



NOAA
FISHERIES

National Marine
Fisheries Service

Pacific Islands
Fisheries
Science Center

2009-2010 CNMI elder fisher perceptions of nearshore marine resource use, change, and management

Mia Iwane, Arielle Levine



2009-2010 CNMI elder fisher perceptions of nearshore marine resource use, change, and management

Mia Iwane¹, Arielle Levine²

¹ Pacific Islands Fisheries Science Center
National Marine Fisheries Service
1845 Wasp Boulevard
Honolulu, HI 96818

² Department of Geography, San Diego State University
5500 Campanile Drive
San Diego, CA 92182

NOAA Data Report DR-23-20

November 2023



U.S. Department of Commerce

Gina Raimondo, Secretary

National Oceanic and Atmospheric Administration

Richard W. Spinrad, Ph.D., NOAA Administrator

National Marine Fisheries Service

Janet Coit, Assistant Administrator for Fisheries

About this report

The Pacific Islands Fisheries Science Center of NOAA's National Marine Fisheries Service uses the NOAA Data Report to disseminate scientific and technical information that has been scientifically reviewed and edited. Documents within this series reflect sound professional work and may be referenced in the formal scientific and technical literature.

Cover photo: Fisher amongst Saipan seagrass. Credits: NOAA Fisheries

Recommended citation

Iwane M, Levine A. 2023. 2009-2010 CNMI elder fisher perceptions of nearshore marine resource use, change, and management. U.S. Dept. of Commerce, NOAA Data Report DR-23-20 44p. doi: 10.25923/5ajh-hr51

Copies of this report are available from

Pacific Islands Fisheries Science Center
National Marine Fisheries Service
National Oceanic and Atmospheric Administration
1845 Wasp Boulevard, Building #176
Honolulu, Hawaii 96818

Or online at

<https://repository.library.noaa.gov/>

Table of Contents

Table of Contents.....	i
List of Tables	ii
List of Figures	iii
About this report	iv
Data Collection.....	iv
Results.....	1
Demographics	1
Fishing history	1
Changes to fishing through time.....	8
Fishing Practices.....	16
Changes in habitat and climate	18
Thoughts on regulations	21
Other thoughts.....	23
Discussion.....	26
Results highlights	26
What's happened since 2010?.....	27
Acknowledgments.....	28
References	29
Appendix: Interview Guide	31
Question Guidelines for Fisherman Interviews	31
Fishing experience and history	31
Nearshore fishing conditions	32
Individual fishing behavior.....	34
Climate and habitat change.....	34
Local Marine Management.....	34

List of Tables

Table 1. Participant ethnicities.....	1
Table 2. Years of fishing experience.....	1
Table 3. Peak fishing avidities cited by participants.....	2
Table 4. Why do you fish?	3
Table 5. All species mentioned by participants who described their “best catch” (n = 52).	6
Table 6. By island, breakdown of participant perceptions of reef fishing overall and 15 types of target species at the time of engagement compared to the past.....	10
Table 7. By age, breakdown of participant perceptions of reef fishing overall and 15 types of target species at the time of engagement compared to the past.....	12
Table 8. Comments on the overall state of reef fishing identifying factors of change.....	13
Table 9. Thematic categories for participants’ suggestions to improve reef fishing.....	14

List of Figures

Figure 1. References to fishing methods practiced prior to, or at the time of, engagement.....	4
Figure 2. Participants' perceptions on reef fishing overall and 15 types of target species at the time of engagement compared to the past.....	10
Figure 3. Participants' perceptions of bumphead parrotfish, humphead wrasse, and shark abundance at the time of engagement compared to the past.	13
Figure 4. Participants' perceived change to corals (n = 78), seagrass (n = 59), and nearshore water quality (n = 76) overtime.....	18

About this report

The Proactive Species Conservation Program funded this work through the Division of Coastal Resources Management (DCRM) in fiscal year 2010. The intent of this work was to document fisher knowledge and experience—especially from elder fishers—to better understand both local nearshore marine resource management priorities and changes to marine species and the nearshore environment through time. Elder fishers' experience make an important contribution as time series data on nearshore marine biomass and habitat appear to be limited pre-2000s. Richmond et al. (2002) describe the Commonwealth of the Northern Mariana Islands' (CNMI) history of marine regulations and military activity that interact with the nearshore marine environment. Although they acknowledge the negative impacts of pollution, coastal development, deforestation as a result of feral animals, and coral bleaching on nearshore water quality and coral health, Richmond et al. describe them as unquantified or undocumented. In 1997, the CNMI Division of Environmental Quality (DEQ) established a local Marine Monitoring Team (MMT). The MMT evolved into a formal, long-term marine monitoring program by 2008, composed of DEQ staff with support from the CNMI Division of Fish and Wildlife (DFW), local non-governmental organizations, the local NOAA field office, and Marianas academic institutions (Benavente et al. 2017).

A collaborative team with representation from the DEQ, DRCM, DFW, NOAA Pacific Islands Regional Office (PIRO), and the Joint Institute of Marine and Atmospheric Research (JIMAR, now referred to as the Cooperative Institute of Marine and Atmospheric Research) contributed to this study and its design. The reef species and habitats featured in this report, along with specific prompts in its interview guide (see [Appendix](#)), likely represented the priorities of participating local and federal marine resource agencies.

Due to staff turnover, data collected in 2009–2010 were not revisited for synthesis until 2022. The prospect of releasing recorded discussions and personally identifiable information over a decade after data collection poses various challenges related to contacting and reestablishing consent with participants. Therefore, this report represents an effort by PIFSC staff to revisit these data and provide summaries for public availability and awareness.

Data Collection

This research was executed by a team of collaborators with representation from the CNMI DEQ, DCRM, and DFW, NOAA PIRO, and JIMAR. Staff from DEQ, DCRM, and DFW collected data and helped with interview design. A JIMAR social researcher provided guidance and logistical support for data collection, and the PIRO Coral Reef Fisheries liaison assisted with local logistics and coordination for the development of the interview guide, data collection, and data compilation.

Interview guides solicited fishers' experiences and perceptions of nearshore fishing practice, marine resource use, and marine ecosystems over time as well as local resource management. Fishers across Saipan, Tinian, and Rota were identified by the data collection team based on their age and willingness to participate with preferences for fishers over the age of 50, having at least 20 years of fishing experience in the Marianas, and who sustained at least a weekly fishing

practice at some point in their life. These criteria selected for experienced, elder fishers given their relatively prolonged interaction with the marine environment over time. Such experience is particularly valuable in local contexts with limited data on both ecological trends and changes to fishing practice and management through time (Levine and Sauafea-Le'au 2013).

Due to research participants' selection based on specific criteria rather than through a probabilistic sampling strategy, data and results reflect participant perceptions and experiences but do not support broader inferences about the island community as a whole. Additionally, the interview guide included key questions and suggested prompts for the research team to use at their discretion. Throughout the [Results](#) section, we identify prompts in cases where they likely influenced fishers' responses and, therefore, the prominence of themes in their discussions.

Between December 2009 and May 2010, 78 interviews were conducted in paired interviewer-note-taker teams consisting of DEQ, DCRM, and JIMAR staff. Discussions were held in English and Chamorro. Fishers were digitally recorded with their permission and asked at the end of their discussions if they would be comfortable being referred to by name in project products. Out of 78 interviewees, 68 fishers agreed to being referred to by their name. The remainder either did not respond or were not asked. Additional fishers were identified through snowball sampling, a process by which participants are asked for referrals to potential research participants in their community (Atkinson and Flint 2001).

Following discussions, members of the research team entered fisher responses into a data matrix. In this matrix, each row represents a fisher, and each column represents an interview question (see [Appendix](#)). The author manually reviewed the matrix and corrected conspicuous misalignments between question columns and individuals' responses. For example, 10 participants' responses were shifted, within each row, either the left or right in consistent increments. This was made obvious by presence of ethnicities in a column otherwise occupied by "yes" or "no" responses, or narrative responses in a column otherwise occupied by "worse," "about the same," or "better" responses. Other question-specific assumptions made about the raw data for the purpose of this data report are detailed in their respective [Results](#) subsections.

This report provides a descriptive summary of the contents of this matrix, which, importantly, includes paraphrased and English-translated responses rather than verbatim fisher quotes. The author coded open-ended, narrative responses to identify recurring and unique themes for each question. The results of this coding process are represented in Tables [4](#), [8](#), and [9](#). Otherwise, thematic coding served as an organizational tool to present narrative descriptions of interviewee responses in the [Results](#) section. In two cases, data were cross-tabulated to analyze differences in perceptions of change to reef fishing through time based on a) island of residence ([Table 6](#)) and b) age ([Table 7](#)). Additional information about the dataset is available online (Pacific Islands Fisheries Science Center 2023).

Results

Demographics

All 78 fishers that participated in this effort were male. Their ages ranged from 32 to 74 with an average age of 51 (n = 75). Over 75% identified as Chamorro, Carolinian, or “Chamolinian” (mixed Chamorro and Carolinian ethnicity) ([Table 1](#)). Those remaining identified as other Micronesian ethnicities (n = 6) including Chuukese, Yapese, and Palauan, sometimes mixed with Chamorro and/or Carolinian; white (n = 4); and Filipino (n = 3).

Table 1. Participant ethnicities.

Ethnicity	% of participants
Chamorro	47%
Carolinian	22%
Chamolinian	14%
Other/mixed Micronesian	8%
White	5%
Filipino	4%
N/A	1%

Staff engaged fishers from Saipan (47%; n = 37), Rota (37%; n = 29), and Tinian (15%; n = 12) with representation from 16 Saipan, 8 Rota, and two Tinian villages. The most common villages represented by participants were San Jose on Tinian (n = 11), Songsong (n = 10) and Sinapalo II (n = 5) on Rota, and Kagman (n = 6), Garapan (n = 5), and Tanapag (n = 5) on Saipan.

Fishing history

Fishers reported a range of 15 to 63 years of fishing experience in the CNMI (see [Appendix Question 1](#)). Most fishers had more than 20 years of fishing experience ([Table 2](#)) with an average of 29 years of fishing experience in the CNMI.

Table 2. Years of fishing experience.

Years fished	% of participants
< 20	13%
20-29	50%
30-39	9%
40-49	18%
> 50	9%
N/A	1%

Fishers also provided a range of fishing avidity (see [Appendix](#) Question 1a), which did not necessarily represent an average across their fishing careers or their current fishing activity. In describing the frequency of their fishing activity, about half of all participants referenced the past, alluding to a change in fishing activity through time ($n = 38$), but only 18 of these explicitly described fishing less over time. For example, some fishers cited periods of relatively high fishing frequency that they sustained prior to some life change (e.g., career change, health issues, aging, changing methods). For the purpose of this report, we present the highest frequency responses provided by each participant ([Table 3](#)). The six fishers comprising the “Other” category provided narrative responses to the question that either do not address frequency of fishing at all, or describe avidity using subjective terms such as “often” or “frequent.”

Table 3. Peak fishing avidities cited by participants.

Frequency of fishing	% of participants
Daily	18%
2-6x/week	60%
1-4x/month	14%
Other	8%

Fishers’ geographic experience was diverse. Of the Saipan ($n = 37$), Rota ($n = 29$), and Tinian ($n = 29$) fishers engaged, 14%, 55%, and 25% of participants, respectively, had fishing experiences restricted to their island of residence (see [Appendix](#) Question 2). However, many had experiences fishing beyond their island of residence. Approximately 25% of Rota and Tinian respondents also had experience fishing around Saipan. Over 40% of Saipan participants had experience fishing around Tinian. A third (33%) of Tinian respondents had experience fishing around Rota. Guam was another popular fishing destination, with 24% of Saipan, 14% of Rota, and 33% of Tinian respondents reporting experience fishing there. A third (33%) of Tinian respondents also described fishing around Goat Island.

More than 40% of all fishers had experience fishing in the Northern Islands of the CNMI ($n = 33$; see [Appendix](#) Question 9), though the majority had never fished in the Northern Islands at the time of engagement ($n = 42$). Other, less prominent fishing geographies described in respondents’ experiences included Micronesian islands such as Pohnpei, Chuuk, Yap, Satawal, and Palau; other Pacific islands such as Hawai‘i and the Philippines, and the U.S. mainland.

Fishing motivations

The most common motivation for fishing, cited by 74 fishers, was to keep fish for food, whether for personal or family consumption ([Table 4](#)). Out of the 77 participants that answered the question of why they fish (see [Appendix](#) Question 8), 33 cited only one reason, and 44 cited two or more reasons. Commercial sale was the second most common reason, cited by 31 participants. Three of the 31 who described selling their catch said they sell to recover fuel costs, which is frequently described as “expense fishing”. Fifteen fishers said they give away their catch (e.g., to friends, the elderly, neighbors, or as a church donation). Other motivations

included special occasions ($n = 8$), hobby or passion ($n = 6$), or health benefits ($n = 3$). Examples of each of these—including notes from participants who cited multiple reasons for fishing—are presented in [Table 4](#). These notes, which are taken directly from the data results matrix with minimal editing, will be italicized throughout the report.

Table 4. Why do you fish?

Reason (n, %)	Exemplary notes from discussions
Keep fish for food (n = 74, 95%)	<ul style="list-style-type: none"> • <i>He goes fishing cause he doesn't want to buy fish, he usually goes fishing to feed the family.</i> • <i>Used to sell fish before and keep good size, not enough reef fish to sell, nowadays, 100% consumption.</i> • <i>Mostly personal consumption. Sizes of fish are getting smaller and the markets are hesitating to sell such sizes.</i> • <i>Traditional fishing village, community's main diet is fish, rely on ocean for livelihood that's how they became good fishermen.</i>
To sell (n = 31, 40%)	<ul style="list-style-type: none"> • <i>Keep and sell. I keep hangon and sell mafuti and hiyok.</i> • <i>For family consumption. Very rare that he will sell. If they ask for bottomfish he might sell a cooler's worth.</i> • <i>Family consumption, give friends and neighbors if I have excess. Never sells reef fish only tuna to recover fuel costs.</i> • <i>Sell for family business, and the rest they keep for consumption.</i>
Give away (n = 15, 19%)	<ul style="list-style-type: none"> • <i>I keep my fish, share with family in exchange for breadfruit or taro. Contribute to religious functions, funerals, weddings, give to older folks who can't fish anymore</i> • <i>Usually gives away to friends except for lobster. And mostly for personal consumption.</i>
Special occasion (n = 8, 10%)	<ul style="list-style-type: none"> • <i>Family meals, for sale, sharing with friends and for special occasional gatherings such as funerals, etc.</i> • <i>Just for family or family functions.</i>
Hobby/passion (n = 6, 8%)	<ul style="list-style-type: none"> • <i>Fishing is a hobby. Fish for personal consumption. When catch is good, he sells.</i>
Health (n = 3, 4%)	<ul style="list-style-type: none"> • <i>For personal use and to replenish the salt in my body.</i> • <i>Exercise for health reasons.</i>

Fishing methods

Fishers were given the opportunity to describe all the types of fishing practiced during their fishing careers (see [Appendix](#) Question 3). Their responses were aggregated by fishing method and period of practice (past versus “present” or time of engagement) and are reported on in [Figure 1](#). The four most common fishing methods in both the past and present were spearfishing, trolling, bottomfishing, and *talaya*.

The aggregation process included the inclusion of “shallow troll” and “trolling with ‘oda’ bait” in the “trolling” category; the inclusion of “deep bottom” and “shallow bottom” in the “bottom” category; and the inclusion of “free dive” and “diving” in the “free dive spear” category. Not displayed in [Figure 1](#) are those aggregated fishing methods with fewer than three references in the past or present categories, including “offshore,” “handline,” “cliff fishing,” “fish kill

method,” “nasa,” “achuman¹,” “gadi,” and “homemade pine.” Finally, the “net fishing” category includes those types of net fishing for which fewer than three references were recorded: “chenchulu²,” “robw (pocket net),” and “drag net.”

Some of these were described as traditional fishing methods. One fisher described quitting achuman fishing in the ‘60s, and his current effort to revive traditional methods of fishing such as achuman and gadi³ (described in the data as a net made of coconut leaves used to catch seasonal mañåhak, goatfish, and juvenile trevally). Another fisher identified robw fishing as a method affected by regulation:

Most common in those days is the chase and surround net we chase the fish into the net, close the net, harvest the fish, let go of the tangs, surgeons, only the lililok and tataga, hiteng, tarakitu are main targets (robw community-based fishing). These have changed overtime because laws changed overtime. My disappointment is...it was an immediate cease and desist with no baseline data as to the kind of fish that were disappearing. Can't remember any fish that disappeared, they are just very seasonal, doesn't mean that we overharvested them.

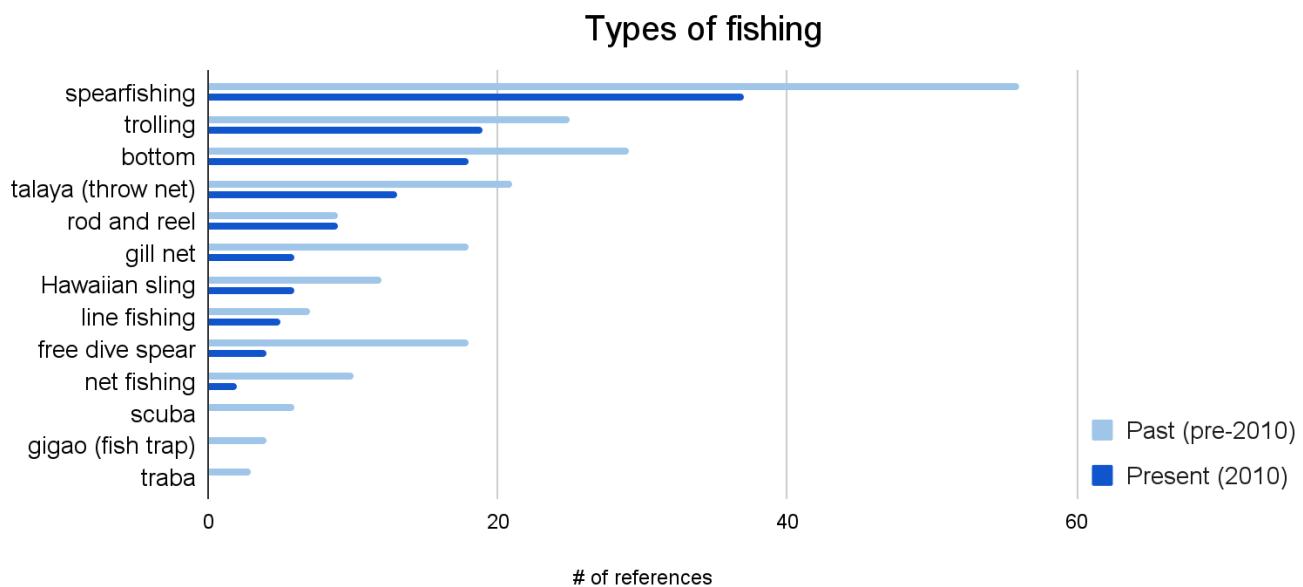


Figure 1. References to fishing methods practiced prior to, or at the time of, engagement.

Some fishers described their reasons for employing certain fishing methods. Some fished for fun ($n = 4$) or to provide food for family or others ($n = 5$). The latter included separate references to “*spearfishing when there’s a big party*,” and gillnetting for fiestas “*back then when there was no gillnet ban, we used it for fiestas*.” One fisher described using a *gigao* (fish traps) to “[harvest] for older folks.” He continued, “*Ancient Chamorros and Carolinians are the*

¹ Mackerel scad (Jennison-Nolan 1979).

² Drag seine/net (Jennison-Nolan 1979).

³ Described by Jennison-Nolan (1979) as a surround net deployed at nighttime, involving 20-30 people.

most conservation minded... We've been practicing these for over a thousand years." Three fishers expressed preference for certain methods, like free dive and scuba spearfishing, because they enable selectivity in size and species. Time of day also came up in several discussions, which referenced using the Hawaiian sling at night and spearfishing during the day ($n = 8$), trolling in the morning, and "net fishing lunch to early morning." Other considerations for using certain fishing methods related to finances, weather, and season.

Factors of changing fishing methods

Thirteen participants indicated no change and 60 participants indicated changes to their fishing methods over time (see [Appendix](#) Question 3b). Fewer than half ($n = 28$) of those who described some change to their fishing methods over time provided details on how their methods changed. In their descriptions of changing fishing methods, fishers cited personal reasons ($n = 15$), regulatory factors ($n = 11$), modernization of fishing gear and technology ($n = 8$), and reef fish decline ($n = 7$).

The 15 fishers that cited personal reasons in their descriptions of change to fishing method through time referenced medical reasons ($n = 7$), aging ($n = 5$), and career-related changes ($n = 3$). For some, methods like rod and reel, talaya, and even boat fishing provided more accessible options than the relatively physically demanding spearfishing and diving. This explained some fishers' shifts away from spearfishing and diving ($n = 4$) and toward other methods with age.

Eleven fishers identified regulatory factors that changed their fishing practice, the most common of which were the gillnet ban and netting regulations ($n = 9$). One fisher said he simply stopped fishing after the gillnet ban. Another fisher described free diving, bottomfishing, and trolling more nowadays given the scuba fishing ban.

Descriptions of changing fishing methods included references to the modernization of fishing gear and technology ($n = 8$) including spears, lures, GPS, flashlights, and depth recorders. Fishers referenced a time when fishers were limited to homemade spearguns⁴ and line fishing before rod-and-reel fishing was available, and the emergence of spearguns with rubber pieces, which replaced the stick-and-rock barbless spears and homemade spearguns built in the '70s with wood and a rod. One fisher spoke of freedive spearfishing when he didn't have access to an ice box, which required him to "*take only what's needed.*" Fishers' references to the appearance and usage of scuba in spearfishing ranged from the '60s to the late '80s. Descriptions of changing fishing methods also included shifts toward troll and bottomfishing ($n = 6$), in some cases due to new access to a boat. Fishers described the use of harmful fishing practices, such as clorox, toxins, and homemade bombs. With regard to net fishing, three fishers described a shift toward talaya, and five fishers described shifts away from net fishing including chenchulu and gillnetting (tekking or "tekin", Jennison-Nolan 1979).

A small share of fishers ($n = 7$, 10%) also attributed changing fishing methods to declines in reef fish. One fisher described switching to pelagic and bottomfish fishing 10 years prior because "*there's barely any reef fish.*" Another fisher switched to pelagic fishing five to six years prior to "*try to put less pressure on reef fish,*" and yet another fisher switched from spearfishing to

⁴ Different spearfishing tools and usage described by Jennison-Nolan (1979).

throw net in the ‘80s “due to overfishing in [the] reef line.” In an example of adapting fishing strategy to decreasing catchability, one fisher described using a longer spear to target deeper fish.

More often, participants commented on changes to their target species (n = 24) when prompted for observed changes to fishing, but did not explicitly cite these observations as triggering a change in fishing methods. For example, fishers referenced onaga fishing improving. We elaborate upon these themes in the next section.

Best catch

Participants were asked to describe the best catch of their fishing careers, however they would qualify it (see [Appendix](#) Question 13). Some fishers described bountiful catches and others described fishing experiences made memorable by those with whom they shared it. [Table 5](#) organizes 52 fishers’ descriptions of their “best” catches, highlighting the maximum volume and size and notes for each catch type, where applicable.

Table 5. All species mentioned by participants who described their “best catch” (n = 52).

Category	Catch type ⁵	n	Max volume	Max size	Discussion notes
Reef	reef fish (general)	3	400 lb (1996)		<i>Back in 1996, he went fishing for 7 hours and caught 400lbs of reef fish.</i>
	hiteng (rabbitfish)	4	300lb; 3 coolers full (talaya, 2004)	12in (300lb, throw net)	<i>“Those days when you catch those hitengs, you’re the man.”</i>
	tåtaga' (unicornfish)	2	-	-	Neither included descriptions of size/volume, just descriptions of 1) spearfishing and 2) fishing Mañagaha Lagoon in the 1970s.
	satmoneti (goatfish)	1	-	-	Did not include descriptions of size/volume (1971 Wing Beach-San Roque, outside reef)
	lililok (emperors)	1	16 pieces	-	<i>Caught 105 lbs tångison in November 2009 below Coconut Village, 16 lililok, 5 red snappers, 2 tarakitu for family reunion. One day catch, 4 hours during the day.</i>
	måtan hågon (large-eyed emperor)	1	1 piece		1989 Wing Beach.
	sweet lips (hamåla, <i>Plectorhinchus</i> spp.)	1	-	25lb	-

⁵ Utilized the University of Guam’s technical report “Fish names of the Mariana Islands, Micronesia” (2012) to translate fish names in Tables 2 and 5:

https://www.uog.edu/_resources/files/ml/technical_reports/139Kerr_2012_UOGMLTechReport139.pdf

	tångison (Napoleon wrasse)	9	6 in a day (speargun)	180lb (scuba, 1992)	-
	laggua (parrotfish)	4	24 (1989 Wing Beach)	15lb	-
	atuhong (bumphead parrotfish)	5	-	116lb (Punia Point, 1988)	-
	lobster	4	six-32 gallon containers (Hawaiian sling, 1970s)	5lb (80s-90s)	<i>Went fishing in the 1970s with two late fishers. Went spearfishing and found lobsters, two-32 gallon containers for each of us. Caught with Hawaiian sling.</i>
	octopus	1	-	9ft (Tinian, 1981)	<i>Octopus were abundant.</i>
Reef-associated	atulai	1	1 ton	-	<i>Caught one ton of atulai every year.</i>
	‘ōpelu	1	"so many" (1996)	-	<i>In 1996, went w/ dad to do achuman-opelu for the first time, got so many fish.</i>
	barracuda	1	-	37lb	Matmo area.
	tarakitu	2	2 pieces	-	See "lililok" notes.
	mamulan	4	-	70lb	Spearfishing at Banzai.
	"skipjack"	1	-	60lb (80s-90s)	-
Snappers and Groupers	sainan guili (black snapper)	1	-	-	1989, Wing Beach.
	red snapper	1	5 pieces	-	See "lililok" notes.
	banded grouper	1	-	103lb	<i>International derby, 103 banded grouper he got the biggest & walked away with a prize.</i>
	grouper	5	-	325lb (2001)	<i>Speared his first grouper at 7 years old on Tinian (1960).</i>
Bottomfish	kalikali	1	489lb	-	Caught bottomfishing in 1998, Goat Island.
	onaga	2	-	36lb (2005-2006)	-
	ehu	1	-	"not too big, family size"	<i>Deep bottom for the first time with uncles for a day and a half. Ehu weren't too big but family size. Late '80s and early '90s.</i>
Pelagics	wahoo	2	10 pieces	-	"Now hard to catch fish."
	yellowfin tuna	4	-	102lb	A different participant: <i>Caught a yellowfin tuna with talaya.</i>
	dogtooth tuna	1	-	221lb	-
	marlin	2	-	900lb	-

				(Marpi Reef)	
	black marlin	1	-	474lb	-
	blue marlin	2	-	700lb (2007)	-
Reptiles	turtle	1	1 turtle	-	<i>Caught turtle with talaya (before regulation).</i>

Changes to fishing through time

Change to fish catch overall

Out of 78 participants, 63 reported some change to their fish catch over time, and four reported no significant change to their fish catch over time (see [Appendix](#) Question 4). The interview guide included prompts for commentary on fish size, species, and quantity. Out of the 33 participants that commented on fish size through time, 19 described fish as smaller⁶ (in some cases, this was in reference to onaga and reef fish like parrotfish), and 14 described fish size changing generally. Additionally, there were fewer than three comments on fish size in the following categories: the same, increased after regulation, and better. Most of the fishers that commented on fish quantity described it as declining ($n = 24$) or changed ($n = 11$). The 24 fishers that commented on fish species through time described general change ($n = 12$) or decline or rarity of some fish ($n = 12$) including parrotfish, cigar wrasse, kabora, tarakitu, hangon, laggua, tåtaga', *guile*⁷, hamåla, hiyok, gådau, *hailan*⁸, *frontalis*⁹, *microrinus*. Fewer than three fishers commented on the change in fish species through time as increasing after regulation and more abundant.

Three participants described changes to various fish attributes on Rota with one participant highlighting differences on the “*front side*.” Another fisher noted having to go to the “*back*” or east side of the island to catch preferred size and species of fish.

Twelve participants described declining catchability, generally describing fishing as getting “*harder*” or commenting on the ease with which they would catch fish before. Some fishers described fish being harder to find, and others described having to go further and fish longer to catch. For example, one fisher described getting a good catch in 5-10 ft of water in the past, and nowadays having to go fish in deeper waters. Another described pelagics and bottomfish fishing getting harder as the “*fish started getting smarter...recogniz[ing] the lines*.”

Fourteen participants offered factors of change. Factors of fish decline, rather than improvement, were more commonly cited and are listed in order of most to least common: overfishing ($n = 5$); a growing fishery with new gear ($n = 4$); overpopulation and increased human activity ($n = 3$); and development ($n < 3$; e.g., shoreline lights shining to the ocean, hotel development). Negative impacts from several specific methods were described including nighttime diving, scuba fishing, gillnet fishing, and the use of clorox. Three fishers highlighted

⁶ Fish sizes characterized as “*worse*” and the rarity of 6-8lb parrotfish both assumed to mean smaller.

⁷ Referred to as “*guile*” in the data matrix notes, this may refer to guili (sea chubs or rudderfishes).

⁸ Unknown.

⁹ In the data matrix, referred to as “*frontalis*” and “*microrinus*”; may refer to types of parrotfish.

impacts of “outsider” activity including non-resident fishers overfishing and negative impacts from the U.S. National Park Service and military activities. The latter was juxtaposed against the U.S. Environmental Protection Agency and the U.S. Army Corps of Engineers being “*adamant about people here damaging the reef*.”

Only six fishers provided time frames for their observations of change. Three fishers described catchability and fish abundance declines in the ‘80s–’90s; two Rota fishers described notable declines in the decade prior to this work.

Changes to reef fishing through time

Participants were asked how reef fishing at the time of engagement compared to that of the past (see [Appendix](#) Question 5). They were asked to comment on reef fishing overall and 15 types of target species ([Figure 2](#)). Fisher responses included the following categories: worse, about the same, better, or didn’t know compared to the past ([Figure 2](#)). Many participants (81%) perceived reef fishing overall to worsen through time. Saipan had the highest proportion of respondents perceiving reef fishing to be worse for 11 out of the 15 target species categories, including big eye scad, juvenile jacks, adult rabbitfish, bluespine unicornfish, orangespine unicornfish, mullets, emperors, parrotfish/wrasse, octopus, giant clam, and trochus aliling-puan ([Table 6](#)). Note that Saipan was also the most represented island in the participant pool ($n = 37$), with fewer respondents from Rota ($n = 29$) and Tinian ($n = 12$). [Table 6](#) presents the percentage of respondents by island, excluding N/A responses.

Differences in perception were also examined by interviewee age. Participants were sorted into two age categories: less than 50 years ($n = 30$) and 50 and above ($n = 45$). In every instance except for the two trochus species, a larger proportion of the older group perceived reef fishing to be worse through time ([Table 7](#)).

Additionally, participants were asked to comment on the abundance over time of sharks and two species of concern: bumphead parrotfish and humphead wrasse ([Figure 3](#); see [Appendix](#) Question 6). Of the participants who responded, 66%, 57%, and 18% perceived bumphead parrotfish, humphead wrasse, and sharks to be less abundant¹⁰. Fishers could also respond that these reef species about the same, more abundant, or didn’t know compared to the past ([Figure 3](#)). Respondents that didn’t know either expressed uncertainty or, less commonly, were unfamiliar with the species. The latter was true for humphead wrasse ($n = 6$) and bumphead parrotfish ($n < 3$).

Fishers were also given the opportunity to elaborate on the responses summarized in Figures [2](#) and [3](#). [Table 8](#) presents the factors of change that fishers identified in their comments on changes to reef fishing overall.

¹⁰ During data summarization, the author combined “about the same” and “same” responses into one category, and “less abundant” and “worse” into one “less abundant” category.

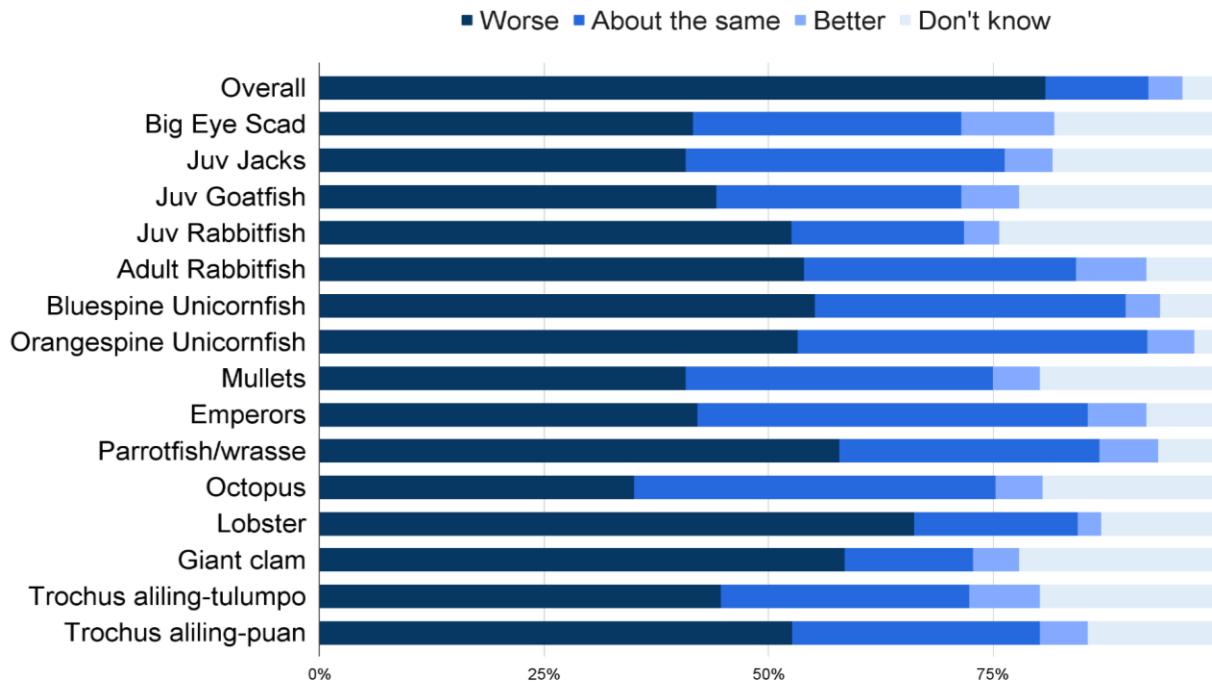


Figure 2. Participants' perceptions of reef fishing overall and 15 types of target species at the time of engagement compared to the past.

Table 6. By island, breakdown of participant perceptions of reef fishing overall and 15 types of target species at the time of engagement compared to the past.

Reef fishing component	Island	Worse	About the same	Better	Don't know
Overall	Saipan	78%	14%	8%	-
	Rota	86%	10%	-	3%
	Tinian	75%	8%	-	17%
Big Eye Scad	Saipan	53%	22%	14%	11%
	Rota	28%	31%	10%	31%
	Tinian	42%	50%	-	8%
Juv Jacks	Saipan	54%	19%	8%	19%
	Rota	25%	46%	4%	25%
	Tinian	36%	64%	-	-
Juv Goatfish	Saipan	51%	19%	8%	22%
	Rota	31%	38%	7%	24%
	Tinian	55%	27%	-	18%
Juv Rabbitfish	Saipan	59%	16%	3%	22%
	Rota	38%	24%	7%	31%
	Tinian	67%	17%	-	17%
Adult Rabbitfish	Saipan	63%	26%	11%	-
	Rota	48%	24%	7%	21%

Reef fishing component	Island	Worse	About the same	Better	Don't know
	Tinian	42%	58%	-	-
Bluespine Unicornfish	Saipan	70%	19%	5%	5%
	Rota	41%	48%	-	10%
	Tinian	42%	50%	8%	-
Orangespine Unicornfish	Saipan	69%	28%	3%	-
	Rota	41%	52%	3%	3%
	Tinian	33%	42%	17%	8%
Mullets	Saipan	51%	17%	9%	23%
	Rota	34%	52%	-	14%
	Tinian	25%	42%	8%	25%
Emperors	Saipan	60%	34%	6%	-
	Rota	28%	52%	-	21%
	Tinian	25%	50%	25%	-
Parrotfish/wrasse	Saipan	69%	17%	11%	3%
	Rota	52%	34%	3%	10%
	Tinian	42%	50%	-	8%
Octopus	Saipan	50%	36%	6%	8%
	Rota	21%	41%	3%	34%
	Tinian	25%	50%	8%	17%
Lobster	Saipan	69%	19%	6%	6%
	Rota	69%	17%	-	14%
	Tinian	50%	17%	-	33%
Giant clam	Saipan	67%	14%	3%	17%
	Rota	55%	10%	-	34%
	Tinian	42%	25%	25%	8%
Trochus aliling-puan	Saipan	60%	17%	6%	17%
	Rota	10%	31%	-	59%
	Tinian	17%	50%	17%	17%
Trochus aliling-tulumpo	Saipan	49%	20%	9%	23%
	Rota	52%	31%	3%	14%
	Tinian	17%	42%	17%	25%

Table 7. By age, breakdown of participant perceptions of reef fishing overall and 15 types of target species at the time of engagement compared to the past.

Reef fishing component	Age (yrs)	Worse	About the same	Better	Don't know
Overall	<50	73%	17%	-	10%
	50+	89%	7%	4%	-
Big Eye Scad	<50	27%	30%	13%	30%
	50+	51%	31%	4%	11%
Juv Jacks	<50	27%	47%	3%	20%
	50+	49%	29%	4%	16%
Juv Goatfish	<50	30%	30%	3%	37%
	50+	53%	24%	7%	13%
Juv Rabbitfish	<50	47%	17%	7%	30%
	50+	58%	20%	-	22%
Adult Rabbitfish	<50	43%	40%	7%	10%
	50+	60%	24%	9%	7%
Bluespine Unicornfish	<50	33%	60%	3%	3%
	50+	71%	18%	4%	7%
Orangespine Unicornfish	<50	30%	60%	7%	3%
	50+	67%	27%	4%	2%
Mullets	<50	37%	40%	3%	20%
	50+	44%	31%	4%	20%
Emperors	<50	33%	50%	7%	10%
	50+	49%	38%	7%	7%
Parrotfish/wrasse	<50	37%	53%	3%	7%
	50+	71%	13%	9%	7%
Octopus	<50	27%	47%	7%	20%
	50+	40%	36%	4%	20%
Lobster	<50	53%	23%	-	23%
	50+	76%	13%	4%	7%
Giant clam	<50	63%	10%	7%	20%
	50+	53%	18%	4%	24%
Trochus aliling-puan	<50	47%	30%	10%	13%
	50+	44%	27%	4%	24%
Trochus aliling-tulumpo	<50	53%	33%	3%	10%
	50+	53%	24%	7%	16%

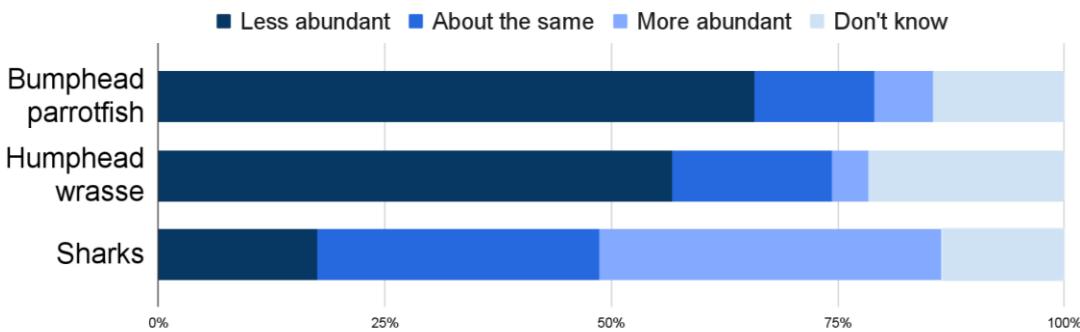


Figure 3. Participants' perceptions of bumphead parrotfish, humphead wrasse, and shark abundance at the time of engagement compared to the past.

Table 8. Comments on the overall state of reef fishing identifying factors of change.

Factor of change (n)	Exemplary notes from discussions
Fishing pressure (26)	<ul style="list-style-type: none"> People take too many of every species, especially with the economic situation some people are fishing more and taking any sizes. A lot better in the past. We catch more fish back then. Number of people fishing increased, now more demand for fishing. Nowadays there's a lot of foreign fishermen fishing in Rota, which forces the locals to fish further out from the reef. Observed problem in mid 80s-90s when guest workers were brought to work on development/road, building construction; fish stock pretty depleted destruction of habitat, pave road and don't take care of runoff and overharvest. Worse because there's less fish, commercial fishing, dynamite, derris¹¹. If this was restricted it won't affect the fish population. When we use this we destroyed everything, even rocks. Could be scuba spearfishing, "derris", whatever... Nowadays nobody waits for the [fish] to get big.
Economic pressure (6)	<ul style="list-style-type: none"> Nowadays life is very hard, people can barely make means, so when they [need] food they just go out and harvest everything on the reef. Back then it was really good, you can sustain your family just by fishing after work. Now you can still do the same, but you have to work twice as hard, and what's worse is they commercialize, nowadays they catch and sell. One of the main thing why it's getting worse [is] commercialization.
Regulation (5)	<ul style="list-style-type: none"> One of the major contributing efforts has to come from the conservation offices in the Department. They are safeguarding our marine resources...if they are lenient or don't have the resources to monitor the fisheries activities, people tend to abuse. The desire to catch more fish to sell drives you to break the law. Outside reef spearfishing, fish are coming back, not like before when they had scuba fishing. [Now] there's a decrease in scuba fishing from ban, gillnet ban...
Water quality (3)	<ul style="list-style-type: none"> Due to overfishing and also from bad water quality from the runoff.
Fish behavior (3)	<ul style="list-style-type: none"> More fishermen, more lights for fish, and they're aware now. Fish are moving depending on the season and weather. Fish are smarter. Seasonal fish due to weather/currents.

¹¹ A type of root used as a fish poison (Jennison-Nolan 1979).

Recommendations to improve reef fishing

Participants were asked to elaborate on their recommendations for mitigating declines in reef fishing or reef species referenced in Figures 2 and 3 using the question, “Is there anything that you think can or should be done to improve this?” (see [Appendix](#) Question 7). In [Table 9](#) we present the themes that emerged from participant recommendations with exemplary notes taken directly from the data results matrix with minimal editing. Recommendations included references to the following themes, in descending order of prominence: area regulations (n = 21), enforcement (n = 20), fishing method regulations (n = 18), problematic human activity (n = 16), seasonal regulations (n = 11), size and species limits (n = 8), education (n = 6), and community input (n = 3). Additionally, [Table 9](#) includes a “Miscellaneous” category, which includes notable themes referenced fewer than three times.

Table 9. Thematic categories for participants’ suggestions to improve reef fishing.

Theme (n)	Exemplary notes from discussions
Area regulations (21)	<ul style="list-style-type: none"> ● More MPAs [marine protected areas], and rotate MPAs every five years, cause people tend to out fish one area, so if you close that one area open another area somewhere the population of fish has gone up. ● Implement MPAs on the areas that are severely damaged and try to restore the fish populations on those areas. ● Need to conserve certain areas in Rota, like for instance should close the entire Sansanhaya Bay. ● Designate a drainage area for the western and eastern side of the islands.
Enforcement (20)	<ul style="list-style-type: none"> ● Stricter enforcement procedures on fines. ● Enforcement and more monitoring. ● Continue enforcement and regulating so it's around for next generation.
Fishing method regulations (18) ○ Derris (8) ○ Scuba (7) ○ Gillnet (6)	<ul style="list-style-type: none"> ● More enforcement should be looked into concerning fish kill method because it destroys the food chain, shelter, etc. ● Derris or other chemical poisons should stop. Any toxic in the water affects the coral reef. ● He believes "derris" and scuba spearfishing should be strictly enforced. Ten years ago the fish population was high, but since the SCUBA fishing was being used, it has gone down. ● Stop net fishing and fish poison method in order for fish to multiply. ● Stop the SCUBA fishing, gillnet size - 3" only. ● More law enforcement on fish regulations to allow gillnet & regulate its size for subsistence fishing only. ● Re-open the use of gillnets. Allow the poor to use gillnets.
Problematic human activity (16) ○ Outsiders (8) ○ Too much fishing (4) ○ Commercialism (3)	<ul style="list-style-type: none"> ● Like he said before, it all depends on the timing of the fishes, when they come in closer to feed, so maybe just don't let outsiders fish and only locals. ● Control non-indigenous fishermen on island. ● He thinks that there should be a policy that if outsiders want to fish, they should pay a fee, and only certain species can be caught. Strictly locals can fish. ● Regulate methods of fishing due to overfishing and abundance of fishermen. ● Stop fishing/minimize fishing. ● Markets are reason behind the depletion of fish.

Theme (n)	Exemplary notes from discussions
Seasonal regulations (11)	<ul style="list-style-type: none"> ● <i>Seasonal fishing for juvenile rabbitfish.</i> ● <i>Provide yearly seasonal fishing for different species such as the mañåhak, mullets and rabbitfish.</i> ● <i>Needs room for improvement for example: i'i, ti'ao fish species to schedule seasonal fishing for fish habitat to have ample time to develop.</i> ● <i>Provide seasonal fishing schedule for octopus since it's very difficult to catch nowadays.</i>
Size/species limits (8)	<ul style="list-style-type: none"> ● <i>Leave bigger fish alone, go for in between, be aware of breeding habits, awareness of reproduction size.</i> ● <i>Spawning areas should be closed, juvenile runs to allow fish to grow.</i> ● <i>Regulate subsistence fishing, limit the size and species when fishing.</i> ● <i>Catch bigger sizes of fish.</i> ● <i>Regulate the size of fish being sold at the markets.</i> ● <i>Mafuti to allow 6 pieces per limit one has to be 14 inches in.</i>
Education (6)	<ul style="list-style-type: none"> ● <i>Need community involvement, public education, traditional-elder fishermen to lecture kids, regulations written in book not enough.</i> ● <i>Awareness, enforcement, education. People need to change their attitudes.</i> ● <i>Need education not only in classroom, outreach and interactive hands-on: targeting of the younger generation as next stakeholders for our natural resources.</i>
Community input (3)	<ul style="list-style-type: none"> ● <i>Community should assist on making rules and regulations to help improve growth of fish population by scheduling seasonal fishing, "free range of spawning" to contribute to fish habitat.</i>
Miscellaneous (6)	<ul style="list-style-type: none"> ● <i>Management and conservation practices may repopulate different fishes back, but only with good management practices.</i> ● <i>Special permits should be revoked in its entirety.</i> ● <i>Eradicate sharks. In Rota when the atulai comes everybody wants to catch it, no control.</i> ● <i>Take example from Palau and study the spawning seasons and restrict fishing during those times; move jetskis when it's spawning season; set route for boats away from fish habitats in the lagoon; turtles need to be monitored; strict MPA</i>

Fishing Practices

Historical local and traditional restrictions

When prompted for descriptions of local or traditional restrictions or limits on fishing, harvesting, or using the coast, 61 respondents replied “No,” 16 replied, “Yes,” and one was not sure (see [Appendix](#) Question 12). Among the 16 fishers that responded in the affirmative, 10 elaborated upon their responses with relevant details. Notable commentary included those related to village or clan customs ($n = 6$), which seemed to align with the well-being and customs of the community. This type of guidance pertained to fishing seasons, off-limits or taboo species, fishing areas, and fishing tools, and could be bestowed by village leaders or elders. In one example, a fisher described an adaptive form of management in which elders implemented seasonal area restrictions after observing high volumes of catch in the previous season. One fisher noted of Tanapag in the ‘60s and ‘70s, *“The ocean out there belongs to the village,”* and catch was distributed as such.

Fewer participants made reference to less formal “restrictions” guided, for instance, by behavioral norms. This included the following exemplary notes from three different interviews:

Before in the old days, there are self-made conservation and conservationists.

Only catch what they are going to eat, whatever is enough on the table. No freezers, either dried or eat it fresh. Can't get big supply of fish back then, everyone catches their own fish and population was not as much, controlled fishing environment.

“Not a restricted area, just a form of respect...” In dangerous places, “don’t fish and don’t make noise or [the] sea will come take you.”

In Tanapag, a fisher was once “told not to go out due to funeral [or some cultural event] ... had a bad catch that day.

There were also one-off references to *“strictly enforced trochus (tulumpo) seasons, and size limits enforced by Japanese companies”*, and *“traditional restrictions to hara species used in local medicine.”*

Avoiding certain fish

Participants were asked if they avoid harvesting any fish (see [Appendix](#) Question 7b). Four fishers responded, “No,” and 25 fishers did not respond. Participants were also asked why they avoid these fish with the following prompts as examples: fish toxicity (ciguatera), cultural beliefs, and personal preference. The most commonly avoided fish was red snapper ($n = 40$) and the most commonly cited reason for avoidance was fish toxicity ($n = 40$). Note that in the review of data, references to *“skipjack,”* avoided at larger sizes, and often for their toxicity, were assumed to be references to trevally rather than tuna. One interviewee demonstrated the colloquial use of *“skipjack”* to refer to trevally, describing, *“Skipjacks such as blackjacks.”*

The most commonly avoided fish was red snapper ($n = 40$)—referred to in the data as *tagåfi*, *hara*, and *marebw*—with 20 fishers referencing its toxicity. The second most avoided fish was *Variola louti* ($n = 9$)—referred to by fishers as red/yellow grouper—with three fishers referencing its toxicity. The third most avoided fish was “skipjack” trevally or mamulan ($n = 7$). Six of the seven fishers that reported avoiding trevally cited its toxicity.

Other groups of avoided fish included parrotfish and wrasses ($n = 6$, also referenced as *tångison* or *palakse*¹²), balloon or pufferfish ($n = 4$), stonefish ($n = 4$), surgeonfish ($n = 4$, also referenced as *hiyok* or *kichu*), barracuda ($n = 3$), butterflyfish ($n = 3$), emperors or mafute' ($n = 3$), and unicornfish ($n = 3$, also referenced as *hangon* and *tåtaga*). Additional marine fauna that fishers avoided (with fewer than three references each) included reef and reef-associated fish like other snappers (black-spotted; *bu'a*), other groupers (spotted black; *låpulåpu* or honeycomb grouper), other trevally (bluefin), goatfish (*satmoneti* or black spot tail), solderfish, squirrelfish (long jawed), angelfish, lionfish, trumpetfish, and eel; invertebrates like octopus and lobster; some bottomfishes, big mouth bass, and turtle.

The most commonly cited reason for fish avoidance was fish toxicity ($n = 40$). Personal preference was the second most prominent reason for avoidance ($n = 13$), and, in some cases, coincided with references to what one fisher referred to as a “*self conservation strategy*” ($n = 6$). This fisher said he, “*Doesn't catch juvenile sizes for the love of Mother Nature, let it go.*” Another fisher cited personal preference and said he, “[Tries] not to shoot [*tångison*] because *economic fish for tourists, very long for them to grow, numbers are way down.*” As an example of a strictly “conservation strategy,” one fisher said he avoids *tåtaga'* because it is not prevalent on Rota. There were various references to cultural practices and beliefs that guided fish avoidance ($n = 9$), which included the following exemplary notes from discussions.

Cultural beliefs change over time. Carolinian family tells you what fish can't come into the house.

Religion and cultural: Depends. Some fish are respected, family can't take eel;

Family couldn't eat certain fish and lobsters, but can't recall names (cultural basis).

Satmoneti used for medicine.

Mom told me not to take red/yellow grouper is special. Should not take, but kids take it since it's ok now. Don't take turtle; it was traditional medicine in the past.

Participants also mentioned general avoidance of small or juvenile fish ($n = 8$), citing personal preference and self-conservation strategies.

¹² A reference in discussion notes to “*palaski*” is assumed to be “*palakse*,” a type of wrasse.

Changes in habitat and climate

Participants were asked about their perceived changes in coral, seagrasses, and nearshore water quality through time (see [Appendix](#) Question 10). The distribution of responses, for those that provided them, are displayed in [Figure 4](#). [Figure 4](#) does not display null responses, for which there were 19 regarding seagrass and two regarding nearshore water quality.

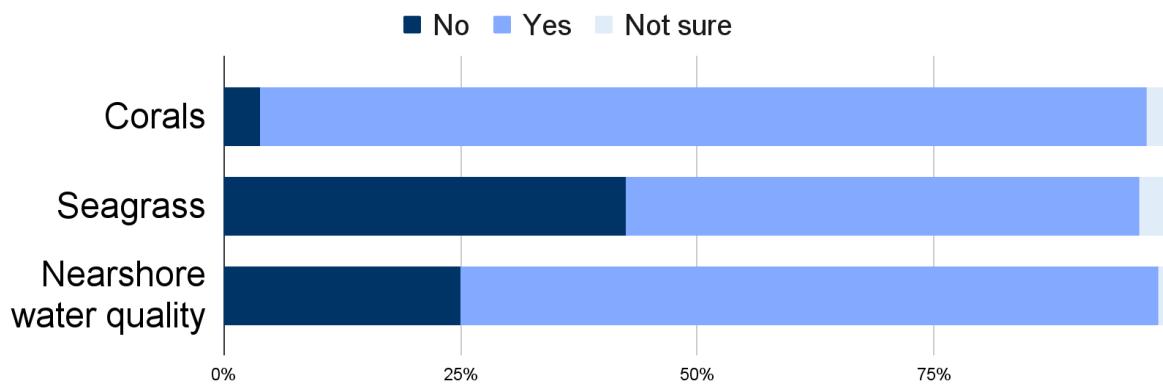


Figure 4. Participants' perceived change to corals ($n = 78$), seagrass ($n = 59$), and nearshore water quality ($n = 76$) overtime.

Change to corals

Of the 73 participants that perceived change to coral through time ([Figure 4](#)), 57 provided additional comments. Only two fishers described coral improvement. Both of these comments were area-specific: within a Tinian marina, and in reference to the “*front side*” of, perhaps, Tinian. Most of these comments, however, described coral declines ($n = 49$) including coral bleaching, death, damage, and algae overgrowth. Comments identified causal factors including water quality factors ($n = 9$) like runoff and algae growth; the use of harmful fishing practices like the fish kill method, which might employ clorox or derris ($n = 5$); crown-of-thorns starfish (COTS; $n = 5$); harbor construction, recreational activity, trash, climate change, and typhoon damage.

Twenty-four fishers described impacts to their fishing practices, primarily from coral declines but also from pollution and fish kill methods.

In some cases, fishers were prompted for their observations of COTS. Thus, COTS was mentioned in 45 participants’ comments on coral change. A fraction of these ($n = 16$) commented specifically on the relationship between COTS and corals, nine of which perceived damaging COTS impacts to corals, six of which perceived no impact, and one of which entertained the possibility of COTS’ responsibility for corals dying. One fisher commented on the relationship between a mollusk and COTS, remembering that in “*1980, people harvested the triton's trumpet which could have controlled the COTS.*”

Five fishers expressed a lack of awareness about COTS, but, by and large, comments about COTS referenced a neutral awareness of COTS ($n = 37$). Many described seeing COTS ($n = 28$), around Saipan (Mañagaha, Smiling Cove, LauLau Bay, PauPau Beach, San Antonio Beach, Agingan Point, Coral Ocean Point), Rota (east side and Wedding Cake Cove to Sasanhaya Bay), Tinian (Barcinas Bay), and Goat Island. Three of these fishers described greater COTS abundance in the '70s. Ten participants, in describing their awareness of COTS, referenced a coordinated COTS campaign consisting of an eradication program or scientific messaging.

The eradication program was described as one in which community members were either incentivized to capture COTS or inject them with formaldehyde. One fisher said, "*I was told COTS could be a factor.*" Another described being "*told COTS will destroy the reef; wrong information from scientists, this never happened.*" He participated in a COTS control program, then stopped because he felt he was "*polluting the water more than controlling it.*" He identified nonpoint source of pollution as a major factor of coral decline, and added, "*Leave starfish alone, they are natural and part of the ecosystem.*"

Change to seagrass

Of the 32 participants that perceived change to seagrass through time ([Figure 4](#)), 28 provided additional comments. Two fishers described the growth of seagrass, but more common was the perception of seagrass decline ($n = 11$), which included descriptions of less seagrass or increased sedimentation, trash, and pollution. Nine fishers described related impacts to fishing, the most common of which was decline in or change to associated fauna ($n = 6$). In one example, a fisher described the disappearance of *kabara* (a seagrass parrotfish) from seagrass through time. Another fisher described the appearance of an invasive catfish that nests in seagrass and has appeared to deplete other fish.

Six fishers commented on an increase in algae, but the connection to seagrasses is unclear. Half of these are in reference to seagrass, but according to data matrix notes actually describe types of algae (*Gracilaria*, *Caulerpa*, *Asparagopsis*):

Primarily pollution changes the seagrass, nutrients make them more prolific, grows much more, hasn't seen tremendous changes. What he has seen that has increased tremendously is the sea grapes (Caulerpa), especially when there is a disturbance. Asparagopsis he's seen quite a few, good to eat. Hasn't really changed in his days in the village.

Some changes. 2 types of grass (algae). Gracilaria and Caulerpa (grapes) very rare; food of guile, laggua and hiteng.

Obyan used to be covered with corals only, no grass, very colorful, now seagrass (but refers to algae) looks like carpet.

The prevalence of mixed references to seagrass and algae in this dataset, the relatively low response rate to the seagrass change inquiry ($n = 59$), and the perceived irrelevance of this question to Tinian ($n = 4$) and Rota ($n = 4$) obscures the reliability of these results.

Change to nearshore water quality

All 56 participants that perceived change to seagrass over time ([Figure 4](#)) provided additional comments. Just over half of these fishers described an explicit decline in water quality (n = 29), using language like “worse,” “dirty,” or “polluted” to refer to water quality today or describing the better water quality of the past: “*It used to be clean and crystal clear,*” or, “*Very poor compared to before when the water was pristine.*” Thirteen of these fishers identified factors affecting the decline in nearshore water quality including runoff and erosion (n = 6); development (n = 5); and contamination or pollution (n = 4). Four fishers that described a decline in water quality also highlighted management issues.

DEQ is working as hard as they can, but need to be more consistent in enforcing oil spills, etc.

Changed dramatically due to development and growth of population and ponding basins not probably addressed. Sediment runoff straight into the ocean destroying the lagoon affecting fish habitats.

Unclean due to runoff and inland pollution, development, not good management practices. Better engineering can assist us in conserving our resources by diverting runoff to ponding basin.

The fourth commented on the people’s ignorance of MPAs.

The remaining 27 participants described variation in water quality without making a value judgment about that change or describing a downward trend through time. For example, there are many comments about water visibility or turbidity changing according to rain, tide, wind, or currents. One person noted that nearshore water quality is affected during “*rainy season only, nothing unusual or any discoloration.*”

Seven participants described water quality impacts to their fishing practices, including one reference each to: less fish, fish moving further from shore, and having to move fishing locations.

Other large-scale changes

Participants were prompted for their observations of other large-scale changes over time like changes in fish, populations, weather patterns, water temperature, or fishing seasons (see [Appendix](#) Question 11). Given the prompt, more than half of all fishers commented on changes in fish population (n = 45), weather patterns (n = 45), water temperature (n = 44), and fishing seasons (n = 37).

Out of the 45 participants who commented on fish populations, 36 noticed some change. The most popular change noted was a decrease in fish abundance (n = 26). Some of these observations were in reference to certain areas like the south or western coasts, or to specific species like ti’ao, mañåhak, or bottomfish. Five of the 36 fishers who noted change described a change in fishes’ location including movement to greater depths or movement in accordance with changing water temperatures.

Out of the 45 participants who commented on weather patterns, 31 noticed some change. Fewer ($n = 19$) elaborated on the type of change they noticed, which included commentary on: changes to rainy and dry seasons ($n = 6$), fewer typhoons ($n = 3$), and—with fewer than three fishers commenting on each—changes to trade wind seasonality, lower tides, less predictability in general, both rougher and calmer waters, and change in wind direction from southward to northward. One fisher noted, “*Normally we have annual typhoons, now almost 20 years without a typhoon. Typhoons clean up the island and reefs so the coral can rejuvenate.*” This comment preceded typhoons Soudelor and Yutu in 2015 and 2018, respectively. Lastly, in contrast with observations of lower tides, one fisher described tides as three to six inches higher than they used to be.

Out of the 44 participants who commented on water temperature, 31 noticed some change. Cooler water was described by 10, and warmer waters were described by 13. One fisher described warmer summer and cooler winter waters.

Out of the 37 participants who commented on fishing seasons, 29 noticed some change. The most popular change noted was a shift toward later fishing seasons ($n = 7$), which was often in reference to reef and reef-associated fish like mañåhak, ti'ao, and atulai. One fisher seemed to describe an absence of such fish, noting that mañåhak and atulai don't come in for their regular run. One fisher described a shorter fishing season. Another provided the example, “*nowadays when you fish in full moon for parrotfish, you also find hiteng (rabbitfish) which is not normal for back then.*”

Ten participants attributed changes they noticed to human impacts. The most commonly cited activities were fishing leading to fish depletion ($n = 4$) and the fish kill method ($n = 3$). Others included nearshore and offshore activities involving motorized vessels, development, runoff, and outsiders targeting land crabs.

Thoughts on regulations

Participants were also prompted for their thoughts on CNMI marine resource use regulations (see [Appendix](#) Question 14). As needed, fishers were prompted with the following as regulation examples: trochus and lobster size limits, MPAs, and the general help or harm provided by regulations. The most common points of discussion were the gillnet ban ($n = 40$), scuba spear ban ($n = 35$), and the need for more or improved enforcement ($n = 33$). Among 40 fishers that mentioned the gillnet ban, 22 agreed outright and eight agreed with caveats. The most common caveats mentioned were allowances for some gillnet sizes and older fishers. The 10 who did not agree with the gillnet ban added commentary about conditional allowances related to net size, season, location, economic hardship, and fishers' lack of access to other types of fishing.

Among 35 participants that mentioned the scuba spear ban, 31 agreed with the ban. Three out of the four that did not agree with the ban explained that scuba divers' effort is limited by the air in their tanks.

Among the 33 participants that expressed a need for more or improved enforcement, the most common specific requests were more enforcement (or monitoring) in the MPAs ($n = 5$) and

improved accountability for conservation officers (n = 3). Related to the latter point, two fishers spoke about the potential for federal or outsider enforcement being more effective given local officers' leniency and connectedness to their community. Other, singular comments called for increased enforcement at night, at the market, and for continuous monitoring of the sea cucumber moratorium.

Over 75% of participants who mentioned the sea cucumber moratorium (17 out of 22), trochus moratorium (15 out of 20), and lobster size limits (15 out of 18) agreed with them. Some fishers' agreement was conditional. For example, one fisher agreed with the sea cucumber moratorium "*depending on economy*." Another fisher suggested a trochus bag limit. One fisher disagreed with "*all moratoriums*," suggesting instead the ban of commercial use and allowance of home use.

The need for more, or different types of regulations came up in 16 fisher discussions, with references to size limits, fishing and spawning seasons, area-specific restrictions, the ban of special permits, implementing regulation lifetimes instead of permanent regulations, and limiting effort or catch. The most common of these was reference to size of target species (n =7).

Four participants specifically cited the desire to support future generations in their expressed agreement with certain regulations.

Four participants commented on the need for education. Three of these comments were in reference to supplementing enforcement. The fourth was in reference to educating the youth in talaya (throw net) fishing, which he referred to as "*a dying custom*."

Three participants described an excess of fishing restrictions. One fisher described an imbalance between enforcement and regulation. The other two fisher described an excess of restrictions impacting "locals" or "veteran" fishers.

Traditional fishing practices, indigenous fishers, and cultural or community events were discussed by ten fishers. Four fishers referenced allowances for cultural purposes, three of which suggested permits as a mechanism. Three fishers referenced allowances for netting. Two of these were in reference to gillnetting. The third appeared to be in reference to chenchulu. The latter asserted: "*Tell me that my net is illegal, and then tell me to speak at schools about traditional fishing is insulting*." One fisher specifically noted the impact to indigenous fishers on Tinian, whose fishing is limited by a large MPA.

Seven participants made explicit references to either "*locals*" or "*outsiders*." Six of these referenced a dynamic in which locals are unfairly regulated because they "shouldn't" be restricted or because their impact to the marine ecosystem has been misconstrued (e.g., gillnetting). Two of these fishers suggested the regulation of fishing by outsiders, while locals are allowed to fish. Only one of these seven fishers highlighted locals' abuse of fisheries for which moratoriums have been implemented.

Other thoughts

At the conclusion of each discussion, fishers were given the opportunity to share additional thoughts relevant to fishing and marine resource use (see [Appendix](#) Question 15). Of the 44 respondents that provided additional comments, 30 commented on regulations and enforcement. Most of these comments either called for more regulations and enforcement or expressed a lack thereof ($n = 21$). Five fishers called for area restrictions, the most common of which was MPAs ($n = 3$) but also included designated Jet Ski areas and restricted areas in general. Enforcement was another common issue. Three out of four fishers highlighted a lack of enforcement funding and resources, such as fuel. Two fishers commented on a need for more monitoring with one suggesting the monitoring of commercial fishing, specifically. One fisher noted the lack of enforcement on Rota.

Other regulatory comments included calls to stop the use of fish poisons ($n = 4$) such as derris and bleach. Fishers also called for a scuba fishing ban ($n = 2$), TNT (blast) fishing ban ($n = 1$), and a gillnet ban ($n = 1$). Two respondents suggested that conditional allowances be permitted for gillnetting. For example, “*Concerning gillnet ban, look into size, and schedule seasonal fishing in terms of size, certain fishing spots for fish to grow.*” In another example, a fisher suggested paid licenses for netting season, which would also generate funds. Although two fishers called for the removal of special gillnet permits, expressing the belief, “*permitting gillnet fishing for fiestas and parties should be [stopped] ‘cause it’s not fair for the rest,*” others supported its continuance in support, for example, of “*traditional cultural events.*”

Three fishers suggested modifications to existing closed areas:

Would like to see changes. Look into shifting sanctuaries like protecting half of the reef (let the fish develop in certain areas).

Open up the sanctuaries and close the areas that lack fish so the fish can come back and reproduce.

The MPA on Tinian should be cut in half.

A few fishers commented on “outsider” fishing activity ($n = 3$). One simply shared that, “*For years he’s been observing scuba spear fishermen coming from Saipan and fishing in Rota.*” The other two called for regulations that would exclude “outsiders”:

[I] always see outsiders ransack our resources and they have no license while I go buy my license. More monitoring of our island’s resources.

We need to stop outsiders from fishing because they don’t know how to fish. Locals know what to catch while outsiders catch anything. It [doesn’t] matter the size.

One fisher called for the limited harvest of turtles by elders: “*Allow the elders to harvest at least one endangered species (turtle) for their consumption.*” Two others expressed concern for turtles:

Green turtle population is getting smaller, but when you go to family parties you see them on the table. I want my kids and their kids to see the turtles.

Some are catching turtle before they reproduce. If it's true that it's for medicinal purposes then everyone will be healthy. They give false impressions about the need and uses of turtles.

We need more enforcement because fish populations and turtles are no longer abundant.

Education was another prominent point of discussion (n = 7). Fishers called for education of the general public, resource users, and youth on such topics as fishing regulations, traditional fishing, and conservation. These notes from the data matrix illustrate the various purposes fishers imagined education might serve:

Public education to understand and appreciate resources.

To reach [the] community in order to prevent people from getting arrested and learning on the spot.

We need to teach people how to conserve and save some of the species.

Would like to see kids get a better understanding of the historical relationship between the island residents and the ocean. Of how important it is to maintain and protect our marine resources. Maybe we can do a lot better in the future.

One fisher suggested that the “*Government should encourage young generation to learn traditional fishing by getting an individual to teach them and how to respect other fishermen's boundaries.*” Another fisher volunteered to help: “*Need to get guys who are on payroll to do public outreach to go to schools at least once every 3 months, do traditional presentation can hire him.*”

Four participants reiterated changes to fish populations including relative scarcity and lack of abundance, and in one example, having to go further offshore to find tuna.

Three fishers expressed discontentment with different types of modern fishing gear, including artificial lights and motorized boats. One described artificial lights as “*unfair*” and “[imposing a] *sustainable fishing issue.*” Another suggested that: “*Use of modern technology should be banned like the two-stroke engine. Four-stroke only.*”

Three fishers expressed generalized support for conservation:

Join together as a team and practice conservation for our children.

He thinks that if they don't do something about the fish problems now, [there will] be more problems in the future.

Need to protect our marine resources.

The remaining comments were thematically unique regarding

- **More research:** *Marine fisheries and their supporting habitat—we should really go forward and study the marine ecosystem.*
- **Concern about commercialization of atulai:** *Fishing historically hasn't changed for us dramatically. We still fish day and night, we catch lobster by hand no spear, we don't scuba dive and catch fish, which is okay with me because we really don't commercialize our catch with scuba. We prefer to go skin diving, but doesn't really bother the major population, only one or two companies enhance their activities. Commercialization, I would like to see like Palau. Atulai should not be marketed but for home consumption. Rod and reel guys should be given first hand in the catch when atulai season is in.*
- **Concern about climate change:** *I just want those people involved in fishing to be sensitive in the climate changes because it affects the tide, and tide assures the fish to come in and out of the lagoon to feed. The only time the fisherman can catch the fish is during feeding time (for talaya). Pacific is highly impacted by rise in tide level.*
- **Concern for future generations:** *Stakeholders should be very serious with this issue, enforcement policies should be stricter. Future generations should be able to see our resources.*
- **Sharks:** *Reduce the number of sharks.*
- **Sharing of fish:** *Notice difference in style of dividing fish. Patti equally boat gets a share is not practiced. Why? Fish are less abundant; more business-like.*

Discussion

This data report provides a summary of a long concluded project's results with limited interpretation.

We hope this report's synthesis of various facets of elder CNMI fishers' experiences and knowledge offers a helpful summary for public availability and awareness.

In reviewing these results, we highlight the following considerations. First, we reiterate that these results reflect the valuable perceptions and experiences of participants at the time of their engagement, in 2009-2010. Results do not support broader inferences about the island community as a whole. Second, fisher discussions were intermittently guided by prompts used at the discretion of the research team. Among these prompts were: fish size, species, and quantity as examples to change to fish through time; fish toxicity, cultural beliefs, and personal preference as examples of reasons to avoid fish; COTS observations as a complement to changes to corals through time; changes to fish population, weather patterns, water temperature, and fishing seasons as examples of other large-scale changes through time; and trochus and lobster size limits, MPAs, and the general help or harm provided by regulations as prompts for thoughts on marine resource use regulations. Finally, participants' frequency and type of interaction ([Figure 1](#)) with the marine environment changed through time. For example, out of the 38 fishers that alluded to a change in fishing activity through time, 18 explicitly described fishing less through time.

Results highlights

- Fishing motivations were layered for a majority of interviewees ([Table 4](#)) but the most common were fishing for food (95%) and commercial sale (40%).
- The four most common fishing methods through time were spearfishing, trolling, bottomfishing, and talaya ([Figure 1](#)). Many participants (77%) indicated change to their fishing methods over time. Some attributed change to health- or career-related reasons, regulations the scuba and gillnet bans, modernization of fishing gear, and reef fish decline.
- Many participants (81%) perceived reef fishing to worsen through time ([Figure 2](#)). Fewer (40-60%) perceived specific species to worsen through time, the exceptions being octopus (35%) and lobster (66%). Across islands, a larger proportion of Saipan residents perceived reef fishing to be worse for 11 out of the 15 species ([Table 6](#)). By age, a larger proportion of participants aged 50 and over perceived reef fishing to be worse for 13 out of the 15 species ([Table 7](#)). The most commonly described factor affecting reef fishing was fishing pressure ($n = 26$) including overfishing, increased participation, an influx of foreign fisher groups, harmful fishing practices, and less discrimination by target species size ([Table 8](#)).
- Recommendations to improve reef fishing included area regulations, enforcement, fishing method regulations, mitigation of problematic human activity, seasonal regulations, size and species limits, education, and community input ([Table 9](#)).

- The most commonly avoided fish was red snapper ($n = 40$) and the most commonly cited reason for avoidance was fish toxicity ($n = 40$).
- Many participants perceived change to corals and nearshore water quality over time ([Figure 4](#); 94% and 72%, respectively), with fewer explicitly describing declines (63% and 37%, respectively). Interviewees identified runoff and erosion, development, and contamination or pollution as factors affecting change to nearshore water quality. Apparent confusion between seagrass and algae, the relatively low response rate for seagrass, and the perceived irrelevance of seagrass to Tinian and Rota obscure seagrass-related results.
- Many fishers (82%) that commented on COTS expressed a neutral awareness of COTS.
- Increasing unpredictability was a common theme across other large-scale changes, such as fish population, weather patterns, water temperature, and fishing seasons.
- Over 75% of participants agreed with most of the discussed regulations including the scuba spear ban, sea cucumber moratorium, trochus moratorium, and lobster size limits. There was least agreement around the gillnet ban (55%). Participants that did not agree outright raised impacts to and allowances for traditional fishing practices, indigenous fishers, elders, and cultural or community events.

What's happened since 2010?

Since interviews were conducted for this study, CNMI's fishing people and nearshore environments have been exposed to a number of ecological changes and research efforts. Nearshore marine landscapes have undergone coral bleaching, with severe events in 2013, 2014, 2016, 2017 (U.S. NOS 2018); major typhoons Soudelor (2015) and Yutu (2018); a 2020 COTS outbreak; and changing fishing pressure and markets due to the COVID-19 pandemic and shifts in tourism (Kleiber et al. 2022).

Impacts from these events may be reflected in snapshots of CNMI coral reef health (U.S. NOS 2018) and assessments of Saipan coral reefs' climate change (Maynard et al. 2012). Regularly published nearshore marine monitoring reports capture metrics, such as coral cover, COTS abundance, and food fish biomass across CNMI geographies (Houk et al. 2012; Benavente et al. 2017). The availability of consistent nearshore marine data since at least 2008 may provide a helpful comparative dataset should elder fisher interviews be replicated in the future. For example, a larger proportion of the older interviewees (aged 50 and above) perceived reef fishing and many reef species to worsen through time ([Table 7](#)). A comparison of fisher perceptions to longitudinal ecological data is required to empirically determine whether or not this pattern indicates shifting baseline syndrome due to generational amnesia (Jones et al. 2020).

Studies have estimated marked declines in fish landings in the CNMI since the 1950s. Zeller et al. (2007) estimate an 86% decline in small-scale commercial catch from 1950-2002, and Cuetos-Bueno and Houk (2015) estimated a 39-73% decline in reef fish landings from 1950-2011. Determining finer scale trends, however, are "difficult (perhaps impossible) because of variable commercial landings associated with CNMI's voluntary data collection system" (Cuetos-Bueno and Houk 2015). Additionally, it is difficult to infer fish biomass from landings without

such socioeconomic context as fisher behavior or the availability of imported versus local seafood. That is not to say socioeconomics of marine resources have been neglected.

Researchers have invested in a range of socioeconomic research including fishing community profiles (Allen and Amesbury 2012; Ayers 2018), socioeconomic surveys of the small boat fishing community (Hospital and Beavers 2014), historical fishing practices in (Kotowicz and Richmond 2013), and perceptions around the Marianas Trench Marine National Monument (Kotowicz and Allen 2015; Richmond and Kotowicz 2015; Kotowicz et al. 2017). Socioeconomic surveys by the NOAA's National Coral Reef Monitoring Program (which conducted its first surveys in 2016 and plan for a second round of surveys in 2024) shed light on nearshore recreational use, perceptions of marine resource condition and change through time, and community social indicators. The 2016 surveys also indicated that perception of change to marine resources in last 10 years was mostly negative, and revealed trends of declining population, declining household income, increasing poverty rate, and increasing dependence on public assistance income (Gorstein et al. 2019).

In addition to perceptions of ecological change, layered factors of change emerged from fisher interviews in a variety of contexts. Fishing methods changed as fishers aged and changed careers, or as regulations disallowed certain practices. Reef fishing changed with perceived increases to fishing pressure and reef fish declines. Fishing pressure changed with shifts in fishing culture, community composition, and practice. Moreover, water quality and corals changed under the stress of development, runoff, erosion, and pollution. The knowledge of long-time resident fishers could play a critical role in weaving together insights from coral reef, fishery, and socioeconomic monitoring efforts. In this way, we might tell more comprehensive stories about ecological change and unlock more robust pathways to resilient communities and marine ecosystems.

Acknowledgments

For facilitating and supporting the revival of this work, we thank DCRM Director Richard V. Salas, DCRM staff Colleen Flores and Art Charfauros, PIRO Coral Reef Fisheries liaison Steven McKagan, and Floyd Masga, contractor, educator, and advocate. Thank you to Steven McKagan for his insights into the original research process.

References

- Allen SD, Amesbury JR. 2012. Commonwealth of the Northern Mariana Islands as a fishing community. U.S. Dept. Commer. NOAA Tech. Memo. NOAA-TM-NMFS-PIFSC-36:89.
- Atkinson R, Flint J. 2001. Accessing hidden and hard-to-reach populations: snowball research strategies. *Soc. Res. Update* (33):1–4. Available online at: <https://sru.soc.surrey.ac.uk/SRU33.PDF>.
- Ayers AL. 2018. The Commonwealth of the Northern Mariana Islands fishing community profile: 2017 Update. U.S. Dept. Commer. NOAA Tech. Memo. NMFS-PIFSC-66:57.
- Benavente D, Comache R, Iguel J, Johnston L, Johnson S, Okano R, Perez D, Waddell J. 2017. Long-term Marine Monitoring Program final report: NA13NOS4820010, award period October 1, 2013- September 30, 2016. Available online at: <https://repository.library.noaa.gov/view/noaa/15434>.
- Cuetos-Bueno J, Houk P. 2014. Re-estimation and synthesis of coral-reef fishery landings in the Commonwealth of the Northern Mariana Islands since the 1950s suggests the decline of a common resource. *Reviews in Fish Biology and Fisheries* 25(1):179-194. DOI: [10.1007/s11160-014-9358-6](https://doi.org/10.1007/s11160-014-9358-6).
- Gorstein M, Loerzel J, Edwards P, Levine A, Dillard M. 2019. National Coral Reef Monitoring Program Socioeconomic Monitoring Component: Summary Findings for CNMI, 2016. U.S. Dept. Commer. NOAA Tech. Memo. NOAA-TM-NOS-CRCP-34:69 + Appendices.
- Hospital J, Beavers C. 2014. Economic and social characteristics of small boat fishing in the Commonwealth of the Northern Mariana Islands. Pacific Islands Fish. Sci. Cent., Natl. Mar. Fish. Serv. NOAA Admin. Rep. H-14-02, 58 p.+ Appendices.
- Houk P, Johnson SM, Benavente D, Castro F, Okano R. 2012. Coral reef ecosystem monitoring grant final report: NA09NOS4260099. Available online at: <https://www.ncei.noaa.gov/data/oceans/coris/library/NOAA/CRCP/other/grants/Monitoring%20Grants%20FY09%20Products/CNMI%20Final%20Report%2012032013%20NA09NOS4260099.pdf>.
- Jennison-Nolan J. 1979. Guam: changing patterns of coastal and marine exploitation. University of Guam. Tech. Report. Available online at: <https://repository.library.noaa.gov/view/noaa/37843>.
- Jones LP, Turvey ST, Massimino D, Papworth SK. 2020. Investigating the implications of shifting baseline syndrome on conservation. *People and Nature* 2(4):1131-1144. DOI: [10.1002/pan3.10140](https://doi.org/10.1002/pan3.10140).
- Kleiber D, Iwane M, Kamikawa K, Leong K, Hospital J. 2022. Pacific islands region fisheries and COVID-19: impacts and adaptations. U.S. Dept. of Commer. NOAA Tech. Memo. NMFS-PIFSC-130:36. DOI: [10.25923/2fpm-c128](https://doi.org/10.25923/2fpm-c128).
- Kotowicz DM, Allen SD. 2015. Results of a survey of CNMI and Guam residents on the Marianas Trench Marine National Monument. NOAA Pacific Islands Fish. Sci. Cent. Data Report. DOI: [10.7289/V5TD9V9G](https://doi.org/10.7289/V5TD9V9G)

- Kotowicz D, Richmond L. 2013. Traditional Fishing Patterns in the Marianas Trench Marine National Monument. Pacific Islands Fish. Sci. Cent., Natl. Mar. Fish. Serv., NOAA Pacific Islands Fish.Sci. Cent. Admin. Rep. H-13-05:54.
- Kotowicz DM, Richmond L, Hospital J. 2017. Exploring Public Knowledge, Attitudes, and Perceptions of the Marianas Trench Marine National Monument. Coastal Management 45(6):452-469. DOI: [10.1080/08920753.2017.1373451](https://doi.org/10.1080/08920753.2017.1373451).
- Levine A, Sauafea-Le'au F 2013. Traditional knowledge, use, and management of living marine resources in American Samoa: documenting changes over time through interviews with elder fishers. Pacific Science. 67(3):395-407. DOI: [10.2984/67.3.7](https://doi.org/10.2984/67.3.7).
- Maynard J, McKagan S, Johnson S, Houk P, Ahmadi G, van Hooidonk R, Harriman L, Mcleod E 2012. Coral reef resilience to climate change in Saipan, CNMI; field-based assessments and implications for vulnerability and future management. NOAA Professional Paper: 45.
- Pacific Islands Fisheries Science Center. 2023: 2009-2010 CNMI Elder Fisher Perceptions of Nearshore Marine Resources and Management.
<https://www.fisheries.noaa.gov/inport/item/70376>.
- Richmond L, Kotowicz D 2015. Equity and access in marine protected areas: The history and future of 'traditional indigenous fishing' in the Marianas Trench Marine National Monument. Applied Geography 59:117-124. DOI: [10.1016/j.apgeog.2014.11.007](https://doi.org/10.1016/j.apgeog.2014.11.007).
- Richmond R, Kelty R, Craig P, Emaurois C, Green A, Birkeland C, Davis G, Edward A, Golbuu Y, Gutierrez J, Houk P, Idechong N, Maragos J, Paulay G, Starmer J, Tafelichig A, Trianni M, Vander Velde N. 2002. Status of the coral reefs in Micronesia and American Samoa: US affiliated and freely associated islands in the Pacific. Status of coral reefs of the world:217-236.
- U.S. National Ocean Service. 2018. Coral reef condition: A status report for the Northern Mariana Islands. Available online at:
https://repository.library.noaa.gov/view/noaa/19539/noaa_19539_DS1.pdf.
- Zeller D, Booth S, Davis G, Pauly D. 2007. Re-estimation of small-scale fishery catches for U.S. flag-associated island areas in the western Pacific: the last 50 years. Fishery Bulletin 105(2):266-277. Available online at: <https://spo.nmfs.noaa.gov/sites/default/files/pdf-content/2007/1052/zeller.pdf>.

Appendix: Interview Guide

Date: _____ Island (circle): Saipan Rota Tinian Other: _____

Village: _____ Notes: _____

Introduction (in your own words): State your name, agency work with (DFW, DEQ, CRM), and explain the project.

We are conducting interviews for a project related to traditional fishing and changes in fishing over time in the Marianas, talking with a number of experienced fishermen in order to learn from their experience about changes in fishing, coastal resources, and the changes in different types of fish and other ocean life over time.

Do you have experience with this topic? (*if yes*) Would you be willing to be interviewed regarding this topic?

- (*if yes*) Explain that there are a number of questions, but they don't have to answer any questions that you don't want to answer. (*Ask permission to record and let them know that they can ask you to turn off the recorder at any time.*)
- (*if no*) Can you recommend anyone who might be a good person for me to talk to about this subject? Thank you for your time.

Question Guidelines for Fisherman Interviews

Name: _____ Age: _____ Gender: Male / Female

Fishing experience and history

1. How long have you been fishing in CNMI? _____

1a. Do you fish often, or did you in the past? How often? (Has this changed over time?)
(*minimum 1x/week at some point in their life*)

2. Have you always fished here, or have you lived and fished in other locations?

(*Prompts: History of where they have lived over time (dates if possible). If they have moved, make sure you are clear about the different locations they are talking about during the interview.*)

3. What **types of fishing** have you done (methods/gears/target species)?

(*Get dates, locations – reasons for choice of method...?*)

3b. (*Follow-up if needed*) Have the fishing method(s) you use **changed** over time? **How?** **When** did you change (dates if possible)? **Why?**

4. How has your fish catch changed over time (in general)?

(*Prompts: Size, species, quantity – when, where, how, why? (Specific years and locations if possible)*)

Nearshore fishing conditions

5. How does fishing now compare to the past for **reef fish (in general)**?

Better About the same Worse Don't know

(For each species where they answer "better / worse", follow up with:

How so? (Clarify **abundance vs. gear**) What do you think are the reasons for these changes? Do you know approximately when these changes took place? (Write detailed notes if necessary)

I have a list and pictures of different types of fish. Could you let me know which ones you have fished, and how fishing now compares to fishing in the past for each of these fish?

Fish

	Better	About the same	Worse	Don't know
Big eye scad <i>Atulai</i>				
Juvenile Jacks <i>EE (i'i')</i>	Better	About the same	Worse	Don't know
Juvenile goatfish <i>Tiao</i>	Better	About the same	Worse	Don't know
Juvenile rabbitfish <i>Manahak</i>	Better	About the same	Worse	Don't know
Rabbitfish (adult) <i>Sesyun/Hiting</i>	Better	About the same	Worse	Don't know
Bluespine Unicornfish <i>Tataga/Alenatag</i>	Better	About the same	Worse	Don't know
Orangespine Unicornfish <i>Hangun/Havgov</i>	Better	About the same	Worse	Don't know
Mullets <i>Laiguan/Aguas/Pegi</i>	Better	About the same	Worse	Don't know
Emperors <i>Mafuti/Lililok/Matan Hagon</i>	Better	About the same	Worse	Don't know
Parrotfish/wrasse <i>Palaksi/Kabora</i>	Better	About the same	Worse	Don't know

Invertebrates

	Better	About the same	Worse	Don't know
Octopus <i>Gamson</i>				

Lobster <i>Mahongang/Papangpang</i>	Better	About the same	Worse	Don't know
Giant clam <i>Hima</i>	Better	About the same	Worse	Don't know
Trochus <i>Aliling-tulumpo</i>	Better	About the same	Worse	Don't know
Trochus <i>Aliling-pulan</i>	Better	About the same	Worse	Don't know

6. What changes have you seen over time for the following species?

a. Bumphead parrotfish (*lagua/atuhung*) (*Show photos with 3 life stages to see which ones they are familiar with and how they have changed*)

More abundant Same Less abundant Not sure Not familiar with this species

Describe: Timeframe, location of fish, life stages observed, change in methods, targeting, other.
Reasons for change?

What is the largest size (pounds or length) of this fish you've seen in the CNMI? What is the largest group of this fish you've seen in the CNMI? Have you seen this fish for sale in the CNMI? (If yes- when and what size?) Are you aware of any cultural importance of this fish?

b. Humphead (Napoleon) wrasse (*tanguison*) (*Show photos with 3 life stages to see which ones they are familiar with and how they have changed.*)

More abundant Same Less abundant Not sure Not familiar with this species

Describe: Timeframe, location of fish, life stages observed, change in methods, targeting, other.
Reasons for change? Have you ever seen this fish in groups in the water? (If yes- when & where)

Have you ever caught this fish? (If so what is the largest, and when did you catch it?) Have you seen this fish for sale in the CNMI? (If yes- when & what size?) Are you aware of any cultural importance of this fish?

c. Sharks (*alu*) (note differences for reef sharks and larger pelagic they've seen (species if possible)

More abundant Same Less abundant Not sure Not familiar with this species

Prompt: For sharks, get them to differentiate for differences in species – ie. Gray, black tip, white tip, tiger(?), pelagic that come near to shore...)

Describe: Timeframe, location of fish, change in methods, targeting, other. Reasons for change?

7. (If they answered "worse" for any options in questions 5 and 6)

a. For the types of fishing that you said have become worse, or the species that are less abundant now, is there anything that you think can or should be done to improve this?

b. Are there any fish that you have avoided taking now or in the past? Why did you avoid them?

(Prompts: Were there health related reasons like fish toxicity (ciguatera), or cultural beliefs? Personal preference?)

Individual fishing behavior

8. Why do/did you usually go fishing? What do you generally do with your catch (keep, sell, give away...)? Does this vary by species? Has this changed over time? How? Why?

9. Have you ever been involved in fishing expeditions to the Northern Islands? *(Prompts: Could you describe a trip out there? When, where, and how often would you go? What methods did you use? What fish did you target? Were you successful? Have you observed changes in those areas changed over time?)*

Climate and habitat change

10. Have you noticed any changes in the coral reefs over time? Y N

What did you observe, did you see a change in species, has it affected your fishing practices?
(prompt – if white coral was observed, show picture of Crown of Thorn Starfish – ask if these were observed)

10a. Have you noticed any changes in the sea grass areas over time? Y N

What did you observe, did you see a change in species, has it affected your fishing practices?

10b. Have you noticed any changes in nearshore water quality over time? Y N

What did you observe, did you see a change in species, has it affected your fishing practices?

11. Have you ever noticed any other large scale changes over time like changes in fish populations, weather patterns, water temperature, or fishing seasons? (Either in the past or in recent times?) Could you describe these changes? (What, when, where, how, why?)

Local Marine Management

12. In the past, have there ever been local or traditional restrictions or limits on fishing, harvesting, or using the coast near your village or elsewhere on the island? Y N

Please describe.

(Prompts: Where? When? Who? Why? How enforced? Permanent/Temporary/Seasonal? Species? Still taking place? Local master fisherman or decision-maker, systems of patrolling, social pressure, limits on fish caught, limit on who can fish, enforcement methods, inter-village collaboration, traditional ceremonies, other)

13. Question about could you describe your biggest/best/most memorable catch- when/what/where? (Flexible question – to be used when/if needed)

14. What do you think about current CNMI regulations on marine resource use? Are there any changes you would like to see in these regulations or how they are enforced? Why?

(Prompts if asked “what regulations?”: Trochus and lobster size limits, MPAs...? Input from them on what regulations are helpful/harmful?)

15. Is there anything else that you would like to share with us about changes in fishing and use of marine resources that we have not yet asked?

(*Prompts: Legends, traditions, stories, other things you think are important?*)

16. What is your ethnicity? _____

Interview conducted in (*Circle language(s) that apply*):

English Chamorro Carolinian Other: _____

Thank you for your time and for sharing you knowledge with us. Are there other experienced long-time fishermen you recommend we talk to? (How can I get in contact with him/her?)

(*Provide contact information for them to get in contact with you if necessary*)

Ask if you have permission to use their name and stories if we decide to use quotes from their interview in a publication.

Interviewer notes: Potential candidate for video footage? Yes _____ No _____

Potentially _____

Explain (why? what topics?):

Permission given = _____ Yes

Permission not given = _____ No