AGREEMENT ON THE INTERNATIONAL DOLPHIN CONSERVATION PROGRAM

36TH MEETING OF THE PARTIES

LA JOLLA, CALIFORNIA (USA)
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DOCUMENT MOP-36-06

RESEARCH PROPOSALS BY THE IATTC STAFF

INTRODUCTION

The AIDCP currently has a US$ 1.4 million budget surplus, mainly because in recent years a number of vessels have paid for services (*e.g*. onboard observers) that were not fully utilized (Document MOP-35-06). This surplus is to be spent on projects of interest to, and in support of, the AIDCP. To this end, the IATTC staff has been asked to prepare appropriate research proposals, for consideration by the Parties.

Three of the five proposals are for studies of alternatives (or supplements) to ship-based line-transect surveys for monitoring dolphin stock status (Proposals 2-3, 5); the other two are related to potential unobserved dolphin mortality (Proposal 1) and to improving dolphin population dynamics modelling (Proposal 4). Projects that are funded will be integrated into the staff's research program.

The funding sought for each of the five proposals is as follows.

		Cost (US$)
1.	Cow-calf separation	90,000*
2.	Movement and tag loss	282,000*
3.	Life history sampling	1,195,000§
4.	Stock assessment	238,000
5.	Drone survey	137,600*

* Costs for these proposals are based on the assumption that vessel time will be provided at no charge. See specific proposals for details.

§ Covers five years of sampling

The cost of administrative support, in terms of staff time, is not included in the proposals.

1. COW-CALF SEPARATION DURING PURSE-SEINE SETS

1.1. Background

The question of whether dolphin calves separate from their mothers during the chase phase of purse-seine sets has been the subject of debate. One study estimated that an additional 14% mortality may be occurring due to unobserved mortality of calves resulting from such separation, and a related analysis

argued that 2-5 unobserved mortalities per set would be expected, while others consider that, in mammals, the reluctance of mothers to leave their young makes such separation unlikely. However, few field observations are available to support or refute the hypothesis that cow-calf separation occurs.

1.2. Statement of the problem

Separation of calves from their mothers is difficult for onboard observers to monitor, and observers do not collect specific data on cow-calf pairings. Any mortality that might result from such separation would not be included in the current estimates of total dolphin mortality. If cow-calf separation is occurring, and if it results in calf mortality, total dolphin mortality associated with the purse-seine fleet would be underestimated.

1.3. Objectives of the study

The objectives of this project are to:

1. determine whether dolphin cows and calves separate during the chase phase of a purse-seine set and/or during the backdown procedure; and
2. obtain a preliminary estimate of mortality associated with such separation, if it occurs.

1.4. Methods

This study will be conducted during regular fishing operations aboard a tuna purse-seine vessel that carries a helicopter, has a Dolphin Mortality Limit (DML), and can accommodate two scientists in addition to the observer. During the chase phase of the set, the helicopter, with a fixed video camera underneath and a scientist aboard, will track the dolphin herd from behind, to observe the behavior of cows and calves and detect dolphins leaving the herd. GPS units on the helicopter and the vessel will track the paths of the dolphins and the vessel. The data recorded will be used to determine the distance that dolphins are chased, their speed, and their behavior in relation to the vessel's operations, and estimate the probability of cow-calf separation. A hexacopter (a type of small drone) with a video camera, remotely operated from the vessel, will be used to determine whether cow-calf separation occurs during backdown. No effects on catches or fishing operations are anticipated. Based on estimates of the probability of separation, and assumptions about cow-calf regrouping, estimates of unobserved calf mortality will be computed.

1.5. Work plan and budget

This research will be planned for late 2018-late 2019, depending on the availability of a purse-seine vessel and the procurement of any relevant permits. The budget assumes that there is no cost to the project for collaboration by the purse-seine vessel, which could fish normally.

Item	Detail	Cost (US$)
Equipment	High-resolution video cameras, hexacopters, lap-top computers, GPS units	77,000
Personnel and travel ex-penses		13,000
Total (excluding staff time)		**90,000**
Staff time	Logistical preparation for the cruise; data analy-sis; report writing (0.4 FTE) Administrative and field office support (0.1 FTE). The work will be spread over two years	0.5 FTE[1]

[1] Full-time equivalent

1.6. Deliverables

In 2020, project results will be presented to the IATTC Scientific Advisory Committee (SAC), and a project report will be submitted to the Meeting of the Parties.

1.7. Challenges expected

Finding a purse-seine vessel willing to collaborate in the study is critical, but may be difficult. Customs regulations, acquiring research permits, and the vessel's unloading and fishing schedules may cause delays. As with any study at sea, research time may be lost due to weather and/or breakdowns.

1.8. Management benefit

Data collected during this project will allow questions about unobserved mortality due to cow-calf separation to be quantitatively evaluated. If a significant number of separations are observed, further analyses could estimate the population effects of potential mortality of calves. If, however, separations are not observed, or are rare events, mortality due to cow-calf separation is likely insignificant.

2. DOLPHIN SWIMMING SPEED, DIVING, MOVEMENTS, AND TAG LOSS

2.1. Background

Mark-recapture methods can be used to estimate abundance, and the potential for a large-scale tagging effort for mark-recapture analysis was discussed in October 2016 at the IATTC Workshop on Methods for Monitoring the Status of ETP Dolphin Populations, where a preliminary one-year study to assess the practicality of large-scale tagging and to estimate the rate of tag loss was proposed. It was suggested that dolphins could be outfitted with satellite-linked tags during one or two purse-seine trips, and these tags could then be monitored for premature tag loss.

Tagging studies have been conducted previously in the ETP, but with only limited success. Large-scale tagging of ETP dolphin species was attempted previously by the US National Marine Fisheries Service (NMFS) in the 1970s, but these early mark-recapture efforts were hindered by small tag numbers that could not be read at a distance, high tag losses, and low return rates. More recently, small-scale tagging and tracking experiments have been succesfully conducted in studies of the tuna-dolphin association, dolphin movements, diving patterns, social associations, stress, and abundance. Some tags were sighted after a year, others were likely lost within a short time. Since then, however, tags have been redesigned and have greater longevity in the pelagic environment.

2.2. Statement of the problem

The first step towards any tagging program in the ETP for estimation of abundance is to demonstrate, the practicality of a large-scale tagging study within the ETP. Such a proof-of-concept project has yet to be undertaken with state-of-the-art tagging technology and funding for such a project has not been available to date.

2.3. Objectives of the study

Trials will be conducted to:

1. evaluate new tagging protocols for future tagging studies;
2. estimate tag losses to assess the feasibility of mark-recapture abundance studies;
3. obtain data on dolphin diving behavior that can be used to help estimate the probability that a dolphin herd would be missed during aerial surveys (*e.g.*, drone surveys); and
4. obtain more movement data that can be incorporated into new methods for estimating abundance.

2.4. Methods

This study will be conducted during two trips aboard a tuna purse-seine vessel that carries a helicopter, has a DML, and can accommodate two scientists in addition to the observer. The tagging will be conducted during normal fishing operations. The backdown may be delayed by up to 30 minutes to allow tags to be attached to the dolphins, and use of vessel's rafts and assistance by the crew may be required to capture and tag the dolphins.

The target is to capture 40 spotted or spinner dolphins and attach satellite tags that transmit location and dive depth data to allow estimation of tag loss rates. If possible, radio tags and time-depth-velocity recorders will also be attached to 20 spotted or spinner dolphins, which will then be tracked from the vessel for 2-4 days, and then recaptured to recover the data on swimming and diving behavior, and replace the radio tags with satellite tags.

Dolphin movements and diving behavior will be monitored until the satellite tags no longer function. Premature loss of satellite signal can be inferred as tag loss, and the rate at which tags are lost can help evaluate the potential usefulness of tagging for mark-recapture population estimates. With this estimated tag loss rate, the sample size required for such estimates can be calculated, and the feasibility of large-scale tagging can be assessed.

2.5. Work plan and budget

This research will be planned for late 2018-late 2020, depending on whether Proposal #1[1] is funded, the availability of a purse-seine vessel, and the procurement of any relevant permits. The budget assumes that there is no cost to the project for collaboration by the purse-seine vessel, which could fish normally.

Item	Detail	Cost (US$)
Personnel and travel expenses	Contracted scientist (1 year), sea pay, travel	46,000
Satellite tags	40 tags	144,000
ARGOS satellite time	US$ 150/dolphin/month	36,000
Radio tags	20 tags	6,000
Time-Depth-Velocity recorders	20 recorders	30,000
Tracking receivers and gear		18,000
Sampling gear	Life history sampling	2,000
Total (excluding staff time)		**282,000**
Staff time	Logistical preparation for the cruise; data analysis; report writing (0.4 FTE) Administrative and field office support (0.25 FTE). The work will be spread over two years.	0.65 FTE

2.6. Deliverables

In 2021, project results will be presented at the IATTC Scientific Advisory Committee Meeting, and a project report will be submitted to the Meeting of the Parties.

2.7. Challenges expected

Finding a purse-seine willing to collaborate in the study is critical, but may be difficult. Customs regulations, acquiring research permits, and the vessel's unloading and fishing schedules may cause

[1] Proposals 1 and 2 cannot be undertaken simultaneously by the staff because of the staff time requirement.

delays. As with any study at sea, research time may be lost due to weather and/or breakdowns.

2.8. Management benefit

The Workshop on Methods for Monitoring the Status of Eastern Tropical Pacific ETP Ocean Dolphin Populations recommended that a tagging study could provide useful information that could lead to development of an alternative method for monitoring dolphin population status if shipboard surveys could not be done. This proof-of-concept study can aid in the development of new large-scale tagging protocols for estimating abundance.

3. DOLPHIN LIFE HISTORY SAMPLING BY OBSERVERS

3.1. Background

Observers from both the NMFS and the IATTC collected dolphin life history data from dead animals since the inception of their respective programs in the 1970s through 1994. They collected reproductive organs for evaluation of population status, stomach contents for food habits studies, teeth for estimating age and age-based population studies, and sometimes the entire carcass, from over 43,000 dolphins. Observers still record body length, girth, sex, and spotted dolphin color phase, but take life history samples only occasionally, for specific projects. The re-initiation of life history sampling by observers was part of the Terms of Reference for the Scientific Advisory Board (SAB) (IRP-33-11a, IRP-33-11b). The SAB recommended that the program be re-initiated, and developed a logistical plan to implement the recommendation (SAB-02-04). This proposal was approved in 2005 by the Meeting of the Parties (MOP-14 Minutes Oct 2005).

3.2. Statement of the problem

Reproductive parameters estimated from biological sampling data are an important input to population dynamics models. However, to date, the necessary funding to implement the 2005 data-collection plan has not been available.

3.3. Objectives of the study

The study has two objectives:

1) Obtain teeth and reproductive organs from dolphins killed incidentally in fishing operations. The resulting data will be used to examine trends in population status by comparing age distributions and reproductive parameters with those from the 1980s and 1990s, and integrating these data into population dynamics models.
2) Collect stomach contents from dolphins killed incidentally in fishing operations, to examine for potential climate-induced decadal diet shifts, as has been found in yellowfin tuna.

Because the current mortality of dolphins in the purse-seine fishery is so low, the data collection will need to be long-term (5 years) and continuous to gather a sample size adequate to compare with older data, and to provide ongoing monitoring of the population in the future.

3.4. Methods

The project will be implemented in two stages. In 2018, a preliminary sampling of a subset of the fishery will develop the logistics for taking, storing, shipping, and analyzing samples. CITES and other required research permits will be obtained. The program will then be expanded to the rest of the IATTC observer program and to collaborating national programs. Samples will be transferred to laboratories expert in estimating age from teeth, reproductive status from gonads, and food habits from stomach contents. The life history results will be incorporated into population dynamics models, and food habits data will be used in trophic models.

3.5. Work plan and budget

The total cost for this project is US$ 1,195,000 over five years, broken down as follows:

Item	Annual cost (US$)		
	Year 1	Year 2	Years 3-5
Contracted personnel	60,000	60,000	60,000
Observer training and travel	60,000	30,000	5,000
Equipment and logistics	145,000	30,000	5,000
Laboratory contracts	-	150,000	150,000
Total (excluding staff time)	**265,000**	**270,000**	**220,000**
Staff time	0.1 FTE	0.1 FTE	0.1 FTE

3.6. Deliverables

Annual summaries of the data collected will be included in annual report on the IDCP. When an adequate sample size has been collected for one or more stocks, the data will be analyzed; the resulting report will provide inputs for population dynamics modeling and compare current reproductive parameters with those from the 1980s and 1990s.

3.7. Challenges expected

Because of the current low incidental mortality of dolphins in the purse-seine fishery, the sampling program will be necessarily long-term. The preparatory process, training, obtaining permits, and logistical organization will require time, and accumulating sufficient samples to analyze will be slow, particularly since there are multiple dolphin stocks involved in the fishery.

3.8. Management benefit

As recognized previously by the International Review Panel (IRP), the SAB, and the Parties, a biological sampling program by observers would provide the data necessary for estimating reproductive parameters and diet composition, contribute to population dynamics modelling, and provide continuous data for monitoring the status of dolphin populations in the ETP.

4. DOLPHIN STOCK ASSESSMENT

4.1. Background

Population dynamics modeling has been the preferred basis for management advice regarding dolphins in the eastern tropical Pacific Ocean (ETP). It has three clear benefits: 1) it can be used to evaluate whether the stocks have rebuilt from the depleted levels caused by the high historic mortalities, 2) it can be used to determine whether current mortality levels are sustainable, and 3) it can be used to define reference points or rebuilding targets. To reach these objectives, a population dynamics model is fitted to abundance estimates, conditioned on the historical mortalities, to reconstruct the population trajectory. However, the hiatus in the NMFS surveys since 2006 has greatly reduced the reliability of the estimates of dolphin stock abundance, because the data are now 11 years out of date. A new survey is proposed for the near future, and the resultant estimate of abundance will help to improve this situation.

However, abundance estimates are only one component of population dynamics modelling. Population dynamics models are based on many assumptions that are uncertain, and thus stock status may still be uncertain, even if accurate estimates of absolute abundance are available. Therefore, it is important to attempt to use all the available data to improve the model. There have been disagreements about whether dolphin populations are recovering at the expected rates, and if not, why not, but no comprehensive analysis has been undertaken to date to resolve the issue.

4.2. Statement of the problem

The current quantitative formulation of dolphin stock assessment models cannot make use of all available data, and as a result, may not represent the best available science. Therefore, an improved model needs to be developed. Information on dolphins that is currently not used in the model includes data on sightings by observers on tuna vessels, age and color phase of mortalities, and pregnancy rates. Including all available information in the stock assessment will involve changing from a simple surplus production model to one that has more structure (*e.g*. age and life stage structure). The model can then be used to evaluate stock status, rebuilding rates, and stock mortality limits, and test hypotheses about the recovery of the stock. Other analyses that could also improve the assessment (*e.g.* including any that may be identified at the 2018 CAPAM spatio-temporal modeling workshop) will also be considered.

4.3. Objectives of the study

The objectives of the study include:

1. Develop a new population dynamics model for ETP dolphins;
2. Apply the model to the spotted and spinner dolphin populations;
3. Evaluate the assumptions of the model;
4. Estimate the current status, rebuilding rate, and stock mortality limits;
5. Evaluate alternative hypotheses about factors influencing the rebuilding rate;
6. Evaluate the data needed to provide adequate management advice and to differentiate among the hypotheses.

4.4. Methods

The population dynamics model would be developed in the integrated analysis framework typically used for fisheries stock assessment models, which is also used for many mammal populations and was recommended in the independent review of ETP dolphin stock assessment. This approach is flexible, allows the inclusion of alternative data sets, and fully accounts for uncertainties. The integrated analysis previously applied to the population of northeastern spotted dolphins in the ETP would be used to guide initial model development, and all previous ETP population modelling studies and available data will be reviewed to help guide the model development.

4.5. Work plan and budget

The research will be carried out from June 2018 to May 2020.

Item	Detail	Annual	Total
Full-time researcher		104,000	208,000
Travel		5,000	10,000
Computer equipment		-	5,000
Recruitment and other admin-istrative expenses	Advertisements, interviews, relocation	-	15,000
Total (excluding staff time)		**109,000**	**238,000**
Staff time	Guidance on data, analyses; report writing	0.2 FTE	0.4 FTE

4.6. Deliverables

The project will produce computer code for a population dynamics model that can be used in future assessments. Progress will be reported at the meeting of the IATTC Scientific Advisory Committee (SAC) in 2019, with a presentation of final project results at the SAC meeting in 2020. A report summarizing the research will be submitted to the Meeting of the Parties in 2020.

4.7. Challenges expected

It may be difficult to find a qualified researcher to carry out the work, and this may delay the project. Also, the new abundance estimates may not be available by the completion date of this project, in which case the assessment will be presented without the new data, and will be updated when the new abundance estimate becomes available.

4.8. Management benefit

This project will generate improved estimates of stock mortality limits that are used for managing the yellowfin tuna fishery associated with dolphins. It will also provide a better understanding of the status of the dolphin stocks.

5. PROOF-OF-CONCEPT EVALUATION OF DRONES FOR USE IN ETP DOLPHIN SURVEYS

5.1. Background

As a result of a hiatus since 2006 in the ship-based surveys of dolphin abundance carried out the by the US National Marine Fisheries Service (NMFS), there are currently no reliable indicators with which to monitor the status of dolphin populations in the eastern tropical Pacific (ETP). This lack of information poses obvious problems for management. For example, the IATTC's Antigua Convention requires that the status of all species potentially impacted by the tuna fisheries in the eastern Pacific Ocean be monitored. In addition, abundance estimates are needed to ensure that incidental dolphin mortalities in the tuna fisheries are both sustainable and insignificant, because the stock mortality limits specified in the AIDCP are based on estimates of abundance. These needs provide impetus for periodic monitoring of ETP dolphin stock status. However, ship-based fishery-independent surveys are expensive (US$10 million for a one-year survey, were it to be conducted by the NMFS in 2017). Therefore, developing a cost-effective means for monitoring dolphin stock status is clearly desirable.

At a workshop hosted by the IATTC in October 2016, several options were identified that may yield indices of dolphin abundance at a lower cost than ship-based surveys, including the use of Unmanned Aerial Systems (UAS) ("drones"). Drone use has proliferated in the ecological survey sector in the last decade, including for transect or plot sampling of marine mammal distributions and abundance. In addition to the obvious financial benefit, lower cost allows flexibility in survey design and frequency, which may lead to better management. Aerial imagery would also provide a permanent record of the survey for future review.

5.2. Statement of the problem

Despite the clear potential of drone surveys, from the scientific perspective, there are several important issues to be addressed. First, it remains to be determined how reliably dolphin species and herd size can be determined from high-resolution drone imagery, and how that reliability is affected by different environmental conditions and by dolphin dive profiles. Second, good automatic detection methods need to be developed in order to reduce the high costs associated with post-processing of aerial imagery. Funds for such research, however, will not be provided as part of the upcoming ship-based survey. Therefore, additional funding is necessary to begin research to develop less expensive methods for monitoring ETP dolphin populations.

5.3. Objectives of the study

There are four objectives to this study:

1. Test the ability of aerial imagery to identify key dolphin species at the proposed image resolution of 4 cm;
2. Investigate the efficacy of using aerial imagery for accurate and precise estimation of dolphin

herd size;
3. Test potential drone survey regimes that might be used in the future; and,
4. Trial and development of deep-learning methods for automated dolphin herd recognition from imagery (building on very promising trials of new methods developed in Germany).

5.4. Methods

To achieve objectives 1-3 it is necessary to conduct drone research simultaneously with a ship-based survey, either during the survey itself or during the calibration 'cruise' before the survey starts. In the 2006 NMFS survey, this calibration cruise lasted two weeks, and was conducted relatively close to the coast.

The drone surveys and the development of automated detection algorithms will be conducted by the multi-disciplinary environmental assessment consultancy company HiDef/BioConsult SH. The project will use medium-sized drones (launched and recovered from the survey vessel) with an endurance of approximately two hours, taking pictures or video at a proposed 4 cm resolution. The drones will fly transects perpendicular to the ship's sailing direction and film the sea surface. Footage will be stored on the drone and downloaded after return to the vessel. The proposed strip-width will be 200 m, which is likely to be sufficient to either achieve complete coverage of dolphin herds recorded in the center of the transect or to allow a high-density sampling regime of the largest dolphin herds dispersed over a wide area. Strip width could be varied by adjusting survey altitude with consequent changes to the image resolution and the ability to discriminate between dolphin species. Footage will be reviewed by trained operators and detected mammals will be determined to species level with support of dolphin identification experts. Some review of images will take place on board the ship. An automatic classification algorithm based on "deep learning" methods will be developed by HiDef/BioConsult SH and tested in parallel with expert review of the drone footage.

5.5. Work plan and budget

Date	Activity	Cost (US$)	
		Calibration cruise	Survey
2019			
Jan-Jul	Equipment preparation/logistical requirements/field site preparation[a]	29,200	31,500
Jul-Aug	Fly sorties from field site during ship-based calibration cruise and collect simultaneous imagery	18,800	34,000
Sep-Dec	Process imagery, create data base	54,800	72,100
2020[b]			
Jan-Apr	Comparison of drone and ship-based sightings data; write project report	-	-
May	Presentation of project report at IATTC SAC meeting	-	-
Total (excluding staff time)		**102,800**[c]	**137,600**[c]
Staff time	Comparison of drone and ship-based sightings, report writing	0.3 FTE	0.3 FTE

a. No specific drones have been selected at this point because in 2019 the market for medium-sized drones will be very different.
b. Activities in 2020 involve IATTC staff time, but no additional expenses.
c. Assumes a berth for the drone operator will be provided on the survey vessel at no cost to the project.

5.6. Deliverables

This project will produce: 1) (by HiDef/BioConsult SH) a database of dolphin herd sightings (date, time, location, species, and group size) from the drone imagery, for comparison to the ship-based survey data; and 2) (by IATTC staff) a report with a statistical comparison of the drone sightings data with the ship-based sightings data and (by HiDef/BioConsult SH) an evaluation of the automatic detection routine. The project report will be a collaboration between HiDef/BioConsult-SH and IATTC staff.

5.7. Challenges expected

The ultimate goal of this project would be to use UAS throughout the ETP study area from land. However, there are considerable, and currently unsurmountable, safety concerns, so an approach based on launch and recovery of UAS from the research ship is proposed. This will avoid the main airspace issues, but good communications will be required to avoid conflicts with fishery- and survey-based helicopter traffic.

The budget is based on being able to obtain an average of two hours of footage per day. However, because of this limit on drone survey time and of the short time period of this project, it may not be possible to conduct trials during all environmental conditions that are found within the ETP survey area during the full ship-based survey period. Technical challenges include the trade-off between strip width, image resolution, and the ability to identify key dolphin species (eastern spinner and offshore spotted), and developing a suitable search pattern for accurate assessment of group size of large dolphin herds.

It is not known how much berth space would be available aboard the survey vessel.

5.8. Management benefit

This proof-of-concept project will provide the first UAS survey data for ETP dolphins from which future UAS work can be planned, contributing to the development of more cost-effective approaches for monitoring ETP dolphin stock status.