2023 Guam bottomfish management unit species data workshops

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Cover photo: A typical targeted deep bottomfishing catch of Etelis coruscans (onaga) in brine to retain freshness of the catch for the Guam market. Photo credit: NOAA Fisheries. Photographer: James Borja

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Executive Summary

In 2019, the NOAA National Marine Fisheries Service's Pacific Island Fisheries Science Center (PIFSC) Stock Assessment Program (SAP) released its benchmark, "Stock Assessments of the Bottomfish Management Unit Species of Guam, the Commonwealth of the Northern Mariana Islands (CNMI), and American Samoa" (Langseth et al. 2019). In the report, the territories' bottomfish stocks were determined to be overfished and experiencing overfishing (American Samoa), overfished and not experiencing overfishing (Guam), and neither overfished nor experiencing overfishing (CNMI). Fishing communities from American Samoa and Guam responded with disagreement on assessment outcomes, frustration with a lack of communication prior to the release of assessment results, and distrust of fishery dependent data used in the assessment. These concerns highlighted the need to conduct territorial BMUS data workshops prior to the development of benchmark assessments. The territorial data workshop process began in American Samoa with an evaluation of available data for its benchmark assessment (Nadon & Bohaboy 2022), American Samoa's data workshop in 2022 (WPRFMC 2022a, 2022b), and subsequent stock assessment in 2023 (in review). This process serves transparency, relevance, inclusiveness, validation, and verification in the stock assessment process as required by National Standard 2 (50 CFR 600.315(a)(6)).

The Guam BMUS data workshops—staggered a year behind those of American Samoa, in congruence with their benchmark assessment timelines—were held on January 17th-19th, 2023. The primary goal of the workshops was to solicit input from the Guam Department of Agriculture's (DOAG) Division of Aquatic and Wildlife Resources (DAWR) and bottomfish fishers to contextualize data and apparent data trends available to PIFSC stock assessors for the 2024 Guam BMUS stock assessment. These workshops are distinct from complementary and parallel efforts of the Fishery Monitoring and Research Division (FRMD; parent division to the SAP). Parallel efforts include data collection improvements, revision of the bottomfish management unit species, and stock assessment improvements.

In addition to the Guam workshops' primary data evaluation goal, a number of supporting goals framed workshop planning and execution:

1. improve transparency around data considered during the stock assessment development;
2. facilitate learning and information exchange amongst Guam DAWR, bottomfish fishers, Western Pacific Regional Fishery Management Council (WPRFMC; hereafter referred to as "the Council"), and PIFSC staff through participatory processes centered around open dialogue;

3. enable new connections between Guam bottomfish fishery stakeholders and PIFSC staff; and

4. document workshop process for continued learning to improve PIFSC engagement processes.

The workshop planning team, composed of this report's authors, conducted a series of brainstorming sessions on the approach to the Guam BMUS data workshop. Major considerations included the state of the relationships between local fishery agencies and fishing communities, and between groups within the fishing communities. The FRMD director, supported by the workshop planning team, coordinated with DOAG and DAWR leadership to:

1. facilitate DAWR and PIFSC staff attendance at each of the workshops,

2. invite agency-external attendees, and

3. coordinate workshop presentations from PIFSC and DAWR staff.

The data workshop convened over a period of three days, each with a specific group: one workshop for DOAG and DAWR staff, one fisher workshop dedicated to members of the Guam Fishermen's Cooperative Association (GFCA), and one fisher workshop dedicated to non-GFCA members. The workshops focused on soliciting data and fishery related insights supported the invitation of select, experienced bottomfish fishers rather than a publicly available and advertised event. Fishers were identified and invited based on their bottomfish fishing experience, willingness to participate in federal fisheries data collection programs, and referrals from other bottomfish fishers and agency staff.

Workshops began with SAP and DAWR presentations, which provided overviews of stock assessment science, creel survey design and implementation, expansion of creel survey data, and the stock assessors' evaluation of available data for the 2024 Guam BMUS stock assessment (Appendix B). The SAP also provided an informational presentation requested by bottomfish fishers during fishing community engagement in November 2022, which included the effects of bad weather days in the catch expansion and a summary of the fishery's performance. Following presentations, participants were divided into breakout groups based on the relevance of guiding breakout group questions to different participants, and the intent to create environments in which participants felt comfortable speaking within their groups.

At the DAWR workshop, DAWR staff were separated into two groups: one group consisted of more active creel survey technicians, and the other consisted of administrators and (boat-based creel survey) leadership. Fisher workshops were attended by those with both deep and shallow bottom fishing experience, non-bottomfish fishing methods (e.g., spearfishing, trolling, netting), and purchasing bottomfish for sale. Participating fishers described fishing for various reasons including

subsistence, for sale, and for sharing within community and amongst family. Fishers were divided into groups based on their level of comfort with one another, fishing experience, and age range.

Breakout group discussions provided information about the bottomfish fishery's cost and materials, trip timing, geographic variability, target species, and marketing strategies. Fishers also shared information about the factors that affect their fishing decisions and success. Attending fishers and DAWR staff offered insights from their experience about the identification and reporting of fish species names and the types of BMUS that are caught together. Finally, attendees offered information about variability in data trends through time, identified gaps in the creel survey, discussed challenges in creel survey implementation, and commented on voluntary data reporting.

Identified priorities for creel survey implementation included getting more "full" creel interviews (in which time is available and taken to count and measure each fish), and taking the time to ensure that oft-assumed information is correct (e.g., rods used, type of trip). Workshop discussions highlighted several challenges to creel survey implementation, as well as enabling factors that would support DAWR implementation of the PIFSC creel survey design. Supporting measures include staffing two survey technicians during busy shifts (e.g., weekend evenings), which is a matter of funding additional personnel; mandatory reporting or participation in DAWR creel interviews; and electronic data collection systems to improve surveyors' efficiency. Pursuing electronic data collection systems is a priority for 2024, and PIFSC hopes to include in such a system photo measurement and species identification capabilities at a later time (possibly within the next five years).

Another strategy to improve surveyors' efficiency arose during workshop discussions related to creel survey design. Participants described a large fleet of small boat fishers that could warrant a distinct category of "fishing type" in the survey. This large fleet was described as largely commercial, employing relatively small vessels, and targeting primarily skipjack using a highly specialized method of handlining. Given this fishery's described volume and fishing frequency, establishing a distinct data collection category in the creel survey could reduce the amount of time spent surveying this group, and allow for the redistribution of survey technician's time to lower volume, more data poor fisheries.

Participating stock assessors highlighted several discussion points that were the most helpful to understand bottomfish fisheries. The experiences of attending fishers agreed with many trends apparent in the boat-based survey participation and landings estimates. These experiences included an increase in deep water bottomfishing in recent years (especially since the COVID-19 pandemic), high variability in bottomfish catch between years (which often spiked in 2-7 year cycles, as seen with pelagics like

mahimahi and wahoo), and that some BMUS are only rarely landed because they are generally undesirable (e.g., *Caranx ignobilis* or mamulan) or not commonly caught (e.g., *Variola louti* and *Pristipomoides sieboldii*). Regarding species identification, workshop participants confirmed that *Etelis boweni*—a relatively newly identified species of ehu formerly thought to be *E. carbunculus*—are present around Guam and caught by fishers. DAWR staff expressed confidence in their abilities to differentiate all sizes of *E. boweni* from *E. carbunculus*. Fishers can tell the difference between large *E. boweni* and *E. carbunculus* (often based on shape of the tail) and showed interest in learning more. Discussions also highlighted confusion between *P. sieboldii* and *P. filamentosus* over the boat-based creel survey time series with improvements to identification since 2014.

Importantly, the Guam data workshop process was informed by its engagement-focused, relational, supporting goals. These goals required the planning team to carefully consider existing relational challenges to create a safe space for sharing of perspectives by DAWR staff and bottomfish fishers. Preliminary consultation with workshop attendees prepared the planning team for challenges that might arise during workshops, and enabled the tailoring of workshop content and structure to participants' needs. Numerous meetings between key PIFSC and DAWR staff enabled staff to raise concerns about attendance, workshop format, attendee roles, and for the planning team to respond with an adaptive workshop structure. This reinforced the agency-agency commitment to maintain cooperative focus on the workshop goal and redirect any unhelpful blame-placing commentary that might arise during the week.

The planning team also consulted with key bottomfish fishers numerous times on what approach would be effective and how to maximize information flow. This allowed fishers to take ownership of the process. In several instances, this empowered key fishers to defuse rising tensions between attending fishers and scientists, and to refocus the group on the workshop purpose. Fisher consultation, consistent communication, and coordination prior to and during the workshops would not have been possible without the cooperation of a knowledgeable, community-imbedded planning team members, such as Eric Cruz.

A number of other strategies identified by Iwane et al. (2022) were employed during these workshops in pursuit of its aforementioned supporting goals. Separate workshops hosted different audiences (DAWR, GFCA fishers, and non-GFCA fishers, respectively) and employed breakout sessions to minimize conflict and encouraged open discussions in more intimate settings. Ground rules, attendee roles, and facilitation capacity distributed over a number of supporting PIFSC and Council staff allowed for adaptive teamwork to maintain focus on workshop goals and document attendee input.

Critical to the workshops' success was coordinated support from leadership and staff at multiple levels. Stock assessment data workshops are not required or clearly incentivized by institutionalized best scientific practices (Iwane et al. 2022), but were made a priority by FRMD leaders and staff. The participation of bottomfish fishers, DOAG and DAWR leadership and staff, Council members and staff, and multiple federal scientists with expertise in stock assessment and creel survey design demonstrated a shared commitment to hear and learn from one another about the bottomfish fishery, data collection, and stock assessment. FRMD staff participation also demonstrated federal scientists' value of fisher knowledge, and recognition that such knowledge can inform quantitative processes like data collection and stock assessment development.

In consulting with local agencies and bottomfish fishers prior to data workshops, responding to their expressed concerns and questions, and designing a process that prioritized the voice and knowledge of those previously excluded from the stock assessment data evaluation process, this engagement process embodied several Equity and Environmental Justice (EEJ) values and objectives. The workshops establish a new precedent for consulting Guam bottomfish fishers, creel survey technicians, and data managers prior to the development of the BMUS stock assessment.

The application of workshop insights in stock assessment will be documented and presented back to workshop participants in a BMUS Data Workshop Feedback Meeting (projected for 2024). The draft stock assessment is scheduled for review in February or March of 2024. The final stock assessment, once it passes peer-review, is projected to be presented to the Council in June 2024.

Introduction

The NOAA Fisheries Pacific Island Fisheries Science Center (PIFSC) provides the science used for federal fisheries management in the Pacific Islands region. The PIFSC Fisheries Research and Monitoring Division (FRMD) Stock Assessment Program (SAP) produces the stock assessments for the management unit species (MUS) described in the Fishery Ecosystem Plans (FEPs) of the Western Pacific Regional Fishery Management Council (WPRFMC; hereafter referred to as the "Council"). The stock assessments are the basis for the stock status determination and Annual Catch Limit management. The process of developing stock assessments to make a "best scientific information available" (BSIA) determination are guided by several policies, namely, National Standard 2, NMFS policy directive 01-101-10, the regional Western Pacific Stock Assessment Review (WPSAR), and the regional BSIA Framework. Currently, the stock assessment development process is internal to FRMD to maintain scientific independence and integrity.

In 2014, a Center for Independent Experts (CIE) review rejected the main Hawaiian Islands deep-seven benchmark assessment on the basis that the deficiencies in input data quality caused the stock assessment to have serious flaws that compromised its utility for management. Subsequently, FRMD SAP initiated the first stock assessment data workshop (Yau 2018). The intent of the data workshop was to identify and agree upon issues that affected the quality and consistency of the fishery dependent data, and to investigate and agree upon acceptable resolution to each issue identified.

The need for a data workshop again emerged with the release of the 2019 benchmark, "Stock Assessments of the Bottomfish Management Unit Species of Guam, the Commonwealth of the Northern Mariana Islands (CNMI), and American Samoa" (Langseth et al. 2019). This time, the main driver for data workshops was not a failure to pass the WPSAR, but general disagreement of the fishing community on the outcome of the assessment, frustration with a lack of communication prior to the release of assessment results, and distrust of the fishery dependent data used in the assessment.

These events highlighted the need to conduct territorial BMUS data workshops prior to the development of benchmark assessments, starting with an evaluation of available data for American Samoa's benchmark assessment (Nadon & Bohaboy 2022), American Samoa's data workshop in 2022 (WPRFMC 2022a, 2022b) and subsequent assessment in 2023 (Nadon et al. 2023) to promote transparency, relevance, inclusiveness, validation, and verification in the stock assessment process as required by National Standard 2 (50 CFR 600.315(a)(6)). Data workshops would allow for inclusion of the fishing community on the science used to manage the fishery they participate in.

The Guam BMUS data workshops were held on Guam from January 17-19, 2023. The information gathered at the workshop enabled the scientists to proceed to the modeling phase of the assessment process. How the scientists utilized the information will be documented and presented back to the workshop participants in a BMUS Data Workshop Feedback Meeting. This community engagement allows the fishing community to track the progress of the stock assessment development. This is projected for 2024. The draft stock assessment is scheduled for review in February or March 2024. The final stock assessment, once it passes the peer-review, is projected to be presented to the Council in June 2024.

The process

The primary goal of the workshops was to solicit input from the Guam Department of Agriculture's (DOAG) Division of Aquatic and Wildlife Resources (DAWR) and bottomfish fishers to contextualize data and apparent data trends available to PIFSC stock assessors for the 2024 Guam BMUS stock assessment. Importantly, this workshop's purpose centered on data evaluation. The workshops were, therefore, distinct from FRMD's complementary and parallel efforts including data collection improvements, revision of the bottomfish management unit species, and stock assessment improvements.

Given the multifaceted impetus for this work as outlined in the background, a number of supporting goals framed workshop planning and execution.

- Improve transparency around data considered during the stock assessment development;
- Facilitate learning and information exchange amongst Guam DAWR, bottomfish fishers, Council, and PIFSC staff through participatory processes centered around open dialogue;
- Improve access of Guam bottomfish fishery stakeholders to PIFSC staff (and vice versa);
- Document workshop process for continued learning to improve PIFSC engagement processes.

This report fulfills the fourth supporting goal.

Planning

The workshop planning team, composed of Marlowe Sabater, Eric Cruz, and Mia Iwane, conducted a series of brainstorming sessions on the approach to the Guam BMUS data workshop. Major considerations included the state of relationships between the local fishery agency and the fishing community and between various groups within the fishing community. In order to address these considerations, the data workshop was convened over a three-day period, each with a specific group: one workshop for the DAWR, one fisher workshop dedicated to members of the Guam Fishermen's Cooperative Association (GFCA), and one fisher workshop dedicated to non-GFCA members.

The intent was to have individual agency staff and fishers attend only one of these meetings as active participants, which allowed for the tailoring of breakout group questions (e.g., for survey techs vs. bottomfish fishers) and maximized our ability to engage more deeply with each group in a social setting comfortable to them. Another consideration was that many bottomfish fishers have full-time jobs during weekdays. In

early discussions, the planning team reflected on the accessibility of evening meetings for fishers. However, discussions with fisher invitees revealed that daytime meetings were feasible with sufficient lead time. Additionally, longer daytime meetings (as opposed to ~3hr evening meetings) accommodated the breadth of presentation and breakout question foci relevant to the workshops.

Participants were invited to the data workshop by the Directors of FRMD and DOAG. The invitation memos can be found in Appendix A. The DOAG Director sent the invite to the DAWR staff. The FRMD Guam Territorial Liaison (GTL) sent the invitation to the University of Guam (UOG), the Bureau of Statistics and Plans (BSP), and the NOAA Office of Coastal Management (OCM) staff. The workshops' focus on soliciting data and fishery related insights supported the invitation of select, experienced bottomfish fishers rather than a publicly available and advertised event. Therefore, based on the GTL's knowledge and experience with the local bottomfish fishery, a list of known bottomfish fishers was compiled.

Fishers were included based on their bottomfish fishing experience, willingness to participate in federal fisheries data collection programs, and recommendations from bottomfish fishers already on the list. This list contained fishers that were either members of the GFCA or non-members. The GFCA was given hard copies of the invitation as well as an electronic copy to provide to its members. The GTL invited members of the GFCA and non-GFCA members through WhatsApp or email, as well as through in-person communication. Invitations were also sent to the Council's Advisory Panel. Fishers were invited to a specific day, however, if they had scheduling conflicts or preference, they were given an option to attend the other workshop day.

Based on the confirmed participants, the workshop planning team looked into several venues that would be suitable for each of the workshops. The Hilton Gallery Ballroom was selected for the DAWR workshop because of its availability, capacity, and available equipment. Fisher workshops were located at the PacAir Properties Guam Integrated Air Cargo Facility[1] because it is more centrally located and more stakeholders were expected to attend.

The FRMD director, along with the workshop planning team, coordinated with leadership from DOAG and DAWR to 1) facilitate DAWR staff attendance at each of the workshops, 2) facilitate PIFSC and DAWR-external attendees' presence at the DAWR workshop, and 3) dedicate presentation time to DAWR staff as an opportunity for PIFSC staff to learn more about DAWR operations. PIFSC staff were especially interested in DAWR implementation of the offshore (or boat-based) creel survey. A discussion was

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[1] 770 East Sunset Blvd, Suite 234, Tiyan

facilitated amongst FRMD staff that would later attend the data workshops to produce this list of prompts for the DAWR presentation.

- What facilitates and hinders interviews
  - Under what circumstances do the number of planned surveys exceed the number of completed surveys?
  - What is the minimum data you try to collect during a creel survey, and in what situations do you try to collect beyond that minimum?
    - In what circumstances are cooler weights estimated vs. measured?
    - In what circumstances are a few fish selected for measurement vs. each fish catalogued?
  - How are calculated weights determined, step-by-step (e.g., from coolers to inputted data)?
- Sampling practices
  - Is the Shiny app still used to select sampling days? When do you reschedule sampling days? How do you select rescheduled sampling days?
  - How do high surf/small craft advisories affect sampling?
- What is included in the data
  - Do you count trailers when they aren't attached to a vehicle?
  - Are kayaks included in boat-based surveys?

These prompts and presentation parameters were shared with DAWR leadership, who elected Tom Flores, Jr. (manager of boat-based creel survey program) as presenter.

Facilitation and workshop structure

Three approximately six-hour days comprised the workshops. The DAWR workshop was held on January 17, 2023, the GFCA-external fisher workshop was held on January 18, and the GFCA-internal fisher workshop was held on January 19. Each day's agenda (Appendix B) consisted of morning presentations and afternoon breakout sessions. The morning presentations served to contextualize the workshop for attendees. Afternoon breakout sessions served to elicit attendees' insights around DAWR operations, fishery operations, and data available for the 2024 BMUS stock assessment. Each workshop day began with attendees introducing themselves, and facilitators establishing ground rules and attendee expectations (see Appendix C for a full list of workshop attendees). These ground rules and expectations served to ensure progress toward the workshops' aforementioned primary and supporting goals.

Ground rules included:

- Listen to others' input with respect and an open mind.
- To maximize our shared time/commitment, we will
  - adhere to the agenda as much as possible,
  - limit questions/discussion to 3-min/person at a time,
  - limit phone usage and side conversations to break times.
- Hold questions until the end of presentations, using notepads to record your comments.
- Tabled discussions tangential to the workshop foci will be noted in the parking lot/ "Idea Marina[2]".
- Try to stay for the duration of the workshop.

Attendee expectations were discussed for both morning and afternoon workshop sessions (Table 1, Table 2). In the mornings, presenting PIFSC and DAWR staff occupied information provision roles, while others were encouraged to ask questions. In the afternoons, DAWR staff's input would be prioritized at the DAWR workshop, and fishers' input prioritized at the fisher workshops (Table 1, Table 2). Those who attended workshops on multiple days were asked to wear different "hats" (i.e., prioritizing their DAWR roles on day one and their fishing experience on day two) to avoid redundant input. Additionally, in an effort to limit overrepresentation of any one attendee's perspective, comments and questions from DAWR and fishers attending for the first time were prioritized by facilitators. Select UOG, BSP, and NOAA OCM staff were invited by PIFSC and DAWR organizers to the DAWR workshop primarily for their awareness (Table 1).

Table 1. DAWR workshop expectations.

	AM Presentations	PM Breakout sessions
NOAA Fisheries staff	**Provide information** - Stock assessment process - Data available for Guam's 2024 BMUS assessment	**Listen + learn** **Remain available** to answer questions about data expansion an interpretation
DAWR staff	**Provide information** - Creel survey	**Offer insights** about data collection and management

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[2] A centrally located poster board capturing discussion points not directly relevant to workshop agenda items.

		through time to provide context for data trends
Council staff	**Listen + learn** **Remain available** to answer questions	
BSP; UOG; NOAA OCM	**Listen + learn**	

Table 2. Fisher workshop expectations.

	AM Presentations	**PM Breakout sessions**
NOAA Fisheries staff	**Provide information** • Stock assessment process • Data available for Guam's 2024 BMUS assessment	**Listen + learn** **Remain available** to answer questions about data expansion an interpretation
DAWR staff	**Provide information** • Creel survey implementation • Data management processes	**Offer insights** about data collection and management through time to provide context for data trends
Council staff	**Listen + learn** **Remain available** to answer questions	
BSP; UOG; NOAA OCM	**Listen + learn**	

During their opening remarks, FRMD and SAP leadership established that these workshops were a response to concerns about the lack of engagement around the previous bottomfish stock assessment. They clarified that the workshops' purpose was not to discuss or determine management decisions, but to gather insights from the local agencies and fishers to contextualize data that stock assessors had access to for the 2024 Guam BMUS benchmark stock assessment. An "Idea Marina" poster was maintained to document themes and ideas raised over the course of the data workshops that did not pertain directly to the workshops' focal topics. This allowed

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facilitators to acknowledge and document emerging issues, while refocusing the group's efforts on the day's goals.

Finally, scientists from the SAP and DAWR shared information about their work and key concepts that would prepare attendees for the afternoon breakout groups. These included overviews of stock assessment science, creel survey design and implementation, expansion of creel survey data, and the stock assessors' evaluation of available data for the 2024 Guam BMUS stock assessment (Appendix B). The SAP also provided an informational presentation requested by bottomfish fishers during fishing community engagement in November 2022. Fishers wanted to know the effects of bad weather days in the catch expansion and requested a summary of the fishery's performance.

Lunch was shared onsite to encourage workshop participants' co-mingling and start building long-term relationships.

Breakout sessions

Stock assessors prepared breakout questions for the DAWR (Appendix D) and fisher workshops (Appendix E) as a resource to guide afternoon breakout sessions. The questions prompted DAWR staff and fishers for observations and operational insights to contextualize available data. However, the application of breakout questions varied according to each individual's group experience and discussion flow.

Breakout groups were determined by a number of factors that balance two priorities: 1) the relevance of questions to different groups of participants, and 2) creating an environment in which participants feel comfortable speaking in front of one another. Stock assessors also requested that to maximize the number of breakout group questions covered by each group, breakout groups contain 3-4 participants each.

At the DAWR workshop, DAWR staff were separated into two groups: one group consisted of more active creel survey technicians, and the other consisted of administrators and (boat-based creel survey) leadership.

Fisher workshops were attended by those with deep and shallow bottom fishing experience, in addition to experiences in non-bottomfish fishing methods (e.g., spearfishing, trolling, netting etc.) and the purchase of bottomfish. Participating fishers described fishing for various reasons including subsistence, for sale, and for sharing within community and amongst family. Although it was expected that fisher workshop participants might be divided by parameters such as their target species or years of fishing experience, most attendees had deep bottom fishing experience. Eric Cruz, given his familiarity with the participants, divided them into groups keeping in mind their

level of comfort with one another, fishing experience, and age range. This process resulted in 2-3 breakout groups on each workshop day, with 2-4 participants per group.

During breakout sessions, PIFSC and Council staff were assigned roles such that each breakout group had dedicated facilitation and notetaking capacity (Table 3). Those not in assigned roles were allowed to observe discussions and answer questions, if asked by breakout group participants.

Table 3. Non-participant breakout group roles.

Role	# per group	Role description	Assignee background
Facilitator	1	Lead breakout group participants through discussions, using breakout questions as needed (Appendix C, D). Create opportunities for those who are less vocal to add to the discussion. Welcome/expect different points of view. Feel free to reference the ~3-min ground rule (limit to comments made by one person at a time).	Ideally a stock assessor or one familiarized with stock assessment processes, not in a perceived leadership position in the context of the workshop.
Note taker (poster)	1	Capture participants' language and key messages on poster paper visible to all participants to visualize and encourage their input. Use the "Idea Marina" as needed to acknowledge comments not directly related to the discussion. Provide facilitation support as needed.	Ideally one with facilitation experience, not in a perceived leadership position in the context of the workshop.
Note taker (digital)	1	Capture participants' words with as much detail and accuracy as possible. Provides a more detailed, easily shareable record.	-
Floating mediators/ Timekeeper	1-3 (per workshop)	Monitor breakout group discussions and provide facilitation support as needed.	Familiarity with diverse workshop participants, ability to restore order with diplomacy.

At the end of each day, photos were taken of all poster papers from breakout sessions and the "Idea Marina". These photos were uploaded to a central folder and digitally transcribed. The digital note takers' documents were also compiled in a central folder. These notes were cross-referenced, reviewed, and are synthesized below.

Additionally, the PIFSC team congregated to discuss amendments to presentations and workshop format for the following day. This resulted in reordered, and sometimes altogether eliminated, presentations where timing was an issue. For example, on the final workshop day, morning presentations were abridged given the smaller number of fishers attending and a late start due to road damage issues and subsequent traffic delays. Most commonly, however, end-of-day discussions resulted in streamlined presentations that used fewer slides to convey messages perceived as more relevant to the audience.

Breakout group discussions

Below we present key themes relevant to bottomfish fishery operations and data collection that emerged during breakout group discussions. Some themes and ideas raised over the course of these data workshops do not pertain directly to the workshops' focal topics. We maintain them in Appendix F. Idea Marina for our records.

Fishery characterization

Stock assessors sought information about participants' experiences in the fishery and the choices fishers make while bottomfishing. For example, when stock assessors generate time series of catch-per-trip data, it is helpful to know which species were targeted on a trip.

Deep bottomfish fishery

Participants that offered their years of bottomfish fishing experience had between four and ten years of deep bottomfish fishing experience with fishing frequencies ranging from a few times a week to twice a month.

Participants described the deep bottomfish fishery as abundant, "[you] just have to know where to find them," and as one in which learning from others was key. The deep bottomfish fishery operates at depths of up to 900ft. It is a seasonal fishery with participants that target non-bottomfish species during the summer (e.g., pelagics) and when weather is unfavorable. For this reason, the seasonality of bottomfish species themselves was difficult for some fishers to comment on.

The motivation and strategy of bottomfishers was described as diverse by attendees with some taking home 5-6 pieces on a trip, and others taking home 60-70. One breakout group noted that fishing is not as good now as it was before, given increasing fishery participation. There was agreement around an influx of bottomfish fishery participation during the pandemic, which coincidentally aligned with an unusually long, calm bottomfishing season.

Cost and materials

Participants described fishing in the '80s using handlines and big reels. This is in contrast to bottomfishing of today, which uses smaller, electric reels, and lighter line and weight. Other equipment might include transducers for fish finders. One attendee said, "those with large transducers will catch." Another fisher estimated that the gear and electronics typically used to bottomfish today cost $10K on the low end with one trip costing around $500. One fisher added, bottomfishing is, "not a poor man's game." As a matter of preference, some bottomfish fishers anchor, and others drift.

Participating fishers described different types of vessels used for fishing including an aluminum monohull, a double hull catamaran, and an inflatable boat. These different vessel types, in addition to varying vessel lengths ranging from 17ft to 30ft, offered access to different types of boat launches. For example, a 17ft flatboat allowed one fisher to exit the ocean in shallow areas without boat ramp infrastructure, as on Guam's east coast.

Trip timing

Attending fishers that commented on trip timing seemed to prefer to bottomfish during the day. One fisher commented that fishing from 6 pm-6 am might fill ⅓ cooler, whereas 6 am-6 pm fishing could fill a cooler. However, in some instances nighttime fishing might be preferable For example, if moon phase and tidal conditions were favorable or certain species were being targeted, like mafute'. Or, perhaps, if an individual's lifestyle was conducive to it: one fisher noted a preference to fish from 7 pm-7 am, before going to work. One fisher commented that during a given trip, the bite is not continuous, perhaps with a 20-minute window of action within eight hours of fishing.

Geographic variability

Attendees described northern islands like Farallon de Mendenilla as surrounded by cooler, cleaner water, with abundant fish (even "too much," resulting in bait and time lost to unwanted species) including onaga. Although some described the banks as more consistent and abundant fishing spots, others preferred to avoid them due to high travel costs and time, lots of sharks, and boat crowding, despite what they perceived as the same amount of fish.

Fishers described increased participation making it harder or less appealing to catch fish on Guam (e.g., six to seven boats at Ritidian or Tarague on Guam) or at the banks (e.g., 15 boats in an area).

On Guam, the east coast was described as relatively "pristine" given the absence of boat ramps and its rougher waters for 65-75% of the year.

What to target and market

Amongst participants, preferred target species within the BMUS included kalekale, mafute', onaga, and opakapaka. Given the cost of boat fishing, however, many fishers talked about bringing mixed gear types to ensure they could recover some trip costs with catch. This could look like switching between bottomfish, net, troll, or spear fishing. Some described switching from deep to shallow bottom fishing when the bite wasn't good, noting "shallow is a guarantee, you will always catch something."

Participants that commented on the marketing of their fish described selling 70-100% of their bottomfish catch to restaurants, the co-op, or family members. They described local demand as limited, with tough prices, making bottomfish sales competitive: "[you] gotta beat out others to restaurants." One fisher commented on the calculus required to determine what you will target during a fishing trip. Bonita (skipjack tuna) and yellowfin tuna, for example, "will eat up ice" and have diminishing returns on the market.

One buyer noted that in 2020-2021 onaga catches were high, with more bottomfish supplied than pelagics.

Fishing factors

The impact of rough weather to creel survey sampling and fishing decisions was of interest to stock assessors because, "bad weather is a recurring topic in our discussions with fishers, and we want to understand how it impacts the data." DAWR staff noted that surveys are only canceled for tsunami warnings or when Guam is placed in Tropical Cyclone Condition of Readiness 2. Participating fishers said they would go out during high surf or small craft warnings. As warnings are coastline-specific, fishers willing to make the 20-minute drive might depart from Agat marina (which was described as "more forgiving") when Agana boat basin is closed due to bad weather. Ultimately, and particularly for more experienced fishers, "as long as you can make it out of the channel it's a go."

Fishers may cancel trips, however, under typhoon conditions, with gale force winds, or when swells exceed 12 ft. These thresholds are specific to individuals. Other fishers talked about preferring <4 ft waves for small boat or spearfishing, or withstanding 4-6 ft seas and 18-20 knot winds during bottomfishing.

Other factors that affect fishing or fishers' decision-making include wind, tide, water conditions, moon phase, current, water temperature, infrastructure, and cost (e.g., fuel prices). For example, cold fronts bring fish closer to shore. If the channel lights are out, fishers may end their fishing trip. And, if the current is too strong, it is difficult to drop fishing lines to bottomfish.

Species identification and groupings

We can learn about rare fish species from more common species that it is caught together with. See Table 4 for details about species groupings and other species-specific insights provided during breakout groups. Importantly, the participants identified the yellow group in Table 4 as shallow water BMUS: blackjack, giant trevally, mafute', funai, and gådao. The cool toned groups comprise those identified as deep water BMUS by participants: yellowtail and pink kalekale, gindai, lehi, yellow eye and pink opakapaka, ehu, and onaga. The color coding represents general trends in the way that

fishers described species typically caught together. However, fisher participants cited several different combinations of species caught together amongst the deep water species. Some of these are detailed in bolded text in the "Notes" column of Table 4.

Species identification and names

Participants noted challenges distinguishing between Pristipoimoides species, particularly after fish become rigid in coolers. One group noted that pink kalekale (*P. sieboldii*) and yellow eye opakapaka (*P. flavipinnis*) look identical when large. Several participants noted that the most challenging to differentiate are the nearly identical pink kalekale (*P. sieboldii*) and pink opakapaka (*P. filamentosus*).

Both survey technicians and a fishers in attendance felt confident in differentiating between *Etelis carbunculus* and *E. boweni* since the latter (giant ehu) was described two years ago.

Participants noted species identification of smaller red fish could be difficult unless the fish is an onaga.

DAWR survey technicians described their effort to use common names (whether Chamorro, Spanish, Japanese, or Hawaiian) despite some challenges. For example, in Guam "bonita" refers to skipjack tuna; in Hawaiʻi, the similar "bonito" refers to a mackerel tuna, or "kawakawa"; and, in the Marianas, "skipjack" is sometimes used to refer colloquially to trevally.

Table 4. BMUS insights from breakout group discussions, bold text details catch groups or change through time.

Color-coded by "fish caught together"	Depth (ft)	Size	Species	Notes
I'e/Tarakitu/ Mamulan/Jacks/ Trevally (*Caranx* spp.)	200-300; Min. 60?	-	Blackjack (*C. lugubris*) Giant trevally (*C. ignobilis*) Bigeye trevally* (*C. sexfasciatus*) Bluefin trevally* (*C. melampygus*)	• I'e has own code in DAWR data, mostly *sexfasciatus* and *melampygus*, less commonly *ignobilis*, never *lugubris* • I'e and tarakitu size preferred by locals for pan frying/consumption • Mamulan size preferred for sport, "social media catch", not for consumption by locals and market (e.g., sashimi) • More incidental catch for bottomfish fishers, target for spearfishers • More active/hunting when moonlight available • Ciguatoxic • **Perhaps decreasing in size over time, but abundant**
Mafute' (*L. rubrioperculatus*)	200-350; Min. 60? Max. 600?	-	-	• Most abundant BMUS (can easily fill ½-⅔ cooler), esp. up north or at southern banks; **getting bigger through time** • **Catch data decline may be "because no one is catching/targeting"** • Can fish at night • Caught for fiestas, not sold

Color-coded by "fish caught together"	Depth (ft)	Size	Species	Notes
Funai/Saas/ "Blueline snapper" (*L. kasmira*)	200-350; Min. 60	-	-	• Abundant; **getting bigger through time** • Not targeted; sometimes given away or sold • "Hogs" - will bite hooks before others • Fished at night
Gådao (*Variola louti*)	200-450; Min. 60?	-	-	• Ciguatoxic, but preferred eating fish for some • May catch 1-2 at a time; other species (e.g., mafute') bite first • Caught shallow bottomfishing or switching methods (troll/shallow/deep)
Kalekale (*Pristipomoides* spp.)	500-700	Some areas 1-2lb; 3-4lb at calmer southern banks	Yellowtail kalekale (*P. auricilla*) Pink kalekale (*P. sieboldii*)	• Most prominently represented BMUS in creel survey • **Caught through the years at different depths, ranging 300-900ft** • Season: March/April to August • *P. auricilla* **can be caught <500ft w/ shallow group** • *P. sieboldii* uncommon; "shallower than onaga, deeper than kale" • **Check Southern Oscillation Index/shifts in *P. sieboldii* distribution**

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Color-coded by "fish caught together"	Depth (ft)	Size	Species	Notes
Gindai (*P. zonatus*)	650-800	1-5lb	Blue-lined and regular gindai?	• **Can be caught <500ft w/ shallow group** • **"Where there is onaga, there is ehu and gindai"** • "Fishers get excited when they catch this" • Not caught in great numbers, maybe 3-4 pieces at most • Caught for self self consumption, primarily incidentally
Lehi (*A. rutilans*)	450-800	-	-	• **Can be caught <500ft w/ shallow group** • **Wider depth distribution than others, but elusive** • Not preferred for market • 2020 great year for onaga and lehi; 2021 no lehi • Decrease in size, amount, # of locations present through time
Opakapaka (*Pristipomoides* spp.)	500-600	10lb record for yellow eye opakapaka	Yellow/golden eye opakapaka (*P. flavipinnis*) Pink opakapaka (*P. filamentosus*)	• Abundant, strong • Sharks like this fish • Marketable, $9/lb • See 3 different types, but names not always known • Yellow eye more common than pink opakapak • **Pink opakapaka hard to catch, patchy, started seeing more in 2020** • **Pink opakapaka can mix with onaga and lehi**

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Color-coded by "fish caught together"	Depth (ft)	Size	Species	Notes
Ehu (*E. carbunculus*)	750-800	2-3lb+	-	• Less common • **Size seems to be increasing over 2-year span** • Onaga more dominant; bites more readily if ehu and onaga present • Good steamed!
Giant ehu* (*E. boweni*)	-	Largest 50lb	-	• Some participants comfortable identifying since described 2 years ago
Onaga (*E. coruscans*)	400+; One of deepest	12-13lb average; sometimes 4-5lb	-	• Typically deep water fish but can be caught 400-600ft, e.g., in areas where waters are cooler • Drop to eat in the morning or afternoon • Too much (moon)light, onaga "go away" • Jan-March and June-Sept better fishing • Presence once day, absence the next not uncommon • **Size and appearance vary through time; temporal pattern** • More shark interactions through time
Monchong*	400-1400	-	-	• Big, elusive deepwater fish • Evening bite • Could be migratory

*Discussed during breakout groups but not represented amongst the 13 BMUS.

Data insights

Data trend variability

In Table 4, species-specific observations and hypotheses of change through time are among the bolded text. Other comments on change through time that may provide context for data trends include

- fishers entering/exiting the fishery;
- increased market incentive to target deep bottomfish in recent years;
- suggestions to examine bottomfish data trends alongside El Niño-Southern Oscillation patterns;
- five-year variability of pink opakapaka (*P. filamentosus*) and others seems plausible; and
- suggestions to examine the closure of fishing grounds alongside bottomfish data trends.

The latter suggestion can be contextualized by the closure of fishing grounds for military firing ranges. W-517 is a 14K square mile area closed for live fire that impacts all of the southern banks, at times for 100 days out of the year. The term "Marines Preserve" was used by participating fishers. Command has provided more outreach with regard to notices, but community members recommended that additional notices (e.g., flags, banners) be provided at boat launching areas and that impacts to fishing activity be minimized. One group suggested that the number of accessible fishing days and area be evaluated before and after the W-517 was implemented in 2010, looking at the impacts to bottomfish data trends.

Other data for consideration might come from UOG (e.g., Frank Camacho), marine surveys, biosampling data from ARC contractors, or polychlorinated biphenyl (PCB) surveys. The reference to a PCB survey effort was related to the PCB contamination around Cocos Island and Merizo village.

Data gaps

In the interest of identifying data gaps and blind spots, stock assessors prompted participants for their knowledge of areas and fishing periods that may not be captured in the creel survey design.

Trailer counts might overlook multiple boats that are dropped off by a single trailer, or trips returning into Tanguisson and Apra. Trailers present at marinas without a truck or many trailers parked long-term may also pose challenges for survey technicians. For

example, protocol dictates that surveyors note, but do not officially count, trailers without trucks. Trailer counts may also be overestimated because they do not directly indicate whether the trip was fishing in nature. Although it is possible to associate a trailer with a historically fishing boat, it does not guarantee that the boat engaged in fishing. This may inflate effort estimates if the boat was not intercepted for an interview.

Apart from the creel survey-monitored Agana Boat Basin, Agat Marina, and Merizo Pier, participants also identified the following areas as fishing departure points: Pago Bay, Achang Bay, Inarajan Bay, Talofofo, and Sumay marina. The infrastructural integrity of these areas to support boat launching is variable. One group noted that Ylig River used to host trailers and boats, but has since closed and is dangerous for boats to navigate. Additionally, stock assessors asked if catch in these areas differed from the survey-monitored areas. Fishers described Pago Bay catch including mafute', gindai, paka, and skipjack (more likely trevally than bonita/skipjack tuna), and Talofofo mostly being used by small 15-foot boats targeting atulai. One group identified Guam's northern Pati Point as fishable 3-4 days/year for "everything except onaga."

Stock assessors asked if fishing trips that return in the 12 am-6 am window differ from those outside that window. One fisher said that similar species can be caught at dusk or early morning, including shallower species. Participants noted that nighttime bottomfishers might head out before dark to target mackerel or sass (funai), or leave midday, stay overnight at the banks for mafute' or jacks, and return at 6 am. Other nighttime catch might consist of larger predatory fish like jacks (blackjack and giant trevally) and atulai, lililok, longtail mafute', squid, oilfish, and Pacific salmon (*Aprion virescens*). One group commented that there are no onaga at night, and other deep bottomfish like opakapaka are better caught outside the nighttime window.

For a few months in 2020, boat-based surveys were suspended due to the COVID-19 pandemic.

Creel survey implementation and challenges

In the '80s and again in 2017, DAWR ran 24-hour creel survey sampling periods to evaluate efficacy of shorter sampling periods in representing fishing activity on Guam. These evaluations found the shortened sampling periods currently used to have >90% coverage of boats either upon their departure or return.

DAWR survey technicians described encountering two boats on a typical shift, or four to five boats during a busy shift. Weekend evenings at Agana might yield the busiest survey shifts, with 20-30 returning boats. In this scenario, survey technicians are unable to interview many of these boats given the high volume and traffic through the area. Bottomfish and spearfishing interviews are particularly time consuming because of the

diversity of species caught. Other staff challenges in survey implementation include limited agency manpower.

In an ideal scenario with no time constraints, survey technicians would measure and log every fish caught. In reality, technicians typically grab the first three fish, at random, of each species represented in the catch.

DAWR staff described fishers refusing interviews for a number of reasons including lack of FADs, DAWR personnel, concerns about data being used to restrict fishing, and because they were instructed by vocal community members not to participate. Survey technicians expressed a reluctance to pursue interviews with uncooperative fishers. They also noted that fisher responses depend on the technician on duty.

Attending fishers expressed a willingness to commit 10-15 minutes to completing creel survey interviews. Attendees suggested that more sharing back of information (e.g., where the data goes) might help to incentivize participation in creel surveys. Others suggested that staff accommodate fishers by offering convenient alternatives to completing interviews on-site upon returning from fishing. For example, staff might pick up forms from fishers later, conducting surveys at residences, or making a drop box available for fishers to return filled forms.

Participating fishers and DAWR survey technicians that fish reported being surveyed infrequently during their fishing careers (e.g., one in eight years for inshore fishing, one to three times a year for boat-based fishing), but participating when approached for survey. An attending PIFSC scientist confirmed this is expected based on calculated sampling probabilities (see Appendix G for a complete description of these calculations), which include the following highlights: A fisher has a 7% chance of seeing the creel on a given random boat-based fishing trip in a month. If a fisher fishes one weekend day per month, that probability increases to 13%, or encountering the creel every 8 months (Figure 1; see Appendix G for more detail). Probabilities are lower for shore fishing activity: One who fishes from shore once per month has a 6% probability of encountering a creel survey, or once every 1.2 years. For a spearfisher, that probability is 0.1% or once every 20 years.
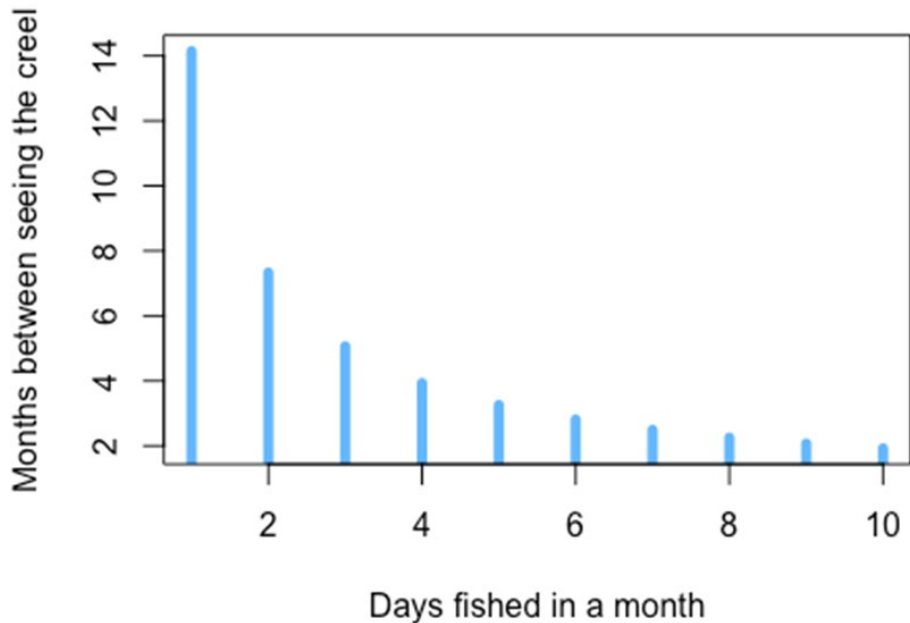
Figure 1. Expected time between encountering a boat-based creel survey based on the number of random days fishing in a month for the boat-based survey in Guam.

Voluntary reporting

Attending fishers expressed a willingness to participate in online voluntary reporting (although some in practice noted inconsistencies in their own participation in the Catch-It-Log-it application), and the belief that 90% or more of the fishery would participate. Alternatively, some fishers expressed support of the idea to collect data from a subsample of the fishery (e.g., 20 people). Fishers, and charter fishers in particular, have pride in their work and would be willing to provide catch information and pictures.

Other considerations highlighted by attendees included technological challenges and fisher preference perhaps to submit data via phone call, or radio communication. The importance of how fishers are approached was also emphasized; for example, incentivizing data submission through motivational instead of restrictive language, and through the development of cooperative relationships.

Key workshop takeaways

In this section, we summarize key takeaways from workshop discussions and processes through three lenses: 1) improving the creel survey, 2) stock assessment, and 3) engagement.

Improving the creel survey

Regarding creel survey implementation, the following are priorities

- getting more "full" creel interviews, in which time is available and taken to count and measure each fish; and
- taking the time to ensure the "assumed" information is correct (e.g., rods used, type of trip).

However, workshop discussions highlighted several challenges to creel survey implementation. Workshop discussions revealed the following enabling factors that would support DAWR implementation of the PIFSC creel survey design:

- staffing two survey technicians during busy shifts (e.g., weekend evenings), which is a matter of funding additional personnel;
- mandatory reporting, or provision of interviews to DAWR staff; and
- electronic data collection systems to improve surveyors' efficiency tablets.

The latter is a priority for 2024, and PIFSC hopes later (in the next five years) to include in such a system photo measurement and species identification capabilities.

Another strategy to improve surveyors' efficiency arose during workshop discussions related to creel survey design. A large fleet of small boat fishers was described by participants that could warrant a distinct category of "fishing type" in the survey. This fishery was described as largely commercial, employing relatively small vessels, and targeting primarily skipjack using a highly specialized method of handlining. Given this fishery's described volume and fishing frequency, establishing a distinct data collection category in the creel survey could reduce the amount of time spent surveying this group, and allow for the redistribution of survey technician's time to lower volume, more data poor fisheries.

Stock Assessment

Participating stock assessors highlighted several discussion points that were most helpful for their understanding of bottomfish fisheries (which complements Bohaboy & Matthews 2023). Fishers' experience agreed with many of the trends apparent in the boat-based survey participation and landings estimates including

- deep water bottomfishing has increased in recent years, especially since the pandemic;
- bottomfish catch is highly variable between years, often spiking in 2-7 year cycles (as with pelagics like mahimahi and wahoo); and
- some BMUS are only rarely landed because they are generally undesirable (e.g., *C. ignobilis* / mamulan) or not commonly caught (e.g., *V. louti* and *P. sieboldii*).

Fishers' behavior regarding if, when, where, and how to fish, as well as which species to target, varies depending on many diverse factors such as wave size, swell direction, current, wave period, wind, catch rates (whether fish bite is good enough), boat size and fisher ability, and fishing experience. Fishers' behavior is also dependent on socioeconomic factors like fuel prices, fish prices, market fish supply (as it is not always possible to sell all the catch), primary job schedules, requests from family and friends for fish or certain species (including special events), shark interactions at fishing sites, and crowding of other people and vehicles at launch points and fishing grounds.

Regarding species identification, workshop participants confirmed that *Etelis boweni* are definitely present around Guam and are being caught by fishers. DAWR staff seem confident in their abilities to differentiate all sizes of *E. boweni* from *E. carbunculus*. Fishers can tell the difference between large ones (often based on shape of the tail) and show interest in learning more. Discussions also highlighted likely confusion between *P. sieboldii* and *P. filamentosus* over the boat-based creel survey time series. But, especially since 2014, identification has improved.

Ten to twelve charter fishing boats, mostly small six-customer trips, continue to operate. Charter fishing behavior differs from that of the majority of Guam fishers with generally lower catch rates and shorter trips, and varying by customer. For example, military charters may harvest more fish, and tourists may be more interested in big game fish or fishing fun. There are no fishing headboats left and charters are less common than they were in the 1990s. DAWR staff reported having good relationships with charters, and noted that charters would likely be amenable to self-reporting.

Engagement

The structure of these data workshops were determined not only by its data-focused goals, but by several engagement-focused, relational supporting goals. They are, again, to:

- improve transparency around data considered during the stock assessment development;

- facilitate learning and information exchange amongst Guam DAWR, bottomfish fishers, Council, and PIFSC staff through participatory processes centered around open dialogue; and
- improve access of Guam bottomfish fishery stakeholders to PIFSC staff (and vice versa).

These goals required the planning team to carefully consider existing relational challenges to create a safe space for sharing of perspectives by DAWR staff and bottomfish fishers.

Preliminary consultation with workshop attendees prepared the planning team for conflicts that might arise during workshops, and enabled the tailoring of workshop content and structure to participants' needs. Numerous meetings between key PIFSC and DAWR staff allowed for staff to raise concerns about attendance, workshop format, and attendee roles, and for the planning team to respond with an adaptive workshop structure. This reinforced the PIFSC-DAWR agency-agency commitment to maintain cooperative focus on the workshop goal and redirect any unhelpful blame-placing commentary that might arise during the week.

The planning team also consulted with key bottomfish fishers numerous times on what approach would be effective and how to maximize the information flow. The consultation brought fishers to the table and allowed them to take ownership of the process. In several instances, this empowered key fishers to defuse rising tensions between attending fishers and scientists, and refocus the group on the workshop purpose. Importantly, fisher consultation, consistent communication, and coordination prior to and during the workshops would not have been possible without the cooperation of a knowledgeable, community-imbedded planning team member, such as Eric Cruz.

In addition to preliminary consultation with DAWR staff and bottomfish fishers, a number of other strategies identified by Iwane et al. (2022) were employed during these workshops in pursuit of its aforementioned supporting goals. Hosting separate workshop days for different audiences (DAWR, GFCA fishers, and non-GFCA fishers, respectively) and employing breakout sessions both minimized conflict and encouraged open discussions in more intimate settings. Ground rules, attendee roles, and facilitation capacity distributed over a number of supporting PIFSC and Council staff allowed for adaptive teamwork to maintain focus on workshop goals and document attendee input.

Critical to the workshops' success was coordinated support from leadership and staff at multiple levels. Such workshops are not required or clearly incentivized by institutionalized best scientific practices (Iwane et al. 2022), but were made a priority by FRMD leaders and staff. The participation of bottomfish fishers, DOAG and DAWR leadership and staff, Council members and staff, and multiple federal scientists with

expertise in stock assessment and creel survey design demonstrated a shared commitment to hear and learn from one another about the bottomfish fishery, data collection, and stock assessment. Additionally, FRMD staff participation demonstrated federal scientists' value of fisher knowledge, and recognition that such knowledge can inform quantitative processes like data collection and stock assessment development.

In addition to PIFSC scientists' attendance, features of the workshops reinforced that they are not a stand-alone engagement exercise, but part of a broader, continuous FRMD engagement effort ("After the workshops" section). For example, stock assessors created a presentation (presentation 8 in Appendix B) in direct response to fishers' November 2022 inquiries during in-person engagement by the same staff. This was important not only to demonstrate accountability to the fishing community, but to enhance fishers' understanding of the importance of providing accurate fishery information.

In consulting with local agencies and bottomfish fishers prior to data workshops, responding to their expressed concerns and questions, and designing a process that prioritized the voice and knowledge of those previously excluded from the stock assessment data evaluation process, this engagement process embodied several EEJ values and objectives. The workshops establish a new precedent for consulting Guam bottomfish fishers, creel survey technicians, and data managers prior to the development of the BMUS stock assessment.

After the workshops

Incentives

Data workshop requires diligent participation from the fishing community. The first step is to get the fishing community to commit to attending. FRMD worked with the Operations, Management, and Information Division (OMID) of PIFSC to secure permission to provide participation incentives to fishermen who will attend the workshop. This was done through an atypical expense request memorandum. The memo was sent to NMFS Headquarters for approval. Once received, the team underwent the internal procurement process to purchase the $25 gas certificates. The Guam staff kept records on the recipient and the certificate number to track the disposition of the incentives.

Social Media Post and Outreach

To acknowledge the valuable participation of the fishing community, FRMD worked with OMID to spread the word through social media. A short blurb regarding the workshop was posted in Facebook and Twitter using #FishFactFriday! and #DYK. Links for more information were added to the post that leads to the Council, DAWR, and FRMD websites. This resulted in two retweets, five likes, 876 views, and 27 engagements.

Post-Workshop Feedback Summary Report

A short summary report was generated to capture the preliminary outcome of the workshop. The report was disseminated to the workshop participants via email. This provides some preliminary feedback to the fishers. There will be a follow-up workshop towards the end of 2023 to show the participants how their inputs contributed to the data improvements that will go to the assessment. The summary report was also added to the PIFSC Director Report for the 147th and 194th meetings of the Scientific and Statistical Committee and WPFMC, respectively. This was also included in the FRMD bi-monthly program highlights shared with agency partners and fishing community groups.

Summary of the Council Meeting Discussion

FRMD staff presented the summary and outcomes from the Guam BMUS Data Workshop at the 147th and 194th meetings of the Scientific and Statistical Committee and WPRFMC, respectively, in March 2023. There was general support and appreciation, both from the SSC and the Council, especially for the inclusion of the fishing community in the science development process.

Concerns were raised at the Council meeting regarding the divisive nature of the workshop whereby the agency was separated from the fishing community. Even within the fishing community, there were two days allocated based on fishers' affiliation with the local fishing cooperative. Concerns were also raised about the workshops not covering species-specific growth rates, the use of spawning potential ratio, effects of habitat, and its lack of attention to the fundamental relational problems between fishers and the local fishery agency data collectors.

FRMD staff responded to these concerns and were further supported by responses from the Council members who participated in the data workshops. One Council member highlighted the importance of participating in the process. The workshop brought the fishing community, local fishery agency, and the federal scientist together and discussed the intricacies of the data, the potential and limitations in the information that can be gleaned from the creel survey data set and other available information sources. Another Council member testified that the local agency staff was present in all three days and interacted with the fishers. The workshop brought everyone together towards taking the first step in improving the fisher and data collector relationship. Another Council member brought up the collaborative nature of the workshop between PIFSC-FRMD, the Council, DoAg-DAWR, and the fishing community. The Council member noted it was well-organized, informative, and interactive, and looked forward to a workshop in their jurisdiction.

Participant feedback

Participants were solicited for feedback on a draft version of this report. The comments received included the following themes

- additional time for breakout session discussions;
- the potential contributions of individual electronic reporting to available data;
- request for additional information about how creel survey data, data reports, and "true data" are collected;
- request for—and concern around the lack of—information shared about how data will be analyzed given their impact to catch limits, "local fishing methods and practices," and Guam fisheries broadly; and
- concern around the reliability of previous analyses and management decisions made by institutions outside of Guam.

Acknowledgments

This endeavor would not have been possible or successful without the cooperation, expertise, and dedicated time of all workshop participants. DAWR leadership played critical roles in co-organizing the workshops and facilitating the attendance of their staff and partners from UOG, BSP, and NOAA OCM. DAWR staff offered invaluable context for the creel survey data they collect including implementation challenges and factors that might support their success. Members of the fishing community carved out time during their weekdays to share their observations and experiences in the fishery through time. These insights inform the ways in which FRMD stock assessors and data managers understand creel survey data from Guam and collaborate with fishers and the DAWR. Council staff and FRMD participants provided invaluable notetaking and facilitation during breakout sessions. To those who attended primarily in an observational capacity, we are grateful for your presence and support of this work. Finally, thank you to the FRMD team for choosing to prioritize engagement with partners and knowledge holders in Guam and investing in collaborative learning opportunities for its staff.

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Appendix A. Guam BMUS data workshop agenda

January 2023

Presentations

9:00-9:10	1.	Welcome remarks	T. Todd Jones
9:10-9:20	2.	Introductions	ALL
9:20-9:30	3.	Today's process	Mia Iwane / Marlowe Sabater
9:30-9:40	4.	Why are we here?	Felipe Carvalho
9:40-9:55	5.	A brief introduction to stock assessment	Erin Bohaboy
9:55-10:10	6.	Break	-
10:10-10:30	7.	Creel survey implementation	Tom Flores, Jr.
10:30-10:50	8.	What do the creel survey data tell us and what do we mean by "expansion"?	Toby Matthews
10:50-11:30	9.	Evaluation of available data for the 2024 Guam BMUS stock assessments	Erin Bohaboy

11:30-12:30	*Lunch break*

Breakout sessions

12:30-14:00	10.	Breakout sessions	ALL
14:00-14:40	11.	Breakout group reporting	ALL
14:40-14:55	12.	Wrap-up and next steps	Felipe Carvalho
14:55-15:00	13.	Adjourn	T. Todd Jones

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Appendix B. Workshop attendees

Table B1. Workshop attendees and affiliation.

Affiliation/ Participant Role	Name	Day 1 (DAWR workshop)	Day 2 (Fisher workshop)	Day 3 (Fisher workshop)
DAWR	Jason Biggs	x	x	x
	Tom Flores, Jr.	x	x	-
	Jay Gutierrez	x	x	x
	Neil Martin	x	x	-
	Chelsa Muña	x	x	x
	Brent Tibbatts	x	x	x
DAWR; Fisher	Jamie Bass	x	x	x
	Michael Dueñas	x	x	x
	Robert Koss	x	x	x
	Felix Sasamoto	x	x	x
Fisher	Monique Amani	-	x	-
	Eric Artero[3]	-	x	-
	Marc Artero[1]	-	x	-
	Eugene Bolton	-	x	-
	James Borja	-	x	-
	Ken Borja	-	x	-
	Julian Flores	-	-	x
	Mike Gawel	-	-	x
	Andrew Kang[1]	-	x	-
	Stephen Meno	-	x	-
	Jason Miller	-	x	-
	Matthew Orot[1]	-	-	x
	Joe Pangelinan	-	x	-
	Jesse Rosario	-	-	x
	Adam San Gil	-	-	x

[3] Did not participate in the breakout session

Affiliation/ Participant Role	Name	Day 1 (DAWR workshop)	Day 2 (Fisher workshop)	Day 3 (Fisher workshop)
	Dominick San Gil	-	-	x
	Mike Snell	-	x	-
	Johnny "Atulai" Taitano[1]	-	x	x
	John Taitano[1]	-	-	x
	Tatiana Talavera	-	-	x
	Cherita Willhite[1]	-	-	x
Council	Josh DeMello	x	x	x
	John Gourley	x	x	x
	Floyd Masga	x	x	x
	Felix Reyes	x	x	x
PIFSC	Rob Ahrens	x	x	x
	Erin Bohaboy	x	x	x
	Felipe Carvalho	x	x	x
	Eric Cruz	x	x	x
	Brad Gough	(virtual)	-	-
	Mia Iwane	x	x	x
	T. Todd Jones	x	x	x
	Hongguang Ma	x	x	x
	Toby Matthews	x	x	x
	Marlowe Sabater	x	x	x
	Jenny Suter	x	x	x
UOG	Frank Camacho	x	-	-
	Brett Taylor	x	-	-
NOAA OCM	Marie Auyong	x	-	-
BSP	Monica Guerrero	x	-	-
	April Trinidad	x	-	-

Appendix C. DAWR breakout questions

Scheduling

- Under what conditions may a survey not be completed as planned?
- How do you decide what day to reschedule a survey to?
- Are surveys ever canceled due to weather or ocean conditions?
- Are canceled surveys entered into the data system? Are surveys without fishing activity entered?

Why we are asking: we want to understand any factors that cause survey days to not be randomly selected.

Boat log (see reference Figures C1 and C2)

- How often do bottomfishers go out at night? Do they often return before or during the AM shift? Is their catch greater or the species different?
- Do you know of any trips that are entirely unobserved by both the AM and PM shifts? Charter trips?

Why we are asking: we want to understand what fishing the creel survey misses, since it does not survey all hours of the day.
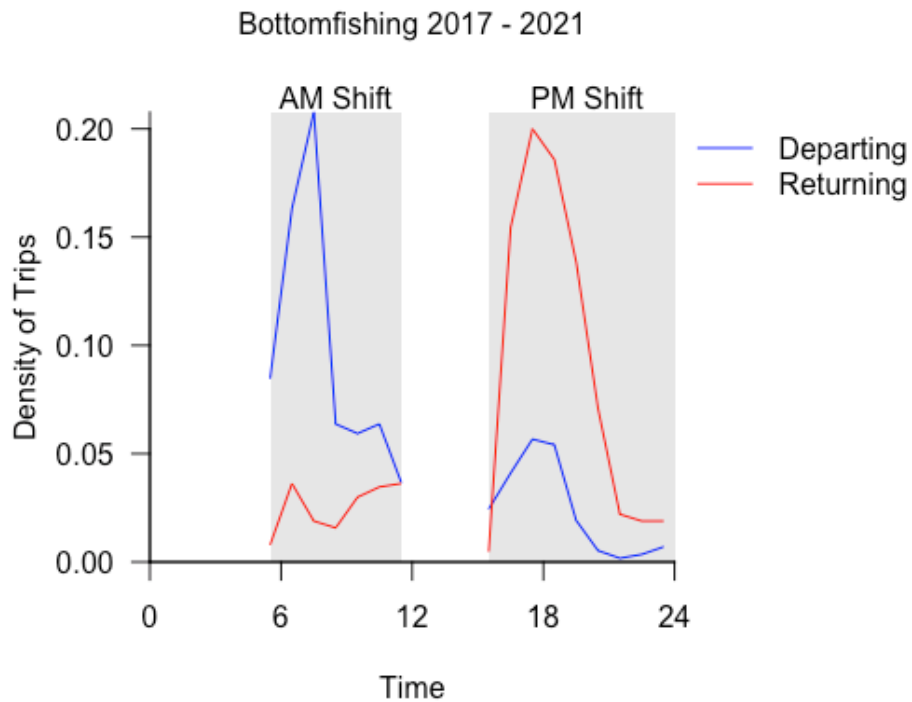
Figure C1. Distribution of time of departure and arrival for bottomfishing trips over a 24 hour period from 2017 to 2021.
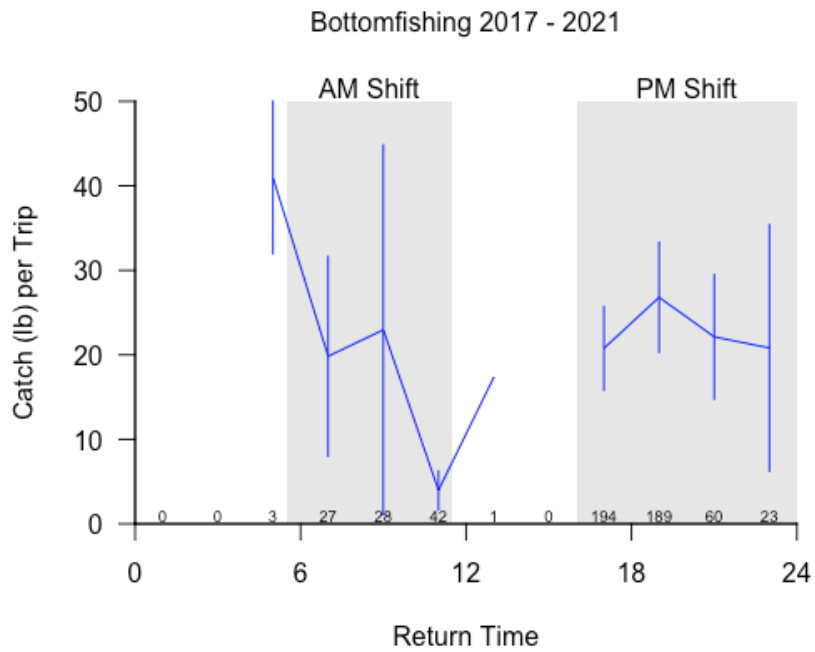
Figure C2. Bottomfishing catch-per-unit-effort (lbs per trip) captured during the morning and evening creel survey shifts from 2017 to 2021.

Trailer counts (see reference **Figure C3**)

- Do you know anyone that departs for bottomfishing trips other than from Agana, Agat, and Merizo?
- What fraction of bottomfishing boats are berthed vs trailered?
- Do you count unattached trailers? Do you think some of these are fishing? Do you notice any trailers leave after dropping off a boat?

Why we are asking: we want to understand what fishing the creel survey misses, outside of the three main ports.

Figure C3. Trends in the number of bottomfishing trips per day at the creel survey monitored ports in Guam.

Bonus: Weather and ocean conditions

- Do you notice a change in the number of fishers or amount of catch under certain weather conditions?
- Does weather influence where or when fishers go out?
- Are there any weather conditions under which you consistently see no fishing activity?

Why we are asking: bad weather is a recurring topic in our discussions with fishers, and we want to understand how it impacts the data.

Interviews

- What factors determine whether you are able to interview a returning trip?
- What percent of fishers are always unwilling to be interviewed?
- In what order do you ask questions, if time is limiting?
- What could be done to make this process easier for you?

Why we are asking: interviews provide critical information for stock assessments and a greater quantity of trip information would be beneficial

Interviews (con't.)

- How do you go about processing a very large catch?
- How do you estimate the species composition?
- How do you decide which individual fish within a species to take lengths of?
- When do you collect weight measurements for individual fish?

Why we are asking: we want to better understand what data is measured/estimated/calculated in an interview and how representative this data is.

Species that are caught together

Please put the species into groups to show which ones are often caught together (*original slides included reference images for the 13 BMUS species*).

Why we are asking: we can learn about rare fish species from more common species that it is caught together with.

Assorted questions

- Are there any other data sources that you think we need to consider?

Why we are asking: we want to make sure that we don't miss anything when conducting our stock assessments!

Lehi (*A. rutilans*) (see reference Figures C4 and C5)

- How often do you see this species?
- Is it more common from any specific ports/fishing areas/etc.?
- Have you noticed any change in it over time?

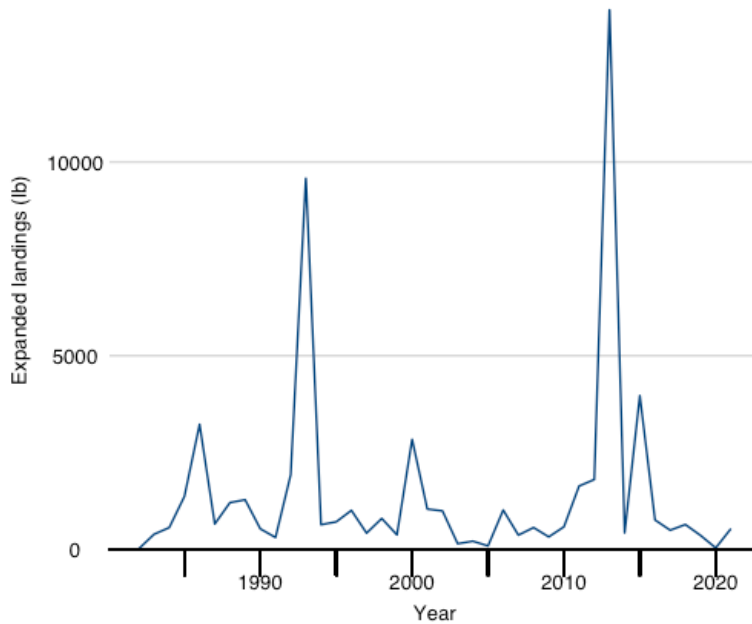Why we are asking: we want to learn more about the specific species we are assessing.
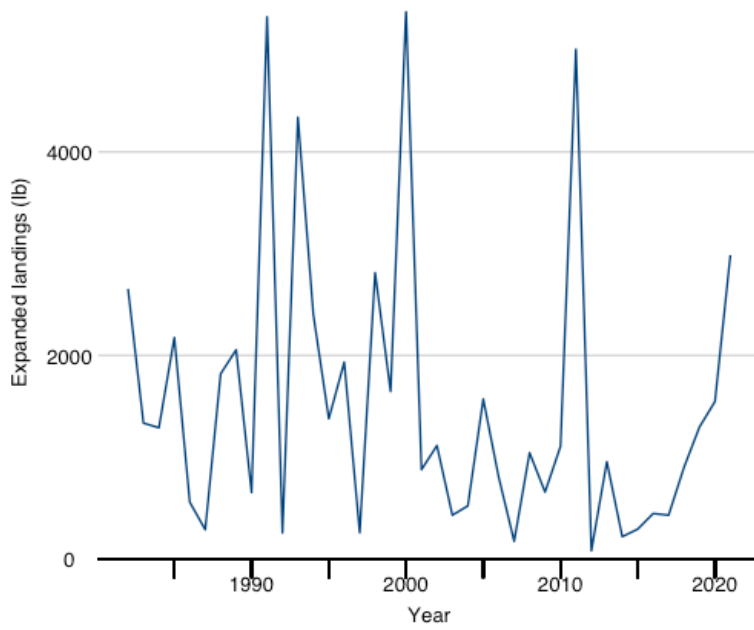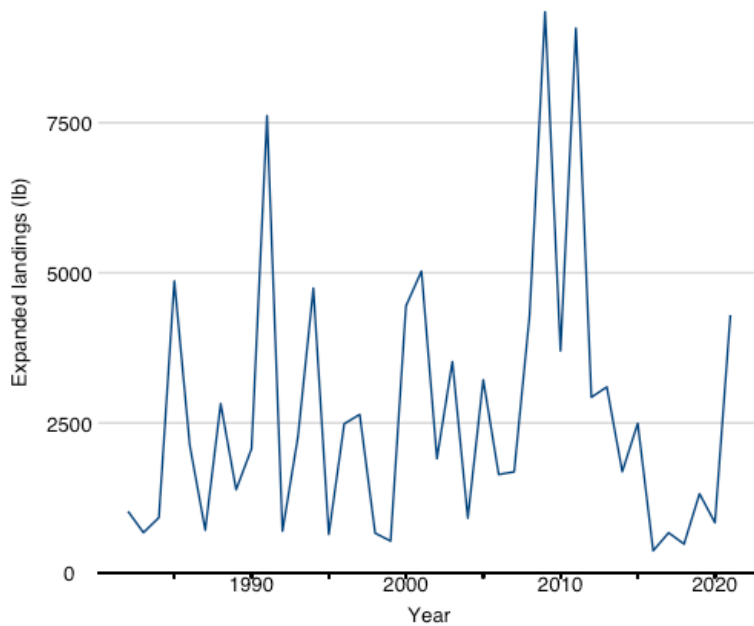
Figure C4. *A. rutilans* expanded landings through time.

U.S. Department of Commerce | National Oceanographic and Atmospheric Administration
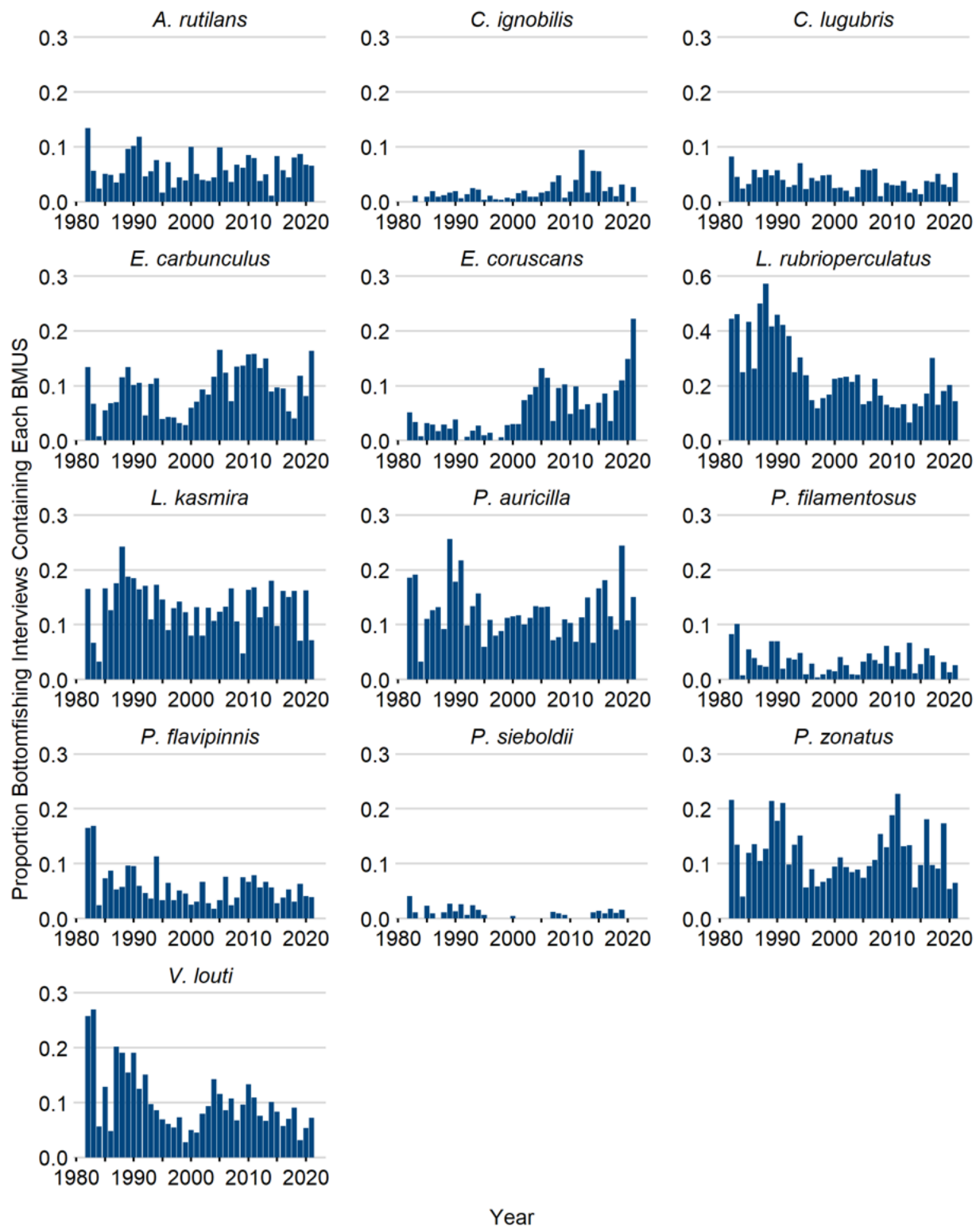
Figure C5. Proportions of creel interviews for bottomfishing trips catching any of the 13 BMUS in Guam.

Tarakitu, Mamulan/Giant trevally (C. ignobilis) (see reference Figures **C5** and **C6**)

- How often do you see this species?
- Is it more common from any specific ports/fishing areas/etc.?
- Do other fishing methods catch it?
- Have you noticed any change in it over time?

Why we are asking: We want to learn more about the specific species we are assessing.

Figure C6. *C. ignobilis* expanded landings through time.

Tarakiton åttelong/Black jack (*C. lugubris*) (see reference Figures **C5** and **C7**)

- How often do you see this species?
- Is it more common from any specific ports/fishing areas/etc.?
- Do other fishing methods catch it?
- Have you noticed any change in it over time?

Why we are asking: we want to learn more about the specific species we are assessing.
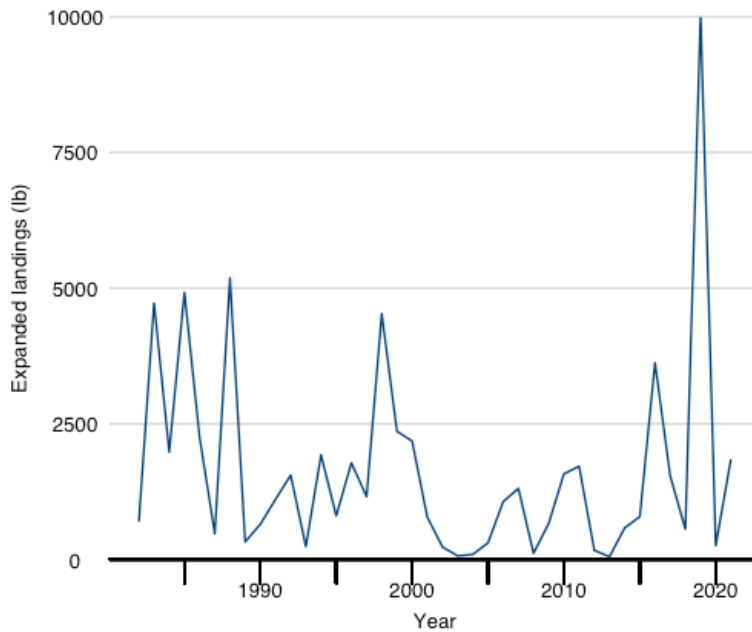
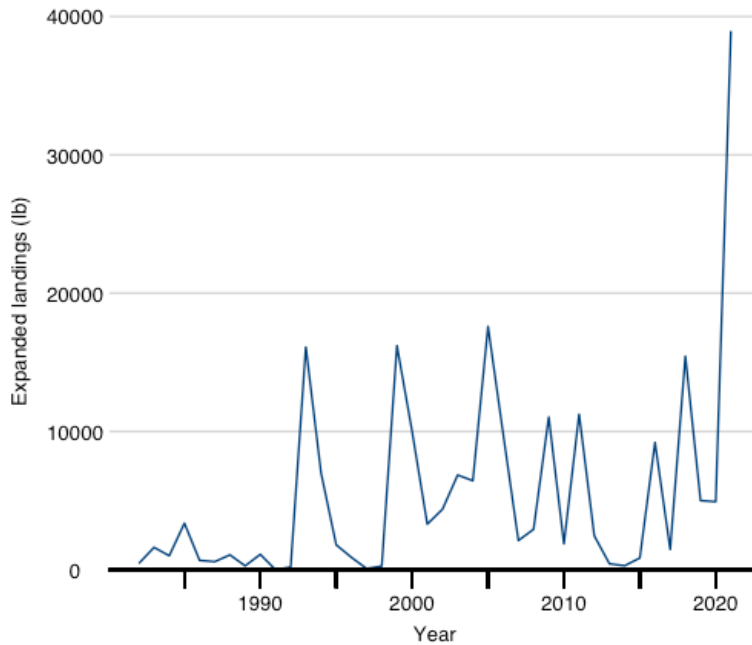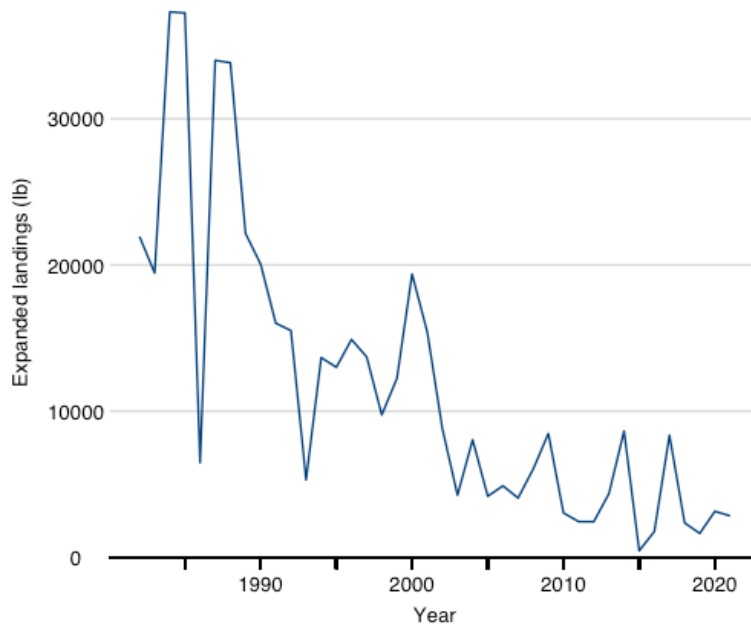**Figure C7.** *C. lugubris* expanded landings through time.

Bonus: i'e'

- Is it possible to do any species identification within i'e'? Do you ever record any such information?
- Do you know anything about which species are represented most within i'e'?
- How much year-to-year variability is there in i'e' abundance? Do you know any factors that may contribute to this?

Why we are asking: we want to learn if any catch of the previous two species may come from this group.

Buninas agaga'/Ehu (*E. carbunculus*) (see reference Figures C5 and C8)

- How often do you see this species?
- How often do you see very large ones (>50 cm)? Do you separate it from *E. boweni*?
- Is it more common from any specific ports/fishing areas/etc.?
- Have you noticed any change in it over time?

Why we are asking: we want to learn more about the specific species we are assessing.

Figure C8. *E. carbunculus* expanded landings through time.

Abuninas/Onaga (*E. coruscans*) (see reference Figures **C7** and **C9**)

- How often do you see this species?
- Is it more common from any specific ports/fishing areas/etc.?
- Have you noticed any change in it over time?

Why we are asking: we want to learn more about the specific species we are assessing.

Figure C9. *E. coruscans* expanded landings through time.c

Mafute' (*L. rubrioperculatus*) (see reference Figures **C5** and **C10**)

- How often do you see this species?
- Is it more common from any specific ports/fishing areas/etc.?
- Do charter trips often catch this species?
- Have you noticed any change in it over time?

Why we are asking: we want to learn more about the specific species we are assessing.
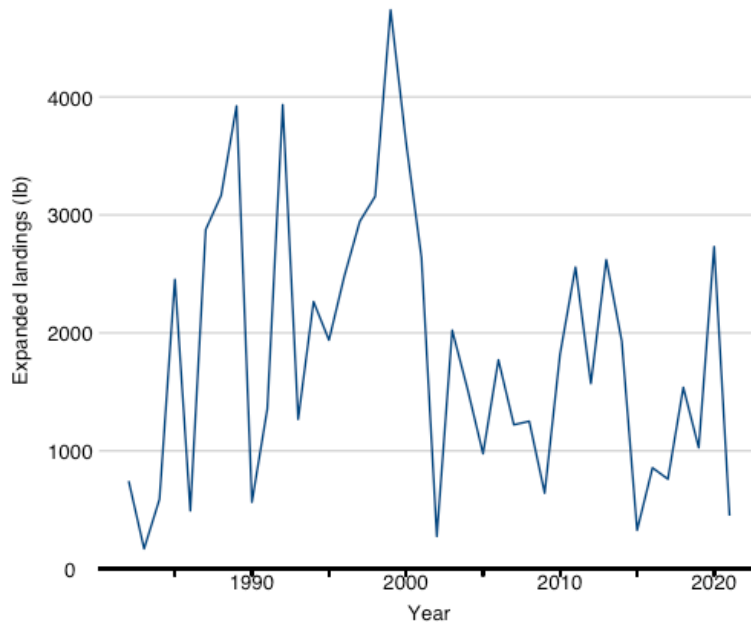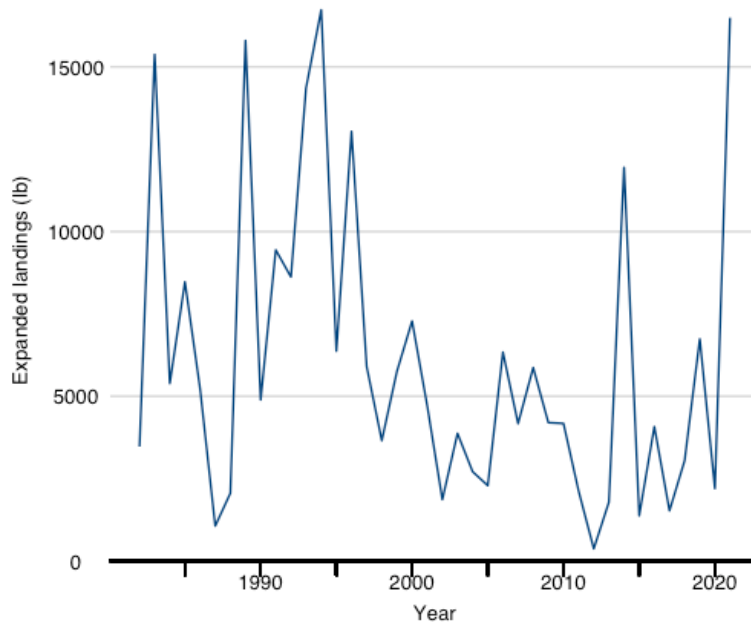
Appendix C10. *L. rubrioperculatus* expanded landings through time.

Funai, Saas, Ta'ape (*L. kasmira*) (see reference Figures **C5** and **C11**)

- How often do you see this species?
- Is it more common from any specific ports/fishing areas/etc.?
- Do charter trips often catch this species?
- Have you noticed any change in it over time?

Why we are asking: we want to learn more about the specific species we are assessing.

Figure C11. *L. kasmira* expanded landings through time.

Buninas/Yellowtail kalekale (*P. auricilla*) (see reference Figures **C5** and **C12**)

- How often do you see this species?
- Is it more common from any specific ports/fishing areas/etc.?
- Have you noticed any change in it over time?

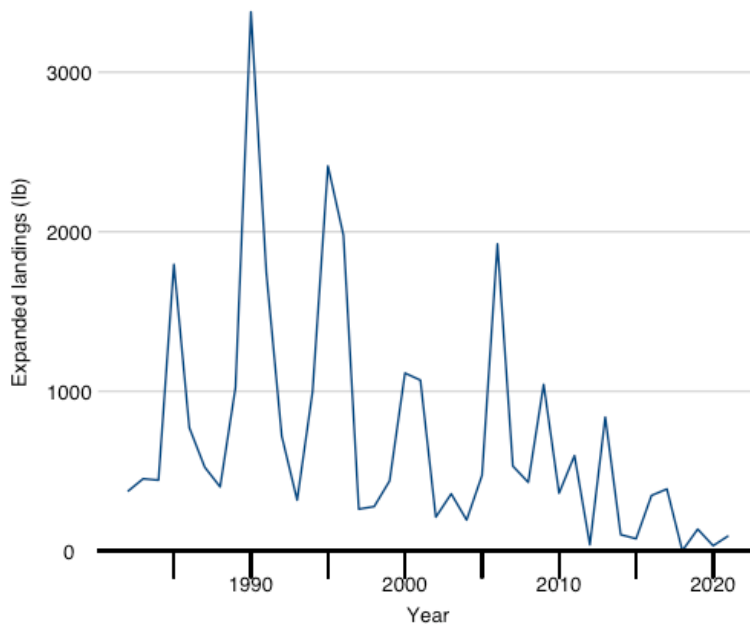Why we are asking: we want to learn more about the specific species we are assessing.

Figure C12. *P. auricilla* expanded landings through time.

Buninas/Pink opakapaka (*P. filamentosus*) (see reference Figures **C5** and **C13**)

- How often do you see this species?
- Is it more common from any specific ports/fishing areas/etc.?
- Have you noticed any change in it over time?

Why we are asking: We want to learn more about the specific species we are assessing.
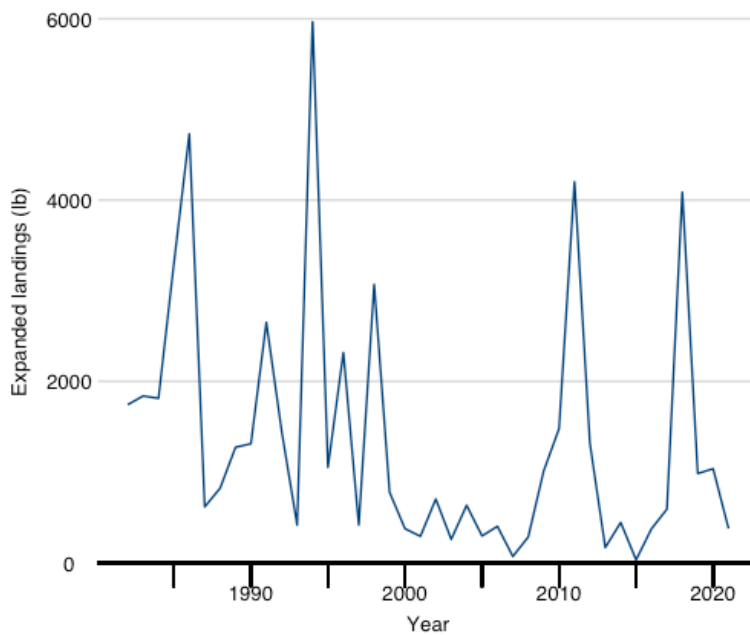
Figure C13. *P. filamentosus* expanded landings through time.

Buninas/Yellow eye opakapaka (*P. flavipinnis*) (see reference Figures **C5** and **C14**)

- How often do you see this species?
- Is it more common from any specific ports/fishing areas/etc.?
- Have you noticed any change in it over time?

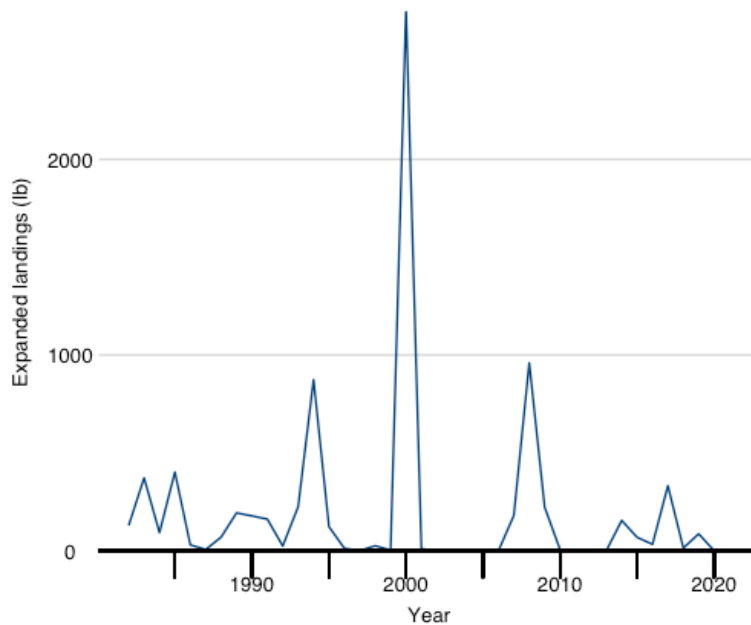Why we are asking: we want to learn more about the specific species we are assessing.

Figure C14. *P. flavipinnis* expanded landings through time**.**

Buninas/Pink kalekale (*P. sieboldii*) (see reference Figures **C5** and **C15**)

- How often do you see this species?
- Could it be mistaken for another species?
- Is it more common from any specific ports/fishing areas/etc.?
- Have you noticed any change in it over time?

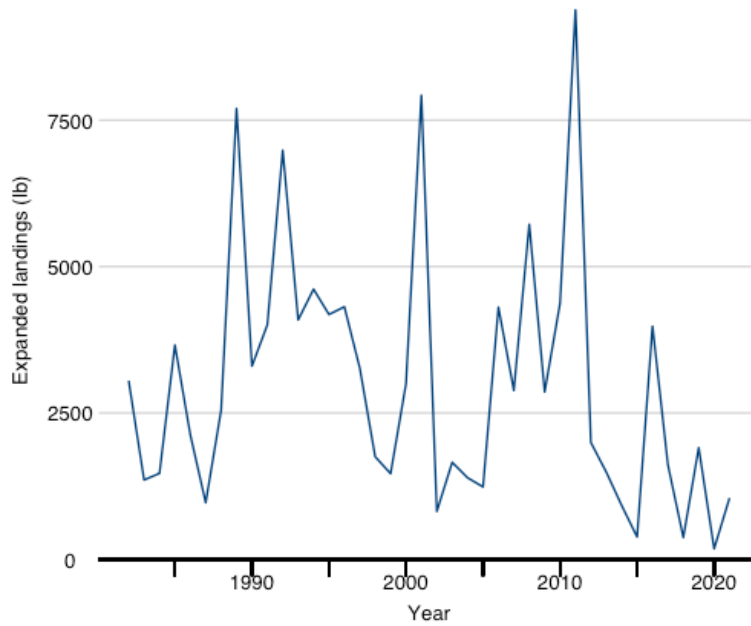Why we are asking: We want to learn more about the specific species we are assessing.

Figure C15. *P. sieboldii* expanded landings through time.

Buninas rayao amariyu/Gindai (*P. zonatus*) (see reference Figures **C5** and **C16**)

- How often do you see this species?
- Is it more common from any specific ports/fishing areas/etc.?
- Have you noticed any change in it over time?

Why we are asking: we want to learn more about the specific species we are assessing.

Figure C16. *P. zonatus* expanded landings through time.

Gádao mattingan, Bueli (*V. louti*) (see reference Figures **C5** and **C17**)

- How often do you see this species?
- Is it more common from any specific ports/fishing areas/etc.?
- Have you noticed any change in it over time?

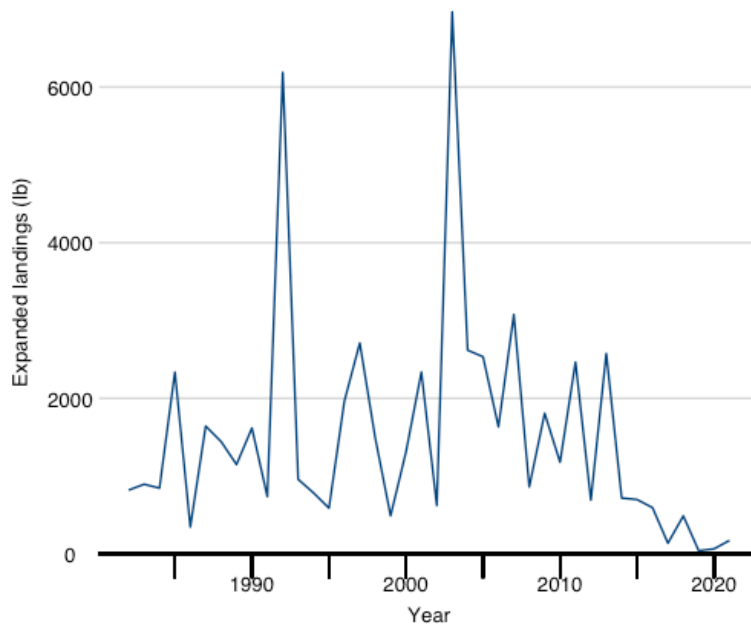Why we are asking: we want to learn more about the specific species we are assessing.

Figure C17. *V. louti* expanded landings through time.

Appendix D. Fisher breakout questions

Tell us about you

- What kind of fishing do you do?
- How long have you been fishing?
- How often do you go fishing?
- What proportion of the bottomfish that you catch do you sell?

Why we are asking: we want to learn about Guam fishers and bottomfishing in Guam.

Before your fishing trip, a.k.a. Weather

- What weather conditions will make you skip a fishing trip you were otherwise planning?
- Would you say that weather influences the number of days you fish, which days you choose to fish, or both?

Why we are asking: bad weather is a recurring topic in our discussions with fishers, and we want to understand how it impacts the data.

Starting your fishing trip (see reference Figures **C1** and **D18**)

- Do you know anyone that departs for bottomfishing trips from somewhere other than Agana, Agat, and Merizo?
- Do you ever plan to return from a bottomfishing trip between 12 am-6 am? Do these trips catch more?

Why we are asking: we want to understand what fishing the creel survey misses, since it does not survey all of the island and all hours of the day.
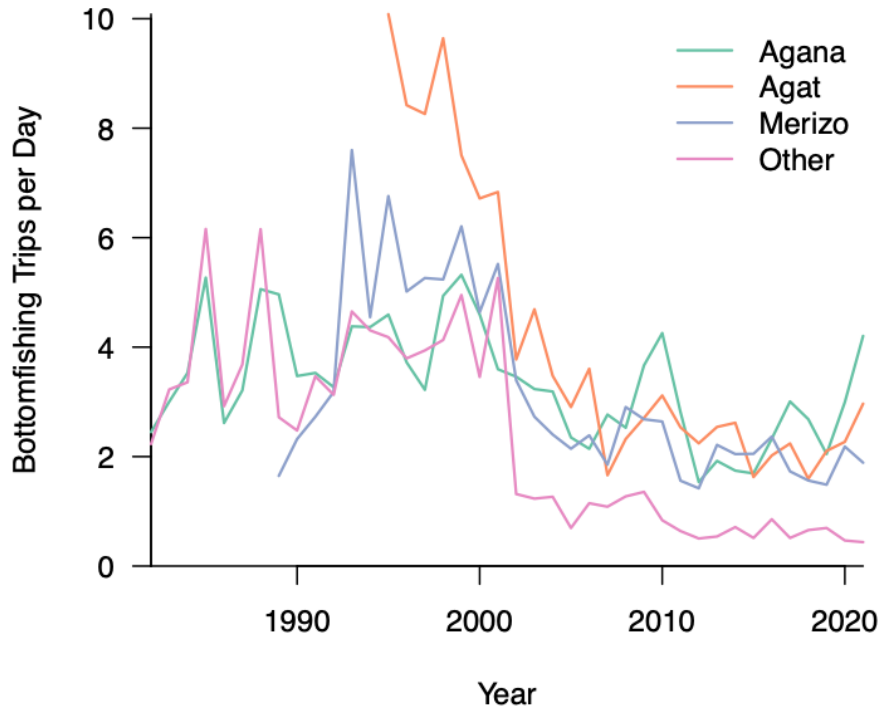
Figure D18. Trends in the number of bottomfishing trips per day at the creel survey monitored ports in Guam.

During your fishing trip (see reference Figures **D19** and **D20**)

- How do you decide when to go fishing at the banks (either north or south), rather than stay closer?
- Do you agree that you can catch about twice as much fish at the banks?
- Do you fish at the banks more often now than you used to?

Why we are asking: we want to understand the choices that you make when bottomfishing.
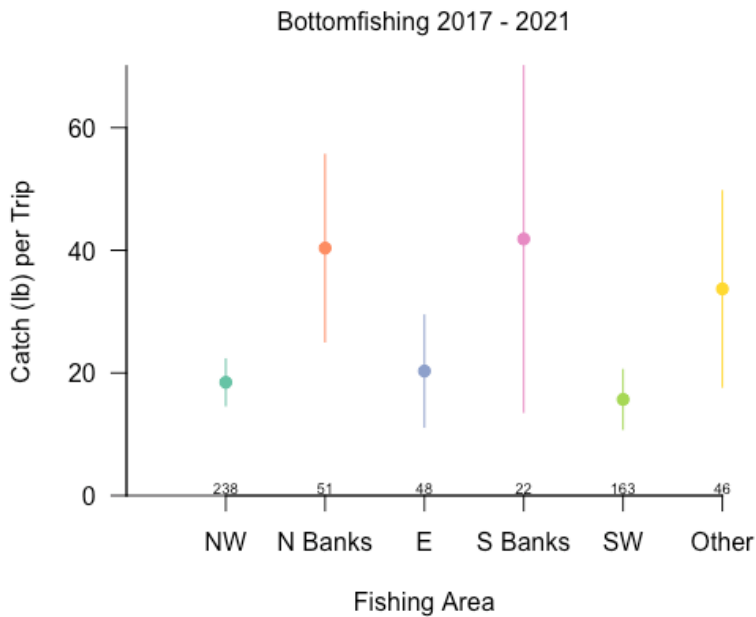
Figure D19. Catch per trip at the different bottomfish fishing areas in Guam from 2017 to 2021.
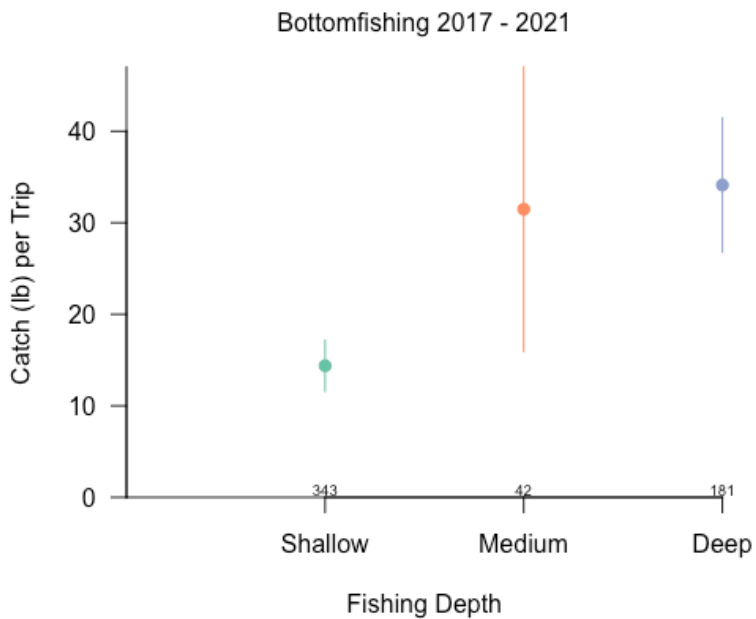

Figure D20. Catch per trip at the different bottomfish fishing depths in Guam from 2017 to 2021.

During your fishing trip (con't.) (see reference **Figure D21**)

- To what extent do you target specific species while fishing? Do you target any species more at specific times of the year?
- Do any species seem more abundant at certain times of the year?

Why we are asking: when generating time series of catch-per-trip data, it is helpful to know which species were targeted on a trip.
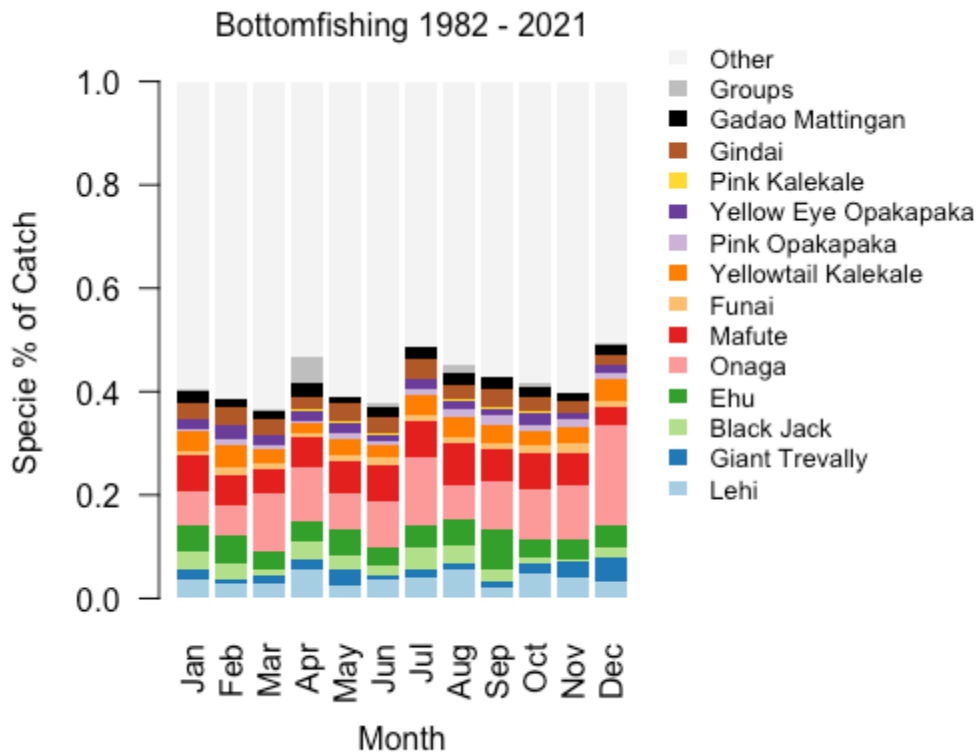

Figure D21. Percent species composition per month from 1982 to 2021.

Species that are caught together

- Please put the species into groups to show which ones are often caught together (*original slides included reference images for the 13 BMUS species*).

Why we are asking: we can learn about rare fish species from more common species that it is caught together with.

After your fishing trip

- In a given year, how many times are you interviewed by DAWR staff? Out of how many trips in that year?
- How much time are you willing to provide for an interview?
- Have you heard of the Catchit Logit app? Do/would you use it?

Why we are asking: interviews provide critical information for stock assessments, and a greater quantity of trip information would benefit.

Assorted questions

- Are there any other data sources that you think we need to consider?

Why we are asking: we want to make sure that we don't miss anything when conducting our stock assessments!

Lehi (*A. rutilans*) (see reference **Figure C4**)

- Do you target this species?
- How often do you catch it?
- Have you noticed any change in it over time?

Why we are asking: we want to learn more about the specific species we are assessing.

Tarakitu, Mamulan/Giant trevally (*C. ignobilis*) (see reference **Figure C6**)

- Do you target this species?
- How often do you catch it?
- Do you catch it other than when bottomfishing?
- Have you noticed any change in it over time?

Why we are asking: we want to learn more about the specific species we are assessing.

Tarakiton åttelong/Black jack (*C. lugubris*) (see reference **Figure C7**)

- Do you target this species?
- How often do you catch it?
- Do you catch it other than when bottomfishing?
- Have you noticed any change in it over time?

Why we are asking: we want to learn more about the specific species we are assessing.

Buninas agaga'/Ehu (*E. carbunculus*) (see reference **Figure C8**)

- Do you target this species?
- How often do you catch it?
- How often do you catch very large ones (>50 cm)?
- Have you noticed any change in it over time?

Why we are asking: we want to learn more about the specific species we are assessing.

Abuninas/Onaga (*E. coruscans*) (see reference **Figure C9**)

- Do you target this species?
- How often do you catch it?
- Have you noticed any change in it over time?

Why we are asking: we want to learn more about the specific species we are assessing.

Mafute' (*L. rubrioperculatus*) (see reference **Figure C10**)

- Do you target this species?
- How often do you catch it?
- Have you noticed any change in it over time?

Why we are asking: we want to learn more about the specific species we are assessing.

Funai, Saas, Ta'ape (*L. kasmira*) (see reference **Figure C11**)

- Do you target this species?
- How often do you catch it?
- Have you noticed any change in it over time?
- Do charter trips often catch this species?

Why we are asking: we want to learn more about the specific species we are assessing.

Buninas/Yellowtail kalekale (*P. auricilla*) (see reference **Figure C12**)

- Do you target this species?
- How often do you catch it?
- Have you noticed any change in it over time?

Why we are asking: we want to learn more about the specific species we are assessing.

Buninas/Pink opakapaka (*P. filamentosus*) (see reference **Figure C13**)

- Do you target this species?
- How often do you catch it?
- Have you noticed any change in it over time?

Why we are asking: we want to learn more about the specific species we are assessing.

Buninas/Yellow eye opakapaka (*P. flavipinnis*) (see reference **Figure C14**)

- Do you target this species?
- How often do you catch it?
- Have you noticed any change in it over time?

Why we are asking: we want to learn more about the specific species we are assessing.

Buninas/Pink kalekale (*P. sieboldii*) (see reference **Figure C15**)

- Do you target this species?

- How often do you catch it? There is very little data for it and we wonder if it is mixed with another species.
- Have you noticed any change in it over time?

Why we are asking: we want to learn more about the specific species we are assessing.

Buninas rayao amariyu/Gindai (*P. zonatus*) (see reference **Figure C16**)

- Do you target this species?
- How often do you catch it?
- Have you noticed any change in it over time?

Why we are asking: we want to learn more about the specific species we are assessing.

Gádao mattingan, Bueli (*V. louti*) (see reference **Figure D18**)

- Do you target this species?
- How often do you catch it?
- Have you noticed any change in it over time?

Why we are asking: we want to learn more about the specific species we are assessing.

Appendix E. Idea Marina

Some themes and ideas were raised over the course of the Guam data workshops that are not directly pertinent to the workshops' focal topics. We therefore maintain them in the Appendix for our records.

- Concerns were raised around:
    - lack of data workshop outreach; needs to be announced so folks can attend on time;
    - data workshops being "public hearings"; part of a process to make new laws in Guam;
    - fishing restrictions as significant decisions that impact people's lives;
    - not all fishers being email accessible; alternatives to communicate with fishers include radio communication, flyers, Whatsapp, 3'x4' signs at marinas, etc.;
    - scientists need to understand fishers' experience by going fishing multiple times;
    - fishers' knowledge as intuitive (e.g., of moon and tide) and not acknowledged;
    - lack of training amongst younger fishers who "don't know what to look for";
    - enforcement issues and the need for data collection initiatives to have more teeth for survey data validity;
    - more outreach required toward military fishers;
    - scuba spearfishing pushing fish into deeper waters; and
    - inability to fish in preserves.
- Although participating in fishing derbies costs money (entry fees, fuel, etc.), attending fishers try to participate in one or two a year. This includes the CNMI tournaments, which are more "like fiestas." The annual Saipan derby has up to 20 boats from Guam each year, despite it being 120-miles from Agana and requiring a six to thirteen hour commute.
- Charter fishing customers are mostly military now, but they used to be from Japan. Tourism from Korea is increasing. Some charters will sell their catch, some prepare sashimi on the dock, and some give it to their customers to take home and/or have it cooked for them.
- DAWR staff referenced a new launching area to be constructed.
- Sharks have increased over the last 10 years and are now taking troll lures. There were easily a dozen around the boats up north last year.
- Why are amberjack and other bottomfish species not included in 13 BMUS? BMUS are a list maintained specifically for federal management and monitoring purposes.

Appendix F. Probability of Encountering a Creel

May 15, 2023

This short note submitted by PIFSC's Robert Ahrens and Toby Matthews covers basic estimation of the probability that an individual will encounter a creel survey while out fishing under some simplifying assumptions. Using the current design from Guam for the boat- and shore-based surveys, the probability of being encountered on a given trip is a function of the type of day (weekend or weekday) relative to the sampling frequency of that day type, the start and end times, and the area it originated from. For a trip on a random day, from a random port, within a given month, the probability p of encountering a creel can be expressed as p(day is sampled) times p(port is sampled) times p(time is sampled).

For the Guam boat-based survey, there are three main ports (Agana, Agat, and Merizo) that are sampled approximately in proportion to the level of fishing activity. Given the random nature of the trip, the p(port is sampled) is 1/3. Assuming there are no trips going out in the early morning hours (midnight to 6 am), then p(time is sampled) is approximated as 14/18 for 14 hours of creel (day and night shift on the same day) and 18 possible hours for fishing. It is important to note that we are not calculating the probability that the trip is interviewed, only that the trip encounters the creel. The probability that a day is sampled can be decomposed into the weekend (WE) and weekday (WD) probabilities and accounting for the sampling schedule at each port. For the boat-based survey each month 2 WD and 2 WE are selected for Agana, 1 WD and 1 WE at Agat, and 1 WD and 1 WE at Merizo. For the shore-based survey each month 2 WD and 2 WE are selected with interviewing split across the three regions.

Focusing on the boat-based survey and assuming a 22 WD and 8 WE each month, the probability that a random day in a month is selected is the probability that the day is a weekday times the probability that the day was sampled given it was a weekday plus the probability that the day is a weekend times the probability that the day was sampled given it was a weekend, which becomes:

$$\left(\frac{5}{7}\right)\left(\frac{4}{22}\right) + \left(\frac{2}{7}\right)\left(\frac{4}{8}\right)$$

Putting all the probabilities together the probability of encountering () the creel survey is:

$$\left(\left(\frac{5}{7}\right)\left(\frac{4}{22}\right) + \left(\frac{2}{7}\right)\left(\frac{4}{8}\right)\right)\left(\frac{1}{3}\right)\left(\frac{14}{18}\right)$$

which results in 0.07 or at 7% chance of seeing the creel on a given random trip in a month. Additionally, this encounter probability would need to be modified by the probability of actually being interviewed given the creel was present.

The probability that you would see the creel at least once if you went out more times in a month can be calculated as or 1 minus the probability of no encounter given the number of times (*t*) fished. Randomly fishing for 4 days in a month you would expect to see the creel at some point in that month 25% of the time or once every 4 months and if you fished 10 days a month you would expect to see the creel once every 2 month or ~50% of the time (<u>Figure 1</u>). If an individual only fishes one weekend day per month the base probability increases to 13% or encountering the creel every 8 months.

Calculating the probability of encountering the creel for shore-based methods is more challenging because the encounter points are not as obvious and the creel is roving within the survey area. The probability of *p*(time is sampled) is dependent on the shore based method. A shore angler staying in a single area for a period of time will have a higher probability of encountering the creel than an individual who only transits such as a spearfisher. For a random day fishing within the area that is surveyed (assumed 3/4 of the available area on the island) the encounter probability becomes:

$$\left(\left(\frac{5}{7} \right) \left(\frac{2}{22} \right) + \left(\frac{2}{7} \right) \left(\frac{2}{8} \right) \right) \left(\frac{3}{4} \right) (?)$$

Here the "?" represents an uncertain amount of time that a fisher might be seen. This can be broken into two probabilities.

The probability that the event falls within the survey time period and the probability that a fisher is seen. For a shore angler, remaining at a single location this could be similar to the boat-based or 12/18 assuming shore angling is not occurring at night. For a spear fisherman, this could be as low as 1/24 or lower given the majority of the time fishing the fisher is not likely to be seen. For the shore angler, fishing once per month the probability of encounter drops to 6% or encountering the creel once every 1.2 years. For the spear fisher, this probability can drop to quite low to 0.1% or encountering the creel once every 20 years. For a spearfisher that only fishes once a month, they may never encounter the shore-based creel. As in the boat-based creel example, these probabilities increase as the frequency of fishing events increase in a month and the interval between encounters declines.