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A PRELIMINARY COMPARISON OF FISHING EFFECTIVENESS BETWEEN CULTURED AND NATURAL BAITFISH SPECIES USED BY TUNA POLE-AND-LINE FISHING GEAR

(Paper Prepared by the Skipjack Programme)

1.0 INTRODUCTION

In situations where the supply of natural baitfish species is seasonally or permanently limited, cultured baitfish may be a valuable supplemental or substitute product, if they effect reasonable tuna catches and can be supplied at a reasonable cost.

Within the South Pacific Commission area several countries have cultured and utilised both mollies (Poecilia mexicana, P. vittata - American Samoa, Western Samoa, French Polynesia, Palau) and milkfish (Chanos chanos - Kiribati, French Polynesia) for fishing tuna with pole-and-line vessels. On a number of occasions, the Skipjack Survey and Assessment Programme's chartered Japanese pole-and-line vessel, the Hatsutori Maru, used mollies and milkfish which were generously supplied to the Programme at no cost by the above countries.

During three years of field work, the Programme collected considerable data on the performance of different bait species in attracting and catching tuna, particularly skipjack. This working paper for the Twelfth Regional Technical Meeting on Fisheries briefly summarizes preliminary comparisons of natural and cultured baitfish. A forthcoming report by the Skipjack Programme will incorporate fishing results in an assessment of economic feasibility for baitfish culture in the South Pacific Commission area.

2.0 DATA COLLECTION

The total weight of loaded bait, dead bait and bait used for chumming were recorded. Weight of bait loaded was estimated from the number of buckets loaded and average weight of bait per bucket. The weight of bait used for fishing was calculated by subtracting the dead bait from the bait loaded. This amount was checked each day against the number of buckets of bait taken from the tanks during the fishing operation, and by visually estimating the quantity of bait that remained in the tanks at the end of each fishing day. Immediately after capture, all bait species were identified from one or more "bucket" samples. Size ranges were determined for the dominant species. The sampling procedure for determining average bucket weight and species composition was to analyze the contents of one bucket for every 20 loaded, up to a maximum of three buckets.

During fishing operations, Programme staff counted all fish that were caught (i.e., fish tagged and released, and fish landed on deck). For each school that was fished, a size range and average weight were obtained for each species caught by sampling fish that remained on deck because they were unsuitable for tagging. Skipjack and small yellowfin (< 70cm) comprised over 95 percent of the catch. From catch and sampling data we estimated the total weight for each species caught, per school and per fishing day. In addition, Programme staff maintained daily records of the number of schools sighted, the number of schools chummed, the number of positive schools (i.e., schools from which at least one fish was poled), and fishing time.

Table 1 presents dates on which cultured bait were loaded on board the research vessel, the amount of bait loaded, and the countries in which these bait were used.

3.0 PRELIMINARY ANALYSES

The following bait categories are compared in this analysis: mollies only, mollies in combination with natural bait, natural bait only, milkfish in combination with natural bait and milkfish only. In the category "mollies with natural bait" 52 percent of the bait used was mollies; for the group "milkfish with natural bait" 55 percent was milkfish.

The dominant natural bait species used in the five baitfish comparisons in this working paper were Sardinella marquesensis, Spratelloides gracilis, S. delicatulus, Rhabdamia cypselurus, Selar crumenophthalmus, Herklotsichthys punctatus.

Cultured baitfish were used under a variety of fishing conditions in seven countries. On several occasions both cultured species were used in the same countries. In order to compare natural and cultured baitfish, data on natural species were chosen from periods and areas bracketing the cultured baitfish trials.

TABLE 1 - LOADING DATES AND FISHING LOCATIONS FOR CULTURED BAITFISH

BAITFISH	LOADING DATE	KG. LOADED	COUNTRY WHERE BAIT WAS USED
Mollies	15/06/78	354	) American Samoa (1st visit)
Mollies	16/06/78	154.5	) Tuvalu (1st visit)
Mollies	21/06/78	211.5	) Kiribati (1st visit)
Milkfish	21/07/78	78	Kiribati (1st visit)
Mollies	09/12/78	238.5	)
Mollies	10/12/78	156	)
Milkfish	02/01/79	37.5	) French Polynesia (1st visit)
Milkfish	03/01/79	273	)
Mollies	18/01/79	138	)
Milkfish	26/01/79	207	)
Milkfish	29/11/79	183	Kiribati (2nd visit)
Milkfish	20/12/79	678	) French Polynesia (2nd visit)
Milkfish	29/01/80	756	) French Polynesia (2nd visit) Pitcairn (1st visit)) Cook Islands (2nd visit)) American Samoa (2nd visit)
Mollies	22/02/80	370.5	) Western Samoa (2nd visit)
Mollies	25/02/80	121.5	) Niue (1st visit)
TOTALS			
Mollies		1,744.5	
Milkfish		2,212.5	

As the vessel was engaged in survey fishing, the catches made underestimate the catches that would have been possible if the vessel had been fishing commercially. This does not affect the comparison between cultured and natural bait since they were both used under the same conditions.

Fishing effort and fishing conditions while using these different baitfish combinations are given in Table 2. Note that the daily fishing condition, as indexed by the number of schools chummed per fishing day,is similar for each group. Abundance of tuna, as estimated by the number of schools sighted per hour spent searching, was approximately the same while using mollies, natural bait or milkfish (Table 2).

TABLE 2 - FISHING EFFORT AND FISHING CONDITIONS DURING BAITFISH TRIALS

	MOLLIES	MOLLIES + NATURAL BAIT	NATURAL BAIT	MILKFISH + NATURAL BAIT	MILKFISH	TOTAL
Number of fishing days	12	21	65	8	17	123
Number of schools chummed	63	102	268	34	99	566
Number of schools chummed/fishing day	5.3	4.9	4.1	4.3	5.8	4.6
Number of schools sighted/hour spent searching	1.06	0.66	1.01	0.66	0.85	-

Data relevant to two principal aspects of baitfish usefulness are presented below; mortality of baitfish in the vessel's holding tanks, an important consideration for medium to long range fishing operations, is presented first. This is followed by catch effectiveness comparisons.

3.1 Baitfish Mortality

The average daily mortality rates for mollies, milkfish and natural bait carried during fishing operations by the Hatsutori Maru were respectively 2.7, 3.3 and 23.0 percent (Figures 1 and 2). Cultured bait were generally carried on board for at least a week, whereas natural bait were generally used or had died within two days.

Mollies and milkfish were generally "strong" (daily mortality less than two percent), and adapted well to transfer operations between the ponds and the vessel's bait tanks. Milkfish were generally loaded in rougher conditions than mollies. However, both cultured species were affected by disease, and this did on occasion cause mortality rates to exceed five percent, particularly after prolonged holding periods (see Figures).

3.2 Catch Effectiveness

A common index for assessing baitfish effectiveness in attracting and catching skipjack and other tunas is the tuna/bait ratio, that is, the number of kg of fish caught per kg of bait used (e.g., Bryan, 1978; Kearney, 1975; Vergne et al, 1978). However, there are other indices that provide equally valuable information. For example, it is important to know how many schools responded positively to chumming (i.e., chumming success), the total catch from each school that was chummed (catch (kg)/school chummed) and from each positive school (catch (kg)/positive school), the total number of fish caught from each positive school (no. fish caught/positive school) and the catch per fishing day (catch (kg)/fishing day). These ratios are given in Table 3 for each of the five baitfish categories.

TABLE 3 - BAITFISH PERFORMANCE INDICES

	MOLLIES	MOLLIES + NATURAL BAIT	NATURAL BAIT	MILKFISH + NATURAL BAIT	MILKFISH
Tuna/bait ratio (kg tuna:kg bait used)	11.1:1	12.0:1	8.4:1	13.1:1	16.1:1
Chumming success (%)	41	50	56	76.5	48.5
Catch (kg)/school chummed	108	181	225	303	241
Catch (kg)/positive school	260	360	400	400	500
Number of fish caught/positive school	101	128	180	172	163
Average size fish caught (kg)	2.6	2.8	2.2	2.3	3.1
Catch (kg)/fishing day	567	878	927	1,287	1,403

On average, cultured bait only or cultured bait mixed with natural bait resulted in higher tuna/bait ratios than did natural bait alone. Mollies performed particularly well in this regard; however, it should be noted that two fishing days out of 12, when only mollies were used, produced 74 percent of the total catch with mollies. In constrast, chumming success, catch per school chummed and catch per fishing day were lowest for mollies only, and for mollies mixed with natural bait. Milkfish used alone or in combination with natural bait resulted in the highest values of these ratios. Two factors that may affect these ratios are discussed below.

3.2.1 Fish size effects

There was some variation in the average size of fish caught for each of the five baitfish categories (Table 3). Within the limits of 2-4kg, the number of fish poled is independent of fish size. Therefore, the number of fish caught within the size range is considered to be a better index of bait effectiveness than the total weight. Some of the indices from Table 3 have been recalculated using an overall average fish size and are presented in Table 4. The ratios do change somewhat; however, the relationships between baitfish categories remained roughly the same, that is the two milkfish categories produced the best overall fishing results considering all indices; and mollies produced the lowest catches.

TABLE 4 - BAITFISH PERFORMANCE INDICES CALCULATED USING A COMMON AVERAGE WEIGHT OF FISH CAUGHT

	MOLLIES	MOLLIES + NATURAL BAIT	NATURAL BAIT	MILKFISH + NATURAL BAIT	MILKFISH
Tuna/bait ratio (kg tuna:kg bait used)	10.5:1	10.4:1	9.3:1	14.0:1	13.0:1
Catch (kg)/school chummed	102	157	249	324	194
Catch (kg)/fishing day	540	760	1,030	1,380	1,130

3.2.2 Baitfish size effects

The results presented in Table 3 for mollies alone and mollies plus natural bait are somewhat contradictory. Tuna/bait ratios for these groups exceeded the same ratio for natural bait, yet chumming success, catch per school chummed, catch per positive school, number of fish caught per positive school, and catch per fishing day were well below values obtained for natural bait. One possible explanation is that chummers threw less mollies per school chummed (9.7 kg per school versus 26.8 kg per school for natural bait). This is largely a result of our general strategy to conserve mollies because they were used in situations where natural bait was scarce, and if existing bait was exhausted, no alternative bait sources were available for at least several days. This artificially inflated the tuna/bait ratio for mollies, but does not completely explain low values for the other indices for mollies.

TABLE 5 - BAITFISH PERFORMANCE INDICES COMPARED FOR CATCHES MADE WITH MOLLIES AND SMALL AND LARGE SIZE NATURAL BAIT. ALL DATA WERE TAKEN FROM THE TROPICAL REGIONS OF THE SPC AREA TO ALLOW COMPARISON BETWEEN CATEGORIES.

	MOLLIES	SMALL SIZE NATURAL BAIT*	LARGE SIZE NATURAL BAIT**
Average bait size (mm)	27-36	35-48	71-97
Number of fishing days	12	20	16
Kg bait used	613.5	1,090.5	1,493.5
Tuna/bait ratio (kg tuna:kg bait used)	11.1:1	9.8:1	9.2:1
Chumming success (%)	41	46	55
Catch (kg)/school chummed	108	132	205
Catch (kg)/fishing day	567	534	858
Kg bait used/school chummed	9.7	13.5	22.3

* Spratelloides gracilis, S. delicatulus, Stolephorus devisi, S. buccaneeri, Allanetta ovalaua

** Sardinella sirm, S. marquesensis, Rastrelliger sp., Stolephorus heterolobus

It was the opinion of scientists and crew on the Hatsutori Maru that bait species of small size, in particular mollies, were less desirable prey for tuna, and were less adept at swimming up the "chum line", hence attracting tuna to the vessel. For this reason, the tuna stayed within range of the fishermen for shorter periods of time. A comparison of fishing effectiveness indices for small and large natural bait species (Table 5) gives some support for these observations. These results suggest that fishing effectiveness for mollies and very small natural bait was similar, and that the smaller species were considerably less effective than larger natural bait species.

4.0 CONCLUSIONS

During the analysis it was noted that the commonly used tuna/bait ratio, kilogrammes of fish captured per kilogramme of bait thrown, when used alone, could lead to misinterpretation of baitfish effectiveness.

In the baitfish trials carried out by the Skipjack Programme, mollies produced considerably poorer catches of skipjack and other tunas than did natural bait or milkfish. Milkfish appeared to be particularly effective especially when mixed with natural bait. These results confirm the general feeling of the scientists and crew involved in the Skipjack Programme that milkfish are an excellent bait while mollies are poor. The usefulness of mollies is considered to be largely restricted to times or places where there is no alternative bait.

Mollies and milkfish were generally quite resistant to holding mortality in the vessel's bait tanks, but on occasion, they suffered heavy mortality due to disease outbreaks which were more frequent after prolonged holding periods.

The subject of baitfish fishing effectiveness is very complex and could only be briefly addressed in a working paper of this length. More comprehensive reports on this subject, including more data contrasting cultured mollies, milkfish and natural bait will be presented at a later date so that countries in the South Pacific Commission area will have the best possible data available for evaluating potential benefits from bait culture operations.

5.0 REFERENCES

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FIGURE 1 - Daily mortality for mollies loaded on the Hatsutori Maru on four occasions. Horizontal axis represents days after loading.

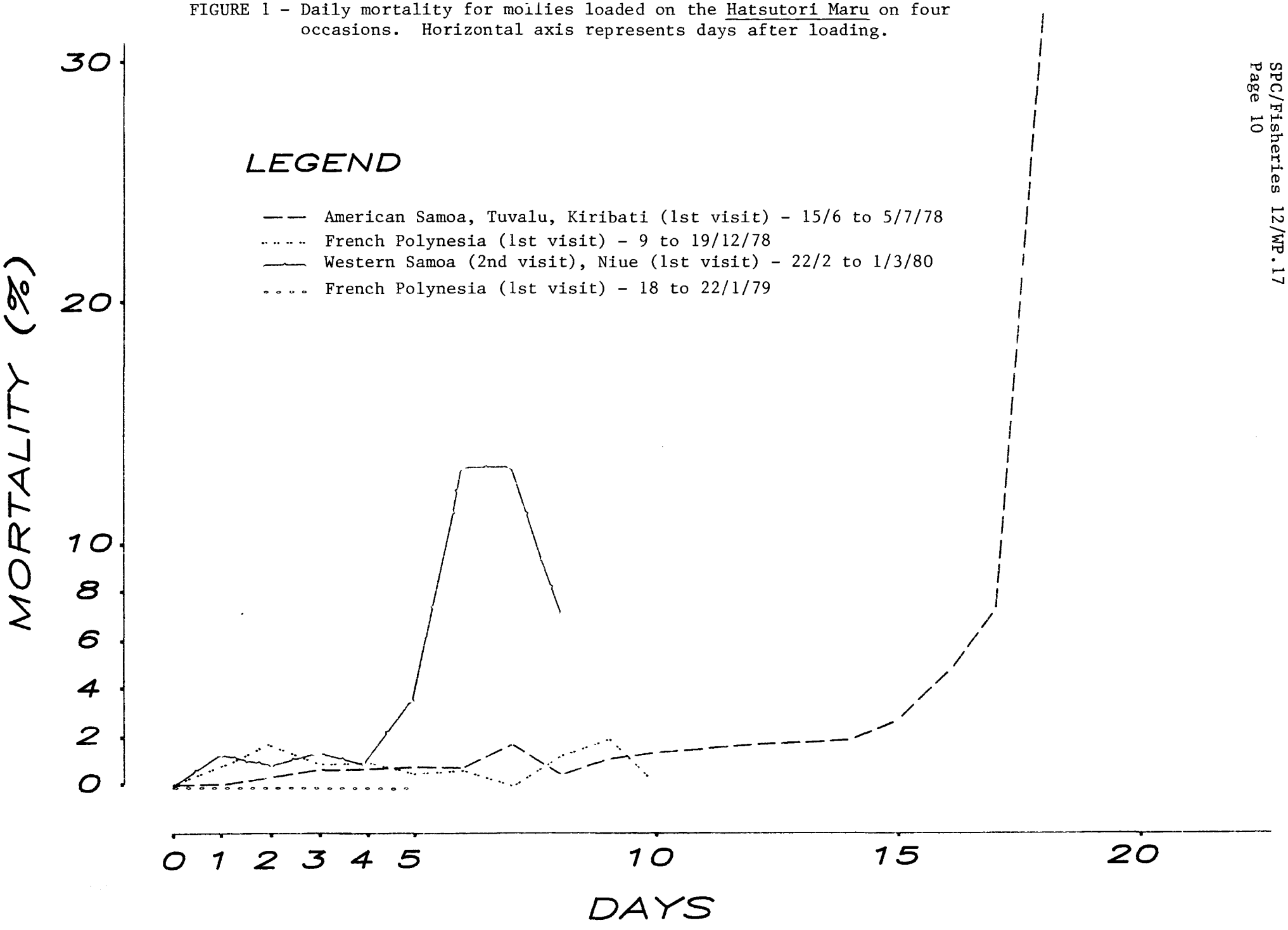

FIGURE 2 - Daily mortality for milkfish loaded on the Hatsutori Maru on five occasions. Horizontal axis represents days after loading.