AGREEMENT ON THE INTERNATIONAL DOLPHIN CONSERVATION PROGRAM

41ST MEETING OF THE PARTIES (2020)[1]

DOCUMENT AIDCP-41-02

REPORT ON THE INTERNATIONAL DOLPHIN CONSERVATION PROGRAM

1. INTRODUCTION

In the eastern Pacific Ocean (EPO), schools of yellowfin tuna frequently associate with marine mammals, especially spotted, spinner, and common dolphins. When the purse-seine fishery for tunas in the EPO began around 1960, the fishermen found that their catches of yellowfin in the EPO could be maximized by setting these nets around a herd of dolphins and the associated school of tunas. However, releasing the dolphins while retaining the tuna proved more difficult, and in the early years of the fishery many dolphins died during this process. As techniques and equipment to solve this problem were developed, this mortality fell, gradually at first and dramatically in the 1990s, thanks to the combined efforts of the fishing industry, governments, the Inter-American Tropical Tuna Commission (IATTC), non-governmental environmental organizations, and other interested parties.

The 1992 La Jolla Agreement provided a framework for international efforts to reduce this mortality and introduced novel and effective measures as Dolphin Mortality Limits (DMLs) for individual vessels and the establishment of the International Review Panel to monitor the performance and compliance of the fishing fleet. The Agreement on the International Dolphin Conservation Program (AIDCP), which built on and formalized the provisions of the La Jolla Agreement, was signed in May 1998 and entered into force in February 1999. The Parties to the AIDCP committed to *"ensure the sustainability of tuna stocks in the eastern Pacific Ocean and to progressively reduce the incidental dolphin mortalities in the tuna fishery of the eastern Pacific Ocean to levels approaching zero and to avoid, reduce and minimize the incidental catch and the discard of juvenile tuna and the incidental catch of non-target species, taking into consideration the interrelationship among species in the ecosystem."*

As of 1 July 2020, Belize, Colombia, Costa Rica, Ecuador, El Salvador, the European Union, Guatemala, Honduras, Mexico, Nicaragua, Panama, Peru, the United States, and Venezuela have ratified or acceded to the Agreement. Bolivia and Vanuatu are applying the AIDCP provisionally. At the request of the Parties and in compliance with Article VII, paragraph 1 (t) of the Antigua Convention, the IATTC provides the Secretariat for the AIDCP including support for implementation of the Agreement, which comprises the

[1] Postponed until a later date to be determined

coordination of the On-Board Observer Program and the Tuna Tracking and Verification System.

2. THE ON-BOARD OBSERVER PROGRAM

The AIDCP On-Board Observer Program is composed of the IATTC observer program and the national observer programs of Colombia (Programa Nacional de Observadores de Colombia, PNOC), Ecuador (Programa Nacional de Observadores Pesqueros de Ecuador; PROBECUADOR), the European Union (Programa Nacional de Observadores de Túnidos, Océano Pacífico; PNOT), Mexico (Programa Nacional de Aprovechamiento del Atún y Protección de Delfines; PNAAPD), Nicaragua (Programa Nacional de Observadores de Nicaragua; PRONAON, administered by the Programa Nacional de Observadores Panameños, (PRONAOP), Panama (PRONAOP), and Venezuela (Programa Nacional de Observadores de Venezuela; PNOV). Additionally, at its 82nd meeting in July 2011, the IATTC agreed on a Memorandum of Cooperation (MOC) with the Western and Central Pacific Fisheries Commission (WCPFC) for cross-endorsement of observers from the IATTC program and the WCPFC's Regional Observer Program to monitor vessels that fish or transit the high-seas or other specified areas in the Convention Areas of both organizations.

2.1. Observer coverage

In 2019, as required by the AIDCP, observers were placed aboard 100% of trips in the Agreement Area by purse-seine vessels of carrying capacity greater than 363 metric tons (Class 6).

Consistent with the provisions of the AIDCP, national observer programs covered a percentage of the trips made by the various fleets. In 2019, the Ecuadorian national program had a goal of placing observers aboard 33% of the trips by Ecuadorian vessels while the Colombian, European Union, Mexican, Nicaraguan, Panamanian, and Venezuelan national programs each had a goal of placing observers aboard 50% of the trips by their respective fleets.

The IATTC program covered the remainder of the trips by vessels of these seven fleets, plus 100% of the trips by vessels of other fleets, which represented a total of 60% of all trips.

During 2019, AIDCP observers departed on 857 fishing trips made in the Agreement Area by vessels operating under the flags of Colombia, Ecuador, El Salvador, European Union (Spain), Mexico, Nicaragua, Panama, Peru, the United States, and Venezuela (Table 1). Of these, 20 trips were by vessels of less than 363 tons capacity required to carry observers. 15 of them, as required by IATTC Resolution C-12-08, because they were operating with sealed wells, 4 of them to maximize the amount of time they can be at sea prior or after a closure, and one as a pilot program by a national program sampling Class-5 purse seine vessels (not included as an AIDCP required trip in Table 1). 21 trips were of Class-6 vessels monitored by WCPFC cross-endorsed observers.

Additionally, there were five trips where AIDCP observers were deployed in the central Pacific Ocean although in the end the vessels did not enter the Agreement Area.

The data collected by the on-board observer for one of the class-6 vessels operating in the Agreement Area, was lost when the vessel sank.

2.2. Observer training

The IATTC staff conducted an observer training course from 27 May to 13 June 2019 in Mazatlán, Mexico, for 15 observers.

In addition, the staffs of the IATTC and WCPFC conducted a training course for 15 WCPFC observers in Nauru, from 28 August to 2 September 2019, with financial support from the WCPFC.

3. DOLPHIN MORTALITY

3.1. Dolphin Mortality Limits (DMLs)

3.1.1. 2019 DMLs

The overall dolphin mortality limit (DML) for the international fleet in 2019 was 5,000 animals, and the unreserved portion of 4,900 was divided among 107 qualified vessels that requested DMLs. The average individual-vessel DML (ADML), based on 107 DML requests, was 45.79. One vessel renounced its DML. Additionally, twelve vessels that did not utilize their DMLs prior to 1 April were allowed to keep them for the remainder of the year under the *force majeure* exemption allowed by the AIDCP, but nine of these DMLs were not utilized. Two vessels lost their DML due to not utilizing them prior to 1 April. One vessel was granted a second-semester DML, but renounced to it subsequently. Three vessels were assigned DMLs from the Reserve DML Allocation (RDA) managed at the discretion of the Director, in accordance with paragraph 7, Section I of Appendix IV of the AIDCP; one was not utilized. No vessel exceeded its DML in 2019.

The distribution of dolphin mortalities in the fishery is shown in Figure 1.

3.1.2. 2020 DMLs

The Parties requested 108 DMLs for 2020 from the unreserved portion (4,900) of the overall fleet mortality limit. As of 26 July, the utilization of these DMLs is as follows:

DML (Limit per vessel)	Assigned	Utilized by April 1	Re-nounced	Lost due to no utilization	Exempt due to *force majeure*
Full year (45)	108	85	3	0	20
Second semester	1	-	-	-	-
RDA	0	-	-	-	-

3.2. Estimates of the mortality of dolphins in 2019 due to fishing

The estimate of the mortality of dolphins in the fishery in 2019 is 778 animals (Table 2), compared to 819 mortalities recorded in 2018. The mortalities for 1979-2019, by species and stock, are shown in Table 3, and the standard errors of these estimates are shown in Table 4. The estimates for 1979-1992 are based on a mortality-per-set ratio, while the mortalities for 1993-2018 are sums of the observed mortalities recorded by the IATTC and national programs, although estimates for 2001-2003 had to be adjusted for unobserved trips.

The mortalities of the principal dolphin species affected by the fishery have declined since the early 1990s (Figures 2-3). Estimates of the abundances of the various stocks of dolphins and the relative mortalities (mortality/abundance) are also presented in Table 2.

The number of sets on dolphin-associated schools of tuna made by Class-6 vessels was 9,680 in 2019, compared to 9,774 in 2018, and this type of set accounted for 37% of the total number of sets made in 2019, compared to 38% in 2018. The average mortality per set was 0.080 dolphins in 2019, compared to 0.084 dolphins in 2018. The trends in the numbers of sets on dolphin-associated fish, mortality per set, and total mortality in recent years are shown in Figure 3.

The catches of dolphin-associated yellowfin increased by 5% in 2019, as compared to 2018. The percentage of the catch of yellowfin taken in dolphin sets was 71% of the total catch in 2019, compared to 67% in 2018, and the average catch of yellowfin per dolphin set was 15.5 metric tons (t) in 2019, compared to 14.7 t in 2018. The mortality of dolphins per metric ton of yellowfin caught was 0.0052 in 2019, compared to 0.0057 in 2018.

The long-term decrease in the mortality per set is the result of efforts by the fishermen to better manage the factors that bring about mortalities of dolphins. Indicative of this effort is the number of sets without mortalities, which has risen from 38% in 1986 to 96% in 2019, and the average number of dolphins left in the net after backdown, which has decreased from 6.0 in 1986 to 0.1 or less since 2001 (Table 5). The factors under the control of the fishermen which are likely to affect the mortality of dolphins per set include the occurrence of malfunctions, especially those which lead to net canopies and net collapses, and the time it takes to complete the backdown maneuver (Table 5). The percentage of sets with major mechanical malfunctions has decreased from an average of approximately 11% during the late 1980s to less than 5% during 1998-2019; in the same period the percentage of sets with net collapses decreased from about 30% to less than 2%, and that of net canopies from about 20% to less than 2%. Although the chance of dolphin mortality increases with the duration of the backdown maneuver, the average backdown time has changed little since 1986.

3.3. Reports of dolphin mortality by observers at sea

The AIDCP requires the Parties to establish a system, based on real-time observer reporting, to ensure effective implementation and compliance with per-stock, per-year dolphin mortality caps. Observers prepare weekly reports of dolphin mortality, by stock, which are then transmitted to the Secretariat via e-mail, fax, or radio. In June 2003 the Meeting of the Parties adopted Resolution A-03-02, which makes the vessel personnel responsible for transmitting these reports. During 2019, the reporting rate averaged 99.9% (Table 6).

Since 1 January 2001, the Secretariat has been reporting weekly to the Parties the cumulative mortality for the seven stocks of dolphins most frequently associated with the fishery. The most recent reported mortalities are shown in Table 7.

4. INTERNATIONAL REVIEW PANEL

The International Review Panel (IRP) follows a general procedure for reporting to the governments concerned non-compliance by their vessels with measures established by the AIDCP. During each fishing trip, the observer prepares a summary of information pertinent to dolphin mortalities, and this is sent by the Secretariat to the government with jurisdiction over the vessel. A number of possible infractions are automatically reported to the government with jurisdiction over the vessel in question; the IRP reviews the observer data for other cases at its meetings, and any cases identified as possible infractions are likewise reported to the relevant government. Governments report back to the IRP on actions taken regarding these possible infractions.

The IRP met in Bilbao, Spain on 15 July 2019 and on 21 October 2019 in La Jolla, California, USA. The minutes of IRP meetings are available on the IATTC website, along with the other documents posted for each set of meetings. Tables 8-9 and Appendix A of this report summarize possible infractions identified by the Panel at these meetings and subsequent action taken by the governments.

5. TUNA TRACKING AND VERIFICATION

The System for Tracking and Verifying Tuna, established in accordance with Article V.1.f of the AIDCP, enables "dolphin-safe" tuna, defined as tuna caught in sets without mortality or serious injury of dolphins, to be identified and tracked from the time it is caught through unloading, processing, and sale. The Tuna Tracking Forms (TTFs), completed at sea by observers, designate the tuna caught as dolphin safe (Form 'A') or non-dolphin safe (Form 'B'). This, in turn, allows for the verification of the dolphin-safe status of any tuna caught by a vessel covered by the AIDCP. This framework, administered by the Secretariat, also allows each Party to establish its own tracking and verification program, implemented and operated by a designated national authority. These programs include periodic audits and spot checks for tuna at the points of capture, landing, and processing, and provide mechanisms for communication and cooperation between and among national authorities, and timely access to relevant data. Each Party is required to provide the Secretariat with a report detailing its tracking and verification program.

All trips by vessels fishing in the Agreement Area that began in 2019 with an IDCP observer aboard were issued TTFs.

6. RESOLUTIONS, AMENDMENTS AND OTHER DECISIONS AFFECTING THE OPERATION OF THE IDCP

During their 39th meeting in July 2019, the Parties adopted Resolution A-19-01 on National Program Funding. Pursuant to this Resolution, the Parties allocated $207,268.90 (10% of surplus as of 31 December 2018) to the national programs with the goal of improving their operation. This funding was to be used to replace and update observer equipment and computer systems used in data processing and management. According to the Resolution, this 10% contribution was to be distributed equitably among all national programs. On 10 August 2020, the Director sent a letter to Mr. Alvin Delgado, in his dual capacities as the Chairman of the AIDCP and as the head of the Venezuelan national observer program, requesting that he coordinate among the national programs to determine an equitable distribution among them. Once this issue is resolved, the purchase of equipment and materials for the programs will be done in coordination with the technical Secretariat of the AIDCP.

At their 38th meeting in 2018, the Parties adopted Resolutions A-18-02 and A-18-03, both on observer safety at sea. Through Resolution A-18-02, the Parties authorized the purchase, and mandated the use, of (1) independent two-way satellite communication devices, and (2) waterproof personal life-saving beacons, to increase the safety of observers in the IATTC and national observer programs that comprise the AIDCP On-board Observer Program. The Parties agreed to cover future costs of maintenance, service, and replacement of these devices from the AIDCP annual budget.

The IATTC staff procured 250 sets of the devices approved by the CPCs. As called for in Resolution A-18-02, the national programs requested 102 pairs of devices as follows:

National Program	Pairs		National Program	Pairs
Colombia	11		Mexico	31
Ecuador	28		Nicaragua	6
EU	5		Panama	11
			Venezuela	10
			Total	**102**

The rest of the devices were assigned to the IATTC field office staff.

On August 2019, a shipment was sent to the IATTC in Panama for distribution to the national programs of Colombia, Ecuador, the EU, Nicaragua, Panamá and Venezuela. The staff in Panama distributed the devices to the national programs of Colombia, Nicaragua, Panama and Venezuela between October 2019 and March 2020.

Due to logistical issues pertaining of the status of the IATTC in Mexico, the staff was not able to send a shipment of devices to the national program of Mexico and the field offices of Mazatlán and Manzanillo until March 2020.

A similar logistical issue in Ecuador has prevented to send a shipment from Panama to Ecuador with the safety devices for the national programs of Ecuador, the EU and the IATTC Ecuadorian offices, except for one pair of devices for an EU observer that was issued by the IATTC staff in Panama.

As of 14 July 2020, 35 trips of IATTC observers in vessels from Colombia, Panama and Mexico have been issued those devices, while 17 trips of observers of the EU and Mexico have been issued.

Resolution A-18-03 establishes procedures and other directions applicable to observer health and safety, as well as the implementation of paragraph 6(f) of Annex II of the AIDCP regarding the responsibilities of

Parties to ensure that the captains, crew and owners of vessels do not interfere in the work of observers. The Resolution addresses circumstances of serious illness or death of an observer, instances where an observer goes missing or is presumed fallen overboard, and processes to be followed where there are grounds to believe that an observer has been assaulted, intimidated, threatened, or harassed.

7. OTHER FUNCTIONS PERFORMED BY THE SECRETARIAT

7.1. Dolphin safety panel alignments

During 2019, the IATTC staff conducted two alignments of dolphin-safety panels (DSP) and inspections of dolphin rescue gear aboard purse-seine vessels.

7.2. Training and certification of fishing captains

The IATTC has conducted dolphin mortality reduction seminars for tuna fishermen since 1980. Article V of the AIDCP calls for the establishment, within the framework of the IATTC, of a system of technical training and certification of fishing captains. Under the system, the IATTC staff is responsible for maintaining a list of all captains qualified to fish for tunas associated with dolphins in the EPO. The names of the captains who meet the requirements are to be supplied to the IRP for approval and circulation to the Parties to the AIDCP.

The requirements for new captains are (1) attending a training seminar organized by the IATTC staff or by the pertinent national program in coordination with the IATTC staff, and (2) having practical experience relevant to making sets on tunas associated with dolphins, including a letter of reference from a captain currently on the List, the owner or manager of a vessel with a DML, or a pertinent industry association. These seminars are intended not only for captains, who are directly in charge of fishing operations, but also for other crew members and for administrative personnel responsible for vessel equipment and maintenance. The fishermen and others who attend the seminars are presented with certificates of attendance.

During 2019, one training seminar was held, which was attended by 56 fishermen.

Date	Program	Location
15-Jan	PNAAPD (Mexican National Program)	Mazatlán, Mexico

7.3. Statements of Participation

Statements of Participation are issued by the Secretariat on request to vessels that carry observers from the On-Board Observer Program. This statement certifies that the vessel has been participating in the IDCP, and that all its trips have been covered by observers; the second, issued to vessels of non-Parties, certifies only that all the vessel's trips have been covered by observers. During 2019, statements of the first type were issued for 125 fishing trips by vessels of Ecuador, El Salvador, the European Union, Nicaragua, Panama, United States, and Venezuela.

8. RESEARCH

8.1. Distribution of fishing effort

Figures 4-6 compare the spatial distributions of fishing effort in the Agreement Area by vessels carrying observers, in numbers of sets, by type, in 2018 and 2019. For unassociated sets, more sets in the far west of the Agreement Area were reported in 2019 than in 2018, continuing a trend noted in the 2018 report (Figure 5).

8.2. Dolphin abundance survey

Due to the hiatus since 2006 in marine mammal surveys conducted by the U.S. National Marine Fisheries Service (NMFS) there is a gap in scientific knowledge about dolphin stock status in the eastern tropical Pacific Ocean (ETP). To fill this gap, and in view of the problematic nature of monitoring stock status from fishery-dependent data[2], the IATTC, in collaboration with the government of Mexico, the Pacific Alliance for Sustainable Tuna (PAST), and the Centre for Research into Ecological and Environmental Modelling (CREEM) at the University of St Andrews, Scotland, is undertaking a project to survey the dolphin populations in the ETP. New abundance estimates are needed to ensure that dolphin mortalities in the purse-seine fishery are both sustainable and insignificant (the AIDCP's Stock Mortality Limit scheme is dependent on such estimates). Hence, particular emphasis has been put on updating the assessments of two of the main stocks that interact with the fishery, the northeastern offshore spotted dolphin and the eastern spinner dolphin. The current project, presented in July 2019 (MOP-39-01 Addendum 1), builds on the IATTC workshop in October 2016 (DEL1) and on the survey designs and project specifics presented in August 2018 (MOP-37-02) and in July 2019 (MOP-39-01 Addendum 1). More information on the Project and the two sea trials that have been conducted to date is provided in Appendix 1 of this report.

There are several documents that are being produced from this project. A detailed report of the trial survey project has already been prepared by scientists from the University of St Andrews and is in the process of being formatted for an IATTC Special Report. In addition, several papers to be published in peer-reviewed scientific journals, ranging in topic from the machine learning algorithms for image analysis developed for the project to MRDS methods that can accommodate both passing and closing mode.

8.3. Climate and the tuna-dolphin bond

Caitlynn Birch of the University of San Diego and Michael Scott of the IATTC are currently preparing a study for publication on how environmental change – seasonal, El Niño/La Niña, and long-term climate trends – affects the distribution and prevalence of the tuna-dolphin bond. Their results show that the climate change is intensifying the oceanographic conditions that promote the tuna-dolphin association. From 1992-2017, the area where the spinner dolphin-yellowfin tuna association occurs has quadrupled; the area where the spotted dolphin-yellowfin tuna association has about doubled. Seasonally, the area where both associations occur expands northward in the northern summer and southward in the southern summer. The management implications have been apparent over the last decade as the relative proportion of spinner mortality has increased, and spinner dolphins have surpassed spotted dolphins as the species with the highest mortality.

[2] https://www.sciencedirect.com/science/article/pii/S0165783615301028

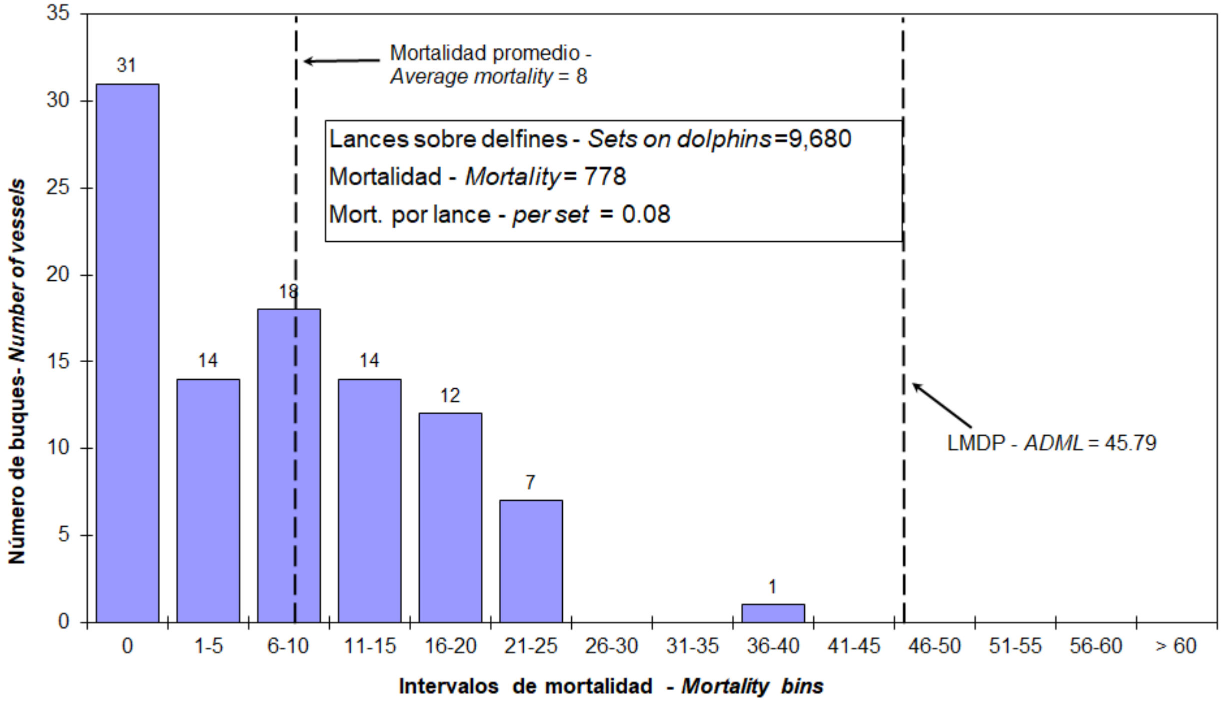

FIGURE 1. Distribution of dolphin mortality caused by vessels with DMLs during **2019**.
FIGURA 1. Distribución de la mortalidad de delfines causada por buques con LMD durante **2019**.

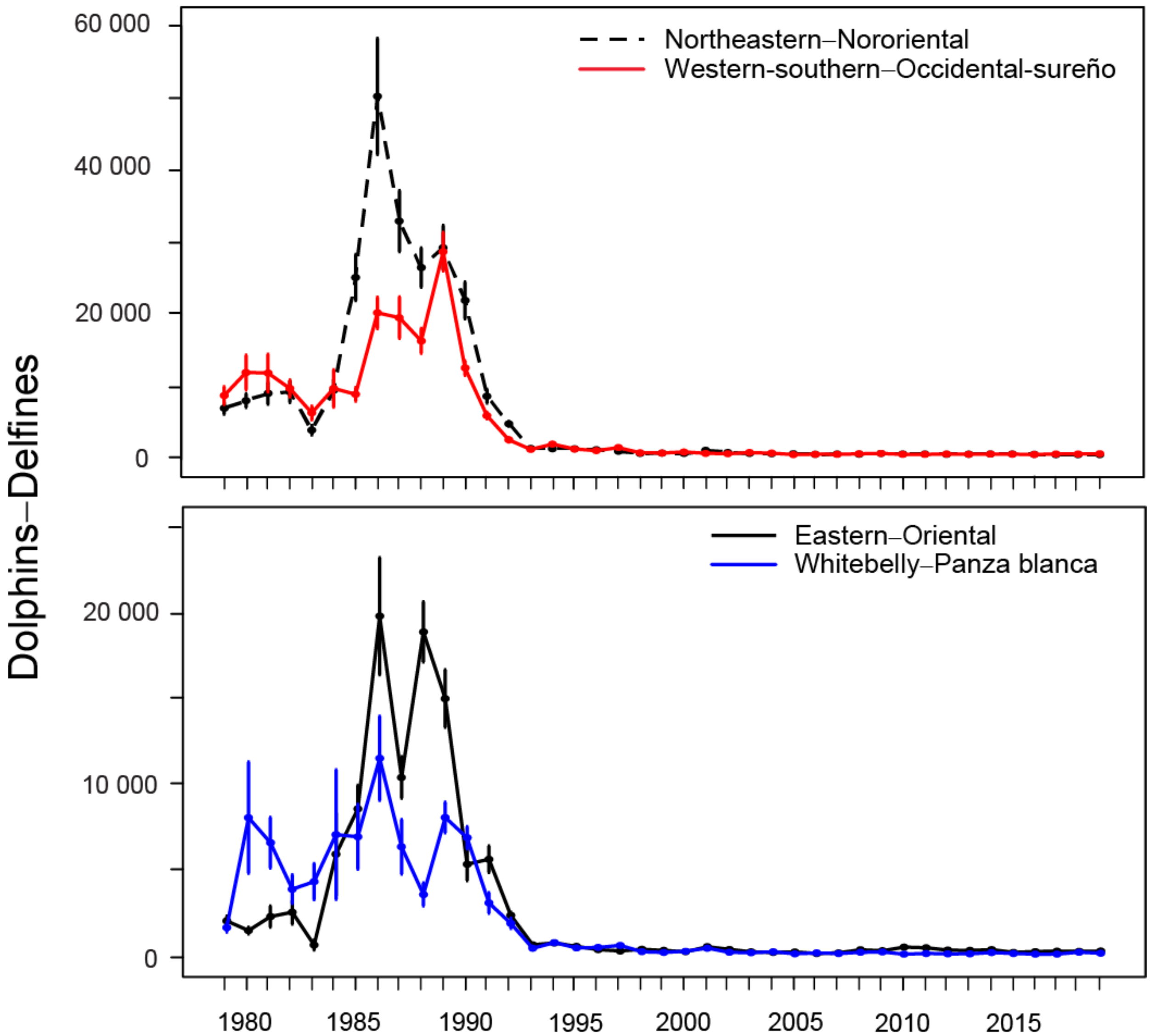

FIGURE 2. Estimated mortalities for the stocks of spotted (upper panel) and spinner (lower panel) dolphins in the Agreement Area, 1979-2019. Each vertical line represents one positive and one negative standard error.

FIGURA 2. Mortalidad estimada de las poblaciones de delfines manchados (panel superior) y tornillo (panel inferior) en el Área del Acuerdo, 1979-2019. Cada línea vertical representa un error estándar positivo y un error estándar negativo.

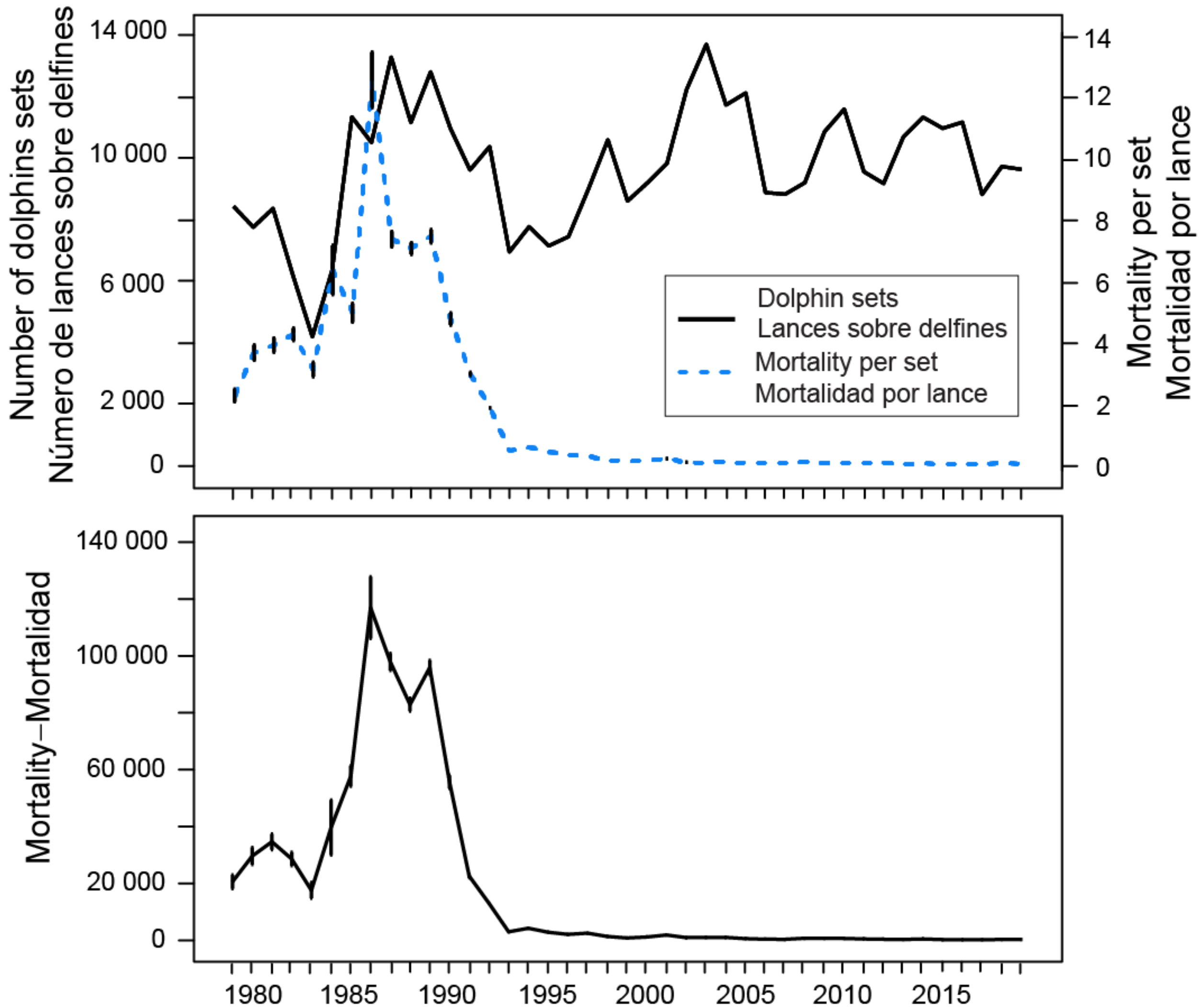

FIGURE 3. Total number of dolphin sets and average mortality per set (upper panel) and estimated total mortality (lower panel) for all dolphins in the Agreement Area, 1979-2019. Each vertical line represents one positive and one negative standard error.

FIGURA 3. Número total de lances sobre delfines y mortalidad media por lance (panel superior) y mortalidad total estimada (panel inferior) para todas especies de delfines en el Área del Acuerdo, 1979-2019. Cada línea vertical representa un error estándar positivo y un error estándar negativo.

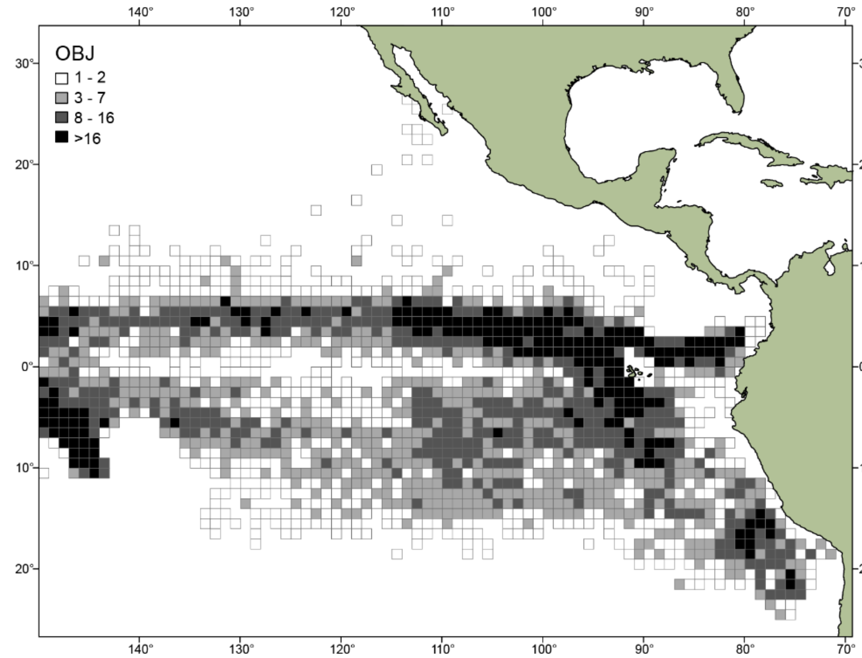

FIGURE 4a. Spatial distribution of sets on tuna associated with floating objects in the Agreement Area, 2018.
FIGURA 4a. Distribución espacial de los lances sobre atunes asociados a objetos flotantes en el Área del Acuerdo, 2018.

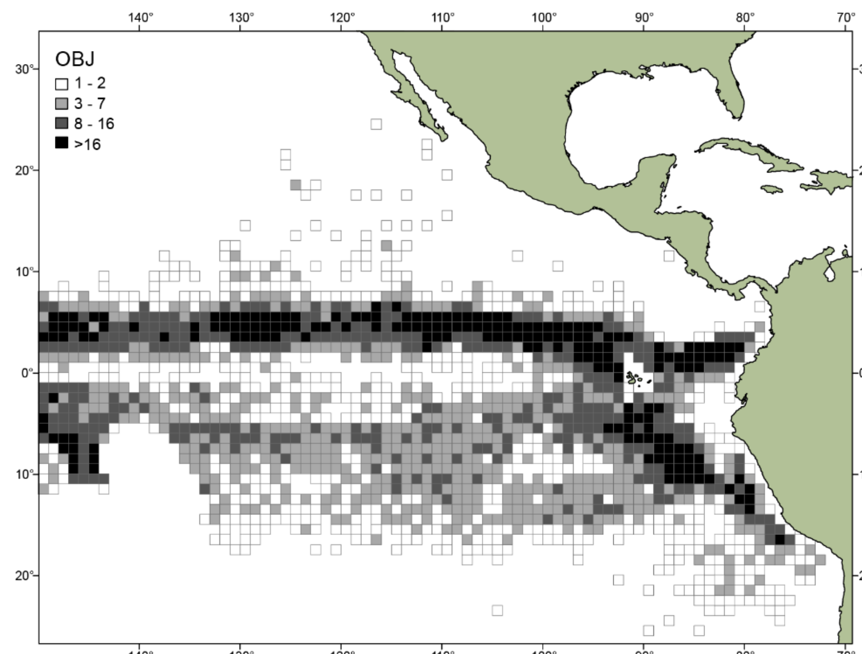

FIGURE 4b. Spatial distribution of sets on tuna associated with floating objects in the Agreement Area, 2019.
FIGURA 4b. Distribución espacial de los lances sobre atunes asociados a objetos flotantes en el Área del Acuerdo, 2019.

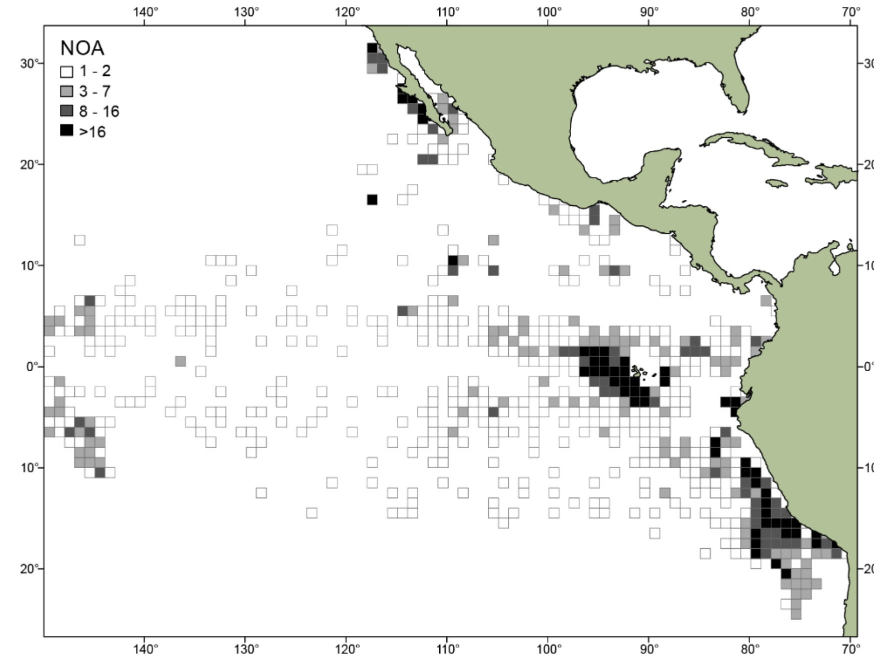

FIGURE 5a. Spatial distribution of sets on unassociated schools of tunas in the Agreement Area, 2018.
FIGURA 5a. Distribución espacial de lances sobre cardúmenes de atunes no asociados en el Área del Acuerdo, 2018.

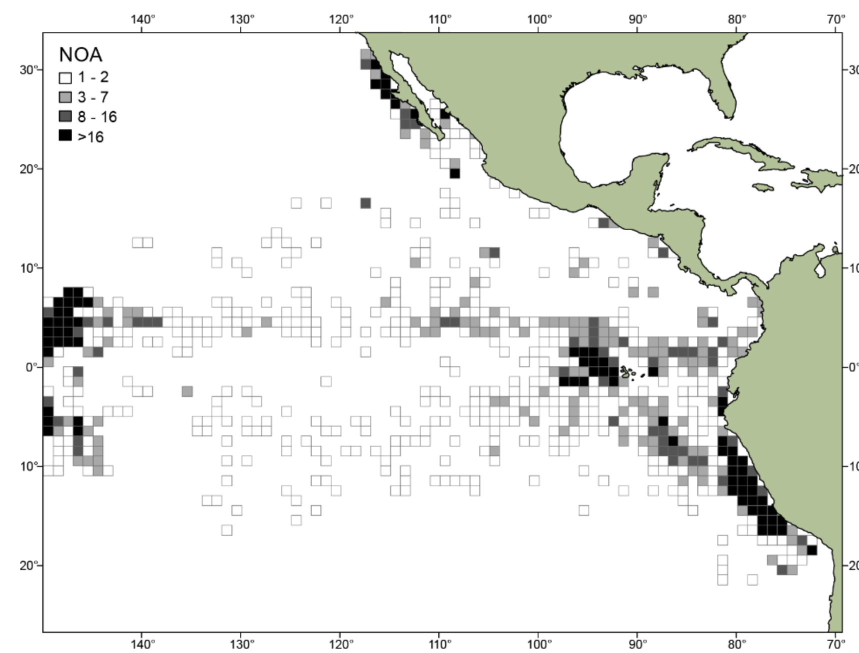

FIGURE 5b. Spatial distribution of sets on unassociated schools of tunas in the Agreement Area, 2019.
FIGURA 5b. Distribución espacial de lances sobre cardúmenes de atunes no asociados en el Área del Acuerdo, 2019.

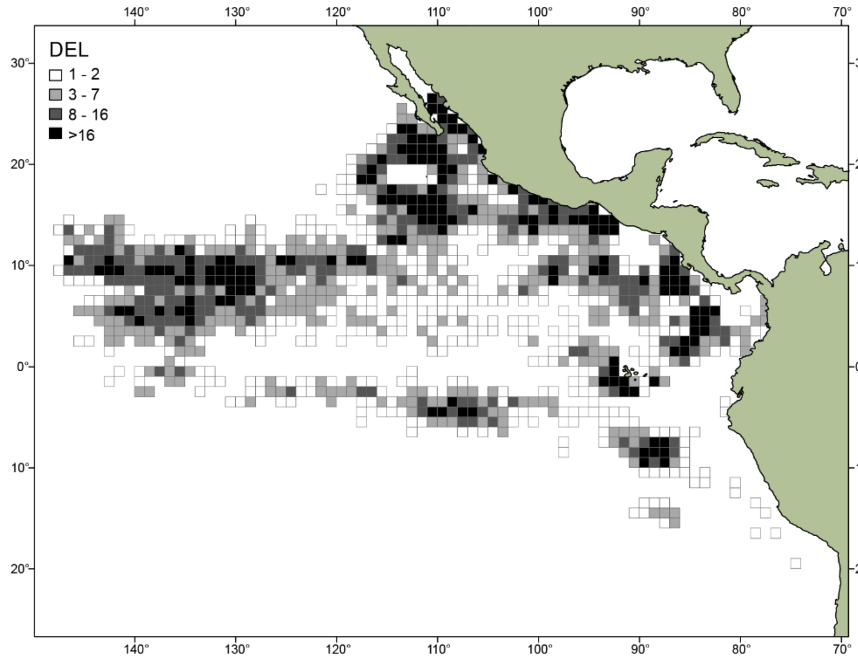

FIGURE 6a. Spatial distribution of sets on tuna associated with dolphins in the Agreement Area, 2018.
FIGURA 6a. Distribución espacial de los lances sobre atunes asociados a delfines en el Área del Acuerdo, 2018.

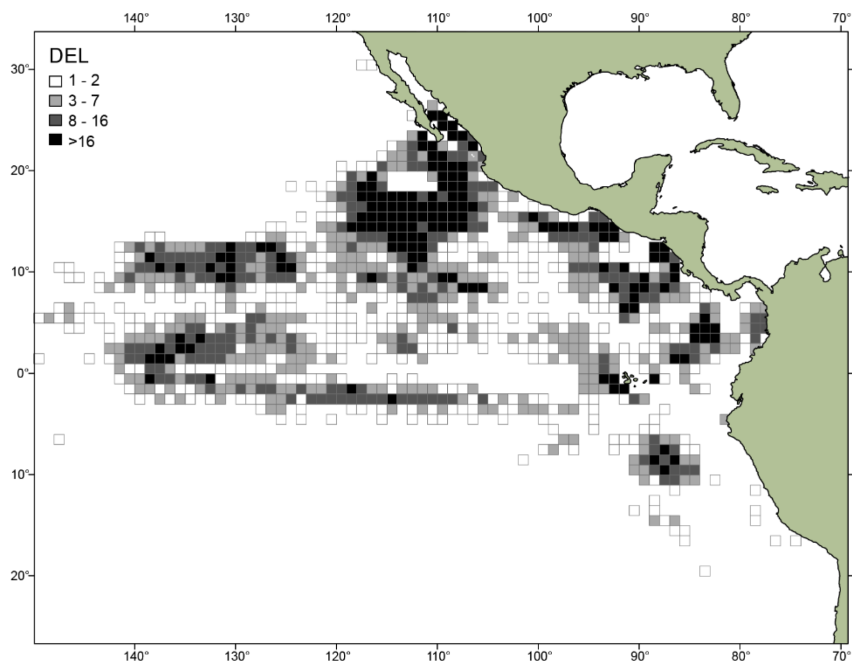

FIGURE 6b. Spatial distribution of sets on tuna associated with dolphins in the Agreement Area, 2019.
FIGURA 6b. Distribución espacial de los lances sobre atunes asociados con delfines en el Área del Acuerdo, 2019.

TABLE 1. Coverage of vessels by the On-Board Observer Program of trips initiated during 2019 with activity in the Agreement Area.
TABLA 1. Cobertura de buques por el Programa de Observadores a Bordo de viajes iniciados durante 2019 con actividad en el Área del Acuerdo.

Pabellón - Flag		Clase 6 – Class-6 por/by prog.			
		Viajes/Trips	**Nac./Nat**	**CIAT/IATTC**	**% obs.**
Colombia	COL	49	23	26	100
Ecuador	ECU	367	122	245	100
El Salvador	SLV	16		16	100
EU–UE (España – Spain)	ESP	7	2	5	100
México	MEX	203	103	100	100
Nicaragua	NIC	22	11	11	100
Panamá	PAN	72	37	35	100
Perú	PER	14		14	100
United States	USA	47	21[1]	26	100
Venezuela	VEN	41	21	20	100
Subtotal		**838**	**340**	**498**	**100**

Pabellón – Flag / Clase - Class			Otras Clases – Other Class por/by prog.[2]			
Ecuador	ECU	4	6	2	4	-
Ecuador	ECU	5	13	4	9	-
			All classes – Todas las clases			
Total			**857**	**346**	**511**	**-**

[1] Sampled by crossed-endorsed observers of the WCPFC – Muestreados con observadores homologados de la WCPFC.
[2] The AIDCP requires 100% coverage only on Class-6 vessels – El APICD requiere 100% de cobertura solamente para buques clase 6.

TABLE 2. Estimates of mortalities of dolphins in 2019, population abundance, and relative mortality, by stock.
TABLA 2. Estimaciones de la mortalidad de delfines en 2019, la abundancia de las poblaciones, y la mortalidad relativa, por población.

Species and stock	Mortality	Population abundance	Relative mortality (%)
Especie y población	**Mortalidad**	**Abundancia de la población**	**Mortalidad relativa (%)**
Offshore spotted dolphin—Delfín manchado de altamar[1]			
Northeastern—Nororiental	104	911,177	0.01
Western/southern—Occidental y sureño	220	911,830	0.02
Spinner dolphin—Delfín tornillo[1]			
Eastern—Oriental	270	790,613	0.03
Whitebelly—Panza blanca	142	711,883	0.02
Common dolphin—Delfín común[2]			
Northern—Norteño	25	449,462	< 0.01
Central	3	577,048	<0.01
Southern—Sureño	2	1,525,207	<0.01
Other dolphins—Otros delfines[3]	12		
Total	**778**		

[1] Logistic model for 1986-2006 (IATTC SAB-07-05);
[1] Modelo logístico para 1986-2006 (CIAT SAB-07-05)
[2] Weighted averages for 1998-2003 (IATTC Special Report 14: Appendix 5)
[2] Promedios ponderados para 1998-2003 (Informe Especial de la CIAT 14: Anexo 5)
[3] "Other dolphins" includes the following species and stocks, whose observed mortalities were as follows: Central American spinner dolphin (*Stenella longirostris centroamericana*) 6, striped dolphin (*Stenella coeruleoalba*) 3, roughtoothed dolphin (*Steno bredanensis*) 2, and unidentified dolphins, 1.
[3] "Otros delfines" incluye las siguientes especies y poblaciones, con las mortalidades observadas correspondientes: delfin tornillo centroamericano (*Stenella longirostris centroamericana*) 6, (*Steno bredanensis*) 2, y delfines no identificados, 1.

TABLE 3. Annual estimates of dolphin mortality, by species and stock since 1979.
TABLA 3. Estimaciones anuales de la mortalidad de delfines, por especie y población desde 1979.

	Offshore spotted[1]		Spinner		Common			Others	Total
	Northeastern	Western-southern	Eastern	White belly	Northern	Central	Southern		
	Manchado de altamar[1]		Tornillo		Común			Otros	Total
	nor-oriental	Occidental y sureño	Oriental	Panza blanca	Norteño	Central	Sureño		
1979	4,828	6,254	1,460	1,312	4,161	2,342	94	880	21,331
1980	6,468	11,200	1,108	8,132	1,060	963	188	633	29,752
1981	8,096	12,512	2,261	6,412	2,629	372	348	367	32,997
1982	9,254	9,869	2,606	3,716	989	487	28	1,347	28,296
1983	2,430	4,587	745	4,337	845	191	0	353	13,488
1984	7,836	10,018	6,033	7,132	0	7,403	6	156	38,584
1985	25,975	8,089	8,853	6,979	0	6,839	304	1,777	58,816
1986	52,035	20,074	19,526	11,042	13,289	10,884	134	5,185	132,169
1987	35,366	19,298	10,358	6,026	8,216	9,659	6,759	3,200	98,882
1988	26,625	13,916	18,793	3,545	4,829	7,128	4,219	2,074	81,129
1989	28,898	28,530	15,245	8,302	1,066	12,711	576	3,123	98,451
1990	22,616	12,578	5,378	6,952	704	4,053	272	1,321	53,874
1991	9,005	4,821	5,879	2,974	161	3,182	115	990	27,127
1992	4,657	1,874	2,794	2,044	1,773	1,815	64	518	15,539
1993	1,112	773	725	437	139	230	0	185	3,601
1994	847	1,228	828	640	85	170	0	298	4,096
1995	952	859	654	445	9	192	0	163	3,274
1996	818	545	450	447	77	51	30	129	2,547
1997	721	1,044	391	498	9	114	58	170	3,005
1998	298	341	422	249	261	172	33	100	1,876
1999	358	253	363	192	85	34	1	62	1,348
2000	295	435	275	262	54	223	10	82	1,636
2001	592	315	470	374	94	205	46	44	2,140
2002	435	203	403	182	69	155	3	49	1,499
2003	288	335	290	170	133	140	97	39	1,492
2004	261	256	223	214	156	97	225	37	1,469
2005	273	100	275	108	114	57	154	70	1,151
2006	147	135	160	144	129	86	40	45	886
2007	189	116	175	113	55	69	95	26	838
2008	184	167	349	171	104	14	137	43	1,169
2009	266	254	288	222	109	30	49	21	1,239
2010	170	135	510	92	124	116	8	15	1,170
2011	172	124	467	139	35	12	9	28	986
2012	151	187	324	107	49	4	30	18	870
2013	158	145	303	111	69	0	8	7	801
2014	181	168	356	183	49	13	9	16	975
2015	191	158	196	139	43	21	12	5	765
2016	127	111	243	89	82	36	9	5	702
2017	92	178	266	98	26	9	16	3	688
2018	99	197	252	205	41	1	18	6	819
2019	104	220	270	142	25	3	2	12	778

[1] Estimates for offshore spotted dolphins include mortalities of coastal spotted dolphins.
[1] Las estimaciones de delfines manchados de altamar incluyen mortalidades de delfines manchados costeros.

TABLE 4. Standard errors of annual mortality estimates of dolphins, by species and stock, for 1979-1994. There are no standard errors for 1995-2000 and after 2003 because the coverage was at or nearly at 100% during those years.
TABLA 4. Errores estándar de las estimaciones anuales de la mortalidad de delfines, por especie y población, para 1979-1994. No se cuenta con errores estándar para 1995-2000 y después de 2003, porque la cobertura fue de 100%, o casi, en esos años.

	Offshore spotted		Spinner		Common			Other
	North-eastern	Western-southern	Eastern	Whitebelly	Northern	Central	Southern	
	Manchado de altamar		Tornillo		Común			Otros
	Nor-oriental	Occidental y sureño	Oriental	Panza blanca	Norteño	Central	Sureño	
1979	817	1,229	276	255	1,432	560	115	204
1980	962	2,430	187	3,239	438	567	140	217
1981	1,508	2,629	616	1,477	645	167	230	76
1982	1,529	1,146	692	831	495	168	16	512
1983	659	928	284	1,043	349	87	-	171
1984	1,493	2,614	2,421	3,773	-	5,093	3	72
1985	3,210	951	1,362	1,882	-	2,776	247	570
1986	8,134	2,187	3,404	2,454	5,107	3,062	111	1,722
1987	4,272	2,899	1,199	1,589	4,954	2,507	3,323	1,140
1988	2,744	1,741	1,749	668	1,020	1,224	1,354	399
1989	3,108	2,675	1,674	883	325	4,168	295	430
1990	2,575	1,015	949	640	192	1,223	95	405
1991	956	454	771	598	57	442	30	182
1992	321	288	168	297	329	157	8	95
2001	3	28	1	6	7	7	-	1
2002	1	2	1	1	1	1	1	1
2003	1	1	1	1	-	1	1	-

TABLE 5. Percentages of sets with no dolphin mortalities, with major gear malfunctions, with net collapses, with net canopies, average times of backdown (in minutes), and average number of live dolphins left in the net at the end of backdown. 1986-2008 data are from trips observed by the IATTC program only; data after 2008 include trips covered by national programs.
TABLA 5. Porcentajes de lances sin mortalidad de delfines, con averías mayores, con colapso de la red, con abultamiento de la red, duración media del retroceso (en minutos), y número medio de delfines en la red después del retroceso. Los datos de 1986-2008 provienen de viajes observados por el programa de la CIAT solamente; los datos posteriores a 2008 incluyen viajes observados por los programas nacionales.

	Sets with zero mortality (%)	Sets with major malfunctions (%)	Sets with net collapse (%)	Sets with net canopy (%)	Average duration of backdown (minutes)	Average number of live dolphins left in net after backdown
1986	38.1	9.5	29.0	22.2	15.3	6.0
1987	46.1	10.9	32.9	18.9	14.6	4.4
1988	45.1	11.6	31.6	22.7	14.3	5.5
1989	44.9	10.3	29.7	18.3	15.1	5.0
1990	54.2	9.8	30.1	16.7	14.3	2.4
1991	61.9	10.6	25.2	13.2	14.2	1.6
1992	73.4	8.9	22.0	7.3	13.0	1.3
1993	84.3	9.4	12.9	5.7	13.2	0.7
1994	83.4	8.2	10.9	6.5	15.1	0.3
1995	85.0	7.7	10.3	6.0	14.0	0.4
1996	87.6	7.1	7.3	4.9	13.6	0.2
1997	87.7	6.6	6.1	4.6	14.3	0.2
1998	90.3	6.3	4.9	3.7	13.2	0.2
1999	91.0	6.6	5.9	4.6	14.0	0.1
2000	90.8	5.6	4.3	5.0	14.9	0.2
2001	91.6	6.5	3.9	4.6	15.6	0.1
2002	93.6	6.0	3.1	3.3	15.0	0.1
2003	93.9	5.2	3.5	3.7	14.5	<0.1
2004	93.8	5.4	3.4	3.4	15.2	<0.1
2005	94.9	5.0	2.6	2.7	14.5	<0.1
2006	93.9	5.7	3.3	3.5	15.8	<0.1
2007	94.2	5.1	1.6	3.4	15.2	<0.1
2008	92.4	4.9	2.9	3.7	16.1	0.1
2009	93.3	5.2	1.8	3.1	16.7	<0.1
2010	94.1	4.7	1.3	2.4	16.2	<0.1
2011	94.0	4.1	1.9	2.1	16.3	<0.1
2012	94.5	4.3	1.9	1.5	16.5	<0.1
2013	95.4	4.2	1.3	1.3	15.4	<0.1
2014	95.5	3.7	1.3	1.3	16.2	<0.1
2015	96.4	4.3	1.1	1.2	15.4	<0.1
2016	96.4	3.8	0.9	0.9	15.2	<0.1
2017	96.2	3.6	1.0	1.0	15.9	<0.1
2018	95.8	3.3	0.8	1.5	17.3	<0.1
2019	95.8	4.1	1.1	1.1	16.6	<0.1

TABLE 6. Weekly reports of dolphin mortality received, 2019.
TABLA 6. Informes semanales de mortalidad de delfines recibidos, 2019.

Flag	Program	Required	Received	%
COL	CIAT - IATTC	237	236	99
	Nal.-Nat.	213	213	100
ECU	CIAT - IATTC	1,563	1,563	100
	Nal.-Nat	830	830	100
ESP	CIAT - IATTC	44	44	100
	Nal.-Nat.	19	19	100
MEX	CIAT - IATTC	699	699	100
	Nal.-Nat.	734	734	100
NIC	CIAT - IATTC	84	84	100
	Nal.-Nat.	77	77	100
PAN	CIAT - IATTC	252	252	100
	Nal.-Nat.	239	239	100
PER	CIAT - IATTC	42	41	97
SLV	CIAT - IATTC	123	123	100
USA	CIAT - IATTC	84	84	100
	WCPFC	168	168	100
VEN	CIAT - IATTC	152	152	100
	Nal.-Nat.	155	155	100
Total		**5,715**	**5,713**	**99.9**

TABLE 7. Preliminary reports of the mortalities of dolphins in 2020, to 19 August.
TABLA 7. Informes preliminares de las mortalidades de delfines en 2020, hasta el 19 de agosto.

Species and stock **Especie y población**	**Total mortality** **Mortalidad total**	**Limit** **Límite**	**Used (%)** **Usado (%)**
Offshore spotted dolphin – Delfín manchado de altamar			
Northeastern--Nororiental	82	793	10.3
Western-southern--Occidental-sureño	110	881	12.5
Spinner dolphin – Delfín tornillo			
Eastern—Oriental	208	655	31.8
Whitebelly--Panza blanca	83	666	12.5
Common dolphin – Delfín común			
Northern—Norteño	1	562	0.2
Central	13	207	6.3
Southern—Sureño	3	1,845	0. 2
Others and unidentified--Otros y no identificados	10		
Total	**510**	**5,000**	**11.4**

TABLE 8. Summary of possible infractions identified by the International Review Panel at its 65th and 66th meetings, **July** and October **2019**.

TABLA 8. Resumen de posibles infracciones identificadas por el Panel Internacional de Revisión en su 65a and 66a reuniones, **julio** y octubre de **2019**.

INFRACCIONES MAYORES / MAJOR INFRACTIONS:	
Viaje sin observador Trips without an observer	1
Viajes con lances en delfines sin LMD asignado Trips with dolphin sets but no DML assigned	0
Viajes con capitanes no incluidos en la lista del APICD Trips with captains not on the AIDCP list	3
Viajes sin paño de protección de delfines Trips without a dolphin safety panel	1
Lances intencionales después de alcanzar el LMD Intentional sets made after reaching the DML	0
Lances o cazas con uso de explosivos Sets or chases with use of explosives	0
Lances sobre stocks o tipos de manadas prohibidas Sets on banned stocks or school types	0
Lances sin retroceso Sets without a required backdown	0
Lances con embolsamiento o salabardeo de delfines Sets with dolphin sack-up or brail	0
Lances sin evitar herir o matar delfines Sets with unavoided dolphin injury or mortality	0
Total	**5**
OTRAS INFRACCIONES / OTHER INFRACTIONS:	
Viajes sin balsa Trips without a required raft	3
Viajes con < 3 lanchas rápidas y/o sin bridas de remolque Trips with < 3 speedboats and/or missing towing bridles	1
Viajes sin reflector de alta intensidad Trips without a required high-intensity floodlight	5
Viajes sin máscaras de buceo Trips without required facemasks	1
Lances nocturnos (ocurrieron en dos viajes) Night sets (occurred in two trips)	0
Lances sin rescate adicional Sets without required deployment of rescuer	0
Lances sin rescate después del retroceso Sets without continued rescue effort after backdown	0
Viajes con lances sobre delfines antes de la notificación del LMD Trips with dolphin sets before the DML notification	0
Total	**10**
Casos de interferencia al observador Cases of observer interference	2
Viajes revisados en estas reunions Trips reviewed in these meetings	889
Lances sobre delfines revisados en estas reuniones Dolphin sets reviewed in these meetings	9,827
Lances accidentales revisados en estas reuniones Accidental sets reviewed in these meetings	1

TABLE 9. Responses for six types of possible infractions identified by the International Review Panel at its 65th and 66th meetings.
TABLA 9. Respuestas para seis tipos de posibles infracciones identificadas por el Panel Internacional de Revisión en su 65a y 66a reuniones.

	No. de casos	Sin respuesta		Respuestas: Bajo investi-gación[1]	No hubo infracción	Infracción: sin sanción	Infracción: aviso	Infracción: sanción[2]	Total	
	No. of cases	No response		Responses: Under in-vestigation[1]	No infrac-tion	Infraction: no sanction	Infraction: warning	Infraction: sanction[2]	Total	
HOSTIGAMIENTO AL OBSERVADOR – OBSERVER HARASSMENT										
ECU	2	1	(50%)	1	0	0	0	0	1	(50%)
Total:	**2**	**1**	(50%)	**1**	**0**	**0**	**0**	**0**	**1**	(50%)
USO DE EXPLOSIVOS – USE OF EXPLOSIVES										
Ningún caso identificado durante el periodo de este informe / No identified cases during this report period										
LANCES NOCTURNOS– NIGHT SETS										
Ningún caso identificado durante el periodo de este informe / No identified cases during this report period										
PESCAR SIN OBSERVADOR – FISHING WITHOUT AN OBSERVER										
USA	1	0	-	0	0	0	0	1	1	(100%)
Total:	**1**	**0**	-	**0**	**0**	**0**	**0**	**1**	**1**	(100%)
PESCAR SOBRE DELFINES SIN LMD – FISHING ON DOLPHINS WITHOUT A DML										
Ningún caso identificado durante el periodo de este informe / No identified cases during this report period										
LANCES SOBRE DELFINES DESPUES DE ALCANZAR EL LMD-- SETS ON DOLPHINS AFTER REACHING DML										
Ningún caso identificado durante el periodo de este informe / No identified cases during this report period										

Appendix 1.

POSSIBLE INFRACTIONS IDENTIFIED BY THE IRP

Brief descriptions of government actions taken, as reported to the Secretariat by July 26, 2020, are included. If no action is listed for a possible infraction, the Secretariat has not received a response from the government.

Abbreviations: DSP = Dolphin Safety Panel

COLOMBIA

Vessel	*IRP recno*	*Review date*	*Identified infractions*
COL 1	2019-563	2019/10	1) 1 Trip without a required raft
COL 2	2019-091	2019/07	1) 1 Trip without a required high intensity floodlight
COL 3	2018-851	2019/07	1) 1 Trip with < 3 speedboats and/or missing towing bridles

ECUADOR

Vessel	*IRP recno*	*Review date*	*Identified infractions*
ECU 1	2019-052	2019/07	1) 1 Trip without a required raft
ECU 2	2019-448	2019/10	1) 1 Case of observer interference
			Action taken: 1) The government initiated the proper administrative process to investigate the possible infractions.
ECU 3	2019-582	2019/10	1) 1 Trip without a required raft
		2019/10	2) 1 Trip without a required high intensity floodlight
		2019/10	3) 1 Trip without required facemasks
			Action taken: 1), 2), 3) After investigating, the government decided that no infraction occurred, since the national authority had not yet notified the vessel owner of the DML allocation.
ECU 4	2019-303	2019/07	1) 1 Trip with captain not on the AIDCP list
ECU 5	2019-372	2019/07	1) 1 Case of observer interference

UNITED STATES

Vessel	*IRP recno*	*Review date*	*Identified infractions*
USA 1	2018-889	2019/07	1) 1 Trip without an observer
			Action taken: 1) A fine was applied to the vessel owner

VENEZUELA

Vessel	*IRP recno*	*Review date*	*Identified infractions*
VEN 1	2018-630	2019/07	1) 1 Trip without a required high intensity floodlight
			Action taken: 1) The government is in the process of imposing a monetary fine.
	2019-074	2019/07	1) 1 Trip without a dolphin safety panel
		2019/07	2) 1 Trip without a required high intensity floodlight
			Action taken: 1), 2) The government is in the process of imposing a monetary fine.
VEN 2	2019-212	2019/07	1) 1 Trip with captain not on the AIDCP list
			Action taken: 1) After investigating, the government decided that no infraction occurred.
VEN 3	2019-278	2019/07	1) 1 Trip without a required high intensity floodlight
			Action taken: 1) After investigating, the government decided that no infraction occurred.
	2019-614	2019/10	1) 1 Trip with captain not on the AIDCP list

Appendix 2

DOLPHIN ABUNDANCE SURVEY

Due to the hiatus since 2006 in marine mammal surveys conducted by the U.S. National Marine Fisheries Service (NMFS) there is a gap in scientific knowledge about dolphin stock status in the eastern tropical Pacific Ocean (ETP). To fill this gap, and in view of the problematic nature of monitoring stock status from fishery-dependent data[4], the IATTC, in collaboration with the government of Mexico, the Pacific Alliance for Sustainable Tuna (PAST), and the Centre for Research into Ecological and Environmental Modelling (CREEM) at the University of St Andrews, Scotland, is undertaking a project to survey the dolphin populations in the ETP. New abundance estimates are needed to ensure that dolphin mortalities in the purse-seine fishery are both sustainable and insignificant (the AIDCP's Stock Mortality Limit scheme is dependent on such estimates). Hence, particular emphasis has been put on updating the assessments of two of the main stocks that interact with the fishery, the northeastern offshore spotted dolphin and the eastern spinner dolphin. The current project, presented in July 2019 (MOP-39-01 Addendum 1), builds on the IATTC workshop in October 2016 (DEL1) and on the survey designs and project specifics presented in August 2018 (MOP-37-02) and in July 2019 (MOP-39-01 Addendum 1).

To date, two sea trials have been conducted as part of this project. On 16 July 2019, Dr. Cornelia Oedekoven of CREEM (the project chief scientist), and staff of the IATTC, PAST, and the Instituto Nacional de la Pesca (INAPESCA) of Mexico, conducted a one-day sea trial, funded by the government of Mexico and PAST, from Mazatlán, Mexico, aboard the INAPESCA research vessel *Jorge Carranza*. Several basic tests were conducted of the suitability of the vessel for a dolphin survey, including: 1) maintaining the survey speed of 10 knots without any vibration of the ship's hull, and 2) rapid speed and direction changes to simulate approaching a dolphin school. In addition, several basic tests of the drone equipment recommended for the project by Gtt NetCorp (the drone provider made available to the project) were conducted: 1) taking off and landing aboard the vessel when underway at the survey speed (10 knots); 2) flying a zig-zag pattern more than 5 km ahead of the vessel; and, 3) transmitting good-quality video to the ship in real time. All tests were completed successfully, and it was concluded that a more extensive sea trial was warranted.

With additional funding provided by the government of Mexico and PAST, a 14-day trial survey on November 17 - 30, 2019, was conducted aboard the *Jorge Carranza.* The trial survey took place in an area off the Mexican coast between Manzanillo and Acapulco because this area has been shown to have the highest density of spotted and spinner dolphins within the ETP regardless of season[5]. The team was led by Dr. Cornelia Oedekoven, and composed of scientists, drone pilots and mechanics from four different countries (Mexico, USA, Germany and Chinese Taipei). The team included staff of the IATTC and PAST. The primary purpose of this trial was to evaluate, in detail, the: a) suitability of the drone equipment selected for and provided to the project by Gtt NetCorp; b) functionality of the drone protocol for the planned main survey that was prepared by Drs. Oedekoven, Stephen Buckland, and Laura Marshall, all of CREEM; and, c) functionality of the flying bridge modifications. The drone protocol involved continuous operation of a drone ahead of the vessel during all daylight hours while marine mammal observers are on duty, and collection of video imagery, both to be archived onboard the drone and transmitted in real time to the ship. The drone imagery was to provide critical data for two primary scientific objectives of the project: a) evaluating the probability of detecting dolphin schools on the ship's trackline, and b) calibrating the observers' estimates of dolphin school size.

In the main survey, imagery collected by the drone will be used to evaluate whether the probability of detecting dolphin schools that are on the ship's trackline by the flying bridge observers is close to the assumed value of 1.0 or biased, as suggested in 2015 in a publication by Dr. Jay Barlow[6]. Bias in the estimate of trackline detection probability leads to biased estimates of dolphin abundance. The preferred

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[4] https://www.sciencedirect.com/science/article/pii/S0165783615301028
[5] https://www.int-res.com/articles/meps/66/m066p001.pdf
[6] https://onlinelibrary.wiley.com/doi/10.1111/mms.12205

method for evaluating trackline detection probability is mark-recapture distance sampling (MRDS[7]). In contrast with conventional distance sampling (e.g., line-transects) where data are collected from a single platform (e.g., the flying bridge), MRDS methods require double-observer platform data where detections of schools are made from two platforms. Here, detections made by one platform (say platform 2) represent trials for the other platform (say platform 1). Each of these trials can have two outcomes, success or failure, depending on whether platform 1 detects the same school or not. For the main survey, a drone will serve as platform 2, while the flying bridge observers will serve as platform 1. In order to test this methodology during the trial survey, video footage captured by the drone was to be sent back to the ship for real-time monitoring by the drone observers and recorded on-board the drone for post-survey image analyses. Detections of cetacean schools made via the drone (both in real time and in post-trial image analysis) were to serve as trials for the flying bridge observers. An important step here is to match detections made via the drone against those made by the flying bridge observers; i.e., to determine if the drone detections were also detected (a success) or missed (a failure) by the flying bridge observers.

For the trial survey, the research vessel was outfitted with a special observation platform on the level above the bridge, called the flying bridge. A team of six experienced observers in a 2-hourly rotation with three observers on watch at any time during suitable conditions scanned the forward 180˚ for cetaceans and logged the required information according to the NMFS survey protocol[8] that has been consistently used during previous ETP surveys. This protocol prescribes that surveys are conducted in closing mode, i.e. upon detection of a cetacean school, the ship approaches the school to gather information on species id, school composition and school size estimates. The alternative to closing mode is passing mode where all information about a detected school is gathered from a distance without changing course and speed of the ship. The protocol also includes a school size calibration component where the school size estimates of the observers are compared against the true counts of those schools for which these could be obtained (the calibration schools). During previous surveys, this entailed that aerial photography of these schools would be taken from helicopters carried on the vessel or from a shore-based fixed-winged aircraft. In the trial survey, drones were used instead. Challenges addressed during the trial survey included manoeuvring the drone above the school and taking suitable footage capturing the entire school so that true counts of these schools could be obtained.

The implementation of the NMFS survey protocol on the *Jorge Carranza* was successful, due in large part to the extensive experience of the flying bridge observers. Flying bridge equipment worked well, although a few fixes and alterations are needed for the main survey. The captain and the other ship officers were very effective and helpful at implementing the survey protocol including quick responses to requests made by flying bridge observers, maneuvering the ship in closing mode so school size and species composition estimates could be obtained. A total of 1,733.06km of transect lines were surveyed during the 14-day trial survey, out of which 766.41 km were conducted in closing mode and 966.65 km in passing mode. It was necessary to switch the flying bridge effort from the required closing mode to passing mode in order to facilitate the testing of the drone for collection of video to evaluate trackline detection probability. This was mainly because the endurance of the Seahawk drone was too short to accomplish the required protocol while the flying bridge operated in closing mode. During the 14-day trial survey, a total of 215 sightings (205 on-effort, 10 off-effort) of 26 different species categories were made by the flying bridge observers. A comparison of estimated detection probabilities for spotted and spinner dolphins from the trial survey with previous surveys conducted on smaller research vessels revealed no significant differences between the ships.

In contrast to the performance of the ship and the flying bridge observers, the results of the trial survey clearly showed that different drones and better cameras will be required for a main survey in order to fully

[7] Borchers, D. 2012. A non-technical overview of spatially explicit capture-recapture models. *Journal of Ornithology.152, (2)*, 435-444.
[8] Kinzey, D., Gerrodette, T., Dizon, A., Perryman, W., Olson, P., & Rankin, S. (2001). *Marine mammal data collected during a survey in the eastern tropical Pacific Ocean aboard the NOAA ships McArthur and David Starr Jordan, July 28 - December 9, 2000.* La Jolla, California: NOAA Technical Memorandum NOM-TM-NMFS-SWFSC-303.

implement the drone protocol, in particular, for the evaluation of trackline detection probability. The drone team was able to launch and land drones in Beaufort sea-states up to 5 without major incidents. However, one drone was lost at sea mid-flight due to a sudden loss of satellite coverage. The drone team performed a total of 94 flights with just over 69 hours flight time. Out of the 94 flights, 74 were flights purely for collection of trackline detection probability data, 15 flights were pure calibration flights and four were a combination of the two modes. However, with only one experienced pilot provided for the trial survey, it was not possible to fly two drones simultaneously, which had been the drone provider's solution to the project's requirement to provide continuous data collection during all times when the flying bridge observers were on effort. As the mean flight time of the Seahawk drone was under 1 hour, this meant that the goal of flying drones during all daylight hours and during closing mode effort was not accomplished. While the drone team safely conducted up to an impressive 13 flights per day, this was not sufficient to cover the entire hours of operation on the flying bridge. Based on the results from this trial survey, it is estimated that more than 27 flights per 12-hour day would be required to provide uninterrupted effort for trackline detection with the Seahawk drone. Even with a second highly skilled pilot on board, a full coverage of all daylight hours would require too many launches and landings during a 120-day main survey, which would be a major safety concern.

The video footage collected with the drone system was of poor quality, negatively impacting both the trackline detection and school size calibration components of the project. The originally prescribed method to capture and archive video was recording on-board the drone. However, contrary to the drone protocol, the drone provider used screen recording as the main method to capture and archive video (which was originally thought of as the back-up method). As a result, the video quality suffered considerably, severely impacting analysis of the video footage both manually by a human observer and automatically using image analyses. The screen recording process of the video footage resulted in major reductions in video quality due to transmission loss, two layers of compression of the video, various artefacts, frequent pixilation, complete loss of the video and a reduction in the frame rate compared to what was originally captured by the camera onboard the drone. Without zooming in with the drone camera, the video quality was too poor to identify objects of potential interest as dolphins with certainty from the still frames. Identification to species of any individuals was impossible without zooming in with the drone camera during real-time monitoring, which required interrupting the collection of trackline detection data. A further result of the poor image quality was that the altitude and speed of the drone had to be reduced which, in turn, resulted in a reduction of the swath width and shorter distances surveyed by the drone, hence in a reduction of the area covered by the drone. The total area covered by the drone during such trackline detection flights amounted to <1% of the area searched by the flying bridge observers within the 3nm turning radius on either side of the trackline.

Despite the poor video quality, the trial survey did demonstrate that detections of cetaceans could be made in real-time by the drone observers and, hence, using drones to collect MRDS data is possible. During real-time monitoring, drone observers logged 92 objects of potential interest; out of these, six could be confirmed as drone detections of cetacean schools during post-flight review by a human observer. Two of these were of the same school, giving a total of five data points (trials) for the MRDS analyses. For three of these trials, the outcome was determined to be a failure, i.e. flying bridge observers did not detect the school that was detected by the drone. These failures occurred at 134 m, 654 m and 5961 m perpendicular distance from the ship's trackline. For the other two drone detections, a potential match with flying bridge detections could neither be confirmed nor completely excluded. Further information, including species id and behaviour, may have improved this assessment; however, due to the poor video quality this information was not available for the drone detections. This information is routinely logged for each detection made by the flying bridge observers. New MRDS analysis methods need to be developed to incorporate this uncertainty in the duplicate matching as well as to accommodate closing mode effort.

As part of the trial survey project, two different machine learning models were developed to analyze the drone video footage. These algorithms will be necessary for a main survey because manual review of the video from 120 sea days would be impossible, and thus computer algorithms will be necessary to screen the video imagery for dolphin schools. The first machine learning model used convolutional neural networks (CNNs) and the still images from the video footage. The second used clustering algorithms and the video footage from which velocities of objects in the frame were calculated using the optical flow technique.

Both these models achieved around 74% balanced accuracy on their test/validation datasets. A third model was then created, which combined these two approaches to achieve a better balanced accuracy of around 85%. Despite this performance on test/validation data sets, the main problem encountered when applying the models to the unscreened video data was that the data were of too poor quality to be able to make useful detections in the footage of both the trackline detection and the calibration flights. Nonetheless, it is concluded that using image data or motion data alone does not yield as good a result as using both in one combined model, which provides an advance in methodology for imagery review.

Despite the failure of the Seahawk drone for collecting suitable data with which to evaluate trackline detection probability, the trial survey demonstrated that calibration flights can be completed successfully with the Seahawk drone. However, as with the trackline detection component of the project, a higher resolution camera is needed to identify *all* individuals to species without having to zoom in during the flight and to ensure animals swimming in close proximity to each other can be distinguished. Both of these are required for obtaining true counts by species for the calibration schools. Recording multiple sweeps across a given calibration school with slightly varying angles proved important to alleviate potential glare issues. For six schools it was possible to capture all clusters with the drone footage. Manual counts were obtained for five of these schools and, hence, are valid calibration schools for use in the analysis of future survey data. At the time of this report, it has been concluded that due to the poor quality of the video, further fine-tuning of the image analysis models is needed to reliably make detections from the calibration flights and obtain counts.

In summary, the trial survey demonstrated that:

- The *Jorge Carranza* can be used as a survey vessel for the next ETP survey upon which the team of experienced observers, in combination with the ship's command, were able to implement the NMFS survey protocol.
- The *Jorge Carranza*, with its custom-made drone platform, can also be used for conducting drone operations in Beaufort Sea states up to 5.
- The Seahawk drone can be used to conduct school size calibration flights; however, a better camera is needed for species identification of all individuals within the calibration schools.
- Collection of MRDS data as part of ETP dolphin surveys is possible using drones.
- The Seahawk drone is not a viable option for collecting data to evaluate trackline detection probability.
- The performance of machine learning models for analyzing video data can be improved by combining models that use image data with models that use motion data.
- Cameras and video archiving/transmission capabilities that meet the specifications in the drone protocol are mandatory for a successful main survey.

In the next phase of the project, drone systems should be tested with longer endurances and better video capabilities than those provided for the trail survey. Higher video resolution would allow the drone to operate at higher altitudes while maintaining the same ground resolution. Increased altitude will increase the area covered by the drone and thus increase the sample size (number of trials) for evaluating trackline detection probability of flying bridge observers. Therefore, we recommend that a different drone-camera system, such as that originally proposed for the project in MOP-37-02, should be tested in a short sea-trial on the *Jorge Carranza*, or on a vessel from which drones can be launched under similar conditions to those of the *Jorge Carranza*. We recommend that before such a trial, any potential drone provider should present a detailed assessment of how they will accomplish the project goals. The duration of such a sea trial should be long enough to collect data suitable for improving image analyses algorithms. This requires that schools of dolphins will need to be captured with the video recorded onboard the drone during trackline detection flights, where the drone will need to achieve full coverage of the area 5nm ahead of the ship, and that the video be manually reviewed, post-flight, on the vessel during the trial.

There are several documents that are being produced from this project. A detailed report of the trial survey project has already been prepared by scientists from the University of St Andrews and is in the process of being formatted for an IATTC Special Report. In addition, several papers, ranging in topic from the machine learning algorithms for image analysis developed for the project to MRDS methods that can accommodate both passing and closing mode, are in preparation for submission to peer-reviewed scientific journals.