenda
   - Identification of previous and current research on TVOD

2. Program Objective.

   "Determine if, and how, tuna vessel observer data can be used to monitor trends in eastern tropical Pacific dolphin populations."

   - Discussion of above objective, including definition of key words.

3. Criteria to determine if we have attained our objective.

   - Group discussion of what are acceptable properties of a monitoring tool using TVOD, what types of findings will lead to an unambiguous answer to the question of "if" TVOD are useful in this way. For example, some potential criteria might be:

   "The precision of the index (or whatever) must be definable by standard statistical methods."

   "The accuracy of the index must be testable by methods now available."

   "The monitoring method must be able to detect a total change in population size of X% over a period of Y years."

4. Identification of major areas needing research.

   - What subject areas do you feel are critical or directly relevant to developing a monitoring method based on TVOD? Please consider this question, and bring a list of your initial thoughts. We will discuss the suggested topics, and perhaps identify more during the discussion. Some of the relevant areas will undoubtedly have been addressed, at least in part, in past or present studies. Others will arise during the course of future research. Regardless, it will be useful if we can agree on some of the major, most important topics at the outset of this new endeavor.

   - Time allowing, we should also discuss relative priorities of the suggested research topics.

5. Topics and target dates for subsequent workshops.

   - Some of the identified research topics will benefit greatly from seperate, technical workshops. For example, it might be relevant to hold a workshop on the application of line transect theory to monitoring via TVOD. We can further discuss who could contribute to such technical sessions, when and for how long the meeting(s) should be held, etc.

6. Closing Remarks.

APPENDIX 3

MEETING FORMALITIES

We will begin at 8:30 am on wednesday 13 November 1985, in the Small Conference Room on the second floor of the Southwest Fisheries Center, 8604 La Jolla Shores Dr., La Jolla, Ca, and will adjourn at 5:30 pm that day. The lunch break will be from 12:00 to 1:15.

Mr. David Mackett, Southwest Fisheries Center Planning Officer, will act as "facilitator", that is he will guide us through the agenda, seeing that the discussions remain focused on the use of tuna vessel observer data for monitoring. Dr. Stephen Reilly is the meeting convener.

Your role as a participant in the workshop will be to share your interest and expertise in the monitoring of dolphin status via tuna vessel observer data by stating explicitly: what you think the objective(s) of the research should be (if different from that stated above), what specific properties you see as necessary for a TVOD-based method to be acceptable, and what research and development are necessary to get there. It may expedite the discussions if you write down your ideas in advance, especially your preliminary list of critical research topics. If you or the institution you represent are willing to commit to involvement in some aspect of the necessary research, this meeting will be an excellent forum to make that known.

The SWFC will edit a report of the meeting proceedings and conclusions, and this report will be distributed to all participants, and to other individuals and institutions that express interest.

If you need information on local hotel accomodations, please contact Steve Reilly at the SWFC (619-453-2820).

APPENDIX 4

MINUTES FROM 7 FEB 1985 DISCUSSIONS ON MONITORING USES OF TUNA VESSEL OBSERVER DATA

PHASE 2

The meeting was convened at 0900, 7 Feb, 1985 at the SWFC, La Jolla, California. This meeting was the second phase of a workshop sponsored by the SWFC to review methods to monitor population changes in ETP dolphin stocks. In addition the participants listed on page 1 of this report, Norm Mendes, Southwest Regional Office, NMFS and Michael Scott, Inter-American Tropical Tuna Commission, participated as observers in this discussion.

1.0 INTRODUCTORY COMMENTS.

The primary goal of this phase of the meeting was to review possible methods to incorporate information from tuna vessels into an ETP dolphin monitoring program. The group was asked to consider two situations where information from tuna vessels could be used: 1. where research vessels would serve as the primary monitoring platform and 2. where the tuna vessel would serve as the primary platform. Three papers were discussed initially to review the current status of analyses that utilize information from tuna vessels. These three documents are listed in Appendix 4.

2.0 REVIEW OF RELEVANT LITERATURE.

2.1 "Relative abundance of ETP dolphins from tuna vessels" by T. Polacheck.

Smith reviewed the contents of this document chapter by chapter. The following conclusions were presented:

1. Tuna vessel effort was not randomly distributed when analyzed by 5 degree squares. An analysis by 2 degree squares also indicated a nonrandom distribution of effort, but this was less significant than the analysis by 5 degree squares.
2. Search patterns vary considerably between skippers.
3. Encounter rates are not random in space.

4. The zig-zag pattern of search is apparent. The ratio of distance traveled between sets and the physical distance between sets is much larger than unity.
5. Sets tend to be clustered in space.
6. The encounter rate of dolphins within a cluster is greater than the encounter rate outside of clusters.
7. The encounter rate of dolphins within dolphin set clusters was greater than the encounter rate within school fish clusters.
8. There was no trend in the encounter rate of dolphin schools from 1977 - 1980.

A number of points were raised during this discussion. Hall pointed out that showing that an individual vessel did not search randomly was not the same as showing that the cumulative set of data from all tuna vessels is not representative of dolphin distributions in general. Chapman asked Smith if a similar analysis could be done from log books from 1962 through 1972 (because there were no observer data for this period), when the greatest change in dolphin populations was taking place. Smith responded that some of the analyses could be completed. Hall asked if Polacheck had analyzed the distribution of dolphin sets. Smith answered that only encounter rates were analyzed in this manner. Broadhead commented that the crew of a tuna vessel generally search a narrower band closer to the vessel in a school fish area than in a dolphin school area. Burnham asked if standard errors had been calculated for encounter rates from tuna vessels. Smith responded that Polacheck had calculated standard errors for the data through 1980, but that in the analysis of the data through 1983 (by S. Boyer) standard errors had not been calculated. Patterson commented that the economic conditions of the fleet, regulatory restrictions, and when the fleet is out in a given year may effect search patterns, and hence, encounter rates.

2.1 Gina Anne report by Allen et al.

Perryman and Scott led this discussion. The experiment was designed to examine the variability in school size estimates from tuna vessel crew, scientific observers, aerial counts, aerial photographs, and counts made during backdown. The results of the study indicated that accurate estimates of school size could be made from aerial photographs from a helicopter and from a tuna vessel, at least one operating in an experimental mode and given the sizes of schools encountered during the experiment.

A discussion followed concerning trends in estimated school size. Broadhead commented that he thought much of the observed trend in the tuna vessel school size data was related to changes in the training regime of NMFS observers in the early years. Perryman commented that he had conducted training classes for school size estimating as early as 1977, and Scott added that IATTC had begun similar training exercises in 1980. This training included the use of movies and slides showing various sizes of dolphin schools. Broadhead suggested consideration should be given to screening data from observers based on observer experience in analyzing school size estimates. Scott stated in the case of the Gina Anne experiment, the level of observer experience did not show any clear patterns. Reilly commented about an experiment that dealt with observer experience in counting gray whales, and reported that experienced observers were often more precise (i.e., consistent), but they were not any less biased. Broadhead commented that he thought there was a real difference in the types of schools encountered on a research vessel and a tuna vessel.

2.3 "Trends in estimates of abundance of dolphins ... " by Hammond and Laake.

Hall led the discussion on this paper. He pointed out that this analysis incorporates 3000 to 9000 sightings per year over the entire ETP. He commented that changes in regulatory procedures (i.e., the imposition of the 200-mile limit in Mexico and the elimination of CYRA quotas) had complicated the analysis of the data to some unknown extent. The following results were discussed.

1. School size estimates vary by area in all years.
2. The observed trends in numbers of dolphins is a result of trends in estimated school size.
3. Differences in encounter rates of schools and individuals were found when the data were stratified by fishing mode and intensity of fishing pressure.

Hall hypothesized that intense fishing pressure may break up schools, and that differences in estimated school sizes between strata may be related to this. Hall mentioned some advantages and disadvantages in using tuna vessel data to monitor population levels of ETP dolphins.

Among the advantages: a very large database provides an extensive coverage in space, as well as a long time series that will continue beyond the time limits considered here. The high level of effort, at least 10 times the level of the proposed effort using research vessels, provides a much higher number of sightings. At the same time, because the observer program is in place with the main objective of estimating mortality of dolphins, there is no additional cost in the acquisition of information for this purpose.

Among the disadvantages, probably the main one, is the lack of control of the platforms, which makes it very difficult to design a sampling scheme to provide a given level of confidence. It may also result in inconsistencies caused by external factors such as changes in economic conditions, regulations, fishing technology or environmental factors. These factors may affect the distribution of effort, the species targeted, etc., and they are not easy to predict. The past differences in school size estimates between research vessels and tuna vessel data suggest the possibility of biases that have to be verified and corrected.

The group then identified a number of activities that could be done to better utilize information from tuna vessels in assessing ETP dolphins.

1. Complete analysis of existing data concerning school size. The analysis should consider factors such as area, season, intensity of fishing pressure, and species.
2. Complete analysis of existing data for those areas where both tuna vessel and research vessel data were simultaneously gathered. This analysis would compare estimates of school size, species proportions, and density of schools.

3. Conduct an experiment to investigate the extent of bias that is associated with estimating schools size, with vessel avoidance, selectivity of detection, and species proportion from both research vessels and tuna vessels.
4. Complete an analysis that would test whether or not the existing information from tuna vessels, when considered in aggregate, is representative over all strata.
5. Pursue possibility of utilizing tuna vessels with helicopters to photograph schools.
6. Continue reliance on information derived from biological specimen material collected by observers on tuna vessels. Consideration of expanding data collection protocol to include behavioral or other data should be done.

Reilly pointed out that the explanation for trends in school size from tuna vessels was not completely satisfying in that some stocks did not show any trends, which would have been suspected if the cause of the trend in school size estimates were due to a trend in observer bias. Broadhead pointed out that a comprehensive analysis of school size for tuna vessel data had not really been done. Hall stated that it might be useful to use two separate sampling designs to estimate school density and school size. Smith noted that one problem has to do with the possible problem of sample selection, where different platforms designs may encounter different size schools at different rates.

3.0 FACTORS IN SURVEY DESIGN.

3.1 School size estimation.

The group discussed the value of additional school size information from aerial photographs, and felt that such information would be extremely useful. The group felt that this was similar to feelings expressed concerning aerial photographs and research vessel data. Chapman commented that before a specific experiment could be designed that utilized tuna vessel helicopters the industry should be approached about their logistical constraints. Smith commented that it was important to realize that the Fishery Service has not in the past been effective at initiating such experiments, and that outside agencies, like the IATTC and the Marine Mammal Commission, consider taking the lead in coordinating such an experiment.

3.2 Tests of representativeness of data.

The panel realized that many of the problems in utilizing data from tuna vessels is how to insure consistency in survey results from year to year. This could create artificial trends or patterns in estimates of encounter rates, school size, and species proportion. At this time, the panel could not identify any specific analyses that would confirm whether or not estimates derived from data collected by observers on tuna vessels in a given strata are unbiased.

3.3 Auxillary information.

Chapman suggested that the panel consider other options with respect to tuna vessel data. He suggested that the panel might consider expanding the coverage of observer placement on tuna vessels. However, it was agreed that some type of precision analysis should be completed before any recommendations for changing the current level of coverage are made. Holt noted that if a research vessel monitoring program were initiated, there would be good reason to increase observer coverage of tuna vessels because this would provide the maximum opportunity to calibrate data from tuna vessels to data collected from research vessels.

Smith suggested that the panel should perhaps reconsider what we ask observers on tuna vessels to collect. There has been a decrease in the emphasis on the collection of life history information by the observer program. Hall mentioned that they were aware of this shift and a greater emphasis on life history data collection will be part of future observer training. These concerns were also raised in the discussion led by Pryor on the previous day. In this same context, Chapman raised the question of a trend in pregnancy rates. There was a consensus of panel members that the Fishery Service continue to collect and process basic biological data. This will be especially important in interpreting any change in the population that might be revealed by any monitoring program.

Burnham suggested that for years the NMFS has been examining isolated aspects of the tuna boat data, but that the Service has never mounted a comprehensive analysis of these data. The panel agreed that a comprehensive review was needed. Such an analysis would provide an independent index of trends against which the trend analysis from research vessels could be compared.

Hall felt that sighting cues needed to be examined if sighting data from tuna vessels were to be used. Reilly reported that the distribution of the birds that are generally used as cues are being catalogued by Robert Pitman, SWFC, and that these distributions match the major oceanic features and the centers of the tuna fishery.

Broadhead reiterated the suggestion by Pryor that photographs might be used to examine the percent of the dolphin population below a certain size, and how this changes over time. Perryman noted that these photographs would have to be taken vertically from a helicopter. The panel felt that this avenue of research was extremely promising, but that because the animals segregate by age and sex, the results would be difficult to interpret.

4.0 ADJOURNMENT.

The panel adjourned on February 8, 1985 at 1330 after approving the minutes for phase 1 and 2. DeMaster agreed to try and get copies of the final minutes out by February 12, 1985.

APPENDIX

AGENDA FOR MEETING OF THE SCIENTIFIC REVIEW COMMITTEE ON ETP DOLPHIN SURVEY DESIGN

PHASE 1 - MONITORING DOLPHIN STOCKS WITH RESEARCH VESSELS.

1. Review of document 1 (Holt supplement, Jan 31, 1985), which will be led by R. Holt

2. Panel discussion of Holt's report

3. Consensus on the expected results of Holt's analysis or an identification of additional analyses needed

4. Discussion of recommended survey options

5. Consensus on survey options, if possible

PHASE 2 - MONITORING DOLPHIN STOCKS WITH TUNA VESSEL DATA.

1. Discussion of how tuna vessel data could be incorporated into the research vessel survey design

2. Discussion of how tuna vessel data could be used to monitor dolphin stocks if research vessels are not utilized in the survey design

Appendices 5 & 6, papers by Polacheck, and Hammand & Laake, will be sent to you if you so request.

APPENDIX NO. 7

SUGGESTED CRITERIA FOR EVALUATION OF RESEARCH RESULTS

"The precision of the index must be testable by standard statistical methods."

"The accuracy of the index must be based on testable assumptions."

"The estimate must either:

a. provide better accuracy and precision than the estimate expected from the research vessel monitoring program, or

b. improve the accuracy and precision of the resulting estimate when combined with the analysis of the research vessel monitoring program."

"Are the results logical in the real world?"

"If the tuna fishery is increasing and trend indicates possible gross decline how can you reconcile?" ??

"Over a five year period ETP dolphin populations can be expressed as increasing, decreasing or remaining the same?" ??

"Procedure must be robust to its assumptions."

"Procedure must 'iron out' known biases in the data. e.g. if sightings of common dolphins in 1985 are only 25% of those in 1984, and the procedure indicates a drop to 25% of 1984 numbers, it (the procedure) is probably not working!"

"Procedure must give 'consistent' results over different species (subject to preferential targeting, etc.)."

"Assumptions of relative abundance estimation should be testable."

"Method should be able to detect a possible change of 40% in 5 years."

"Method should be useful on at least 4 principal spp."

"Standard statistical criteria of assuming alpha and beta levels and apply Gerrodette method (regression over time)."

"Compare with unexploited populations (stocks) see if change significant."

"Survival into 21st Century of dolphin populations."

"Detect changes of a given magnitude over a given time of enough quality to convince a judge."

"Be able to test independently all assumptions."

"Detect a change before it is (otherwise) obvious."

APPENDIX NO. 8

LINE TRANSECT

NUMBER

2. Apply line transect methodology (e.g., extend Hammond & Laake analysis) to all available data.

11. Review assumptions in line transect theory and development of methods for testing the assumptions both from available data and for design of future experiments.

20. Analyze the error levels of the line transect surveys to determine to what extent additional TVOD from 86 onward could improve precision.

22. Pursue making line transect analysis robust to rounding.

24. Investigate new line transect models and criteria for determining data fit.

15. Explore randomization of observer data by sub-sampling.

STRATIFICATION AND SEARCH

1. Identify functionally different modes in which tuna vessels can operate.

2. Explore data dependent stratification procedures.

27. Examine environmental effects on abundance estimates.

23. Define time and space scales of non- randomness in search in relation to dolphin distribution.

25. Examine effects of different sighting cues on detection rates, etc.

27. Examine the limitations that the tuna fishery imposes on the data.

38. Compare U.S. and foreign fleet fishing strategies.

42. Examine Watershed year (1978 or 1979).

28. Determine the effect of different weather conditions on observations.

33. Define index areas (based on geographical patterns and trends in fishing effort and strategy).

35. Optimize data stratification system.

37. Study causes of patchiness or clustering in porpoise and tuna? Are the causes the same for both?

SCHOOL SIZE

21. General analysis of size estimation.

6. Study natural- and fishery-induced school dynamics.

18. Are problems with school size estimation the same for both tuna vessel observers and research vessel observers?

34. Examine effects of interactions of school size and school density on estimates.

41. Investigate use of tuna vessel helicopters for use in estimating school size.

LINE TRANSECT AND SCHOOL SIZE

3. Make distinction between estimating particular school size and average school size.

OBSERVERS

7. Examine feasibility of equipping observers with binoculars.

16. Examine problems and propose corrections for estimating density of striped and common dolphins.

8. Determine effects of helicopters on sightings.

9. Develop observer training program to ensure observation techniques are consistent.

32. Define observer effects (bias, rounding off, etc.)

STOCK ID

10. Address problems of identifying stocks of spinners (eastern vs. whitebelly vs. undistinguishable) in past and future assessments.

39. How will the redefiniition of stocks affect looking at past and future data?

METHOD COMPARISONS

13. Explore non-parametric adaptations of traditional analytic methods.

14. Compare various abundance indices including use of Gerrodette type analysis.

APPENDIX 9

Rank Sum	Topic
19	#2. Extend Hammond & Laake analyses using longer time series.
	12. Data-dependent stratification procedures.
18	5. Compare TV & RV data for common space/time.
	15. Randomization by sub-sampling.
	27. Examine environmental effects on abundance estimates.
17	1. ID functional modes of tuna vessel searching.
	4. Explore CPUE methods.
	11. Review LT assumptions develop tests for these.
	21. School Size: general analysis of problem.
	23. Define time-space scales of non-randomness in TV searching.
16	19. Compare LT with CPUE.
	34. Investigate interaction of School Size and School Density.
15	9. Train observers for consistent estimates.
	22. Make LT robust to rounding of distance & angle estimates.
	24. Identify new LT models and detection criteria.
	25. Examine sighting cue effects.
	26. Experimental calibration TV observer data with controlled platform.
	41. Investigate use of TV helo for School Size verification.
14	6. Study natural and fishery-induced dynamics of school size.
	17. ID tuna fishery limitations on dolphin study results.
	20. ID LT error levels and various levels of observer sampling.
	32. Observer effects on school size estimation.
	35. Optimize data stratification scheme.
	36. Compare results from different TV fishing in same area.
	39. Effect of Stock ID definitions on monitoring results.
13	8. Examine influence of helicopter on sightings results.
	10. Examine effects varying spinner stock ID on past and future monitoring.
	28. Examine effects of weather on sighting results.
	33. Define index areas for between time period comparisons.

12 3. Replace average SS with single animal empahsis in LT.
7. Equip observers with 25x binoculars.
13. Explore non-parametric adaptations of traditional methods.

11 14. Gerrodette comparisons of various abundance indices.
18. RV to TV comparison of observer bias in SS estimates.
31. Compare sighting results for exploited and non-exploited species.

10 29. Which monitoring method(s) can detect the levels of change in N as
30. predicted by quotas for fishery.

9 37. Study causes of patchiness of distribution for dolphins and tuna.

8 16. Examine striped and common dolphin density estimates.

40. Literature search for additional topics.

7 42. Examine watershed year (78-79?)

19. Compare various abundance indices including use of Gerrodette type analysis.

4. Investigate CPUE concepts for relevance.

29. How much change is expected in porpoise populations and in which direction?

30. Can any monitoring system detect expected levels of change in porpoise populations?

31. Compare data for "exploited" or "non-exploited" stocks.

CALIBRATION

26. Devise experiment to calilbrate data from tuna boats with controlled platforms.

5. Compare tuna vessel and research vessel data in areas where both occurred simultaneously.

36. Compare data from different tuna vessels searching in the same area.

ECONOMICS

(No individual topics were suggested, but the group felt the general area of economics of the fishery should be considered.)

MORE TOPICS

40. Search literature for research topics not listed here.

ATTACHMENT 2

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Pacific Fisheries Environmental Group
P.O. Box 831
Monterey, Ca. 93942

17 March 1986

To: Steve Reilly, F/SWC1

From: Roy Mendelssohn, PFEG, F/SWC4 Roy Mendelssohn

Subj: Porpoise Observer Data

I finally had a chance to read over the papers you sent me on the porpoise observer data. I am always very hesitant to comment in situations like this, since I know very little about the tuna/porpoise problem, and I have not been involved in past discussions on this data set. Thus anything I say may have been discussed already by others or may be impractical or otherwise absurd given a more thorough understanding of the problem. I apologize for any such shortcomings.

I see two possible areas where some progress might be made, but there are serious difficulties with both of these suggestions. Let me discuss each area and then describe the potential problems I see.

First, I found the evidence that fishing effort is non-random pretty convincing. It would be of some use if it could be determined what variables the fisherman are looking for in deciding where to fish. We have several techniques that may be well suited to examining this problem. These techniques look at the whole field simultaneously through time, and can deal with the uneven distribution of the data. The problem is that these techniques are brand new - we are just in the process of using them, so that I am not certain how well they really work. Also, these techniques assume a kind of spatial stationarity that may be too strict for the porpoise data. Moreover, these methods are not that easy to use - it is not simply a question of sending down code and having someone run it. And most of the descriptions of the code are highly mathematical and assume some knowledge of multivariate time-series and maximum likelihood estimation.

The second area is in estimating density of schools. Most of the techniques described run up into the problem that density estimates depend on effort and effort may well depend on observed estimates of density or other measures. Suppose that we have successfully completed the first analysis so that we have some idea of the variables that control where effort goes. For simplicity of description, assume that there are only two areas. Let x(t) be the underlying state variable at time t. This would probably include density in each area (perhaps also values of this variable lagged in time), effort in each area (again perhaps also lagged in time), and whatever other variables were found to be important. Also, suppose that we have an observation vector y(t). This would include estimated effort in each area at time t, the number of encounters in each area at time t, and the observed value of any of the other variables at time t. Then there are a variety of techniques based on Kalman filtering that deal with models of the following form:

$$x(t) = Ax(t-1) + Bu(t)$$

$$y(t) = f(x(t)) + e(t)$$

where u(t) and e(t) are random vectors of appropriate dimensions.

What this modeling scheme accomplishes is that now we differentiate between underlying variables (e.g. density) from observed quantities (e.g. encounters), we allow error in the observation process, and we model all the variables simultaneously - thus density can be a function of effort and effort a function of encounter rate (or other variables) at the desired lags.

The problem arises in that the algorithms are only well behaved if f() is linear, and hopefully f() and A at most vary slowly in time or in some regular fashion. This is not likely to be the case in the porpoise data. Thus someone would have to develop the likely forms of the model for the porpoise data, and work out the mathematics required to modify the existing algorithms to cover this extended case. Let me emphasize that this is probably a non-trivial piece of work. I don't know who could do it in-house, and the cost to contract could be considerable, plus with contracts it is difficult to insure that you get exactly what you really wanted.

My final concern about these methods is based on some of the objectives stated in the 6 December 1985 meeting. While I believe the types of analyses I have suggested will give more insight into the process and probably more realistic numbers, I wouldn't be surprised if the estimated standard errors are relatively large. Thus if " the monitoring method must be able to detect a total change in population size of X% over a period of Y years" and X and Y must be significantly improved over the numbers determined by the research vessel monitoring program, then I wouldn't be at all surprised if these analyses provided little statistically significant improvement. I think this reflects the difference between purely statistical measures that can be written into a law, and measures based on an understanding of the process involved and our ability to integrate knowledge into some idea of what is most likely happening, even where our statistical tests fail.

I hope this has been of some help. Let me know if I am suppose to return the documents you sent. It was unclear in you memo.

cc: A. Bakun
I. Barrett
J. Carr
G. Sakagawa

ATTACHMENT 3

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Southwest Fisheries Center
P.O. Box 271
La Jolla, CA 92038

May 18, 1987 F/SWC1

MEMORANDUM FOR: F/SWC1 - D. DeMaster

FROM: F/SWC1 - S. Reilly

SUBJECT: Minutes from the meeting of the SWFC Survey Design Group on design of an experiment to calibrate tuna vessel observer data (TVOD) with research vessel data and helicopter photographs.

On Tuesday , May 12, I called together the in-house survey design group to discuss an experiment to calibrate TVOD. The SWFC had been advised that such an experiment was necessary by a panel of experts in a workshop held at the Center on December 6, 1985. The purpose of the workshop was to forge a research plan to determine if, and if so, how TVOD can be used to index trends in ETP dolphin abundance.

The meeting agenda was proposed and accepted as follows:

1. Delineate options for conducting a TV-RV experiment.
2. Discuss the pros and cons of each option.
3. End the meeting with a reduced set of options, to facilitate further planning.

The attached appendix lists the options identified by category. During three hours of discussion the following points emerged as either consensus, or majority opinions. We do not at this time clearly understand what a field experiment should calibrate. Much discussion centered on the topic listed in the appendix as E.1: "Can we get appropriate or enough data to answer any pertinent questions?" The consensus was that it was questionable if we could get appropriate or adequate data. Also, much appears to hinge on the results of the current study of existing TV and RV data from the "same" areas and times. This study is being conducted by Holt et al., and is not yet to the point where results are available.

The group felt strongly that it would be unwise to proceed with detailed planning, including spending money for equipment or supplies for an experiment, until at least two studies were available: the Holt et al. TV-RV comparison, and a separate study focusing on the feasibility of a field experiment, given the results from the first (and from other sources as well, as listed in category A of the appendix). Two other points discussed by the group involved the time frame for the experiments. First, the consensus was that any experiment would likely have to be repeated on subsequent years to consider interannual variation. A three year experiment was considered minimal. Second, it was noted that a consequence of not deciding to begin an experiment in FY88 would cause delay of the beginning of field work (should it be considered appropriate) until October 1988 at the earliest.

Attachment

cc: SWFC Survey Design Group
J. Barlow
D. DeMaster
A. Dizon
R. Holt
W. Perryman
L. Vetter

APPENDIX

LISTING OF OPTIONS NECESSARY TO CONSIDER IN PLANNING A FIELD EXPERIMENT TO VERIFY TVOD

A. Information necessary or useful to successfully design an experiment.

1. RV-TV historical analyses
2. Results from TOPS
3. Buckland's TVOD results
4. Photogrammetry results from MOPS-87
5. Summary of past season/area spatial distribution of the tuna fleet

B. What will be calibrated?

1. Encounter rates with schools
2. School sizes
3. Species proportions
4. School density from line transect analyses (LTA)
5. Changes (in above) from year-to-year
6. MOPS results from same time period.

C. Factors/Strata to include in experimental design

1. Fishing mode (e.g. "dolphin" or "schoolfish")
2. Area
3. Season
4. Vessel type (size?)
5. Vessel origin (flag)
6. Hi vs. low dolphin density areas

D. Duration of the experiment

1. Intra-year
   - 1.1 2 months
   - 1.2 other length?
2. Inter-year
   - 2.1 1 year
   - 2.2 2 years
   - 2.3 3 years (probably the maximum, givenlogistic constraints)

E. Cost-benefit and sensitivity

1. Can we accomplish this with MOPS alone?
2. Can we get appropriate or enough data to answer the pertinent question(s)?

F. Inclusion of tuna vessels

1. Should we charter tuna vessels, or just monitor their activities?

G. When should we begin?

1. During a planned MOPS time-of-year
   - 1.1 Aug-Sept FY88
   - 1.2 Oct-Nov FY89
   - 1.3 Aug-Sept FY89
   - 1.4 Oct-Nov FY90
2. During a non-MOPS time of year (this would save on purchasing duplicate equipment).