

**WPSAR Tier 3 Panel Review of  
Stock Assessment Updates of the Bottomfish Management Unit Species of  
American Samoa, the Commonwealth of the Northern Mariana Islands, and  
Guam in 2015 Using Data through 2013**

August 11-12, 2015

Prepared For  
Pacific Islands Fisheries Science Center, NOAA/NMFS  
Pacific Islands Regional Office, NOAA/NMFS  
Western Pacific Regional Fishery Management Council

Prepared By  
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**Background**

This document provides a Tier 3 Western Pacific Stock Assessment Review (WPSAR) of the draft version of the “Stock Assessment Updates of the Bottomfish Management Unit Species of American Samoa, the Commonwealth of the Northern Mariana Islands (CNMI), and Guam in 2015 Using Data through 2013” by Yau et al. (May 29, 2015) also referred to as the “Assessment Update” throughout the report. The goals of this WPSAR peer review are to:

1. Suggest any minor revisions that may improve the draft 2015 Territorial Bottomfish Stock Assessment before the National Marine Fisheries Service finalizes the assessments; and
2. Make recommendations regarding future research, data collection, and changes in methods that may improve future iterations of territorial bottomfish assessments.

To accomplish the stated goals, the Panel Chair (Franklin) provided a consensus report and each reviewer (Franklin, Chaloupka, and Kobayashi) also provided an individual report addressing each of the terms of reference listed below. Reports were provided to the Coordinating Committee at the close of the review on August 12, 2015. Any minority opinions were recorded in the reports. WPSAR reports will be made public on the WPSAR website shortly after the review is closed.

## **Tier 3 WPSAR Consensus Report for the draft version (May 29, 2015) of “Stock Assessment Updates of the Bottomfish Management Unit Species of American Samoa, the Commonwealth of the Northern Mariana Islands, and Guam in 2015 Using Data through 2013”**

The goals of this peer review are to: (1) suggest any minor revisions that may improve the draft 2015 Territorial Bottomfish Stock Assessment before the National Marine Fisheries Service finalizes the assessments; and (2) make recommendations regarding future research, data collection, and changes in methods that may improve future iterations of territorial bottomfish assessments.

The report addresses the following Terms of Reference (in bold):

**1. Review the soundness and reliability of the results and conclusions, including estimated population benchmarks and management parameters (e.g. MSY, Fmsy, Bmsy, MSST, and MFMT).**

The WPSAR panel finds that the results and conclusions are reliable and sound including the estimated population benchmarks and management parameters for the updated draft stock assessment (Yau et al, May 29, 2015) for the bottomfish fisheries of American Samoa, CNMI and Guam given the limitations in available datasets.

**2. Review that the data and procedures used to produce the assessments are documented in sufficient detail so as to be reproducible.**

The WPSAR panel finds that the data and procedures used to produce the assessments are generally documented in sufficient detail as to be reproducible. One significant exception is the lack of sufficient documentation for the MSY estimates from the Our Living Oceans reports. The panel also recommends the inclusion of analysis scripts and input data files in an appendix to the report that would allow reproduction of assessment results.

**3. Review that all scientific uncertainties and sources of statistical error are clearly identified and characterized.**

The WPSAR panel finds that the scientific uncertainty and sources of statistical error are clearly identified and characterized for most of the assessment. There remain however a large number of uncertainties in processes not addressed that could be incorporated in a more inclusive manner in future assessments. For

example, environmental effects on both stock productivity and fishing operation success could be brought in to improve model performance.

**4. Review that data source limitations, model assumptions, and gaps in scientific information are identified. Review that any decisions to exclude data from analysis are explained.**

The WPSAR panel finds that the data source limitations, model assumptions, and gaps in scientific information were adequately identified. The exclusion of nominal CPUE data from the CNMI for 2006-2013 was explained and justified but this is a dataset that has to be incorporated in the next assessment. In addition, the MSY estimates from the Our Living Oceans reports must be better verified and documented.

**5. For consideration in future benchmark assessments, make recommendations regarding future research, data collection, and changes in methods that may improve future iterations of territorial bottomfish assessments.**

The WPSAR panel recommends the following improvements to future benchmark assessments, research, and data collection (listed in order of priority) that:

- (1) include all years of CNMI boat-based creel CPUE series into future assessments,
- (2) sufficiently verify and document the analysis and results for the MSY estimates (if these are included in future assessments as a model constraint) from the Our Living Oceans report (Humphreys and Moffitt 2009) and Polovina and Ralston (1986) used for the BMUS Assessments for Guam, CNMI, and American Samoa,
- (3) investigate additional analysis that excludes the MSY prior values as a constraint to compare output with MSY-constrained models,
- (4) include a detailed explanation of the expansion algorithm used to generate catch data,
- (5) explore splitting the BMUS into shallow and deep species components for future assessments,
- (6) consider using standardized CPUE rather than nominal CPUE in future assessments,
- (7) explore macro-scale oceanographic effects on the process component of the model such as SST on productivity via the  $r_{max}$  parameter (make  $r_{max}$  a varying parameter rather than a fixed parameter based

- on an environmental driver),
- (8) explore local-scale oceanographic effects on the observation component of the model such as wind and current that influence fisher and fish behavior and catchability,
  - (9) account for the varying BMUS species composition over time by either incorporating multilevel priors (Jiao et al 2009 Hierarchical Bayesian approach for population dynamics modelling of fish complexes without species-specific data. *ICES Journal of Marine Science* 66: 367–377) or in the CPUE data standardization process,
  - (10) account for unreported landings by perhaps using a censored catch approach within the Bayesian stock assessment model (Hammond & Trenkel 2005 Censored catch data in fisheries stock assessment. *ICES Journal of Marine Science* 62: 1118-1130),
  - (11) investigate other prior distributions (e.g. uniforms) as well as document the various distributions used as well as show graphically how informative or uninformative they are,
  - (12) integrate fishery area map designations into creel surveys to standardize reports of spatial fishing effort for American Samoa and CNMI, and
  - (13) explore length-based data and life history-based approaches for the assessment process if sufficient data is available.

## **6. Summarize the strengths and limitations of the overall product.**

The WPSAR panel finds that the Update is an adequate application of a standard Bayesian state space surplus production model to assess the status and associated uncertainty of bottomfish fisheries in American Samoa, CNMI and Guam against management benchmarks given the limited catch and CPUE data available. Limitations of the Update that could be addressed in future assessments include (1) a lack of species-specific and location-specific management advice, (2) an incomplete accounting of the effects of recruitment and environmental variability on stock dynamics, and (3) an incomplete accounting of the factors affecting catchability in a multigear fishery.

## **7. If the assessment under review is found to be lacking in scientific robustness, identify an assessment previously used for the management of this stock that you consider to be more scientifically robust and explain why.**

The WPSAR panel finds that this updated assessment is considered adequate for management decision-making at this time.

## **Tier 3 WPSAR**

### **Territories Bottomfish Stock Assessment Review (August 11-12 , 2015)**

**Dr Milani Chaloupka  
Ecological Modelling Services P/L (Australia)**

The Terms of Reference for this Tier 3 WPSAR review of the status of the bottomfish resources of American Samoa, CNMI and Guam where:

- 1. Review the soundness and reliability of the results and conclusions, including estimated population benchmarks and management parameters (e.g. MSY, Fmsy, Bmsy, MSST, and MFMT).**

The updated draft stock assessment (Yau et al, May 29, 2015) for the bottomfish fisheries of American Samoa, CNMI and Guam was based on a standard surplus production model incorporating nominal CPUE data. The CPUE data used were limited but are the best currently available and standardization was not undertaken due to the limited variability in the data series — that conclusion appears to be reasonable. A Bayesian statistical modelling approach was then used to implement this assessment accounting for the CPUE data input and catch history. The statistical modelling approach also included several standard parameter priors based on previous assessments for the Territories. Overall, the modelling approach was acceptable given the limited data inputs. The model complexity was consistent with the use of limited data. So the results are considered acceptable given the limited data available. It appears that the BMUS stock assemblages in American Samoa, CNMI and Guam are not overfished nor experiencing overfishing. The modelling presented supports those conclusions. So the updated stock assessment is considered

adequate for management decision-making at this time.

- 2. Review that the data and procedures used to produce the assessments are documented in sufficient detail so as to be reproducible.**

The CPUE data series used in the assessment were adequately documented as was the Bayesian statistical modeling approach. Some minor queries arose about the adequacy of the priors used for some parameters such as the carrying capacity (K) and the intrinsic growth rate parameter (rmax), but it is unlikely that any changes here would have any significant effect on the current updated assessment results and conclusions.

- 3. Review that all scientific uncertainties and sources of statistical error are clearly identified and characterized.**

The Bayesian statistical modeling approach adopted in this updated assessment accounts for the significant uncertainty in data inputs and parameter estimates. The updated assessment has addressed this issue adequately although as mentioned under (2) above that there were some minor queries regarding model sensitivity to the specification of the priors for the K and rmax parameters.

- 4. Review that data source limitations, model assumptions, and gaps in scientific information are identified. Review that any decisions to exclude data from analysis are explained.**

The updated assessment report adequately addressed the data limitations, model assumptions and relevant knowledge limitations. The major data exclusion decision was to only include CPUE data from bottomfish fishing trips where at least 50% of the catch comprised BMUS species — this seems a reasonable way to define a relevant bottomfish fishing trip for this assessment.

**5. For consideration in future benchmark assessments, make recommendations regarding future research, data collection, and changes in methods that may improve future iterations of territorial bottomfish assessments.**

Three important directions to improve the assessment in the future given the probable ongoing data limitations would be:

- (1) to explore the effect of macro-scale oceanographic effects such as SST on productivity via the rmax parameter (make rmax a varying parameter rather than a fixed parameter based on an environmental driver).\
- (2) to account for the varying BMUS species composition over time by either incorporating multilevel priors (Jiao et al 2009 Hierarchical Bayesian approach for population dynamics modelling of fish complexes without species-specific data. ICES Journal of Marine Science 66: 367–377) or in the CPUE data standardization process in the first place
- (3) to account for unreported landings by perhaps using a censored catch approach within the Bayesian stock assessment model (Hammond & Trenkel 2005 Censored catch data in fisheries stock assessment. ICES Journal of Marine Science 62: 1118-1130)

**6. Summarize the strengths and limitations of the overall product.**

The major strength and limitation of this updated assessment are related. Its major strength is that it is a simple Archipelago-wide model consistent with the limited data availability but the limited data can only support a simplistic model. Hence the model cannot account for spatially explicit catch and effort and fishing impacts within a complex archipelago landscape such as American Samoa or CNMI/Guam.

- 7. If the assessment under review is found to be lacking in scientific robustness, identify an assessment previously used for the management of this stock that you consider to be more scientifically robust and explain why.**

This updated assessment is considered adequate for management decision-making at this time.



## **WPSAR Tier 3 Review of Stock Assessment Updates of the Bottomfish Management Unit Species of American Samoa, the Commonwealth of the Northern Mariana Islands, and Guam in 2015 Using Data through 2013 (Aug 11-12, 2015)**

**Dr. Erik Franklin**

**Hawaii Institute of Marine Biology, School of Ocean and Earth Science and Technology,  
University of Hawaii at Manoa**

This document provides a Tier 3 Western Pacific Stock Assessment Review (WPSAR) of the draft version of “Stock Assessment Updates of the Bottomfish Management Unit Species of American Samoa, the Commonwealth of the Northern Mariana Islands (CNMI), and Guam in 2015 Using Data through 2013” by Yau et al. (May 29, 2015) referred to as the “Assessment Update” throughout the report. The report addresses for the the following Terms of Reference:

### ***1. Review the soundness and reliability of the results and conclusions, including estimated population benchmarks and management parameters (e.g. MSY, Fmsy, Bmsy, MSST, and MFMT).***

The Assessment Update provides sound and reliable estimated benchmarks and management parameters for the BMUS of American Samoa, Guam, and the CNMI given the limited nature of the fisheries-dependent survey data available (i.e., nominal CPUE data) to inform the analyses. Results indicate that no stocks are overfished and overfishing is not occurring but caution should be exercised given the incomplete nature of the fishery-dependent data that the assessment primarily relies upon. HMSY (catch as a proportion of the stock) is utilized in the report instead of FMSY. There is no presentation of MSST (minimum stock size threshold) or MFMT (maximum fishing mortality threshold) but it can be inferred that the MSST is  $(1-M)*BMSY$  or  $0.7*BMSY$  and MFMT is HMSY. The approaches utilized are consistent with the detail of the information available and sufficient for management decision-making on the status of the fisheries.

### ***2. Review that the data and procedures used to produce the assessments are documented in sufficient detail so as to be reproducible.***

The data and procedures used to produce the assessments are generally documented in sufficient detail as to be reproducible but there are some exceptions. The input data consists primarily of boat-based creel surveys that provide time series of catch and CPUE for each fishery. Supplementary material provided during the review included creel survey operating procedures but these documents did not include a detailed description of the expansion algorithms used to generate the catch and CPUE data utilized in the assessment. The CNMI CPUE series only includes data to 2005 due to problems with the CPUE data after 2006.

The Assessment Update methods utilize a standard Bayesian state space Schaefer surplus production model to infer the past and current status of each fishery against management benchmarks and project the risk of overfishing for 2016-2017. The model framework is strongly constrained by MSY prior values derived from Polovina and Ralston (1986) and presented in the the Our Living Oceans (OLO) reports (Humphreys and Moffitt 1999, Moffitt and Humphreys 2009). The values utilized in the Update Assessment (from the OLO reports) do not precisely

match those from Polovina and Ralston (1986). Furthermore, there are no methods or results on the analysis used to derive MSY for American Samoa using the approach.

The analysis procedure and model framework is adequately documented in the text and tables of the report but the software code to replicate the analysis are not provided. **Reviewer recommends that all computer scripts and input data necessary to reproduce results should be included in the Appendix.**

***3. Review that all scientific uncertainties and sources of statistical error are clearly identified and characterized.***

The Bayesian framework for the surplus production model includes process error (i.e., dynamics of the biotic and abiotic system) and observation error (i.e., variability introduced by the survey procedures). Model parameter prior values and probability distributions are identified in report tables and text. Posterior estimates of model parameters and management benchmark values include estimates of uncertainty. The methods and data utilized did not account for all possible sources of scientific uncertainty and error but provided sufficient characterization for those included in the assessment. **Reviewer recommends that equation for posterior distribution be edited to remove prior for natural mortality ( $p(M)$ ).**

***4. Review that data source limitations, model assumptions, and gaps in scientific information are identified. Review that any decisions to exclude data from analysis are explained.***

There was adequate identification of data limits, model assumptions and science gaps with a few exceptions. The fishery-dependent survey data used for each BMUS fishery do not provide complete temporal and spatial coverage of fishing activities so catch and effort may be underreported and under-represented in the Update. The lack of inclusion for CNMI CPUE data from 2006-2013 reflects the poor quality of that data set. Model output is conditioned on old data (pre-2005) and estimated through 2013 giving the impression that the estimates are based on recent data in the figures and output. Catch in CNMI has declined during this period but it is not possible to evaluate if that decline is due to a decrease in effort or a decrease in CPUE.

The derivation of the OLO-derived MSY estimates needs to be transparent for American Samoa and differences in values from Polovina and Ralston versus those in the Update should be clarified for the CNMI and Guam.

Units of CPUE need to be better described. Currently catch per line/hr and catch per trip. Can CNMI survey use catch per line hr. If you can utilize per line/hr catch rates then why not include the surveys with < 50% BMUS catch.

***5. For consideration in future benchmark assessments, make recommendations regarding future research, data collection, and changes in methods that may improve future iterations of territorial bottomfish assessments.***

A number of improvements can be made in methods, data collection and model structure for the future benchmark assessment which include:

**Reviewer recommends that the CNMI boat-based creel CPUE series from 2006 and after be included in future assessments.**

**Reviewer recommends that an additional analysis that excludes the MSY prior values as a constraint to compare output with MSY-constrained models.**

**Reviewer recommends that the analysis and results for the MSY estimates from OLO (Humphreys and Moffitt 2009) and Polovina and Ralston (1986) used for the BMUS Assessments for Guam, CNMI, and American Samoa be reconstructed, documented, and published as a NOAA Tech Memo.**

**Reviewer recommends that the creel surveys integrate fishery area map designations to standardize reports of spatial fishing effort for American Samoa and CNMI.**

**Reviewer recommends that creel survey documentation includes a description of the expansion algorithm used to generate catch and CPUE data.**

**Reviewer recommends incorporation of length-based data and life history approaches if sufficient data are available.**

***6. Summarize the strengths and limitations of the overall product.***

The primary strength of the Update is the sound application of a standard Bayesian state space surplus production model to assess the status and associated uncertainty of bottomfish fisheries in American Samoa, CNMI and Guam against management benchmarks given limited catch and CPUE data.

The fishery-dependent data surveys are limited in spatial and temporal extent so catch and effort may be underestimated. MSY priors from OLO work significantly influence reference point values. The field work to generate the OLO estimates occurred approximately 40 years ago. There are inherent limitations in the interpretation of results provided by a surplus production model.

***7. If the assessment under review is found to be lacking in scientific robustness, identify an assessment previously used for the management of this stock that you consider to be more scientifically robust and explain why.***

The assessment is sufficient as an update to inform fishery management and no prior assessment is more scientifically robust but there are limitations identified that need to be resolved during the next “full” assessment planned for these fisheries.

**WPSAR panelist report for review of “Stock Assessment Updates of the Bottomfish Management Unit Species of American Samoa, the Commonwealth of the Northern Mariana Islands, and Guam in 2015 Using Data through 2013”**  
**Donald R. Kobayashi, Pacific Islands Fisheries Science Center**  
**August 12, 2015**

The goals of this peer review are to:

1. Suggest any minor revisions that may improve the draft 2015 Territorial Bottomfish Stock Assessment before the National Marine Fisheries Service finalizes the assessments; and
2. Make recommendations regarding future research, data collection, and changes in methods that may improve future iterations of territorial bottomfish assessments.

This reviewer reports on each of the following terms of reference as presented in the original WPSAR Terms of Reference (Appendix 1):

1. Review the soundness and reliability of the results and conclusions, including estimated population benchmarks and management parameters (e.g. MSY, Fmsy, Bmsy, MSST, and MFMT).

*This reviewer feels that the estimated population benchmarks and management parameters are adequately sound and reliable given the data quality and nature of the fishery (e.g., short time series with questionable requisite contrast in exploitation schedules to ensure robust model fitting). The methodological approach is probably overkill for the task, but this is not necessarily a detriment. That said, it would be comforting if a statistically simpler model were also applied to give similar results.*

2. Review that the data and procedures used to produce the assessments are documented in sufficient detail so as to be reproducible.

*This reviewer feels that there could be minor improvements in the documentation of some of the key input data. In particular, the OLO estimates of MSY that are used to tune the model are clearly not well documented by these authors or even the authors of the OLO reports themselves. The length-of-contour with biomass multiplier approach needs to be thoroughly investigated via careful examination of all of the OLO reports to better understand how these numbers were determined and/or evolved over time. Some additional documentation on the variety of prior distributions used in the Bayesian model would be helpful. It is realized though that both of the above points pertain to methods duplicated from the benchmark assessment, but it remains that such documentation would have also helped in the benchmark assessment document. Other input data and procedures are adequately documented in my opinion.*

3. Review that all scientific uncertainties and sources of statistical error are clearly identified and characterized.

***This reviewer feels that the scientific uncertainty and sources of statistical error in the processes addressed are adequately treated by the modeling framework. There remain however a large number of uncertainties in processes not addressed that could be incorporated in a more inclusive manner. For example, environmental effects on both stock productivity and fishing operation success could be brought in to improve model performance.***

4. Review that data source limitations, model assumptions, and gaps in scientific information are identified. Review that any decisions to exclude data from analysis are explained.

***This reviewer has concerns about the CNMI dataset exclusion, particularly since this is the more recent data, which may have more meaningful information for current conditions of the stock and fishery. However, this is handled in the same way for the benchmark assessment, so I understand that dealing with this exclusion can be postponed until the next benchmark. But given that this is not a newly found issue, it would have been preferable to see more progress on why these data are considered unusable. This has been an issue for many years now, and it is disheartening that the assessors and/or the data managers are not apparently able to adequately answer the question of why we cannot use the most recent of CNMI CPUE data.***

5. For consideration in future benchmark assessments, make recommendations regarding future research, data collection, and changes in methods that may improve future iterations of territorial bottomfish assessments.

***This reviewer feels that there are a suite of improvements to make for the next benchmark assessment: 1) Thoroughly document the OLO MSY estimates, 2) Enable use of all of the CNMI CPUE data, 3) Investigate other prior distributions (e.g. uniforms) as well as document the various distributions used as well as show graphically how informative or uninformative they are, 4) Investigate environmental linkages, both long-term stock related and short-term fishing success related, 5) Investigate model fits without the OLO MSY estimates as tuning parameters, 6) Explore statistically models to confirm robustness of results (perhaps a good candidate for a model-averaging exercise using various data-poor approaches?).***

6. Summarize the strengths and limitations of the overall product.

***This reviewer feels that this product is quite strong given the compromised situation presented (short uninformative time series, questionable data in certain stanzas, multispecies agglomeration, etc.). The outputs are acceptable for fishery management purposes.***

7. If the assessment under review is found to be lacking in scientific robustness, identify an assessment previously used for the management of this stock that you consider to be more scientifically robust and explain why.

***This reviewer feels that this assessment update is not lacking in scientific robustness.***

## Appendix 1: Terms of Reference

Version: 6/12/2015

### **Stock Assessment Updates of the Bottomfish Management Unit Species of American Samoa, the Commonwealth of the Northern Mariana Islands, and Guam in 2015 Using Data through 2013:**

#### **Tier 3 WPSAR Terms of Reference**

The goals of this peer review are to:

1. Suggest any minor revisions that may improve the draft 2015 Territorial Bottomfish Stock Assessment before the National Marine Fisheries Service finalizes the assessments; and
2. Make recommendations regarding future research, data collection, and changes in methods that may improve future iterations of territorial bottomfish assessments.

To accomplish the stated goals, the Panel Chair will provide a consensus report and each reviewer will also provide an individual report addressing each of the terms of reference listed below. Reports should be provided to the Coordinating Committee at the close of the review. Any minority opinions will be recorded in the reports. WPSAR reports will be made public on the WPSAR website shortly after the review is closed. The reports must address the following Terms of Reference:

1. Review the soundness and reliability of the results and conclusions, including estimated population benchmarks and management parameters (e.g. MSY, Fmsy, Bmsy, MSST, and MFMT).
2. Review that the data and procedures used to produce the assessments are documented in sufficient detail so as to be reproducible.
3. Review that all scientific uncertainties and sources of statistical error are clearly identified and characterized.
4. Review that data source limitations, model assumptions, and gaps in scientific information are identified. Review that any decisions to exclude data from analysis are explained.
5. For consideration in future benchmark assessments, make recommendations regarding future research, data collection, and changes in methods that may improve future iterations of territorial bottomfish assessments.
6. Summarize the strengths and limitations of the overall product.
7. If the assessment under review is found to be lacking in scientific robustness, identify an assessment previously used for the management of this stock that you consider to be more scientifically robust and explain why.

## **Appendix: List of documents provided to WPSAR panel for review.**

### *Draft stock assessment under review:*

Yau A, Nadon M, Richards B, Brodziak J, Fletcher E (May 29, 2015) DRAFT Stock assessment updates of the bottomfish management species of American Samoa, the Commonwealth of the Northern Mariana Islands, and Guam in 2015 using data through 2013. NOAA Tech Memo NMFS-PIFSC-XX

### *Supporting documents provided for review:*

Brodziak J, O'Malley J, Richards B, DiNardo G (2012) Stock assessment update of the status of the bottomfish resources of American Samoa, the Commonwealth of the Northern Mariana Islands and Guam, 2012. PIFSC Cent Admin Rep H-12-04. 124 pp.

Humphreys R, Moffitt R (1999) Western Pacific bottomfish and armorhead fisheries. Unit 17 in Our Living Oceans. 4 pp.

Moffitt R, Humphreys R (2009) Western Pacific bottomfish and groundfish fisheries .Unit 17 in Our Living Oceans. 4 pp.

NMFS. 2009. Our living oceans. Report on the status of U.S. living marine resources, 6th edition. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-F/SPO-80, 369 p.

Oram R, Flores Jr T, Tibbatts B, Gutierrez J, Gesner JP, Wusstig S, Quach M, Hamm D, Tao P (2011) Guam boat-based creel survey documentation. 23 pp.

Oram R, Flores Jr T, Tibbatts B, Gutierrez J, Gesner JP, Wusstig S, Quach M, Hamm D, Tao P (2011) Guam shore-based creel survey documentation. 19 pp.

Oram R, Roberto R, Trianni M, Quach M, Hamm D, Tao P (2011) Saipan boat-based creel survey documentation. 22 pp.

Oram R, Roberto R, Trianni M, Quach M, Hamm D, Tao P (2011) Saipan shore-based creel survey documentation. 16 pp.

Oram R, Tuisamoa N, Tomanogi J, Sabater M, Quach M, Hamm D, Graham C (2011) American Samoa boat-based creel survey documentation. 14 pp.

Oram R, Tuisamoa N, Tomanogi J, Sabater M, Quach M, Hamm D, Graham C (2011) American Samoa shore-based creel survey documentation. 33 pp.

Polovina JJ, Ralston S (1986) An approach to yield assessment for unexploited resources with application to the deep slope fishes of the Marianas. Fish Bull 84:759-770.