AGREEMENT ON THE INTERNATIONAL DOLPHIN CONSERVATION PROGRAM

36TH MEETING OF THE PARTIES

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ELECTRONIC RECORDING OF DATA BY OBSERVERS AT SEA

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1. INTRODUCTION

The IATTC has asked its staff to investigate the feasibility of electronic data collection at sea by observers aboard purse-seine tuna vessels, by replacing the paper forms on which observers currently record data with tablet computers or similar devices. This would potentially allow the data to be transmitted in near-real time to the IATTC or national observer program or competent national authority. This would be a novel and substantial undertaking, since programs whose observers currently record data electronically collect small amounts of data compared to the scope and breadth of data that AIDCP observers collect. Other fisheries organizations have implemented at-sea electronic data collection with varying degrees of success. Many have found it necessary for observers to continue to collect data on paper forms, and transfer them to electronic format at the end of each day, or when the vessel is not actively fishing.

Thus, the two approaches are for observers to either record data directly into a computer, or record them on paper forms and subsequently enter them into a computer.

This document discusses the likely costs, advantages, disadvantages. and challenges associated with each approach, and whether either warrants further exploration through a pilot study.

2. BACKGROUND

2.1. History of observer program data collection

Observers were first placed aboard purse-seine vessels in 1966 by the US National Marine Fisheries Service (NMFS) to collect data on dolphin mortality in the purse-seine fishery. Accordingly, the first-generation data forms focused on dolphin interactions with the fishery. Observers recorded dolphin behavior during all phases of a set, and documented any resulting dolphin injury or mortality. In 1979 the IATTC established its own observer program, using forms (Appendix 1) based on NMFS forms (Daily Activity Record, Marine Mammal Sighting and Set Record, Schoolfish and Flotsam Set Record, Vessel Record, and Cetacean Life History Record), which have remained virtually unchanged since. Additional forms have been introduced as the need arose, to collect data on floating objects (1987), billfishes (1989), sea turtles (1990), bycatch (1993), sharks (2004) and rays (2017). Additionally, observers complete various non-scientific forms, including the Compliance and International Review Panel (IRP) forms, Tuna Tracking Forms (TTFs), and at-sea reports. The data collected on all these forms would need to be assimilated into software if the goal is to move entirely away from paper forms.

2.2. Data-processing procedures

Observer training sessions last about three weeks, and focus on four main topics, with the last requiring the most time:

1. The IATTC and the AIDCP
2. Purse-seine fishing operations
3. Identification of tunas and other animals
4. Data collection procedures

The data collected by observers are subjected to a three-step process to ensure consistency and quality. Upon completion of a fishing trip, observers attend a debriefing and preliminary data review with IATTC field office staff. Any problems encountered are discussed with the observer, and corrected if possible. Occasionally, field office staff may consult with the staff in La Jolla for more detailed review or questions. The observer then receives an evaluation score and, if warranted, recommendations for improving his performance.

Following this initial screening, the data on the paper forms are digitized, using data entry programs developed by IATTC staff. The data are then subjected to a secondary review by a data editor, using a specialized computer program, correcting any data entry errors and reconciling inconsistencies. Finally, a different editor in La Jolla reviews the data completely one more time, to minimize the possibility of overlooking any errors; once this process is complete, the data are transferred to the main IATTC database. Since this final review occurs in La Jolla, and must thus wait for the arrival of the paper forms from the field offices, it typically takes 4-6 weeks after the completion of a fishing trip for data to be incorporated into the IATTC database.

One feature of paper forms is that they allow staff to track modifications to the original data through color-coded corrections. Observers record data in pencil, and corrections made by the observer during a debriefing are done in blue ink; field office editors use green ink, and editors in La Jolla use red ink. In this way, it is easy to determine who made a correction, and when. If paper records are eliminated, an electronic equivalent will be needed to maintain the same standards of quality control.

2.3. Use of observer data

When considering the possible advantages near real-time or accelerated data reporting by observers at sea, it is important to understand the current primary uses of observer data. For example, IATTC scientists conducting routine annual stock assessments need the data from the most recent year during the first quarter, in order to present the results at the IATTC Scientific Advisory Committee (SAC) meetings, which typically occur in May, so the inclusion of new data is cut off in March to allow the analyses to begin. However, some trips that begin at the end of one year do not finish until February or March of the following year, and so their data cannot be included in the analyses. Electronic recording and transmission of observer data while the vessel is at sea would deliver the raw data quicker, but, because only edited, verified data are included in the database, and the editing process cannot begin until the vessel returns to port, this would not alleviate the problem of processing the data in time for inclusion in the stock assessments.

Data related to compliance with IATTC and AIDCP resolutions, IRP regulations, and dolphin-safe certification are used as soon as they are available, but must also first go through the editing process. Therefore, electronic data collection would not speed up the availability of data for these purposes.

Near real-time catch and effort data are also relevant for monitoring compliance with catch limits or other limits that can be quantified or estimated from observer data, such as in IATTC Resolution C-16-03 and other resolutions on Pacific bluefin tuna and the individual-vessel and per-stock dolphin mortality limits established under the AIDCP. However, observers already transmit these data electronically weekly during fishing trips.

3. PILOT PROJECT OPTIONS

The two approaches to electronic data collection and entry that might be explored in a pilot study are to 1) replace paper records entirely, and have observers record data directly on a tablet computer, with specially developed software, and 2) have observers continue to record data on paper forms, but digitize the data daily while still at sea. In both cases, the data could be transmitted to the IATTC or national program in near real-time, preferably independently of the vessel's communications equipment.

For both options, the IATTC staff would need to research, purchase, and distribute the electronic equipment, track equipment assignments to observers, develop additional training materials, and maintain and replace the equipment as needed. This may require either additional staff, or delaying or canceling other staff obligations.

3.1. Option 1: Replacing paper records with tablet computers

Data would be recorded on tablet computers with touch screens, on which observers can record numbers, notes, and sketches with a stylus, using software specifically designed for the AIDCP program. This would include automatic, tamper-proof recording of the GPS coordinates, date, and time of any entries.

3.1.1. Cost considerations

1. **Software development** is likely the greatest initial cost in transitioning to electronic data collection. Observers presently use 16 separate data forms (Appendix 1), many of which are multi-page, so data entry screens for as many as 30 different pages would be needed. Because observers need to be able to fill various forms concurrently during a set, it will be critical that this software allow quick and efficient transitions among forms, while auto-saving the data recorded. Additionally, since observers also make hand-written notes and sketches, reliable handwriting recognition will be needed. No such software exists, and would need to be developed before even a pilot study can be conducted. No quotes have been solicited from potential vendors yet because of the significant amount of staff time required to develop a specification. However, given the scope of the task, the number of forms involved, and the transition efficiency required, the cost will likely be substantial: US$ 150,000, assuming a conservative rate of US$ 50/hour for development and 3,000 hours, and could well be higher.

   It should also be noted that observer forms evolve, in accordance with the requirements of the scientists using the information and the demands for data by governments. Modifying paper forms is simple; modifying electronic forms requires greater expertise, and is therefore more expensive.

   Instruction in data collection is the most time-consuming part of observer training. Electronic data collection would require additional training, and thus additional expense. Observers would still need to be trained to use paper forms, because electronic equipment can malfunction, and paper forms would be needed as a back-up at sea.

2. **Tablet computers and associated electronic equipment** would be the other major cost. Examples would be the Dell Latitude 12" Rugged Tablet (US$ 1,850) and the Rock Seven Mobile Rockstar satellite-capable communication gear (US$ 660), for a total of US$ 25,100 for a pilot project using 10 units, disproportionately small relative to the initial investment in software development. The

equipment costs for a full transition to electronic data collection would be considerable. In 2016 there were as many as 97 IATTC observers at sea concurrently, so the initial cost of equipping them all would be about US$ 250,000. This does not include repair, maintenance, and replacement costs; given the working conditions, it is reasonable to assume the tablets would need to be replaced every 3-4 years.

3. **Data transmission at sea** would also be a significant cost. Current transmission rates are approximately US $69/month for up to 50 KB of data (1/20 of a megabyte). The numeric data for a complete trip is estimated to be about 250 KB on average, not including sketches and hand-written notes stored as images, which can easily be several megabytes each. At-sea transmission of complete observer data could therefore be cost-prohibitive.
4. **IATTC staff time**. Implementing electronic data collection will require an unknown, but certainly substantial, investment of time by IATTC staff. Software developers will rely on the staff's expertise in data collection, editing, and storage procedures, and interacting with them will be time-consuming.

3.1.2. Advantages

1. **Elimination of data entry**. With average data entry costs of about US$ 200/trip, and the recent annual average of 490 trips covered by the IATTC program, the potential annual savings could be about US$ 100,000.
2. **Possible elimination of expense of printing paper forms.** Paper forms might still be desirable as a backup to electronic data, given the possibility of computer malfunction or damage and consequent loss if complete data are not regularly transmitted to land. Other organizations implementing electronic data collection continue to use paper forms as a backup.
3. **Real-time data reporting.** Data could be transmitted to land as often as needed.
4. **Compliance monitoring.** Possible compliance violations could be notified to national authorities in advance of a vessel's return to port.
   Some certifications can be issued only for trips with no infractions or compliance problems. Sometimes such problems are not detected until after the certificate is issued. Real-time data, even unedited, might allow these problems to be detected before a trip terminates.
5. **Conservation of all observer notes and sketches** (net configuration, species identification, *etc*.)
   At present, only numeric data fields are entered in the database. The paper forms contain many hand-written descriptions, drawings, and notes, on species identification characteristics (Appendix 2), marine mammal behavior, dolphin rescue efforts, probable causes of dolphin mortality, and causes of gear malfunctions. This information is used during the editing process to verify data and, in some cases, recover missing data or correct errors, and is also used during the IRP reviews of possible infractions. The drawings of net configurations in relation to the vessel, for example, help understand the causes of dolphin mortality in sets.
   Presently, paper forms are stored for seven years before being destroyed. Due to budget constraints, no digital copies are made, so older written notes and sketches are not available.
6. **Trip-by-trip data exchange with national observer programs throughout the year**
   With a secure data exchange system, it would be easy to share data with interested and authorized organizations. This is currently possible, but to date there have been no requests for complete trip data before the end of a complete year.
7. **Automatic recording of location, date, and time**
   Positional and temporal metadata could be stored along with new data.

3.1.3. Disadvantages and challenges

1. Paper forms allow observers to quickly write notes about species identification characteristics or details of fishing operation, and sketch net configurations, animals, and floating objects (Appendix 2). Though only numeric data are entered in the database, these written notes and sketches are essential to the editing process, as noted above. Eliminating paper forms would require that the observer record all such ancillary data on a screen, and store them as image files, which, as also noted above, would be cost-prohibitive to transmit at sea. Because of the quantity of data that must be recorded in a limited time during a set, it is not feasible for observers to type notes on a computer rather than writing on paper; for the same reason, observers must be able to enter alphanumeric data directly rather than select from drop-down menus or a list of options in the data entry program.
2. To be useful for research and other purposes, data need to be edited, a process that currently starts with debriefing the observer once the trip has terminated. This is the most efficient procedure, since the data represent a complete trip, the observer is present to answer questions, and the data need to be gone over only once. Editing partial data sets transmitted during a trip, from up to 100 trips at sea, would put a tremendous burden on the editing staff. Therefore, recording data at sea would not shorten the time between data collection and availability to the staff for scientific purposes or compliance review.
3. High initial cost of equipment and software development (discussed above).
4. Repair and/or replacement of damaged and lost equipment.
5. Updating of software as forms change.
6. Additional training of observers in the use of computers and procedures.
7. Potential data loss due to observer saturation.
   Observers are required to fill multiple forms concurrently during sets. If recording data on a tablet computer is slower than writing on a form, observers might not be able to witness all data events, or might not have time to record all required data items.
8. Data recording errors due to software limitations (character recognition), resulting in increased editing time.
9. Safeguarding data.
   Possible security vulnerability in transmitting confidential data.
   Electronic data can be easily copied and transmitted by anyone with access to them.
10. Paper forms still needed as backup and for confirmed documentation.
11. Potential additional expense for transmitting data while at sea.
12. Potential requirement for increased access to the ship's communications for data transmission.
13. Post-trip edits to the data will need to be tracked through computer timestamps and user identification, rather than marking the paper forms in pencil and colored ink.
14. Possible data biases if not all national observer programs adopt electronic data collection.
15. Additional potential challenges in electronic data collection:
    a. Screen readability in bright outdoor conditions.
    b. Effects of moisture (ocean spray, rain) on electronic equipment.
    c. Maintaining battery power throughout a 12-hour shift.

3.2. Option 2: Data entry by observers while at sea

Under this option, observers would continue to collect data on paper forms, but would enter the data into a laptop computer at sea. This method has been used by the European Union's observer program since its inception. As with Option 1, observer data could be transmitted while at sea, but with the same caveats regarding editing data and transmission costs.

3.2.1. Cost considerations

The costs and investments for this option are considerable, but much less than for Option 1. Electronic forms would not be needed, and the data entry software used by IATTC staff on land could be used. Suitable laptop computers cost much less than tablets (as little as US$ 850); with the same data transmission equipment as for Option 1 (US$ 660), the initial equipment cost per observer (without a backup system) would be at least US$ 1,510, or US$ 15,100 for a pilot project with ten observers, or about US$ 151,000 for the entire IATTC observer program.

Data transmission rates would be the same as for Option 1, although some of the data, such as drawings and written descriptions, would not be entered, and so the total amount of data would be less. Other costs would include training observers to digitize their own data, although, if this option were adopted, this would eventually become part of the regular training courses.

This option shares most, but not all, of the advantages and disadvantages of Option 1.

3.2.2. Advantages

1. **Elimination of data entry**. With average data entry costs of about $200/trip, and the recent annual average of 490 trips covered by the IATTC program, the potential annual savings could be about US$ 100,000.
2. **Real-time data reporting.** Data could be transmitted to land as often as needed.
3. **Compliance monitoring.** Possible compliance violations could be notified to national authorities in advance of a vessel's return to port.
   Some certifications can be issued only for trips with no infractions or compliance problems. Sometimes such problems are not detected until after the certificate is issued. Data entered at sea, even unedited, might allow these problems to be detected before a trip terminates.

3.2.3. Disadvantages and challenges

1. To be useful for research and other purposes, data need to be edited, a process that currently starts with debriefing the observer once the trip has terminated. This is the most efficient procedure, since the data represent a complete trip, the observer is present to answer questions, and the data need to be gone over only once. Editing partial data sets transmitted during a trip, from up to 100 trips at sea, would put a tremendous burden on the editing staff. Therefore, recording data at sea would not shorten the time between data collection and availability to the staff for scientific purposes or compliance review.
2. The additional duty of data entry would add to the observers' existing 12-hour workday.
3. Repair and/or replacement of damaged and lost gear.
4. Additional training of observers in the use of computers and procedures.
5. Safeguarding data:
   Possible security vulnerability in transmitting confidential data.
   Electronic data can be easily copied and transmitted by anyone with access to them.

6. Potential additional expense for transmitting data while at sea.
7. Potential requirement for increased access to the ship's communications for data transmission.
8. Additionally, paper forms would still be needed, so there would be no savings in terms of printing forms.

4. DISCUSSION

In order to evaluate the feasibility of replacing paper forms with electronic data collection, the objective for the change should be identified.

Possible objectives include:

1. **Access to real-time data during a fishing trip**
   Data collected electronically can be instantly available but, as noted above, sending complete trip data regularly via satellite would be cost-prohibitive. If only a subset of data is required, the exact data needs should be established. Presently observers transmit each week information on the date, type, position within a 5x5° cell, and retained catch of tuna, by species, for each set, and a summary of dolphin mortality for the trip. If additional "real-time" information is required, it could easily be added to this report at no additional expense.
   The information in the weekly reports is used mainly for compliance-monitoring purposes. In practice, analyses based on purse-seine data are undertaken only once a year, usually once the data for an entire year has been completed.
2. **Economic savings by eliminating data entry**
   As noted above, data entry costs the program about US$ 100,000 annually. However, about half of the IATTC data is entered at field offices, where salaries are lower than at IATTC headquarters.
3. **Faster data availability to scientists**
   Data recorded electronically during a fishing trip would eliminate the time needed to enter the data after the trip, saving about 4 hours of staff time per trip. Since the delay resulting from the editing process would be the same for electronic data and paper forms, the data entry cost-per-trip is lower.
4. **Prevention of possible loss of data**
   Paper forms have been lost at sea or in transit, and the trip data lost. The last time this occurred was in 2013 with data lost in transit. Before that, trip data were lost when a vessel sank in 2006.
5. **Automatic addition of temporal and spatial information** (vessel position, date and time)
   This would aid in preventing data falsification.

5. CONCLUSION

From an economic standpoint, the gains do not seem to merit the expense. Currently data entry for IATTC observer data costs US$ 100,000/year. Tablet computers with data transmission capability would cost US$ 250,000 for 100 sets, and probably US$ 50,000/year in maintenance and replacement. Software development is estimated to cost a minimum of US$ 150,000, plus a substantial time commitment by existing IATTC staff. Data transmission expenses would depend on the amount of data sent while at sea, but at a minimum of US$ 69/month for 100 observers, would be US$ 82,800/year. Alternatively, if observers entered the data on laptop computers while at sea, it would save $100,000/year, offset initially by the cost of 100 suitable computers (US$ 85,000, without GPS and data transmission capabilities), and an annual cost of US$ 17,000 for maintenance and replacement. Additional expenses include observer training in at-sea data entry, and IATTC staff time for purchasing and maintaining the equipment. The additional duty of data entry, presumably in the evening following all fishing operations, would also add to the observers’ existing 12-hour workday.

From an operational standpoint, there is not much gain in transmitting the data while at sea. The data must be verified, through the editing process, before they are useable for most analyses and reports, and this can only occur after the fishing trip has ended. As noted above, observers already transmit near real-time information weekly throughout the fishing trip. Nearly 100% of these at-sea reports are received each week, at no cost to the IATTC. If other information were needed, it could easily be added to that weekly data report.

The biggest advantage of electronic data collection would be the preservation of hand-written observer notes and sketches. Currently only numeric data are entered, and when the paper forms are destroyed after seven years, the notes and sketches are permanently lost. Given this situation, the IATTC staff considers that, rather than implement electronic at-sea data collection and transmission, the funds would be better spent making digital copies of all paper forms currently in storage.

Considering the lack of a clear cost benefit, and of a need for additional fisheries data in near-real time, and the limited value of unedited data, the Secretariat does not recommend implementing a pilot project for either approach at this time.

Appendix 1: List of observer forms

Form:	Number of forms assigned for a trip:
Vessel Record	2
Daily Activity Record	75
Marine Mammal Sighting and Set Record (pages 1-2)	300
Marine Mammal Sighting and Set Record (pages 1-8)	75
Schoolfish and Floating Object Set Record	15
Floating Object Record	70
Cetacean Life History Record	25
Sea Turtle Record	25
Marine Fauna Record	75
Shark Record	75
Billfish Record	10
Ray Record	25
At-Sea Report	15
International Review Panel form	2
Compliance form	5
Tuna Tracking Form	2

Appendix 2: Example data forms with numeric values, notes and sketches

REGISTRO DE OBSERVACIONES DE MAMIFEROS MARINOS Y DATOS DEL LANCE

NO. DE LA OBSERVACION 003 NO. DEL LANCE 004 PAGINA 1

FECHA 890331 (AA MM DD) NO. DEL CRUCERO 0800 HORA DEL AVISTAMIENTO DE MAMIFEROS MARINOS 0945

1. ESTIMACION INICIAL DEL NUMERO Y DE LA COMPOSICION POR ESPECIE DE LA MANADA ENTERA

	NUMERO TOTAL	% MANCHADO	% TORNILLO ORIENTAL	% TORNILLO PANZA BLANCA	% TORNILLOS NO IDENT.	% DELFIN COMUN	% OTRAS ESPECIES (1)	% OTRAS ESPECIES (2)	STOCK DEL MANCHADO	OTRAS ESPECIES STOCK (1)	OTRAS ESPECIES/STOCK (2)
TECNICO	1600	090	009	0	0	0	001	0	ALTAMAR	NEGRO	
TRIPULACION	2000	095	0	005	0	0	0	0	MANCHNI		
AEREA	1500	100	0	0	0	0	0	0	MANCHNI		
									CODIGO	CODIGO	CODIGO

2. NOTAS DEL AVISTAMIENTO E IDENTIFICACION

NOTAS DEL AVIST.: 0940 Tripulante en el puente con X20 avista pájaros a 35° babor. 0945 Helicóptero confirma presencia de delfines El radar indica que aquel se encuentra a 40 millas. El piloto del helicóptero comenta que vuela sobre la manada.

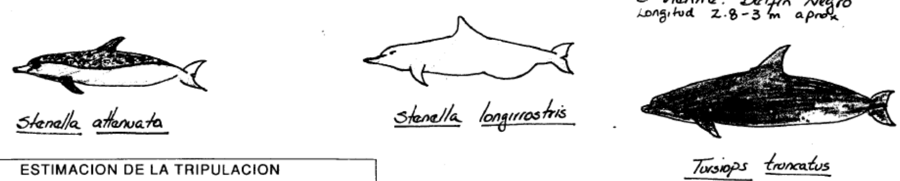
ANOTE LAS CARACTERISTICAS OBSERVADAS QUE LE PERMITIERON IDENTIFICAR CADA ESPECIE Y HAGA UN DIBUJO DE ESTAS

Hocico mediano bién diferenciado de la cabeza, aleta dorsal falcada, manto gris oscuro con manchas claras, vientre gris claro con manchas oscuras. Longitud ≃2mts. Delfín Manchado Altamar

Hocico largo difer. de la cabeza aleta dorsal triangular, en algunos falcada al frente, coloración gris uniforme, protuberancia ventral ≃2m. Delfín tornillo Oriental

Hocico corto bien diferenciado de la cabeza; Aleta dorsal ancha en su base, falcada y alta. Cuerpo robusto, algunos delfines con manchas claras e irregulares en el vientre. Delfín Negro Longitud 2.8-3 m aprox

MANCHADO:	
NEON.	1 %
DOS-T.	20 %
PEC.	20 %
MOT.	40 %
ADUL.	19 %



ESTIMACION DE LA TRIPULACION

	TOTAL	% COMPOSICION POR ESPECIE
1	1200	100% 'Spoter'
2	2000	85% 'Pintos' 15 'Trompos'
3	2000	100% Manchados

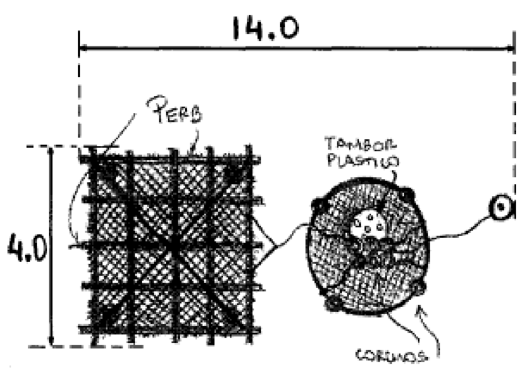
Altamar y Negro: Encubierta

DISTANCIA MAS CERCANA EN QUE OBSERVO CADA ESPECIE Tornillo 100 m.

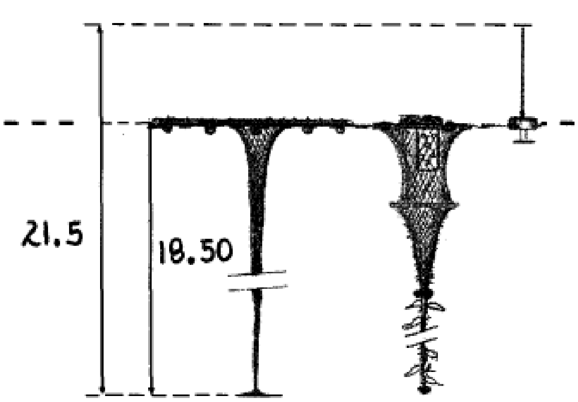
CIAT Atún-Delfín ROMMDL 10/89

DATOS REVISADOS ☑

I.a. VISTA DE ARRIBA (incluya dimensiones)



I.b. VISTA DE PERFIL (incluya dimensiones)



J. COMENTARIOS ADICIONALES

ES EL MISMO OBJETO QUE REVISAMOS LA TARDE DE AYER CON LA RADIO BOYA #18
EL CAPITAN DECIDIO COLOCAR MAS CARNADA EN EL CONTENEDOR.