Chair's Report
of the ISSF Tuna-Dolphin Workshop

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1. Introduction and Objectives

The Workshop (see Appendix 1 for list of invited participants) was held to review the current state of scientific knowledge regarding impact of the dolphin-associated tuna purse seine fishery in the Eastern Pacific Ocean (EPO). Direct mortality of dolphins in the fishery has been substantially reduced and is estimated well below that prescribed as permitting rebuilding of the dolphin stocks of concern. However, hypothesized indirect mortality or reduced reproductive success due to stress induced by chase and capture could be preventing rebuilding at rates hypothesized as the expected ones. To that end, the Workshop reviewed the available information with an eye toward identifying which of the following four possibilities is more likely for the fishery at the present time and what additional research may be needed to improve our understanding:

(A) Adverse effects on dolphin populations are not expected.
(B) Adverse effects on dolphin populations are expected, but the management and monitoring measures in place are expected or known to mitigate these effects.
(C) Adverse effects on dolphin populations are expected, but the management and monitoring measures in place are not expected or are insufficient to mitigate these effects.
(D) Insufficient information is available to determine any of the above.

These possibilities relate to the ISSF sustainability definitions and color coding for fisheries harvesting 23 stocks of the major commercial tuna species worldwide, which consider three dimensions: abundance, exploitation/management and environmental impact (bycatch). These three dimensions are similar to Principles 1, 2 and 3 in the Marine Stewardship Council's (MSC) Fishery Assessment Methodology. However, ISSF's ratings are less detailed.

Currently, ISSF has characterized the EPO dolphin associated purse seine fishery as not expected to have adverse population effects on bycatch (i.e., a Green rating) using the following logic (directly quoted from the ISSF Stock Status Ratings)[1]:

> *"In the EPO, purse-seine fishermen have learned to take advantage of the association between yellowfin schools and herds of dolphins that is prevalent in the region. Fishermen maximize their catches of yellowfin by setting their nets around these associations. Mortality of dolphins was very high early on, but the IATTC estimates that it has since the late 1980s declined by 98% after fishermen and scientists developed techniques for releasing the dolphins alive after a set, and retaining the tunas. Some scientists believe that there is an un-quantified level of mortality after the sets, caused by stress,*

[1] ISSF. 2012. ISSF Stock Status Ratings, 2012: Status of the world fisheries for tuna. ISSF Technical Report 2012-04A. International Seafood Sustainability Foundation, Washington, D.C., USA.

and this remains a controversial issue. However, based on fishery-independent surveys, the abundance of most dolphin populations in the region is estimated to be either stable or increasing, while a few may be declining. The Agreement on the International Dolphin Conservation Program (AIDCP) establishes allowable dolphin mortality limits; current (2011) levels are one-fourth of that level. There is a 100%-coverage observer program in place for these operations. Catches of non-target species in these operations are very small."

The primary stocks of concern are the ones that are considered by NOAA as depleted (coastal and northeastern offshore spotted and eastern spinner dolphins).

This report was prepared by the author as meeting Chair. While it does not necessarily represent a consensus view shared by all participants, the Chair tried to do his best to represent all views in a balanced way. The report benefitted greatly from comments on an earlier draft made by meeting participants. Participants were given an opportunity to submit dissenting opinions from the final report (one was received, see Appendix 5).

2. Background documents and presentations

A large number of background documents were provided to the Workshop participants (Appendix 2). The following presentations were made:

- The tuna-dolphin issue: A historical perspective. *Bill Perrin*
- Pelagic predator associations: tuna and dolphins in the ETP. *Michael Scott*
- Purse seine methods for fishing tuna associated with dolphins in the ETP. *Ernesto Altamirano*
- Dolphin mortality estimates, focusing on the early ones. Observer programs. *Martin Hall*
- International management of the tuna –dolphin problem. The Agreement for the International Dolphin Conservation Program (AIDCP). *Martin Hall*
- Procedures used to scan observers for evidence of biased data. *Cleridy Lennert-Cody*
- NOAA's Cetacean and Ecosystem Assessment Surveys in the Eastern Tropical Pacific. *Lisa Ballance*
- Abundance and Trends of Depleted Dolphin Stocks. *Tim Gerrodette*
- Revised dolphin mortality figures with the small seiners included. *Cleridy Lennert-Cody*
- Assessment of EPO dolphin populations. *Mark Maunder*
- Evidence for Indirect Effects of Chase and Encirclement on Depleted Dolphin Stocks. *Lisa Ballance, Nick Kellar and Shawn Noren*

3. Additional analyses

In addition to the presentation on assessment of dolphin populations, Mark Maunder (IATTC) provided results of fitting log-linear models to the survey abundance data for NE spotted and E spinner dolphins, following recommendations made by Andre Punt in a review of IATTC's modeling work. The log-linear fits were made for the periods 1986-2006 and 1998-2006. Results of this work are provided in Appendix 3. The fits to the last five values in the time series indicate positive growth rates for these two populations, at least up to 2006 (the last year a survey was conducted).

It was noted that the sensitivity of the model to the stock-boundary assumptions had not been tested and some participants felt that the assumption that current stock boundaries are accurate is a critical one. On the other hand, it was noted that the current stock boundaries have been used for some time to measure trends in dolphin abundance.

The results presented during the workshop also confirm the finding of Gerrodette et al. (2008) that the stocks were growing during the last part of the survey time series. However, some participants expressed concern that there is uncertainty in the stock structure for spotted dolphins, and that the trend in abundance would decline if the data for the NE region (~860,000 individuals) of the survey were combined with the data for the W/S region (~440,000 individuals).

4. Discussions and conclusions

After considering the presentations and discussions, there was general agreement that direct mortality of dolphins in the fishery has been reduced to levels below those prescribed as sustainable. There also appeared to be general agreement that even if the direct mortality were underestimated by an order of magnitude, such levels would still be sustainable.

The main source of information used to measure trends in dolphin abundance is a series of fishery-independent surveys. The last five surveys available (1998-2006) indicate that the stocks of concern were increasing at that time (see Section 3). A new survey would add crucial information to the debate. Consider the estimate that the NE spotted stock is growing at an annual rate of 3.5%: If a new survey were conducted in, say, 2014, the projected stock size would be almost 30% higher than it was in 2006 and such a change would likely be statistically significant with the typical survey CVs that are in the order of 25%-30%.

However, several participants noted that fishery-independent surveys are expensive and there are more cost-effective means to estimate (relative) abundance. One such possibility would be to use the extensive data set collected by IATTC observers and apply standardization methods to estimate relative abundance, similar to what is done with fishery CPUE. This has not been pursued yet but appears to be a feasible alternative that should be explored.

Unfortunately, there was not general agreement about whether indirect effects are allowing recovery at the expected rate (what is to be "expected" is itself a subject of debate). Some participants felt that continued chase and capture could be having adverse impact on the stocks' rebuilding rate. While most participants agreed that adverse impacts by the mechanisms identified were plausible, especially at the individual level, as these indirect impacts have not been quantified in a population context, the overall impacts remain largely hypothetical. Various studies have produced quantitative results that could potentially serve as the basis for estimates of population-level effects, pending availability of specific data on the fishery. However, this has not been done. In addition, some of the physiological research presented on indirect effects is not being done on the species of concern, but on other dolphins instead, which further adds to the differing views.

In terms of ISSF ratings of the environmental impact of this fishing mode, Appendix 4 contains the Chair's own conclusions after considering the Workshop discussions. The section below contains recommendations for ways in which some of the remaining uncertainties could be addressed.

5. Recommendations

- The discussion about whether or not dolphin populations are rebuilding is anchored on surveys, the last of which took place in 2006. It is important to evaluate trends in abundance that are up-to-date. This can be done by either a new survey (or a series of new surveys), or by modeling the available observer database.

- The sensitivity of the abundance estimates to the stock boundary assumptions should be evaluated. Furthermore, evaluation of habitat definitions based on oceanographic correlates should be conducted and the implications of habitat contraction/expansion scenarios for inferring stock rebuilding should be studied.

- Novel approaches for estimating stock abundance should be pursued. One such approach is estimation based on close-kin genetics as a form of mark-recapture. Another approach that should be further investigated is the use of pit-tags for mark-recapture estimation.

- Application of integrated population dynamics modeling which considers the range of available data (*e.g.* Hoyle and Maunder 2004) is critical to permit inference about population level effects of the various forms of chase and capture induced mortality. This form of modeling should make use of all available data potentially informative on the critical issues of indirect and direct mortality, including:
    - Observer data on dolphins (encounters in time and space);
    - Identification of plausible ranges of rates of indirect mortality or reduced reproduction;
    - Evaluation of impacts of uncertainty and plausible bias in estimates of direct mortality over time;

- Inference about stress related mortality/reduced reproduction is limited by small sample sizes. Full-scale necropsies of animals killed in a set should be reinitiated. At a minimum, reinvigoration of basic life history sampling of specimens killed should be an ongoing task for on-board observers.

- Further research into mitigating dolphin deaths in sets, such a methods to further reduce the occurrence of net 'canopies' should be pursued.

- Samples from the locomotor muscle from dolphin species of concern should be collected to measure the development of the muscle biochemistry that supports swimming performance.

- An ecosystem approach to setting goals for the different species involved in the fishery would be a useful step.

- Estimation of population-level indirect effects of the fishery on dolphins should include greater spatial and temporal detail of fishery activity with respect to dolphins, not simply on the total number of dolphin sets in the year. Toward this end, the various data sets available could be analyzed in a collaborative manner by scientists from IATTC and other organizations.

Appendix 1: Participants

Alexandre Aires da Silva (IATTC)
Robin Allen (ISSF SAC)
Ernesto Altamirano (IATTC)
Lisa Ballance (NOAA)
Jim Coe (Retired)
Guillermo Compean (IATTC)
Rick Deriso (IATTC and ISSF SAC)
Michel Dreyfus (INAPESCA, Mexico)
Luis Fleischer (INAPESCA, Mexico)
Bill Fox (WWF and ISSF Board)
Tim Gerrodette (NOAA)
Martin Hall (IATTC)
Susan Jackson (ISSF)
Nick Kellar (NOAA)
Shawn Noren (UCSC)
Cleridy Lennert-Cody (IATTC)
Mark Maunder (IATTC)
Bill Perrin (NOAA)
Victor Restrepo (ISSF SAC; Workshop Chair)
Michael Scott (IATTC)
Gerry Scott (NOAA and ISSF SAC)
Cisco Werner (NOAA)

Appendix 2: Background Documents

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Appendix S1. General logistic population dynamics model and definition of Nmin.

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Maunder, M. 2012. Evaluating recent trends in EPO dolphin stocks. IATTC, unpublished ms. Available from IATTC, LaJolla, CA

Noren, S.R., T.M. Williams, D.A. Pabst, W.A. McLellan & J.L. Dearolf (2001). The development of diving in marine endotherms: preparing the skeletal muscles of dolphins, penguins, and seals for activity during submergence. J. Comp Physiol. B, 171:127-134

Noren, S.R. (2004). Buffering capacity of the locomotor muscle in cetaceans: Correlates with postpartum development, dive duration, and swim performance. *Marine Mammal Science, 20(4):808-822*

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St. Aubin, D. J., Forney, K. a., Chivers, S. J., Scott, M. D., Danil, K., Romano, T. a., Wells, R. S., et al. (2011). Hematological, serum, and plasma chemical constituents in pantropical spotted dolphins (*Stenella attenuata*) following chase, encirclement, and tagging. *Marine Mammal Science*.

Appendix 3: Log-linear model fits to the survey abundance data (M. Maunder, IATTC)

A log-linear model of the form

$$\ln[X_t]=a+b_t+\epsilon_t$$

was fitted to the survey abundance data using a Bayesian approach in which allowance is made for variance about the abundance estimates in addition to sampling variance. Two time periods were considered: The entire series (1986-2006), and the most recent 5 surveys (1998-2006). For the longer time series, the fits were made with and without accounting for the fishery mortality estimates. The estimated annual rates of increase are given in Table A3, and the fits are shown in Figure A3.

Table A3. Annual rates of increase estimated by fitting log-linear models to the dolphin survey abundance data (values shown are the posterior means).

	E. Spinner	**N.E. Spotted**
1986-2006 with catch	2.6%	2.2%
1986-2006 no catch	1.9%	1.0%
1998-2006	9.7%	3.5%

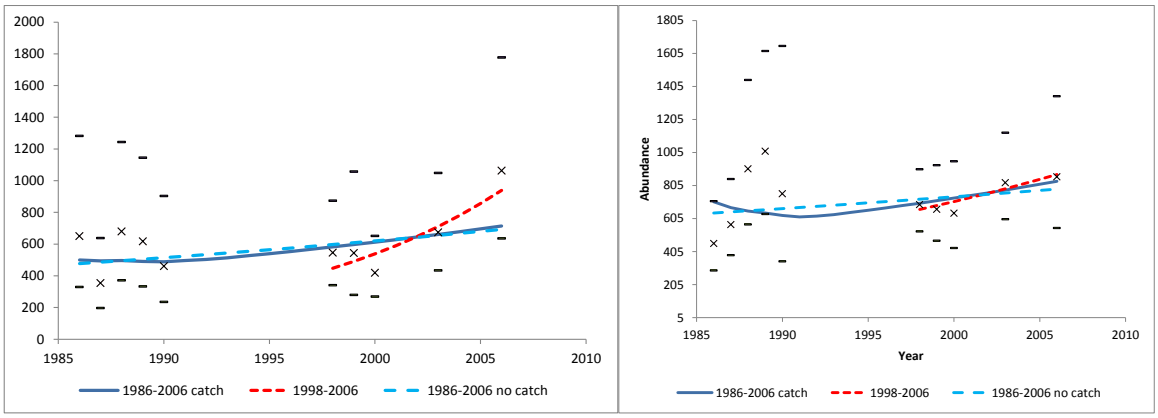

Figure A3. Log-linear fits to the survey abundance data for E. spinner (left) and NE spotted (right) dolphins in the EPO.

For the fits using the most recent five years of data, the posterior distributions suggest a high probability that the annual rate of increase is positive (p=0.82 and 0.97 for NE spotted and E spinners, respectively).

Appendix 4: Chair's thoughts on ISSF ratings for dolphin sets*

* This Appendix reflects the views of the Chair which are not necessarily shared by all Workshop participants

During the last day of the Workshop, I invited participants to express their views on the following, which were the basic objective of the meeting:

> (A) Adverse effects on dolphin populations are not expected.
> (B) Adverse effects on dolphin populations are expected, but the management and monitoring measures in place are expected or known to mitigate these effects.
> (C) Adverse effects on dolphin populations are expected, but the management and monitoring measures in place are not expected or are insufficient to mitigate these effects.
> (D) Insufficient information is available to determine any of the above.

While most participants expressed views in favor of (A) or (B), and a few for (D), all noted that the questions were worded in a contradictory manner. Suggestions for rewording were made but no consensus was reached.

As Chair of the ISSF SAC, I believe that the ISSF ratings are useful to provide a general comparison between fishing gears (or between set types in the case of purse seine fisheries). But they were not intended to rate any one fishery in particular detail.

ISSF generally supports the MSC process for fishery certification because it is compliant with the FAO eco-labeling guidelines. If a detailed rating is to be made for the tuna-dolphin fishery in the EPO, then perhaps the best way forward would be to score it using the MSC methodology. This can be done under Performance Indicators 2.3.1, 2.3.2 and 2.3.3 for ETP species (Endangered, Threatened or Protected under some international agreement or national legislation).

The MSC methodology considers three thresholds of scoring guidelines (SG): 100, 80 and 60. If any indicator fails to reach 60, then the fishery would not be eligible for certification. In order to 'pass', the average score must be at least 80. Anything between 60 and 79 would be a conditional pass, with various conditions put on the client to ensure that the score will be at least 80 the next time the fishery wants to be re-certified (within five years). To link the MSC methodology with the ISSF color ratings, I believe that the following apply:

> Orange = PI score below 60
> Yellow = Average score between 60 and 79, with Conditions.
> Green = Average score ≥ 80.

I have some experience with the MSC process (for full disclosure, I am a member of the MSC Technical Advisory Board and I attended my very first meeting immediately after the Workshop). However, I am not an expert and have not been trained to assess fisheries against the MSC standard. Therefore, my thoughts on the possible scores that follow should be considered as very preliminary and are certainly not a substitute for a rigorous assessment by a trained certifier.

> NOTE 1: These thoughts on scores apply to the fishery at present.

NOTE 2: I have not included comments on other species that could be considered as ETP, such as turtles. However, I believe based on reading IATTC reports that those interactions are minimal.

PI 2.3.1 (Outcome)

Scoring Issue a (Fishery effects within limits). I believe that the fishery would score above 80. The AIDCP sets conservative dolphin mortality limits (for each stock, the mortality limit is set to 0.1% of the lower bound of the abundance estimate, N_{min}). In the recent time period, observed mortality has been about 0.025% of N_{min}. The IATTC uses statistical methods to screen observer data for unusual patterns (Lennert-Cody, 2007). Also if there is mortality caused by fishing sets made by purse seiners under 363 t (those that do not require 100% observer coverage), that mortality is estimated to be low (Lennert-Cody et al. 2012).

Scoring Issue b (Direct effects). Similar to issue a, I believe that the fishery would score above SG80, perhaps substantially above. I don't think there would be any disagreement from the experts on this topic.

Scoring Issue c (Indirect effects). Here is where there is disagreement amongst various experts. Part of the PI 2.3.1 outcome is that "*The fishery does not pose a risk of serious or irreversible harm to ETP species and does not hinder recovery of ETP species*". This is basically what is argued by, on one hand, those who believe indirect effects could be substantial and, on the other hand, those that believe that the data do not support a high risk from indirect effects or unobserved direct mortality.
Based on the presentations and discussions at the Workshop, I believe that the score would be at SG80. Indirect effects have been considered through fitting population models to the survey abundance data, and testing various hypotheses about alternative growth rates and alternative levels of mortality. One of the models that best explains the survey data is one that fixes the population growth rate at 4% per year, and allows for mortality to be 22 times higher than the observed mortality. Even in this case, the fitted population trends were increasing. Note that the word "unlikely" at SG80 is associated with a probability threshold level of 70%. Measuring this probability may be doable through the log-likelihood values of alternative population model fits but I don't know if that has been done. The conclusion that analyses conducted are sufficient to meet the 70% probability level is my own qualitative judgment.
On the other hand, I can see how another assessor could come up with justification for a score under 80, or even with justification for a score above 80. The MSC scoring system leaves room for subjectivity and this scoring issue could easily lead some assessors to score at (or above) 80, and some below.

PI 2.3.2 (Management strategy)

Scoring Issue a (Management strategy in place). I believe that this would score above SG80, perhaps substantially above. The strategy in place is through the AIDCP and its member countries. Dolphin mortality limits are set conservatively and then allocated to individual vessels that request them. If a vessel reaches its limit, then it has to stop making sets on

tuna-dolphin associations. In addition, through IATTC, the entire large scale purse seine fishery has to stop fishing during two months of the year.

Scoring Issue b (Management strategy evaluation). Again, I believe that the score would be higher than SG80. The strategy is based on data from the fishery and from the species involved, and the dolphin mortality limits are set quantitatively.

Scoring Issue c (Management strategy implementation). I believe this would score at SG80. The objective of the strategy is to reduce incidental dolphin mortalities in the purse-seine fishery in the eastern Pacific Ocean to levels approaching zero. There is evidence that this is being implemented successfully, even though some doubts remain about possible indirect mortalities.

Scoring Issue d (Management strategy evidence of success). I would say that the SG100 (the only SG under this Issue) cannot be met, primarily because the last survey is now becoming outdated (it was in 2006). Updated information on dolphin abundance would be needed to address this question (although not necessarily from an updated fishery-independent survey; other information sources are available such as the IATTC observer data).

PI 2.3.3 (Information/Monitoring)

Scoring Issue a (Information quality*)*. I believe that the SG80 requirement would be met, perhaps higher. Impacts of the fishery are estimated quantitatively.

Scoring Issue b (information adequacy for assessment). I would score this at 80 but probably not higher at present. Accurate and verifiable information on indirect mortality will remain a topic of discussion until it is resolved by either new analyses (such as an updated survey or indices of relative abundance) that show increasing or decreasing dolphin abundance, and/or until estimates of indirect mortality are made at the population level (instead of at the individual level).

Scoring Issue c (information adequacy for management). I had some difficulty with this one. The fishery-independent surveys are a crucial source of information, but the last one was done in 2006 and it is a bit outdated. Nevertheless, these data are still used to calculate N_{min} and to fit population abundance models and I did not hear any experts complain about this. Therefore, I would score at SG80.
On a related note, the IATTC observer data are available, and they could be used to develop adequate (fishery-dependent) indices of relative dolphin abundance. But, my understanding from the workshop is that this has not been done for many years now.

Conclusion

With my limited knowledge of the MSC scoring, especially under Principle 2, my preliminary scores would be at least 80 for PIs 2.3.1, 2.3.2 and 2.3.3. That would translate to Green in the ISSF rating methodology used in the Status of Stocks report. Therefore, there would be no change from the decision already adopted by the SAC.

There are, however, significant caveats (besides not being an experienced MSC assessor). These are (i) the lack of scientific consensus on the issue of indirect mortality, and (ii) the lack of estimates of recent trends in abundance (e.g., from an updated survey or from integrated population models) that could shed important light into the debate. Therefore, I recommend to the SAC that:

1) The ISSF rating for this fishing method remain Green for now.

2) In *x* years (to be decided by the SAC), consider changing the rating to Yellow if there are no additional analyses (such as relative indices of abundance for dolphins or a new fishery-independent survey) that provide additional evidence that indirect effects pose low risk.

3) Consider whether to recommend that ISSF hire a trained assessor to score the fishery against the MSC ETP component (PIs 2.3.x), and have it peer-reviewed.

4) Actively support the need for a new population trend analyses (a survey or relative indices of abundance) as well as the other recommendations in the report of the workshop.

Finally, I sincerely want to thank all of the experts that participated in the Workshop. It was extremely informative and cordial.

Component	PI	Scoring issues	SG60	SG80	SG100
ETP species	**Outcome** ***Status*** **2.3.1** The fishery meets national and international requirements for protection of ETP species. The fishery does not pose a risk of serious or irreversible harm to ETP species and does not hinder recovery of ETP species.	a. Fishery effects within limits	Known effects of the fishery are **likely** to be within limits of national and international requirements for protection of ETP species.	The effects of the fishery are known and are **highly likely** to be within limits of national and international requirements for protection of ETP species.	There is a **high degree of certainty** that the effects of the fishery are within limits of national and international requirements for protection of ETP species.
		b. Direct effects	Known direct effects are **unlikely** to create **unacceptable impacts** to ETP species.	Direct effects are **highly unlikely** to create **unacceptable impacts** to ETP species.	There is a **high degree of confidence** that there are **no significant detrimental direct effects** of the fishery on ETP species.
		c. Indirect effects		Indirect effects have been considered and are thought to be **unlikely** to create unacceptable impacts.	There is a **high degree of confidence** that there are **no significant detrimental indirect effects** of the fishery on ETP species.

Component	PI	Scoring issues	SG60	SG80	SG100
ETP species	***Management strategy*** **2.3.2** The fishery has in place precautionary management strategies designed to: - meet national and international requirements; - ensure the fishery does not pose a risk of serious or irreversible harm to ETP species; - ensure the fishery does not hinder recovery of ETP species; and - minimise mortality of ETP species.	a. Management strategy in place	There are **measures** in place that minimise mortality of ETP species, and are expected to be **highly likely to achieve** national and international requirements for the protection of ETP species.	There is a **strategy** in place for **managing the fishery's impact** on ETP species, including measures to minimise mortality, which is designed to be **highly likely to achieve** national and international requirements for the protection of ETP species.	There is a **comprehensive strategy** in place for managing the fishery's impact on ETP species, including measures to minimise mortality, which is designed to **achieve above** national and international requirements for the protection of ETP species.
		b. Management strategy evaluation	The measures are **considered likely** to work, based on **plausible argument** (e.g. general experience, theory or comparison with similar fisheries/species).	There is an **objective basis for confidence** that the strategy will work, based on **information** directly about the fishery and/or the species involved.	The strategy is mainly based on information directly about the fishery and/or species involved, and a **quantitative analysis** supports **high confidence** that the strategy will work.
		c. Management strategy implementation		There is **evidence** that the strategy is being implemented successfully.	There is **clear evidence** that the strategy is being implemented successfully.
		d. Management strategy evidence of success			There is evidence that the strategy is achieving its objective.

Component	PI	Scoring issues	SG60	SG80	SG100
ETP species	*Information / monitoring* 2.3.3 Relevant information is collected to support the management of fishery impacts on ETP species, including: - information for the development of the management strategy; - information to assess the effectiveness of the management strategy; and - information to determine the outcome status of ETP species.	a. Information quality	**Information** is sufficient to **qualitatively** estimate the fishery related mortality of ETP species.	**Sufficient information is** available to allow fishery related mortality and the impact of fishing to be **quantitatively** estimated for ETP species.	Information is **sufficient to quantitatively** estimate outcome status of ETP species with a high degree of certainty.
		b. Information adequacy for assessment of impacts	Information is **adequate** to **broadly understand** the impact of the fishery on ETP species.	Information is **sufficient** to **determine whether the fishery may be a threat** to protection and recovery of the ETP species.	**Accurate and verifiable information** is available on the **magnitude of all impacts, mortalities and injuries** and the **consequences for the status** of ETP species.
		c. Information adequacy for management strategy	Information is adequate to support **measures** to manage the impacts on ETP species	Information is sufficient to measure trends and support a full **strategy** to manage impacts on ETP species	Information is adequate to support a **comprehensive strategy** to manage impacts, minimize mortality and injury of ETP species, and evaluate with a **high degree of certainty** whether a strategy is achieving its objectives.

Appendix 5. Dissenting opinion (S. Noren, UCSC)

I have read the Chair's Report of the ISSF Tuna-Dolphin Workshop and I disagree. The conclusion of a "green" rating was primarily based on a model assessing dolphin populations in the Eastern Tropical Pacific (ETP) presented by Mark Maunder (IATTC). The outcome of the model is only as good as the data and the assumptions that were entered into the model. There was disagreement among the workshop attendees that have expertise in modeling as to whether or not the most appropriate assumptions were put into the model. It should not be ignored that experts in modeling from NMFS warned that new analyses indicate that the stock boundaries currently used for abundance estimates may not be correct. Revised abundance estimates using more accurate stock boundaries could result in very different abundance and trends for depleted stocks. These concerns make it uncertain as to whether or not the tuna fishery in the ETP adversely impacts the dolphin populations that interact with this fishery.

Uncertainty in the model results alone may not in itself warrant concern about the impacts of this fishery on dolphins. However, this coupled with other scientific research on the indirect effects on dolphins by the activities of this fishery, should be considered when deciding whether or not this fishery adversely impacts dolphins. The final draft of the report does not mention the quantitative results from the species and stocks of concern that show that exposure to this fishery alters the pregnancy rate of spotted dolphins (Kellar et al. in review) and lowers the percentage of calves found in spinner dolphin schools (Cramer et al. 2008). Other quantitative studies on the species and stocks of concern suggest that mother-calf pair associations are disrupted during the chase activities of this fishery, as the majority of lactating females that were historically captured in the nets were not accompanied by their calf (Archer et al. 2004). Additional research demonstrates the mechanism by which mother-calf pairs can become separated during fishery activities (Noren 2008, *in review*; Noren and Edwards 2007, 2011; Noren et al. 2006, 2008, Weihs 2004, 2006).

Aquatic air-breathing vertebrates (including dolphins) require a prolonged postnatal development period to obtain mature muscle physiology (Noren et al. 2001, Noren 2004); this results in lowered swim performance in young animals (Noren et al. 2006). To improve dolphin calf swim performance, mother-calf pairs often swim in formation (Noren et al. 2008, Noren and Edwards 2011), yet this behavior alters the swimming gait of the mother and lowers her performance (Noren 2008, Noren in review). Although these swimming kinematic studies were done on a model species (bottlenose dolphins), hydrodynamic models of formation swimming by spinner dolphin mother-calf pairs by Weihs (2004, 2006) supported these findings. The results of these studies provide a mechanism by which mother-calf dolphin pairs can become permanently separated during fishery interactions. This provides a plausible explanation for the separation of mother-calf pairs observed after fishery induced chase (Archer et al. 2004). Noren et al. (2011) also demonstrated that near-term pregnancy alters swimming gait and performance, which could preclude pregnant dolphins from maintaining position with the pod during high speed chase or release. Permanently separated calves can in part explain the lower percentage of calves found in spinner dolphins schools observed by Cramer (et a. 2008) and permanently separated near-term pregnant dolphins can in part explain the lower pregnancy rate observed in spotted dolphins by Keller et al. (2008). Beyond these indirect effects, concerns remain regarding the physiological effects that accompany the stress of fishery interactions on these animals (St. Aubin et al. 2011).

Ultimately, given the numerous avenues of uncertainty, a green rating seems inappropriate.