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Economic Contributions of Small Boat Fisheries in Guam and the CNMI

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Executive Summary

The chief domestic fishery in Guam and the Commonwealth of the Northern Mariana Islands (CNMI) is a small boat, 1- to 2-day fishery that uses different gears to target pelagic, bottomfish, and coral reef fish. Fishers have a variety of fishing motivations ranging from full-time commercial, part-time commercial, recreational, cultural, to subsistence. This variation of fishing motivations demonstrates the importance of small boat fisheries in contributing to the local economy socially and culturally as well as economically. The purpose of this study is to evaluate the economic contributions of small boat fisheries in Guam and the CNMI.

Three distinct economic effects of the fisheries are evaluated in this study including direct, indirect, and induced. The direct effects include the ex-vessel values of the fish landed in Guam and the CNMI. The indirect effects of the fisheries are upstream effects from the fishing operations including (1) fishing trip spending that is required to support daily fishing activities, such as fuel, bait, food, and gear, and (2) annual fixed expenditures that are incurred by fishers that are highly independent of number of fishing trips taken in a year, such as repair and maintenance, gear, electronics, and insurance. These expenditures trigger a ripple effect in the economy by bolstering supporting industries, resulting in business-to-business purchases in the region. This interdependence of industries, fueled by the spending to support fishing operations, leads to additional output/sales, value-added, income, and employment. Induced effects are generated from households spending on goods and services locally with (1) income earned by fishers from selling fish as a direct effect, and (2) wages and salary earned by employees support the indirect effects. Direct, indirect, and induced effects are measured by four metrics: output/sales, value-added, employment, and income.

The indirect and induced effects from the small boat fisheries landings in Guam and the CNMI are estimated using IMPLAN, a commercially available software that uses input-output analyses to track the interrelationships among industries and consumers. By tracking these interrelationships, IMPLAN quantifies the regional contribution of an event, or change in an industry's production or household income, on all other industries, households, and governments. This study uses the 2019 Guam IMPLAN model and 2019 Northern Mariana Islands IMPLAN model (the most recent model available at time of publication) to examine the regional contributions of small boat fisheries in Guam and the CNMI, respectively.

The IMPLAN model results show that the indirect and induced output effects in Guam due to small boat fisheries in 2019 are between \$2.23 million and \$3.26 million, equivalent to about 0.03% to 0.04% of the total output in Guam in 2019. Value-added effects range from \$1.49 million to \$2.18 million, representing 0.02% to 0.03% of 2019 GDP in Guam. Total employment effects range from 30 to 44 jobs, which represent 0.03% to 0.05% of total employment within Guam in 2019. The labor income effects range from \$0.92 million to \$1.36 million, representing 0.02% to 0.03% of total 2019 labor income in Guam.

Small boat fisheries in the CNMI had smaller economic contributions due to lower fishing-related spending. The IMPLAN model results show that the indirect and induced output effects in the CNMI due to small boat fisheries in 2019 are between \$0.57 million to \$0.90 million, equivalent to about 0.03% to 0.04% of the 2019 total output in the CNMI. Value-added effects range from \$0.33 million to \$0.51 million, representing 0.03% to 0.04% of 2019 CNMI's GDP. Total employment effects range from 8 to 14 jobs, which represent 0.03% to 0.06% of total employment in the CNMI in 2019. The labor income effects range from \$0.20 million to \$0.34 million, representing 0.03% to 0.04% of total 2019 labor income in the CNMI.

The relative importance of small boat fisheries to total economic contributions in Guam and the CNMI is computed by the ratio of total output effects relative to ex-vessel value. The ratios are 5.5 to 7.6 in Guam, and 1.9 to 2.4 in the CNMI, representing that for every \$1 of ex-vessel value, an additional \$4.5 to \$6.6 of output/sales is generated in Guam, and an additional \$0.9 to \$1.4 output/sales is generated in the CNMI. In terms of value-added/GDP effect, every \$1 of ex-vessel value supports \$3.0 to \$4.4 of GDP in Guam and \$0.5 to \$0.8 of GDP in the CNMI. In terms of employment effects, for every \$1 million of ex-vessel value, small boat fisheries support 61 to 90 jobs in Guam and 12 to 22 jobs in the CNMI. For the labor income effects, for every \$1 of ex-vessel value, small boat fisheries support \$1.9 to \$2.8 of labor income in Guam, and \$0.3 to \$0.5 of labor income in the CNMI.

When comparing these ratios with the economic contributions of commercial fisheries in American Samoa (Chan, 2023), which includes the U.S. commercial fisheries of purse seine, longline, and small boat, the ratios are highest in Guam, followed by American Samoa, and lowest in the CNMI. The higher contributions relative to ex-vessel value in Guam could be attributed to its larger economy compared to the CNMI and American Samoa. A larger economy usually supports more industries and has a more diverse economy, thereby providing increased opportunities for spending to circulate and stimulate further economic activity. This results in a larger multiplier effect within the local economy. The other reason for larger contribution effects could be the relatively lower imports in Guam compared with the other two islands economies. Lower imports means lower leakages and more money staying and circulating within the local economy.

This is the first study to evaluate the economic contributions of small boat fisheries in Guam and the CNMI. This information is critical for fisheries managers to consider and reference when assessing fisheries policies or evaluating ecosystem factors that could potentially affect fishing activities and therefore their economic contributions in the two island economies. It is noteworthy that small boat fisheries in Guam and the CNMI make important contributions to local food security, preserve culture and traditions, and support resilient island communities (Leong et al., 2020, Smith et al., 2022). Although this report does not fully evaluate these benefits, that would be an important topic for future research.

Introduction

The chief domestic fishery in Guam and the Commonwealth of the Northern Mariana Islands (CNMI) is a small boat, 1- to 2-day fishery that uses different gears to target a variety of pelagic, bottomfish, and coral reef fish. The fishery is important to the local community in terms of a source of fresh local protein and has deep roots in the island culture. Fishers with different fishing motivations are well documented in previous cost-earnings surveys (Hospital and Beavers 2014, 2012), from full-time commercial, part-time commercial, recreational, cultural, to subsistence. This variation of fishing motivations demonstrates the importance of small boat fisheries in contributing to the local economy socially and culturally as well as economically. This study aims to evaluate how small boat fisheries contribute to the economies of Guam and the CNMI, and it is the first study that quantifies their economic contributions.

There are three distinct economic effects generated from small boat fishing: direct effects, indirect effects, and induced. Extraction of fish from the ocean requires labor, and the sale of fish generates revenue; these are the direct economic contributions from the fisheries. Therefore, the direct effects of the fisheries include the ex-vessel values of fish landed in Guam and the CNMI, the dollar value of fish landings received by fishers. However, for small boat fisheries in Guam and the CNMI, a substantial portion of landings are not for sale but for self-consumption, given to friends or relatives. We are not able to determine the non-market value of the fish. Therefore, the ex-vessel value of the fish only includes the value of fish recorded in the commercial receipt book. Typically, the direct effects of the commercial fishery include the employment of crew and captains, and income earned by crew, captains, and vessel owners. For the small boat fisheries in Guam, almost no fishers identified themselves as full-time commercial fishers. In the CNMI, although more fishers identified themselves as full-time commercial fishers and fishing as captains or crew, their income was predominantly from fish sales. In addition, crew members did not receive wages or salary but shared a portion of fishing trip costs by selling fish (Dombrow et al., 2024a). Although fishing with crew is common in both areas, no wage or salary was paid to crew members and no new jobs were created due to small boat fishing. As a result, captains and crew are not included as direct effects in terms of employment and income in this study. However, selling fish generated income for fishers, and their spending contribute to the local economy (induced effects).

The indirect effects of the small boat fisheries are upstream effects from fishing that include (1) spending that is required to support daily fishing activities, such as fuel, bait, food, gear; and (2) annual fixed expenditures incurred by fishers, such as those incurred in a year that are highly independent of the number of fishing trips such as boat insurance and repair and maintenance of vessels, gear, and electronics. The expenditures in (1) and (2) generate further rounds of indirect economic effects through supporting industries that create business-to-business purchases in the region. Additional output/sales, value-added, income, and employment are generated through the interdependence of industries in the economy. Induced effects are generated from households spending on goods and services locally with (1) income earned by fishers from fish selling (direct effects), and (2) wages and salary earned by employees

(indirect effects). Figure 1 shows the three types of economic contributions generated by small boat fishing fisheries.

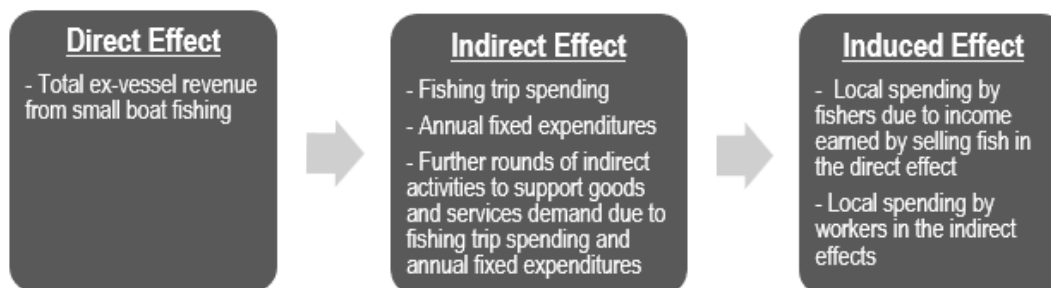


Figure 1. Types of economic contributions generated by small boat fisheries in Guam and the CNMI.

The data for the ex-vessel values of the fisheries were collected through the Western Pacific Fisheries Information Network (WPacFIN) Commercial Sales Receipt Books Program. The trip costs for the small boat fisheries were the economic trip cost data collected from the boat-based creel survey and the most recent cost-earnings survey of small boat fisheries in Guam and the CNMI conducted in 2018 for the 2017 fishing year. Two different sources of data were used because the trip costs data collected from the boat-based creel survey are limited to a few items including fuel cost, ice cost, bait cost, and cost of gear lost due to the limited time available for collecting the data when fishers initially returned to the fishing port. When fishers have more time to fill out the paper version of cost-earnings survey, more trip costs items were enumerated in addition to those collected in the boat-based creel survey such as food and beverage and truck fuel. Together, these two data sources were used as the lower and upper bounds of the trip costs. Details of the small boat economic data collection program can be found in Chan and Pan (2019). And the 2018 cost-earnings survey results are summarized in Dombrow et al. (2024a, 2024b). Indirect and induced effects from the fisheries are estimated using the commercial software IMPLAN which uses input-output analyses to track the interrelationships among industries and consumers within the economy.

Methods

IMPLAN Modeling

The indirect and induced effects due to small boat fisheries in Guam and the CNMI are estimated using IMPLAN. This is the same approach used in Chan (2023) to evaluate the economic contributions of commercial fisheries in American Samoa. Indirect and induced effects are measured in four metrics: output/sales, value-added, employment, and labor income. Output/sales is the total dollar value of production from all industries in an economy. Value-added is the measure of the additional value created in production, calculated by subtracting the cost of intermediate inputs from the total output. Value-added is equivalent to gross domestic product (GDP) in IMPLAN. Employment includes both full-time and part-time wages and salary positions, along with self-employment, within a given region. Income is quantified through employee compensation, including full-time and part-time wages, and self-employment compensation.

This study uses the 2019 Guam IMPLAN model and 2019 Northern Mariana Islands IMPLAN model to examine the regional contributions of small boat fisheries in Guam and CNMI, respectively (IMPLAN, 2019 Data). This is the latest available model for both economies.¹ An IMPLAN model could have up to 546 industries in a region. The 2019 Guam IMPLAN model has 186 industries and the 2019 Northern Mariana Island IMPLAN model has 169 industries.

Direct Effects of Fisheries in Guam and the CNMI

Ex-vessel Revenue

The Guam and the CNMI small boat fisheries are classified in terms of target species and gear usage including the pelagic fishery that uses trolling gear to target pelagic fish, the bottomfish fishery that uses bottomfish gear to target bottomfish, and the coral reef fish fishery that uses spear/snorkel and net to target reef fish. The estimated 2019 pelagic fish landings based on boat-based creel surveys were 759,653 pounds in Guam and 466,269 pounds in the CNMI (WPRFMC, 2023a). On a smaller scale, the estimated 2019 bottomfish landings based on boat-based creel surveys were 28,849 pounds in Guam and 21,012 pounds in the CNMI (WPRFMC, 2023b). Based on the commercial receipt data, the estimated 2019 commercial landings of reef fish were 43,680 pounds in Guam and 24,189 pounds in the CNMI (WPRFMC, 2020). Multiple gear usage is common in both island areas. Fishing for commercial sale is an important motivation in small boat fisheries in Guam and the CNMI. However, it is challenging to gauge the percent of landings that were sold due to low coverage of dealer participations in the Commercial Receipt Books Program in Guam, and no mandatory vendor reporting program existed in the CNMI until 2019. The ex-vessel revenue is collected from the Commercial Sales Receipt Books Program including the commercial revenue for Pacific Pelagic Management Unit Species (PMUS) caught by trolling in the pelagic fishery

¹ At the time of publication, IMPLAN is not intending to produce a more updated version of the Guam and CNMI models, so this can be considered the latest version.

(WPRFMC, 2023a), the commercial revenue for the Bottomfish Management Unit Species (BMUS), and commercial revenue for the top 10 ecosystem component species (ECS) (WPRFMC, 2023b). Table 1 shows the 2017–2019 total ex-vessel revenue (in 2019 dollars) from the small boat fisheries in Guam and the CNMI. The particularly high ex-vessel value in Guam in 2017 was due to a soar in commercial landings and revenue in the coral reef fish fishery (WPRFMC, 2019). This could also be attributed to the monitoring uncertainty in the Commercial Receipt Books Program as it is a non-census data collection program.

Table 1. Estimated ex-vessel revenues for small boat fisheries in Guam and the CNMI, 2017–2019 (in 2019 \$).

Year	Guam estimated ex-vessel value (\$)	CNMI estimated ex-vessel value (\$)
2017	1,042,172	695,565
2018	493,359	671,124
2019	490,812	649,216

Crew and Captain Jobs and Income

According to the most recent cost-earnings survey for small boat fisheries conducted in Guam and the CNMI for the 2017 fishing year (Dombrow et al., 2024a, 2024b), most fishers are not full-time commercial fishers. Only 2 out of 109 (2%) sampled in Guam identified themselves as full-time commercial fishers. Both of them were boat owners and fished as captain. No wage or salaried jobs for captain or crew were created due to small boat fishing. In the CNMI, 15 out of 67 (22%) identified themselves as full-time commercial fishers. Among them, 9 (60%) mostly fished as captain and 5 (33%) mostly fished as crew. And for those CNMI fishers who identified themselves as full-time commercial and fished as captain most of the time, 7 out of 9 (78%) had most or almost all of their personal income from fish sales. All CNMI fishers who identified themselves as full-time commercial and fished as crew most of the time received some trip revenue sharing as a form of payment. All crew sold most of the fish they caught. They also indicated that they shared a fraction of trip costs by selling fish to cover expenses and 4 out of 5 (80%) made most or almost all of their personal income from fish sales. Although more fishers identified themselves as full-time commercial in the CNMI, it is unlikely that wage or salaried jobs were created due to small boat fishing. Therefore, no direct effects in terms of employment and income due to small boat fishing are included in this study.

Indirect Effects of Fisheries in Guam and the CNMI

Upstream effects of fisheries are derived from (1) small boat fishing trip costs, (2) annual fixed expenditures incurred by fishers (captains and crew), and (3) the subsequent effects on local economy via the supporting industries that are impacted by the spending activities in (1) and (2) above. The combined effects from (1), (2), and (3) are called indirect effects from the small boat fisheries. This section describes the

estimation of spending activities for (1) and (2), and the estimation of subsequent influencing factors (3) using IMPLAN.

Fishing Trip Costs

The small boat fisheries in Guam and the CNMI include fishers using small boats to target pelagic fish, bottomfish, and coral reef fish using gears including troll, bottomfish, spear snorkel, and spear scuba. The number of trips by different gear types are estimated using the interview data that are collected through the boat-based creel survey. Due to variations in survey coverage rates in the creel survey program, we used a 5-year (2018–2022) average to represent the number of trips for Guam (Table 2) and the CNMI (Table 3).

Table 2. Estimated number of small boat fishing trips by gear type in Guam in 2018–2022 (average).

	Estimated number of trips
Trolling ^a	9,114 ^c
Bottomfish ^b	119
Spear snorkel ^b	28
Spear scuba ^b	5

Sources: ^a Table A-59 in WPRFMC. 2023a.

^b Table 32 in WPRFMC. 2023b.

^c Excluded charter trips.

Table 3. Estimated number of small boat fishing trips by gear type in the CNMI in 2018–2022 (average) .

	Estimated number of trips
Trolling ^a	3,517 ^c
Bottomfish ^b	46
Spear snorkel ^b	10

Sources: ^a Table A-24 in WPRFMC. 2023a.

^b Table 10 in WPRFMC. 2023b.

^c Excluded charter trips.

Small boat fishing trip costs were regularly collected in Guam and the CNMI through the PIFSC economic data collection programs' add-on to the boat-based creel survey. The survey is implemented through collaborative efforts of the PIFSC Social-Ecological and Economic Systems (SEES) Program, the WPacFIN, Guam Division of Aquatic and Wildlife Resources (DAWR), and the CNMI Division of Fish and Wildlife (DFW) that collect fishing catch and effort data through creel surveys. Due to the variations in survey coverage rates in the creel survey program, we used a 5-year (2018–2022) average with adjustment of each year's value to 2019 dollars to represent the 2019 fishing trip costs for this data source. Fishing trip costs were also collected in the 2018 Guam and the CNMI cost-earnings surveys for 2017 fishing activities (Dombrow et al., 2024a, 2024b). The trip costs collected in the cost-earnings surveys (adjusted to 2019 dollars) were higher than those collected through the add-on to the boat-based creel survey. So, we considered these two sources as upper (cost-earnings surveys) and

lower bounds (economic data add-on to the boat-based creel survey) of the trip costs for economic contribution evaluation. Table 4 and Table 5 provide the estimated 2019 fishing trip costs by gear type in Guam and the CNMI, respectively.

Using the estimated number of trips (Table 2 and Table 3) and fishing trip costs by gear type (Table 4 and Table 5), Table 6 and Table 7 show the estimated fleetwide trip costs for small boat fisheries in Guam and the CNMI, respectively.

Table 4. Estimated per trip fishing trip costs for Guam small boat fishery by gear type in 2019, inflation adjusted to 2019 values (\$).

Lower Bound	Fuel cost	Ice cost	Bait cost	Daily maintenance cost	Food cost	Total cost
Trolling	59.66	14.59	3.02	15.54	-	92.81
Bottomfish	31.06	11.72	5.61	5.56	-	53.94
Spearfishing snorkel	15.38	4.67	0.00	0.00	-	20.06
Spearfishing scuba	36.13	18.31	0.00	10.42	-	64.86
Upper Bound						
Trolling	182.62	23.27	11.04	36.17	29.51	282.61
Bottomfish	127.17	6.05	23.31	26.08	23.51	206.13
Spearfishing snorkel	116.03	7.12	1.96	28.12	25.17	178.40

Table 5. Estimated per trip fishing trip costs for the CNMI small boat fishery by gear type in 2019, inflation adjusted to 2019 values (\$).

				Daily maintenance cost	Food cost	Total cost
Lower Bound	Fuel cost	Ice cost	Bait cost			
Trolling	74.03	9.43	0.00	0.00	-	83.46
Bottomfish	40.62	5.21	0.00	0.00	-	45.84
Spear snorkel	22.10	3.39	0.00	0.00	-	25.49
Upper Bound						
Trolling	176.28	10.60	17.26	25.63	14.37	244.15
Bottomfish	148.75	8.00	27.60	13.70	13.30	211.35
Spear snorkel	50.39	5.73	0.00	10.08	17.64	83.84

Table 6. Estimated fleetwide fishing trip costs for Guam small boat fishery in 2019, inflation adjusted to 2019 values (\$).

	Fuel cost	Ice cost	Bait cost	Daily maintenance cost	Food cost	Estimated fleetwide trip costs
Lower bound	548,049	134,590	28,192	142,345	-	853,176
Upper bound	1,682,781	213,002	103,447	333,544	272,457	2,605,231

Table 7. Estimated fleetwide fishing trip costs for the CNMI small boat fishery in 2019, inflation adjusted to 2019 values (\$).

	Fuel cost	Ice cost	Bait cost	Daily maintenance cost	Food cost	Estimated fleetwide trip costs
Lower bound	262,453	33,439	0	0	-	295,892
Upper bound	627,323	37,706	61,973	90,872	51,327	869,201

Annual Fixed Expenditures by Small Boat Fishers

Fishers in Guam and the CNMI incur fixed expenditures regardless of the number of trips in a year. Vessel owners need to pay various expenses associated with small boat fishing operations including boat insurance, annual repair and maintenance for vessels, engines, or trailer, fishing gear, electronics, safety equipment, financial services, oil and lube, and fees. To a lesser extent, crew members also incur certain fixed expenditures such as those associated with fishing gear and repair/maintenance.

To estimate the fixed expenditures for the whole fleet, several assumptions must be made. One is about the number of fishers as there is no fisher registration in Guam or the CNMI. Although there is vessel registration in both areas, we do not know whether the vessels are active in a particular year. Boat-based creel surveys are used to

estimate the number of active vessels which is calculated by matching the vessels recorded in the creel survey with the vessel registration (WPRFMC, 2023a, 2023b). To account for the variations in survey coverage rates in the creel survey program, the number of active vessels is calculated based on the estimated number of trolling vessels that were in the pelagic fishery between 2018 and 2022 (WPRFMC, 2023a) and number of vessels that used bottomfish gears, spearfish/snorkel gear, and spearfish/scuba gear between 2018 and 2022 (WPRFMC, 2023b), as the estimated number of vessels in 2019. Another assumption needs to be made regarding how the vessels overlap in their use of different fishing gears as employing multiple fishing gears during one trip is common in both areas. One assumption is complete overlap between vessels using trolling gear and those using bottomfish, spearfish/snorkel, and spearfish/scuba gears; the estimated figure is treated as the lower bound estimation of the number of vessels. Another assumption is no overlap between vessels using different gears, and the estimated figure is treated as the upper bound estimation. These bounds are considered the lower and upper parameters of the number of boat owners.

The number of crew is estimated based on the most recent (2018) cost-earnings surveys conducted in the areas (Dombrow et al., 2024a, 2024b). The median fishers on board in a fishing trip was three in Guam and two in the CNMI. We, therefore, assume the number of crew to be twice the boat owner population in Guam and the number of crew to be the same as the number of boat owners in the CNMI (Table 8).

Table 8. Estimated number of vessel owners and crew in Guam and the CNMI, 2019.

	Guam	CNMI
Number of vessels used different gears		
Trolling	463	71
Bottomfish gear	80	37
Spearfish/snorkel gear	20	9
Spearfish/scuba gear	3	-
Estimated number of boat owners		
Lower bound	463	71
Upper bound	566	117
Estimated number of crew		
Lower bound	926	71
Upper bound	1,132	117

The average per person annual fixed expenditures by category came from the 2018 cost-earnings surveys conducted in both areas. They collected the annual fixed expenditures incurred in 2017. These expenditures were inflation adjusted to 2019 values to estimate the fixed expenditures in 2019. In addition, we made an adjustment to account for some spending that occurred outside of Guam and the CNMI. The survey asked fishers the percentage of fishing gear, electronics, and safety equipment that were purchased off-island, online, or through a catalog. The average percentage was 31% in Guam and 55% in the CNMI. For fishing gear, electronics, and safety equipment, 69% of spending was assumed to be local in Guam and 45% of spending

was local in the CNMI. Table 9 and Table 10 show the per person on-island spending in Guam and the CNMI in 2019, respectively.

Table 9. Estimated per person on-island annual fixed expenditures in Guam, 2019 (\$).

Spending category	Boat owner	Crew
Repair/maintenance for vessel, engines, or trailer	2,212	122
Gear	1,179	295
Loan payment	925	335
Electronics	435	43
Oil and lube	331	33
Boat insurance	246	0
Safety equipment	140	41
Fees	110	18
Moorage fees	70	2
Financial services	61	0
Estimated per person annual fixed expenditures	5,709	888

Table 10. Estimated per person on-island annual fixed expenditures in the CNMI, 2019 (\$).

Spending category	Boat owner	Crew
Repair/maintenance for vessel, engines or trailer	1,029	86
Gear	584	371
Loan payment	368	14
Electronics	345	85
Oil and lube	533	78
Boat insurance	5	5
Safety equipment	115	18
Fees	58	6
Moorage fees	0	0
Financial services	0	0
Estimated per person annual fixed expenditures	3,037	664

Using the estimated number of vessel owners and crew (Table 8) and the per person on-island spending in 2019 (Table 9 and Table 10), the estimated upper and lower bound of fleetwide annual fixed expenditures in 2019 in Guam and in the CNMI are shown in Table 11 and Table 12, respectively. The fleetwide fixed expenditures range from \$3.47 million to \$4.24 million in Guam, and \$0.26 million to \$0.43 million in the CNMI.

Table 11. Estimated fleetwide annual fixed expenditures in Guam, 2019 (\$).

Spending category	Boat owner (lower bound)	Boat owner (upper bound)	Crew (lower bound)	Crew (upper bound)
Repair/maintenance for vessel, engines, or trailer	1,023,961	1,251,754	112,749	137,831
Gear	545,978	667,438	273,519	334,367
Loan payment	428,502	523,827	309,815	378,737
Electronics	201,375	246,174	39,498	48,285
Oil and lube	153,081	187,135	30,606	37,414
Boat insurance	113,807	139,124	-	-
Safety equipment	64,872	79,304	37,892	46,321
Fees	50,991	62,335	16,748	20,473
Moorage fees	32,485	39,712	1,788	2,186
Financial services	28,219	34,496	-	-
Estimated annual fixed expenditures	2,643,271	3,231,299	822,612	1,005,613

Table 12. Estimated fleetwide annual fixed expenditures in the CNMI, 2019 (\$).

Spending category	Boat owner (lower bound)	Boat owner (upper bound)	Crew (lower bound)	Crew (upper bound)
Repair/maintenance for vessel, engines or trailer	73,094	120,450	6,133	10,106
Gear	41,469	68,336	26,355	43,430
Loan payment	26,118	43,039	1,023	1,685
Electronics	24,483	40,345	6,008	9,900
Oil and lube	37,817	62,318	5,554	9,153
Boat insurance	358	590	341	561
Safety equipment	8,166	13,457	1,253	2,065
Fees	4,150	6,839	443	730
Moorage fees	-	-	-	-
Financial services	-	-	-	-
Estimated annual fixed expenditures	215,654	355,374	47,109	77,630

To estimate the indirect and induced effects of the small boat fisheries, the spending activities listed in Table 11 and Table 12 are assigned to the appropriate industry or commodity related to the spending, and entered in IMPLAN to run the associated contribution effects. The assigned industry/commodity is shown in Table 13. Boat insurance expenditure is multiplied by the average net profit margin for property and casualty insurance firms in 2019 (8.6%) to reflect the net expenditure impact of the industry. Repair and maintenance of vessels, engines, or trailers are divided among three industries based on the share of the household demand in each one: 402: retail - motor vehicle and parts dealers; 504: other amusement and recreation industries; and

516: personal and household goods repair and maintenance. Note that although loan payment is an important expenditure for some vessel owners, it is generally considered transfer payment that generates no economic impacts. Loan payment is, therefore, not included in the analysis. Spending on food was allocated across commodity output sectors based on the National Income and Product Accounts (NIPA) food and nonalcoholic beverages purchased for off-premises consumption from Bureau of Economic Analysis (BEA) consumer expenditures survey in 2018. It represents the national average personal consumption expenditure patterns on food and nonalcoholic beverages.

Table 13. Spending by category and IMPLAN sector assignment.

Spending category	IMPLAN sector for Guam	IMPLAN sector for the CNMI
Fuel	Commodity output 3154: refined petroleum products	Commodity output 3154: refined petroleum products
Ice	Industry output 406: retail food and beverage stores (Note: commodity 3105: manufactured ice does not exist in Guam IMPLAN model)	Commodity output 3105: manufactured ice
Bait	Commodity output 3017: fish	Industry output 410: retail—sporting goods, hobby, musical instruments, and bookstores (Note: commodity 3017: fish does not exist in CNMI IMPLAN)
Gear, safety equipment	Industry output 410: retail—sporting goods, hobby, musical instruments, and bookstores (Note: commodity 3382: sporting and athletic goods does not exist in Guam IMPLAN model)	Commodity output 3382: sporting and athletic goods
Food	Commodity output NIPA: 27 food and nonalcoholic beverages	Commodity output NIPA: 27 food and nonalcoholic beverages
Boat insurance	Industry output 444: insurance carriers, except direct life	Industry output 444: insurance carriers, except direct life

Spending category	IMPLAN sector for Guam	IMPLAN sector for the CNMI
Financial services	Industry output 456: accounting, tax preparation, bookkeeping, and payroll services	Industry output 456: accounting, tax preparation, bookkeeping, and payroll services
Moorage fees	Industry output 504: other amusement and recreation industries	Industry output 504: other amusement and recreation industries
Repair/maintenance for vessels, engines. or trailers	Industry output 402: retail—motor vehicle and parts dealers	Industry output 402: retail—motor vehicle and parts dealers
	Industry output 504: other amusement and recreation industries	Industry output 504: other amusement and recreation industries
	Industry output 516: personal and household goods repair and maintenance	Industry output 516: personal and household goods repair and maintenance
Oil and lube	Commodity output 3157: petroleum lubricating oil and grease	Commodity output 3157: petroleum lubricating oil and grease
Electronics	Commodity output 3312: search, detection, and navigation instruments	Industry output 404: retail-electronics and appliance stores (Note: commodity 3312: search, detection, and navigation instruments does not exist in CNMI IMPLAN model)
Fees	50% institution spending 12001: state/local govt other services	50% institution spending 12001: state/local govt other services
	50% industry output 523: business and professional associations	50% industry output 523: business and professional associations

Induced Effects of Fisheries in Guam and the CNMI

As indicated in Figure 1, induced effects include those generated from households spending on goods and services locally with income earned by fishers (direct effects), and the wages and salary earned by employees (indirect effects). The induced effects generated from the employees described as the indirect effects are estimated using IMPLAN as described in the previous section. The induced effects generated from fishers' spending due to fishing income is estimated using IMPLAN, through the IMPLAN household income event and applying the estimated ex-vessel value in 2019 in Table 1.

Results

Direct, Indirect, and Induced Effects of Fisheries

Small boat fisheries economic contributions to Guam and the CNMI are summarized in Table 14 and Table 15. Lower bound estimations of boat owners, crew, and trip costs and upper bound estimations of these variables were applied. To demonstrate the output effects on the local economy stemming from the ex-vessel revenue generated by the fisheries, we look at the indirect and induced output effects, i.e., excluding direct effects of ex-vessel revenue. The indirect and induced output effects range from \$2.23 million to \$3.26 million in Guam and \$0.57 million to \$0.90 million in the CNMI. The total value-added effects range from \$1.49 million to \$2.18 million in Guam and \$0.33 million to \$0.51 million in the CNMI. The total employment effects range from 30 to 44 jobs in Guam and 8 to 14 jobs in the CNMI. The income effects range from \$0.92 million to \$1.36 million in Guam, and \$0.20 million to \$0.34 million in the CNMI. As the fishing related expenses (trip costs and fixed costs) were lower in the CNMI, it is not surprising that overall fishery contributions were also smaller in the CNMI.

Table 14. Summary of small boat fishery contributions to Guam.

Lower Bound				
Impact Type	Employment (number of jobs)	Labor Income (\$)	Value-Added (\$)	Output (\$)
Direct effect	-	-	-	490,812
Indirect effect	25	732,714	1,094,537	1,682,835
Induced effect	5	184,267	397,705	544,270
Total effect	30	916,981	1,492,242	2,717,917
Upper Bound				
Impact Type	Employment (number of jobs)	Labor Income (\$)	Value-Added (\$)	Output (\$)
Direct effect	-	-	-	490,812
Indirect effect	38	1,117,508	1,662,615	2,546,955
Induced effect	7	239,813	517,591	708,336
Total effect	44	1,357,321	2,180,205	3,746,103

Table 15. Summary of small boat fishery contributions to the CNMI.

Lower Bound				
Impact Type	Employment (number of jobs)	Labor Income (\$)	Value-Added (\$)	Output (\$)
Direct effect	-	-	-	649,216
Indirect effect	4	95,651	109,160	211,567
Induced effect	4	103,920	218,883	362,394
Total effect	8	199,572	328,043	1,223,177
Upper Bound				
Impact Type	Employment (number of jobs)	Labor Income (\$)	Value-Added (\$)	Output (\$)
Direct effect	-	-	-	649,216
Indirect effect	10	221,907	261,062	486,193
Induced effect	4	119,841	252,417	417,914
Total effect	14	341,748	513,479	1,553,323

Table 16 compares the current study results with the results for the economic contributions of commercial fisheries in American Samoa (Chan, 2023). It is important to note that fisheries in American Samoa are very different from the small boat fisheries in Guam and the CNMI. In addition to the small boat fishery, fisheries in American Samoa also include the U.S. commercial purse seine fishery and the U.S. commercial longline fishery that supply a large amount of tuna to the cannery in American Samoa. Therefore, the ex-vessel value of fish landed in American Samoa was much higher (\$88.5 million in 2019 vs. \$0.5 million in Guam and \$0.6 million in the CNMI). Also, the upstream effects of fisheries stemming from the spending activities by fishing vessels were much higher in American Samoa due to the large fuel requirement by the longline and purse seine vessels. In addition, there are downstream effects of fisheries in American Samoa stemming from fish supply to the cannery that support production and employment in the cannery plus the other local industries that provide goods and services to support the cannery. But these downstream effects do not exist in Guam and the CNMI as neither area has a fish processing firm. Therefore, the employment, labor income, value-added, and output contributions from fisheries are much higher in absolute values and also relative to the size of economy in American Samoa. Another note is that the lower and upper bounds in the American Samoa IMPLAN model (Chan, 2023) referred to the lower and upper bound estimation of fuel costs. In terms of the fisheries' economic contribution relative to the total economy, the output effects (indirect and induced effects) generated by the small boat fishery in Guam represent 0.03% to 0.04% of the total Guam output in 2019, and 0.03% to 0.04% of total CNMI output in 2019. The total value-added effects range from 0.02% to 0.03% of GDP in Guam and 0.03% and 0.04% of GDP in the CNMI in 2019. The total employment effects in terms of jobs represent 0.03% to 0.05% of total 2019 Guam employment and 0.03% to 0.06% of total 2019 CNMI employment. The total labor income effects represent 0.02% to 0.03% of total labor income in Guam and 0.03% to 0.04% the CNMI total labor income in 2019. These contributions are much smaller compared with the contributions from U.S. commercial fisheries to American Samoa.

However, the economic contribution of fisheries relative to the ex-vessel value of the fisheries, the results are more comparable among the three island economies. Using Table 14 and Table 15, the ratio of the total output effects vs. the direct effects (ex-vessel value) represents how a \$1 ex-vessel value of fish contributes to the economy (Table 16). The ratio of total output vs. ex-vessel value is 5.5 to 7.6 in Guam and 1.9 to 2.4 in the CNMI. This means for every \$1 of ex-vessel value in Guam, an additional \$4.5 to \$6.6 of output/sales is generated in the Guam economy. For every \$1 of ex-vessel value in the CNMI, an additional \$0.9 to \$1.4 of output/sales is generated in the CNMI economy. The ratios in Guam are larger than the ratios in American Samoa (4.3, meaning for \$1 of ex-vessel value, an additional \$3.3 of output/sales was generated), thus the indirect and induced effects generated by the fishing activities had a larger contribution in the Guam economy. The larger contributions relative to ex-vessel value in Guam could be due to the larger economy of Guam compared with the CNMI and American Samoa. Guam's GDP in 2019 was 434% larger than CNMI's and 889% larger than in American Samoa. A larger economy usually has more industries, and a more diverse economy would allow more opportunities for spending to circulate and stimulate further economic activity and generate a larger multiplier effect within the local economy. Larger contribution effects could also be due to the relatively lower imports in Guam compared with the other two islands economies. The dollar value of imports in each island economy in 2019 represented 84% of Guam GDP, 117% of the CNMI GDP, and 130% of the American Samoa GDP (IMPLAN, 2019 Data). The lower imports in Guam mean fewer leakages and more money is staying and circulating within the local economy.

For value-added effect, every \$1 of ex-vessel value supports \$3.0 to \$4.4 of GDP in Guam and \$0.5 to \$0.8 in the CNMI. In terms of employment effects, every \$1 million of ex-vessel value supports 61–90 jobs in Guam and 12–22 jobs in the CNMI. Note that because the ex-vessel value is less than \$1 million in Guam and the CNMI, the actual employment effects were smaller. For labor income effect, every \$1 of ex-vessel value supports \$1.9 to \$2.8 of labor income in Guam and \$0.3 to \$0.5 of labor income in the CNMI. Similar to the output ratios, the ratios of GDP, employment, and income relative to the ex-vessel value were largest in Guam, followed by American Samoa, and lowest in the CNMI. The lower contributions relative to ex-vessel value in the CNMI compared with Guam could be attributed to several factors: (1) lower estimated fishing related costs in the CNMI, e.g., estimated fleetwide trip costs in the CNMI were about one-third of the amount in Guam, and the estimated annual fixed costs in the CNMI was about 8%–10% of Guam's annual fixed costs; and (2) the ex-vessel value in the CNMI was higher than in Guam so the denominator of the ratio was larger in the CNMI.

Table 16. Comparison of results for studies evaluated economic contributions of fisheries using IMPLAN.

Fishing sector	Guam small boat fisheries in 2019 (lower bound)	Guam small boat fisheries in 2019 (upper bound)	The CNMI small boat fisheries in 2019 (lower bound)	The CNMI small boat fisheries in 2019 (upper bound)	American Samoa commercial fisheries in 2019 (lower bound)	American Samoa commercial fisheries in 2019 (upper bound)
Ex-vessel value (\$)	490,812	490,812	649,216	649,216	\$88.52 mill	\$88.52 mill
Total employment (number of jobs)	30	44	8	14	3,480	3,500
Total labor income (\$)	916,981	1,357,321	199,572	341,748	74.30 mill	74.89 mill
Total value-added (\$)	1,492,242	2,180,205	328,043	513,479	142.10 mill	142.96 mill
Total output (\$)	2,717,917	3,746,103	1,223,177	1,553,323	380.01 mill	381.07 mill
Total contribution relative to overall economy						
% of total employment	0.03%	0.05%	0.03%	0.06%	20%	20%
% of total labor income	0.02%	0.03%	0.03%	0.04%	18%	18%
% of total value-added	0.02%	0.03%	0.03%	0.04%	22%	22%
% of total output (excluding ex-vessel value)	0.03%	0.04%	0.03%	0.04%	28%	29%
Total contribution relative to ex-vessel value						
Total employment to \$1 million ex-vessel value	61.0	90.1	11.9	21.5	39.3	39.5
Total labor income to \$1 ex-vessel value	1.9	2.8	0.3	0.5	0.8	0.8
Total value-added to \$1 ex-vessel value	3.0	4.4	0.5	0.8	1.6	1.6
Total output to \$1 ex-vessel value	5.5	7.6	1.9	2.4	4.3	4.3

Discussion

Understanding the economic contributions of small boat fisheries to the economies of Guam and the CNMI is important for fisheries managers and industry participants. This study provides the first economic contribution analyses of small boat fisheries for these two islands. In addition to the direct effects resulting from small boat fisheries that generate ex-vessel value of fish, the upstream indirect effects stemming from the fisheries are considered. These include the effects from spending for fishing operations, i.e., fishing trip costs and the annual fixed expenditures, and the subsequent effects from the supporting industries that provide goods and services to meet the demand from these spending. Finally, there are induced effects when fishers spend their fishing income and workers involved in the indirect effects spend their income and generate sales within the local economy.

The small boat fishery in Guam required \$0.85 million to \$2.61 million of spending on fishing trips and \$3.47 million to \$4.24 million of annual fixed spending to support the fishing activities in 2019. The small boat fishery in the CNMI required \$0.30 million to \$0.87 million of spending on fishing trips and \$0.26 million to \$0.43 million of annual fixed spending to support the fishing activities in 2019. Large leakages occurred due to off-islands spending on fishing gear, electronics, and safety equipment in Guam with an average of 31%, and 55% for the CNMI. The total economic contributions of the small boat fishery in Guam in 2019 are estimated at 30 to 44 jobs, \$0.92 million to \$1.36 million of income, \$1.49 million to \$2.18 million of value-added. The indirect and induced output effects amount to \$2.23 million to \$3.26 million. These effects are relatively small when compared with the total economy as they are equivalent to 0.03% to 0.05% of total employment and 0.02% to 0.03% total labor income, 0.02% to 0.03% of Guam GDP, and are 0.03% to 0.04% of total output.

The total economic contributions of the small boat fishery in the CNMI in 2019 are estimated at 8 to 14 jobs, \$0.20 million to \$0.34 million of income, \$0.33 million to \$0.51 million of value-added. The indirect and induced output effects amount to \$0.57 million to \$0.90 million. These effects are relatively small when compared with the total economy as they are equivalent to 0.03% to 0.06% of total employment and 0.03% to 0.04% total labor income, 0.03% to 0.04% of the CNMI GDP, and are 0.03% to 0.04% of total output.

Although the economic contributions of small boat fisheries were relatively small in the absolute terms and in terms of the total economy, the contributions relative to ex-vessel value are large in Guam. A \$1 value of fish landed in Guam generated an additional \$4.5 to \$6.6 of output in the local economy. For every \$1 value of fish, it supports \$3.0 to \$4.4 of value-added/GDP in the economy. For every \$1 million of ex-vessel value, it generated approximately 61–90 jobs. For every \$1 of ex-vessel value, it supports \$1.9 to \$2.8 of labor income. These ratios are all higher than the ratios in American Samoa due to commercial fisheries (Chan, 2023), indicating larger multiplier effects occurred in Guam due to small boat fishing. This could be due to the larger economy in Guam and lower imports relative to the size of the economy.

Smaller economic contributions relative to ex-vessel value were observed in the CNMI. A \$1 value of fish landed in the CNMI generated an additional \$0.9 to \$1.4 of output in the local economy. Every \$1 value of fish supports \$0.5 to \$0.8 of value-added/GDP in the economy. Every \$1 million of ex-vessel value generated approximately 12–22 jobs. Every \$1 of ex-vessel value supports \$0.3 to \$0.5 of labor income.

Small boat fisheries in Guam and the CNMI make important contributions to local food security, preserve culture and traditions, and support resilient island communities (Leong et al., 2020; Smith et al., 2022). While these benefits are not fully evaluated in this report, it is an important topic for future research. In addition, certain information is missing, such as the economic data for charter fishing trips in Guam, making it challenging to conduct a full economic contribution analysis. Nevertheless, given the available data, this study provides a baseline estimation of the overall economic contributions by the small boat fishing in Guam and the CNMI. Understanding the economic contributions of small boat fisheries in the local economies is crucial for effective fisheries management and it also provides valuable information when considering equity and environmental justice in marine policy analysis.

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