JOB PROGRESS REPORT
RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: F-1R-8
SUB-PROJECT NO.: F-1
STUDY NO.: 1
JOB NO.: 2

STUDY: Fisheries Participation, Effort, and Harvest Surveys (2430)

JOB TITLE: Inshore Fisheries Survey

PERIOD COVERED: October 1, 1999 to September 30, 2000

SUMMARY

Monthly inshore fisheries surveys were conducted along Guam's shoreline from October 1999 through September 2000. The total estimated inshore fisheries catch for this time period was 38.1 mt (metric tonnes), 88% of which were finfish (excluding the juvenile rabbitfish or mañåhak and juvenile fusilier or achemsom). Hook & line was the most practiced method accounting for 59% of the total participation (excludes seasonal mañåhak and Bigeye scad or atulai data) or 37,042 participants. Top fishing methods for day, night, and overall harvests included the following: Other Methods = 1.29 kg/gear-hour (gh) with a daytime harvest of 2.5 mt; Drag Netting = 4.55 kg/gh with a nighttime harvest of 0.4 mt and; Hook & line = 0.11 kg/gh with an overall harvest of 13.1 mt. The seasonal mañåhak and achemsom catch was not surveyed in FY00. Chamorro fish names were derived from Kerr (1990).

Aerial Survey

The aerial survey report is included in Appendix 1.

Abandoned Gill Net Removal/Study

The gill net removal/study is included in Appendix 2.

Kid's Fishing Derby

The Kid's Fishing Derby was inactive in FY00.

BACKGROUND

Effective management of Guam's inshore fishery resources requires accumulating data on the types of fishing methods used, fishing pressure, and annual catch (Amesbury et. al., 1991). To

identify trends in fishing participation, effort, and catch, the Division of Aquatics and Wildlife Resources (DAWR) has been monitoring day and night coastal fishing activities since FY85. Over this period of time, survey and analysis methodologies (Hensely and Sherwood, 1993) have changed in response to fluctuations in budget and staff. In the last several years, however, field survey techniques have been expanded and refined, while estimates of Guam's recreational and subsistence fishing activities have come to be based on more reliable data analysis techniques.

Data Analysis

The adoption of the Acius Inc. ©, 4th Dimension (4D) database program (Mayall 1989) has greatly reduced the time needed to compile, expand, and analyze Guam's inshore survey data with expansion algorithms (Amesbury et. al., 1991). This has allowed more time to upgrade data collection procedures and to ensure statistical reliability.

OBJECTIVES

1) To maintain the collection of baseline catch and effort data and identify harvest trends in Guam's inshore fishery.

2) To gather limited biological (opportunistic) data on fishing methods, reef fish species, and habitat for management purposes.

PROCEDURES

During FY00, four fishermen interview survey days were selected per month. Fishermen-intercept interviews were conducted to determine amount of effort, fishing method, location, reef zone, species composition, and amount caught for both day and night fishing (Hensley and Sherwood, 1993). The day survey covered a six-hour interval (beginning at sunrise or 0600h) and the night survey covered a five-hour interval (beginning at dusk or 1900h). On any given survey day, one survey area is randomly selected from either Gun Beach to Adelupe (region I: locations 1-11), Adelupe to Agat (region II: locations 12-34), or Pago to Merizo (region III: locations 41-71) and inshore data collection is restricted within the selected region (Figure 1).

During FY00, day and night "inshore-participation" surveys were conducted on four randomly selected days per month, which did not occur on the same days as the "inshore creel" surveys. These surveys entailed making visual observations of fishing participation within readily accessible portions of Guam's coastline (Figure 1, locations: 1-21, 23-26, 29-35, 40-43, 51-57, 60-69, 71, 72). Fishing catch and effort data is collected by instantaneous counts, while driving in a continuous route, around the island (Amesbury et. al., 1991). The route is alternated each survey between "clockwise" and "counterclockwise" and the starting locations are randomly selected (Figure 1). Since the participation survey includes both day and night fishing, start times begin at 0600h and 1900h and end once the entire island circuit has been completed.

During FY00, four "inshore creel-participation" surveys were conducted by fishing method during the inshore creel survey. Methods observed during the creel survey were listed according to the numbers of fishermen and gear for reef zones and locations within the survey route.

Seasonal data on the Bigeye scad mackerel (atulai), juveniles of Yellowstripe goatfish (ti'ao), and jacks (i'e') were acquired through actual participation and catch surveys. Species of fish that seasonally recruit *en masse* on Guam's reefs, i.e., juveniles of rabbitfish (mañåhak), and fusiliers (achemsom), were not entered into the database due to the sporadic nature of these fisheries.

Mañåhak *en masse* recruitment events are predicted to occur up to three times a year for approximately one-week, depending on the overall size of the run. Recruitment events are expected to begin the day of or days following the fourth, fifth, and tenth last quarter moon phase. Recruitment events of achemsom are irregular, but have been significant in terms of island-wide total harvest in certain years and usually recruit with mañåhak when they occur.

Atulai migrate into inshore areas throughout the year, which may cover a period lasting up to nine months. They usually enter protected locations, e.g., bays and channels, at daybreak and swim into deeper water before evening. A significant portion of the annual catch is not reported from this fishery because the larger net catches are sporadic and seldom appear on regular surveys.

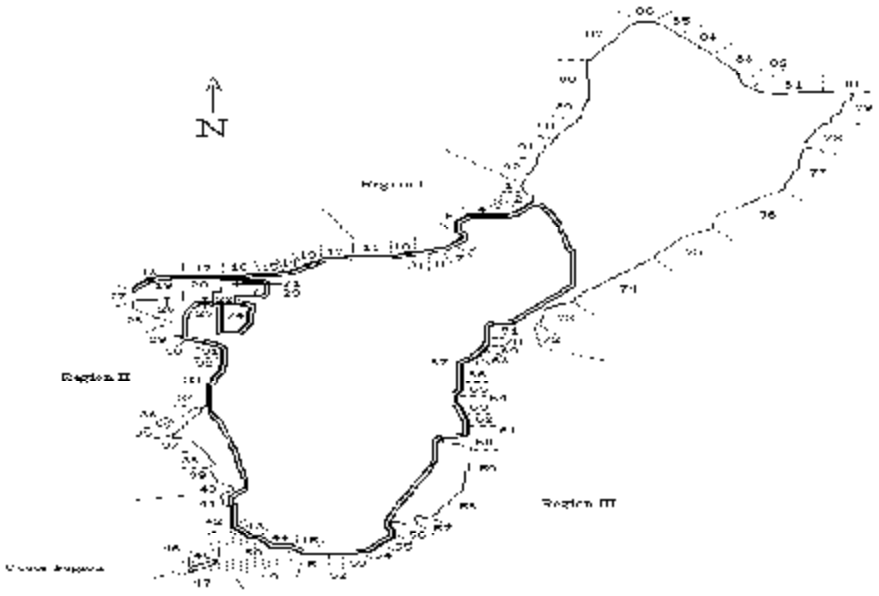


Figure 1. Inshore Fisheries "Participation Survey" Route with Area and Location Codes.

Mulloides ti'ao and *Caranx* i'e' recruit annually on reef flats and make up a large portion of the annual catch and effort. Ti'ao generally recruit within a few days of the May full moon and during strong recruitment years, pulses of new recruits will also follow the June and July full moons. *Caranx* i'e' recruitments start following the full moon in May and can continue after each full moon through November. It is speculated that continued recruitment may be linked to rainfall. Past recruitment events of these species have shown to be highly significant in terms of total catch, especially *Caranx ignobilis*, *C. melampygous*, *C. papuensis*, and *C. sexfasciatus* with hook & line, and *Mulloides flavolineatus* and *M. vanicolensis* with cast nets, when they occur.

The FY00 inshore harvest estimates were statistically expanded by a computer software package for Macintosh known as the Fourth Dimension (4D) database program (Mayall 1989). The 4D program utilizes formulae described in the FY83 inshore annual report (DAWR 1983) to compile and expand inshore survey data for the fiscal year.

RESULTS

During FY00, the estimated inshore harvest for day, night, and seasonal fishing around Guam was 38.1 metric tonnes (mt). Finfish accounted for 88% of total harvest or 33.5 mt. The total inshore catch of finfish and invertebrates resulted from a total effort of 193,531person-hours (ph) and 173,040 gear-hours (gh). Overall, approximately 0.22 kg/gh of fish were harvested with 143 daytime and 179 nighttime species identified in FY00 (Table 1). The seasonal mañåhak harvest was infrequent and low in certain locations on the east and west sides of the island during the month of April, e.g. East Agana and Pago Bays, but were not recorded in FY00.

Table 1. Combined estimated inshore participation, effort, and total harvest (mt) for all methods during the day and night in FY00.

METHOD	Persons	Gears	Trips	Per-Hrs	Gear-Hrs	Catch	Finfish	Inverts	CPUE†
Hook & Line	37,042	36,853	20,544	124,511	123,769	13.132	13.018	0.113	0.14 wed
Cast Net	8,030	7,509	6,987	15,840	14,467	6.109	5.965	0.144	0.89 wn
Gill Net	8,587	4,312	2,693	30,241	14,899	8.615	7.832	0.782	0.80 wd
Surround Net	902	341	264	5,199	2,601	0.424	0.424	0	0.14 wd
Spear Snorkel	5,095	4,714	2,001	10,750	9,996	6.424	5.658	0.767	0.85 wn
Spear SCUBA	158	117	93	107	76	0.069	0.068	0.001	1.34 wen
Drag Net	447	72	72	557	87	0.395	0.395	0	5.15 wen
Hooks & Gaffs	1,177	1,455	1,238	3,705	4,524	0.227	0	0.227	0.05 wd
Other††	1,439	1,439	929	2,621	2,621	2.708	0.108	2.601	1.64 wed
TOTAL	62,877	56,812	34,821	193,531	173,040	38.103	33.468	4.635	0.22

†CPUE summary derives the greatest weekday (wd), weeknight (wn), weekend day (wed), or weekend night (wen) values from Tables 2 and 3. The greatest CPUE value for hook & line was in region 3.
††Other Methods usually include: gleaning, hand nets, traps, and spears.

CATCH

Hook & line fishing yielded the largest overall catch with 13.0 mt or 39% of the total finfish harvest. Gill netting was second with 7.8 mt or 23%, while cast netting was third with 6.0 mt or 18%, and snorkel spearfishing was fourth with 5.7 mt or 17% of the total finfish harvest (Table 1).

The top three daytime methods for finfish, accounted for approximately 93% of the daytime total and 69% of the combined total harvest (Tables 1 and 2). Hook & line fishing accounted for the most fish with 10.8 mt or 43% of the day finfish harvest. Gill netting was second with 6.4 mt or 26%, while cast netting was third with 5.9 mt or 24%, and snorkel spearfishing was fourth with 1.3 mt or 5% of the total day finfish harvest.

Table 2. Estimated inshore participation, effort, and total harvest (mt) for all methods during the day in FY00.

METHOD	Persons	Gears	Trips	Per-Hrs	Gear-Hrs	Catch	Finfish	Inverts	CPUE†
Hook & Line	27,886	27,255	16,374	94,385	92,292	10.806	10.758	0.048	0.14 wed
Cast Net	8,028	7,358	6,836	15,635	14,313	6.015	5.871	0.144	0.78 wd
Gill Net	6,396	3,365	2,272	20,302	10,624	7.081	6.351	0.730	0.80 wd
Surround Net	888	327	250	5,142	2,544	0.367	0.367	0	0.14 wd
Spear Snorkel	2,755	2,445	1,159	4,930	4,355	1.714	1.282	0.432	0.50 wd
Spear Scuba	123	82	82	92	61	0.061	0.061	0	1.00 wed
Drag Net	0	0	0	0	0	0	0	0	0.0
Hooks & Gaffs	1,053	1,330	1,175	3,630	4,450	0.153	0	0.153	0.05 wd
Other††	1,156	1,156	779	1,960	1,960	2.532	0.060	2.472	1.64 wed
TOTAL	48,285	43,318	28,927	146,076	130,599	28.729	24.750	3.979	0.22

†CPUE summary derives the greatest weekday (wd) and weekend day (wed) values. The greatest CPUE value for hook & line was in region 3.
††Other Methods usually include: gleaning, hand nets, traps, and spears.

The top three nighttime methods accounted for approximately 94% of the night total and 24% of the combined total finfish harvest (Tables 1 and 3). Snorkel spearfishing accounted for the most fish caught with 4.4 mt or 51% of the total night finfish harvest and hook & line fishing was second with 2.3 mt or 26%. Gill netting was third with 1.5 mt or 17% and drag netting was fourth with 0.4 mt or 5% of the total night finfish harvest.

Table 3. Estimated inshore participation, effort, and total harvest (kg) for all methods during the night in FY00.

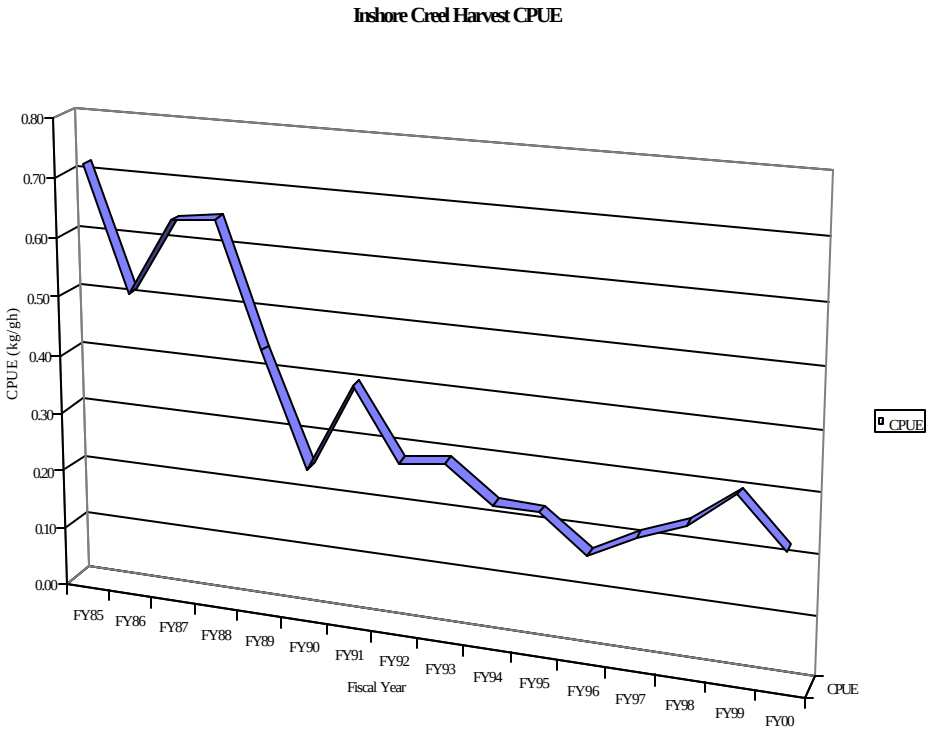
METHOD	Persons	Gears	Trips	Per-Hrs	Gear-Hrs	Catch	Finfish	Inverts	CPUE†
Hook & Line	9,156	9,599	4,170	30,126	31,477	2.326	2.260	0.066	0.08 wen
Cast Net	201	151	151	205	153	0.094	0.094	0	0.89 wn
Gill Net	2,192	947	421	9,939	4,276	1.533	1.481	0.052	0.44 wn
Surround Net	14	14	14	57	57	0.057	0.057	0	1.00 wn
Spear Snorkel	2,340	2,269	843	5,819	5,641	4.710	4.376	0.334	0.85 wn

Spear SCUBA	35	35	12	15	15	0.008	0.007	0.001	1.34 wen
Drag Net	447	72	72	557	87	0.395	0.395	0	5.15 wen
Hooks & Gaffs	124	124	62	74	74	0.074	0	0.074	1.00 wen
Other††	283	283	151	660	660	0.177	0.048	0.129	0.29 wen
TOTAL	14,792	13,494	5,896	47,452	42,440	9.374	8.718	0.656	0.22

†CPUE summary derives the greatest weeknight (wn) and weekend night (wen) values. The greatest CPUE value for hook & line was in regions 1 and 2.
††Other Methods usually include: gleaning, hand nets, traps, and spears.

CATCH PER UNIT EFFORT (CPUE)

Other methods had the highest daytime CPUE of 1.64 kg/gh for weekend day fishing and gill netting followed in second with 0.80 kg/gh and cast netting was third with 0.78 kg/gh (Table 2). Drag netting had the highest nighttime CPUE of 5.15 kg/gh for weekend night fishing, SCUBA spearfishing followed in second with 1.34 kg/gh, and cast netting was third with 0.89 kg/gh (Tables 1 and 3).



Summary information concerning effort and harvest for methods not discussed are included in Tables 1-3. Other boat-based inshore fisheries harvests on Guam, were recorded in the FY00 Offshore Fisheries Report (DAWR, Study F-1, Job 1, 2000).

Species and Family Harvests

The expanded species composition for the combined day and night efforts were calculated for FY00 and identified to species level with the assistance of Myers (1999). The top species caught was the scribbled rabbitfish, *Siganus spinus*, with 4.7 mt or 13.97% and *Caranx* i'e' was the top seasonal species caught, which ranked third with 2.0 mt or 5.99% of the finfish total. Acanthuridae was the top family for combined harvest, with 7.3 mt or 21.79% and 3 species listed in the top 10 for FY00 (Table 4).

Table 4. FY00 combined day and night catch composition for the top ten species and families of finfish harvested. Juvenile *Caranx ignobilis, C. melampygous, C. papuensis*, and *C. sexfasciatus* (i'e' ≤ 200mm), *Mulloides flavolineatus* (ti'ao ≤ 100mm), and *Siganus spinus* (mañåhak), are listed separately from the intermediate to adult size classes. Finfish harvest percentages were derived from the total day and night catch (33.543 mt).

SPECIES	**Harvest**		**FAMILY**	**Harvest**	
	mt	**%**		**mt**	**%**
Siganus spinus	4.686	13.97	Acanthuridae	7.309	21.79
Naso unicornis	3.512	10.47	Siganidae	5.106	15.22
Carnanx i'e'	2.010	5.99	Carangidae	5.038	15.02
Mulloides flavolineatus	1.590	4.74	Mullidae	2.331	6.95
Kyphosus vaigiensis	1.513	4.51	Mugilidae	1.882	5.61
Acanthurus triostegus	1.163	3.47	Kyphosidae	1.794	5.35
Liza vaigiensis	1.007	3.00	Lethrinidae	1.657	4.94
Decapterus macrosoma	0.921	2.75	Lutjanidae	1.048	3.12
Lethrinus harak	0.901	2.69	Scaridae	1.021	3.04
Naso lituratus	0.785	2.34	Labridae	0.818	2.44
TOTAL ANNUAL COMBINED CATCH	18.088	53.93		28.004	83.48

Siganus spinus topped the daytime finfish species harvests with 4.2 mt (73% by cast net, 16% by hook & line, 8% by gill net, and 3% by snorkel spearfishing) or 17.01%, while *Caranx* i'e' ranked third for the daytime seasonal species harvest with 1.8 mt or 7.35%. Acanthuridae was the top daytime family harvested, with 4.6 mt or 18.72% and 3 species listed in the top 10 for FY00 (Table 5).

Table 5. FY00 day catch composition for the top ten species and families of finfish harvested. Juvenile *Caranx ignobilis, C. melampygous, C. papuensis*, and *C. sexfasciatus* (i'e' ≤ 200mm), *Mulloides flavolineatus* (ti'ao ≤ 100mm), and *Siganus spinus* (mañåhak), are listed separately from the intermediate to adult size classes. Finfish harvest percentages were derived from the total day catch (24.751 mt).

SPECIES	**Harvest**		**FAMILY**	**Harvest**	
	mt	**%**		**mt**	**%**
Siganus spinus	4.215	17.01	Acanthuridae	4.634	18.72
Naso unicornis	2.833	11.44	Siganidae	4.459	18.02
Caranx i'e'	1.818	7.35	Carangidae	4.290	17.33
Kyphosus vaigiensis	1.478	5.97	Kyphosidae	1.686	6.81

Mulloides flavolineatus	1.033	4.17	Mullidae	1.560	6.30
Decapterus macrosoma	0.921	3.72	Mugilidae	1.537	6.21
Liza vaigiensis	0.879	3.55	Lethrinidae	0.965	3.90
Acanthurus triostegus	0.715	2.89	Lutjanidae	0.708	2.86
Gerres acinaces	0.661	2.67	Gerreidae	0.661	2.67
Lethrinus harak	0.636	2.57	Labridae	0.635	2.57
TOTAL ANNUAL DAY CATCH	15.189	61.34		21.135	85.39

Method Harvests

Naso unicornis topped the total night finfish harvested with 0.7 mt (99% by snorkel spear and 1% by gill net) or 7.72%. Acanthuridae was the top night family harvested with 2.7 mt or 30.43% and 6 species listed in the top 10 in FY00 (Table 6).

Table 6. FY00 night catch composition for the top ten species and families of finfish harvested. Juvenile *Caranx ignobilis, C. melampygous, C. papuensis*, and *C. sexfasciatus* (i'e' $\leq$ 200mm), *Mulloides flavolineatus* (ti'ao $\leq$ 100mm), and *Siganus spinus* (mañåhak), are listed separately from the intermediate to adult size classes. Finfish harvest percentages were derived from the total night catch (8.792 mt).

SPECIES	**Harvest**		**FAMILY**	**Harvest**	
	mt	**%**		**mt**	**%**
Naso unicornis	0.679	7.72	Acanthuridae	2.675	30.43
Mulloides flavolineatus	0.557	6.34	Mullidae	0.771	8.77
Siganus spinus	0.471	5.36	Carangidae	0.748	8.51
Acanthurus triostegus	0.448	5.10	Lethrinidae	0.692	7.87
Acanthurus lineatus	0.366	4.16	Siganidae	0.647	7.36
Acanthurus xanthopterus	0.351	3.99	Scaridae	0.529	6.02
Naso lituratus	0.349	3.97	Holocentridae	0.419	4.77
Lethrinus harak	0.265	3.01	Mugilidae	0.345	3.92
Naso tuberosus	0.233	2.65	Lutjanidae	0.340	3.87
Lutjanus fulvus	0.215	2.45	Labridae	0.183	2.08
TOTAL ANNUAL NIGHT CATCH	3.934	44.75		7.349	83.60

The top harvest of finfish species for hook & line method was listed for FY00 (Table 7). *Naso unicornis* ranked first with 2.4 mt for day (22.70%), while *Lethrinus harak* ranked first with 0.2 mt (9.56%) for night finfish harvested. The top day and night seasonal species harvested respectively was *Caranx* i'e', with 1.5 mt (13.82%) and *Selar crumenophthalmus*, with 0.1 mt (5.40%). Carangidae was the top finfish family harvested for hook & line with 4 species listed each for day and night in FY00 (Table 7).

Table 7. FY00 day and night catch composition for the top ten species of finfish harvested by hook & line method. Juvenile *Caranx ignobilis*, *C. melampygous*, *C. papuensis*, and *C. sexfasciatus* (i'e' ≤ 200mm), are listed separately from the intermediate to adult size classes. Finfish harvest percentages were derived from the total day (10.758 mt) and night (2.260 mt) hook & line catch.

Day Species	**Harvest**		**Night Species**	**Harvest**	
	mt	**%**		**mt**	**%**
Naso unicornis	2.442	22.70	*Lethrinus harak*	0.216	9.56
Caranx i'e'	1.487	13.82	*Lutjanus fulvus*	0.169	7.48
Decapterus macrosoma	0.921	8.56	*Decapterus macrosoma*	0.143	6.33
Siganus spinus	0.668	6.21	*Selar crumenophthalmus*	0.122	5.40
Selar crumenophthalmus	0.567	5.27	*Caranx ignobilis*	0.096	4.25
Lutjanus bohar	0.388	3.61	*Caranx* i'e'	0.088	3.89
Lethrinus harak	0.332	3.09	*Lutjanus argentimaculatus*	0.080	3.54
Hyporhamphus acutus	0.331	3.08	*Monotaxis grandoculus*	0.075	3.32
Liza vaigiensis	0.323	3.00	*Gnathodentex aurolineatus*	0.065	2.88
Caranx melampygous	0.286	2.66	*Naso tuberosus*	0.055	2.43
Total Top Ten Hook & Line Catch	7.745	72.00		1.109	49.08
Total Combined Hook & Line Catch	8.854				

The top harvest of finfish species for gill net method was listed for FY00 (Table 8). *Mulloides flavolineatus* ranked first with 1.0 mt (15.24%) for day and first with 0.3 mt (16.61%) for night finfish harvested. Acanthuridae was the top finfish family harvested for daytime gill net with 4 species, while Mugilidae topped the night gill net list with 3 species in FY00 (Table 8).

Table 8. FY00 day and night catch composition for the top ten species of finfish harvested by gill net method. Juvenile *Caranx ignobilis*, *C. melampygous*, *C. papuensis*, and *C. sexfasciatus* (i'e' ≤ 200mm), *Mulloides flavolineatus* (ti'ao ≤ 100mm), and *Siganus spinus* (mañåhak), are listed separately from the intermediate to adult size classes. Finfish harvest percentages were derived from the total day (6.352 mt) and night (1.481 mt) gill net catch.

Day Species	**Harvest**		**Night Species**	**Harvest**	
	mt	**%**		**mt**	**%**
Mulloides flavolineatus	0.968	15.24	*Mulloides flavolineatus*	0.246	16.61
Gerres acinaces	0.459	7.23	*Siganus spinus*	0.167	11.28
Liza vaigiensis	0.441	6.94	*Acanthurus triostegus*	0.109	7.36
Acanthurus triostegus	0.392	6.17	*Valamugil seheli*	0.090	6.08
Naso unicornis	0.381	6.00	*Diodon hystrix*	0.082	5.54
Valamugil seheli	0.352	5.54	*Valamugil engeli*	0.082	5.54
Siganus spinus	0.339	5.34	*Caranx* i'e'	0.068	4.59
Hymantura fai	0.313	4.93	*Liza vaigiensis*	0.053	3.58
Naso lituratus	0.224	3.53	*Gerres acinaces*	0.046	3.11
Naso tuberosus	0.214	3.37	*Naso annulatus*	0.044	2.97
Total Top Ten	4.083	64.29		0.987	66.66

Gill Net Catch	
Total Combined Gill Net Catch	5.070

The top harvest of finfish species for snorkel spear method was listed for FY00 (Table 9). *Gerres acinaces* ranked first for day, with 0.2 mt (12.17%), while *Naso unicornis* ranked first at night, with 0.7 mt (15.29%) of the snorkel spear finfish harvest. Acanthuridae was the top finfish family harvested for snorkel spearfishing with 3 species listed for day and 7 at night in FY00 (Table 9).

Table 9. FY00 day and night catch composition for the top ten species of finfish harvested by snorkel spear method. Finfish harvest percentages were derived from the total day (1.282 mt) and night (4.376 mt) snorkel spear catch.

Day Species	**Harvest**		**Night Species**	**Harvest**	
	mt	**%**		**mt**	**%**
Gerres acinaces	0.156	12.17	*Naso unicornis*	0.669	15.29
Siganus spinus	0.145	11.31	*Acanthurus lineatus*	0.366	8.36
Acanthurus lineatus	0.133	10.37	*Naso lituratus*	0.339	7.75
Lethrinus harak	0.100	7.80	*Acanthurus triostegus*	0.314	7.18
Naso lituratus	0.097	7.57	*Siganus spinus*	0.264	6.03
Arothron nigropunctatus	0.087	6.79	*Acanthurus xanthopterus*	0.192	4.39
Liza vaigiensis	0.076	5.93	*Naso tuberosus*	0.177	4.04
Epinephelus merra	0.070	5.46	*Lethrinus atkinsoni*	0.108	2.47
Acanthurus xanthopterus	0.054	4.21	*Acanthurus guttatus*	0.095	2.17
Valamugil seheli	0.051	3.98	*Mulloides flavolineatus*	0.094	2.15
Total Top Ten Spear Snorkel Catch	0.969	75.59		2.618	59.83
Total Combined Spear Snorkel Catch	3.587				

Seasonal Harvests

The seasonal catch of certain juvenile fishes is widely anticipated by local fishermen. The FY00 harvests of *Caranx* i'e' were well represented within the expansion total (Tables 4-6). During FY00, a significant *Caranx* i'e' recruitment event occurred from May – July, while smaller runs occurred in October, December – January, March, April, August, and September. *Caranx* i'e' ranked third for combined and daytime harvests (Tables 4 and 5), second (1.5 mt) and sixth (0.1 mt) for day and night hook & line (Table 7), and seventh (0.1 mt) for night gill net (Table 8). In addition, small pulses of recruiting *Mulloides* ti'ao (*M. flavolineatus*) occurred in November, December, and April – September, but did not rank in the top ten (0.3 mt) for FY00.

FY00 marked an infrequent and low recruitment year for mañåhak (ha'tang or *Siganus spinus* and lesso' or *S. argenteus*). One run occurred in the last week of April FY00 and harvests were observed during a creel survey on April 25, 2000. As of June FY98, DAWR suspended the collection of mañåhak harvest data, because this information was not critical to management of the reef fishery.

The atulai (*Selar crumenophthalmus*) season occurred during the last two months in FY00, with 0.7 mt or 2.1% of the total harvest for FY00. The total inshore harvests of atulai (99% of day and night harvest) were caught with hook & line, due to the high incidence of catch interviews at the Agana Boat Basin channel (Fig. 1, location 9 and Table 7).

Invertebrates Harvested

In addition to finfish, a significant number of marine invertebrates were harvested from Guam's reefs (Smith 1986). The spiney lobster, *Panulirus penicillatus*, was the most harvested invertebrate with a day and night harvest of 0.75 mt (85% by gill net and 15% by snorkel spearfishing) in FY00.

An estimated 0.7 mt of octopus, e.g., *Octopus cyanea* (0.5 mt) and *O. ornatus* (0.1 mt), was approximately 15% of the total invertebrates harvested and the second most caught invertebrate in FY00. Daytime octopus harvests accounted for 0.6 mt (40% by snorkel spear, 27% by hooks and gaffs, 25% by cast nets, and 8% by hook & line), while nighttime harvests accounted for 0.1 mt (54% by snorkel spear, 33% by other methods, and 13% by gill nets) in FY00.

The third most caught invertebrate was the longspine urchin, *Echinothrix diadema*, with an estimated 0.6 mt (100% by other methods) in FY00. Harvests of reef algae, molluscs, crustaceans, and echinoderms accounted for an estimated 1.5 mt, 0.5 mt, 0.4 mt, and 0.2 mt respectively in FY00. Other methods, e.g., gleaning, crab trapping, and hand netting, produced an estimated 2.7 mt of finfish and invertebrates, e.g., Sargassum for bait and Echinothrix sea urchins for "uni", with a catch rate of 1.0 kg/ph of fishing effort.

Table 10. Inshore Creel Participation Survey Results. Method abbreviations are listed as follows: Hook & line (HL); Cast Net (CN); Gill Net (GN); Surround Net (SN); Spear Snorkel (SpSn); Spear SCUBA (SpSc); Hooks and Gaffs (HG); Drag Net (DN); and Other Methods (OM) for July – September 1999. Percent values illustrate rarely encountered and interviewed methods.

Inshore Creel Participation

	Total # Observed Methods				**Total # of Non-Interviews**				**%Summary**			
	Persons		Gears		Persons		Gears		%Persons		%Gear	
Methods	WD	WE	WD	WE	WD	WE	WD	WE	WD	WE	WD	WE
HL	522	706	543	705	121	177	138	169	77	75	75	76
CN	85	113	76	100	30	41	27	39	65	64	64	61
GN	188	187	123	126	80	73	43	45	57	61	65	64

SN	9	10	2	2	0	8	0	1	100	20	100	50
SpSn	178	152	175	148	93	93	91	94	48	39	48	36
SpSc	2	10	2	10	0	7	0	7	100	30	100	30
HG	14	2	23	4	9	2	18	4	36	0	22	0
DN	8	16	3	2	0	0	0	0	100	100	100	100
OM	42	31	40	34	17	9	16	5	60	71	60	85

An "inshore creel-participation" survey was conducted in FY00 to quantify the actual participation by method during the creel surveys. Percent coverage of persons and gears were listed for all methods observed and listed in Table 10. Methods with the least number of persons and gears observed included the following for weekday and weekend surveys respectively: surround net (9/2, 10/2), SCUBA spear (2/2, 10/10), hooks and gaffs (14/23, 2/4), drag net (8/3, 16/2). Methods with < 50% of persons interviewed, include the following for weekday (wd) and weekend (we) surveys: surround net (20% we), snorkel spearfishing (48% wd and 39% we), SCUBA spear (30% we), and hooks and gaffs (36% wd and 0% we).

Fishable Index Hours (FIH)

The FIH default is a parameter used in the expansion to identify the amount of time a person can fish with a particular method during a survey day. Windows of survey fishable time included: the a.m. (0600-1200 hours), p.m. (1900-2400 h), whole day (0600-1800 h), and whole night (1900-0200 h). The FIH is determined by dividing the survey fishable time by the whole day fishable time for each method. Fishable hours for each method are determined by the state of the tide. Some methods are not restricted by tide, e.g. hook & line and spearfishing. Net fishing is limited to tides above 0.5 ft., while hooks and gaffs for octopus and gleaning are limited to tides below 0.5 ft (Table 11).

Table 11. Fishable Index Hours (FIH). Methods are listed as follows: Hook & line (HL); Cast, Gill, Surround, and Drag Nets (N); Snorkel and SCUBA spear (SP); Hooks and Gaffs (HG); and Other Methods (OM), are listed for day and nighttime values for FY00.

Daytime FIH Values for FY00

Method	Oct	Nov	Dec	Jan	Feb	Mar	April	May	June	July	Aug	Sep
Nets	2.80	2.40	2.28	2.20	2.20	2.10	2.00	2.00	1.88	1.63	2.16	2.20
HG	1.00	1.00	1.00	1.00	1.00	1.50	2.00	2.00	2.92	3.50	3.23	1.46

Nighttime FIH Values for FY00

Nets	1.38	1.23	1.23	1.42	1.50	1.31	1.56	1.50	1.50	1.50	1.50	1.50
HG	1.25	2.00	2.50	1.63	1.23	1.83	1.25	1.00	1.00	1.00	1.00	1.00

	Day	**Night**
HL	2.00	1.40

SP	2.00	1.40
OM	2.00	2.00

RECOMMENDATIONS

Considering the inshore fisheries survey provides information important for management and planning, it is recommended that this job be continued. It is recommended that the aerial surveys be continued into FY01, due to approximately 11% average of all methods combined of the participants and gear-units occurring outside the inshore participation route (avg. P_2 values).

Overall declines in annual harvests and shifts in species composition have been documented in the last 16 years. With the recent legislative approval of Marine Preserve Areas (MPAs) and the implementation of new fishing regulations, we can begin to manage levels of fishing activity and preserve critical areas for reef fishes to mature and reproduce (DAWR 1999). As of June 2000, DAWR began the daytime enforcement of Guam's MPAs. Since then, a sharp decline in fishing participation was observed within the survey areas with a 46% decline in total harvests and a 29% decrease in CPUE of reef fish species for FY00. The overall success of the MPAs will be seen in the near future if enforcement measures are maintained over time. In addition, the implementation of new survey strategies may be necessary to document the change in reef fish biomass, biodiversity, habitat, and catch rates in reef areas adjacent and within MPAs over time.

PROJECT COSTS

The estimated cost of this project was $166,950.

This report was prepared by: Todd J. Pitlik, Fisheries Biologist III.

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APPENDIX 1

INSHORE AERIAL SURVEY

PERIOD COVERED: October 1, 1999 to September 30, 2000

SUMMARY

A total of 24 inshore aerial surveys were conducted in FY00 for a total of 1,283 persons and 1,112 gear units. Hook & line was the most frequently encountered method with 630 persons and 631 gear units. A ratio of participants / method observed in areas outside the inshore participation route to the total number for all methods surveyed during the "inshore aerial" were calculated as variables (P_2 values) for the inshore expansion. The values ranged from 72% for weekday cast nets to 100% for rare and night-practiced methods, e.g., surround net, SCUBA spear, hooks and gaffs (day only), and drag net fishing.

Incidental biological sightings resulted in a total of 279 turtles, 321 dolphins, 11 sharks, 48 eagle rays, and 8 manta rays for FY00.

BACKGROUND

DAWR aerial surveys were established in the early 60's and reinstated in FY90 to provide fishing participation by method in areas not covered by the "inshore-creel" and "inshore-participation" surveys.

PROCEDURES

"Inshore-aerial" surveys were conducted twice monthly on regularly scheduled participation days (one weekday / weekend). Start times are moved up in one-hour intervals for each subsequent survey (0800-1200h), then repeated after reaching 1200h. Visual observations of areas not covered in the "inshore-participation" survey (Fig.1 locations: 22, 27, 28, 35-39, 44-50, 58, 59, 70, and 73-92) included fishing effort data. The first scheduled weekday and weekend participation survey dates of each month were selected to allow rescheduling in the event of poor weather conditions.

Each survey started in location 11 and proceeded in a clockwise direction all the way around the island to location 12 (Fig. 1). The seaward flight distance from the reef margin was 200-300m with an altitude of 170-200m. The flight pattern was modified over larger reef flats by flying over the mid-reef flat to observe fishing methods. The aerial itinerary also included a semi-circular flight pattern within Cocos Lagoon and Apra Harbor. In addition, the pilot was instructed to circle over reef flat areas when it was difficult to observe or determine activity.

The aerial survey observations were sorted by method and type day (weekday / weekend). A ratio of the persons / method observed in areas outside the inshore participation route were compared to the total number of persons / method observations for the island for each type day. The resultant P_2 values provided variables (%) that could be used to expand inshore participation values to island-wide participation values.

Other biological data collected, included incidental observations of marine mammals, turtles, sharks, and rays at or near the surface of various reef zones, e.g., Pago Bay and the fore reef slope, along the aerial survey route.

RESULTS

The most frequently encountered methods included hook & line, cast net, gill net, snorkel spear, hooks and gaffs, and other methods, while surround net, spear SCUBA, and drag net methods were less common. Ratio frequencies were highest (100%) for the least common methods, which were due to the rarity of their use during the day, e.g., spear SCUBA and drag net are primarily night methods. Hook & line, cast net, gill net, surround net, snorkel spear, hooks and gaffs, and other methods (weekday and weekend days respectively) had P_2 values (Table 1) listed as percentages: (86/84), (72/74), (78/88), (100/100), (86/93), (100/85), and (88/74), respectively for FY00.

Table 1. P_2 values derived from aerial survey data in FY00. Ratios were calculated from a ratio of method sightings within aerial locations to participation locations. Methods abbreviations are listed as follows: Hook & line (HL); Cast Net (CN); Gill Net (GN); Surround Net (SN); Spear Snorkel (SpSn); Spear SCUBA (SpSc); Hooks and Gaffs (HG); Drag Net (DN); and Other Methods (OM).

Ratios	HL	CN	GN	SN	SpSn	SpSc	HG	DN	OM
Weekday	28/175	29/75	14/51	0/6	6/37	0/0	0/5	0/0	3/21
Weekend	70/357	21/59	13/99	0/81	5/68	0/0	4/22	0/0	9/25
WD Ratio	175/203	75/104	51/65	6/6	37/43	0/0	5/5	0/0	21/24

WE Ratio	357/427	59/80	99/112	81/81	68/73	0/0	22/26	0/0	25/34
WD P_2	86	72	78	100	86	100	100	100	88
WE P_2	84	74	88	100	93	100	85	100	74

Aerial survey counts indicated hook & line with the greatest number of participants in FY00 (Table 2).

Table 2. Total number of people and gear units observed during aerial surveys in FY00. Method abbreviations are listed in Table 1 with weekday (WD) and weekend (WE) days listed below.

	Within Par Route				**Outside Par Route**			
	Persons		**Gears**		**Persons**		**Gears**	
Methods	WD	WE	WD	WE	WD	WE	WD	WE
HL	175	357	172	361	28	70	28	70
CN	75	59	74	56	29	21	26	20
GN	51	99	29	44	14	13	9	6
SN	6	81	2	12	0	0	0	0
SpSn	37	68	37	66	6	5	6	5
SpSc	0	0	0	0	0	0	0	0
HG	5	22	5	22	0	4	0	4
OM	21	25	21	25	3	9	3	9
Total	370	711	340	586	80	122	72	114

Dolphins topped the list of the most frequently sighted marine animals during the aerial surveys with 321 sightings. The greatest monthly total of 95 dolphin sightings were observed in November. Turtle, eagle ray, and shark sightings ranked second, third, and fourth, respectively for annual sightings. The greatest monthly total of turtles were sighted in May with 61 and eagle rays in November with 16. In addition, a total of 11 sharks and 8 manta rays were sighted in FY00 (Table 3).

Table 3. Number of turtle, dolphins, shark, and ray sightings by aerial surveys around Guam in FY00.

	MONTHS												
SPECIES	O	N	D	J	F	M	A	M	J	J	A	S	**TOTAL**
Turtle	18	37	8	18	16	8	20	61	5	0	39	49	279
Dolphin	75	95	0	0	90	0	25	20	0	0	16	0	321
Shark	0	1	0	0	0	0	4	0	0	0	0	6	11
Sting Ray	0	0	0	0	0	0	0	0	0	0	0	0	0
Eagle Ray	6	16	0	13	1	0	3	3	0	0	3	1	46
Manta Ray	1	3	1	0	0	1	0	0	0	0	1	1	8

Zero cancellations occurred in FY00.

PROJECT COST: Flights cost approximately $10,780.

This report was prepared by: Todd J. Pitlik, Fisheries Biologist III

APPENDIX 2

ABANDONED GILL NET REMOVAL/STUDY

PERIOD COVERED: October 1, 1999 to September 30, 2000

SUMMARY

Abandoned gill nets were retrieved from nineteen locations (Table. 1) on Guam. A total of 72 nets were recovered with an average mesh size of 1.8 in. and a total length of 3,600 ft. Four nets contained five fish with a total weight of .3 kg, nine nets contained 34 invertebrates with a total weight of 2.8 kg, and fourteen nets contained 76.5 kg of algae. Also, coral damage was assessed during the study. Five coral colonies had severe damage (70 - 100 %), 3 had moderate damage (31 - 69 %) sixteen had slight damage (1 - 30 %), and 10 had no damage. Seven species of coral were identified, and a total of 197 coral pieces were found in the abandoned gill nets.

OBJECTIVES

1) To identify and remove abandoned gill nets on reefs around Guam reported by fishermen and concerned citizens.

2) To collect data related to the destruction of reef habitat and incidental catch of marine organisms caused by abandoned gill nets.

3) To analyze data and identify locations affected by abandoned gill nets and evaluate the need for effective management related to this occurrence.

PROCEDURES

Information on the location and condition of abandoned gill nets were obtained during creel surveys during FY00. Net location was verified by staff following the survey and removed at a later date. Gill net, marine organism, and coral data were collected to quantify damage to organisms and coral. Data included locality, reef zone, retrieval time, # nets, net, mesh size, net length, additional remarks, coral and habitat damage, and marine organisms collected (condition, length, weight, and species identification). Marine organisms capable of survival were released. In addition, several abandoned gill nets were identified on reef flats during the aerial survey in FY00.

RESULTS

A summary of abandoned gill net data collection is included in Table 1. Data was subdivided into the following categories: locations, nets, and marine organisms. Abandoned gill nets were located in 19 inshore locations and collection data was summarized for each one. Cocos island had the greatest number of abandoned gill nets collected for a total of 23. Invertebrates comprised the majority of the incidental catch with 2.87 kg with the most catch in location 71. The majority of the, incidental catch for fish, was in location 63 with 0.2 kg. In addition, approximately 76.5 kg of marine algae was collected during the study period.

Table 1. Summary data from abandoned gill nets collected during FY00. Location numbers were derived from the inshore report (Figure 1).

LOCATIONS	# Nets	Avg Mesh (in)	Length (ft)	# Fish	Fish (kg)	# Inverts	Inverts (kg)	Algae (kg)
1	3	1.7	40	0	0	0	0	0
4	4	2.2	42	0	0	0	0	0
11	1	1.5	300	1	.04	0	0	20
12	1	1.5	100	0	0	1	.04	0
24	2	1.8	220	0	0	4	0.5	0
33	3	1.3	20	0	0	0	0	0
38	1	2.5	50	0	0	0	0	0
44	1	2	15	0	0	0	0	1.3
53	1	1.5	100	0	0	0	0	0
55	2	1	75	0	0	0	0	0
61	3	2.3	180	1	0.04	2	0.2	0.5
62	8	1.96	570	0	0	0	0	0
63	5	1.7	137	2	0.2	6	1.3	0
65	3	1.7	40	0	0	0	0	0
66	1	1.5	20	0	0	3	N/A	0
67	1	2	100	0	0	0	0	4
71	2	1.8	150	0	0	8	0.8	0.1
92	7	2.5	598	1	0.1	10	.03	0.1
Cocos	23	2	843	0	0	0	0	50.5
Total	**72**	**1.8**	**3600**	**5**	**0.38**	**34**	**2.87**	**76.5**

A summary of coral damage from abandoned gill nets is included in Table 2.

Table 2. Summary of coral damage data of abandoned gill nets collected during FY00. Coral damages ranged from 0-100% (none to severe) of affected corals. See Figure 1 for location numbers.

Locale	**Coral Colony /Species**	**0**	**1 - 30%**	**31 - 69%**	**70-100%**	**Total # of colonies**	**Coral in net**
44	Porites cylindrica	0	2	1	0	3	2
	Acropora	0	0	0	2	2	0
	Porites massive	0	2	2	3	7	0
92	Pocillopora damicornis	0	1	0	0	1	0
92	Pavona decussata	0	1	0	0	1	31
	Pocillopora verrucosa	4	1	0	0	5	3
	Psammocora obtusangula	0	5	0	0	5	107
	Pocillopora damicornis	2	1	0	0	3	5
92	Pavona decussata	0	1	0	0	1	16
	Pocillopora damicornis	2	0	0	0	2	0
	Pocillopora verrucosa	1	0	0	0	1	1
	Psammocora obtusangula	0	2	0	0	2	30
92	Pocillopora verrucosa	1	0	0	0	1	1

55	Pocillopora damicornis	0	0	0	0	0	1
	Total	**10**	**16**	**3**	**5**	**34**	**197**

Coral damage was subdivided into the following categories: no damage, slight damage, moderate damage, severe damage, and coral in net. Corals damaged in close proximity to abandoned gill nets were located in 3 locations and collection data was summarized for each one. Location 44 had the most coral damage with a total of 5 colonies having severe coral damage. Also, location 44 had the most moderate coral damage with a total of 3 colonies. A total of 197 pieces of coral were found in the nets.

RECOMMENDATIONS

Current fishing regulations have addressed the need to reduce the impacts of gill netting on Guam's reefs. Newly passed laws prohibit the use of gill nets within Marine Preserve Areas in addition to a recent change to increase the mesh size and reduce the overall length of gill nets used outside of prohibited areas. Results obtained from this study will provide the scientific data used to justify the modification of gill net regulations if deemed necessary.

Photo documentation should be included in the study to improve habitat assessment. The significant number of abandoned gill nets collected over the study period emphasizes the need for continued removal and to further document the incidental catch and damage on coral habitats on Guam.

PROGRAM COST

The estimated cost of the project was $9,000.

This report was prepared by: Jay T. Gutierrez, Fisheries Biologist III.