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THE CHARACTERISTICS OF PHILIPPINE SMALL PELAGIC FISHERIES AND OPTIONS FOR MANAGEMENT[1]

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ABSTRACT

An account is given of the present status of small pelagic fisheries in the Philippines. Small pelagic fishes account for about one-quarter of all fish landed in the Philippines and about 20% of the total value of the fisheries production. The commercial and small-scale municipal sectors of the Philippine fishing industry catch roughly equal amounts of the half million tons of small pelagic fishes landed annually. However, the gross benefits from the resource are divided between far fewer fishermen within the commercial sector. Small pelagic fisheries in the Philippines are at present biologically and economically overfished. The expansion of commercial fisheries after World War II and the continued growth of the small-scale municipal sector parallel with population increase have led to the overexploitation of Philippine small pelagic fishery resources. Regulation of the commercial fisheries sector should be relatively straightforward by the use of existing fisheries and related legislation. Such solutions are acknowledged to be ineffective with municipal fisheries, and wholesale reduction of fishing effort will only be possible through increasing opportunity costs for labor and the withdrawal of a substantial number of fishermen from the municipal sector.

INTRODUCTION

The Philippines is currently the 12th largest fishing nation in the world. The country's production of fish and aquatic products from 1982 to 1986 ranged from 1.9 million to 2.1 million tons, with an average production of 2.05 M tons worth 25 billion pesos (US$1.25 B)[2] . Fisheries production contributes to five percent of Philippine

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[1] Modified version of the Final Report of the Small Pelagics Management Project, Department of Agriculture/BFAR-ICLARM.

[2] US$1 = PHP20.386 (1986).

gross national product and provides employment to four percent of the labor force (NEDA, 1987). Small pelagic fishes comprise about 26% of total landings, and during 1986 were worth about PHP7.42 B (US$37 M) or 20% of the total value of fisheries production. These small fishes are relatively inexpensive and are usually consumed locally -- either in fresh, dried, or canned form, or as fermented paste. Small pelagic fishes are not luxury items such as prawns, lobsters and some fish species. However, in common with most marine resources in the Philippines, the stocks of small pelagic fishes are overfished. The level of fishing effort directed towards small pelagic fishes is too high, both from industrial and artisanal fishing.

The gross overfishing of Philippine small pelagic fisheries is essentially a post-World War II phenomenon. Industrial expansion resulted from the initial profit potential of these fisheries while, more recently, increasing rural poverty has driven people into small-scale artisanal fishing as a means of survival. An estimated 12% of the population or about seven million people are dependent in some way on the fishing sector (Librero, 1985). This and the fact that fish is a staple of the Philippine diet mean that fisheries cannot be dismissed lightly from government consideration. Fish provides 50% to 70% of the animal protein eaten by Filipinos (Ronquillo, 1975; Gonzales, 1985). The fishing industry as a whole cannot be an area for speculative investment, since the societal impact of large production fluctuations would be considerable.

Patterns of food consumption related to earnings in the Philippines show that the per capita consumption of fish increases with annual income (Table 1). In the two lower income groups (I and II), an average of about 66% of the families' total annual income is spent on food. Of this, about 16.2% is spent on fish and represents about one-quarter of all monies used to purchase food. In the two higher income brackets (III and IV), only 28% of total income is disposed of on food, and of this, 11% is used to purchase fish. The lower income groups, however, account for about 70% of fish consumed in the Philippines and use a substantial portion of their annual income for fish purchase. The demand elasticity for fish shows that these groups are the most sensitive to changes in price.

Table 1. Food consumption related to earnings in the Philippines[a].

Income	I[b]	II[c]	III[d]	IV[e]
Total number of families (x 10^3)	3,270	3,476	2,130	972
Average annual income (pesos)	11,467	27,735	46,174	123,624
Percentage of income spent on food	89.2	44.0	30.8	18.9
Percentage of income spent on fish	21.2	11.2	7.9	4.8
Annual per capita fish consumption (kg)	31.2	35.9	41.1	42.1
Demand elasticity for fish	-1.441	-0.9508	-0.8888	-0.4800

[a] Compiled from Gonzales (1985) and NEDA (1987).
[b] PHP6,000-14,999/year (US$300-750/year).
[c] PHP15,000-29,999/year (US$750-1,500/year).
[d] PHP30,000-59,999/year (US$1,500-2,950/year).
[e] PHP60,000-100,000+/year (US$3,000-5,000+/year).

The small pelagic fishes, particularly roundscads, anchovies and sardines, are on the average priced lower than the other species (Table 2). Given the volume of small pelagics landed and the sensitivity of the lower income groups to price changes of fish, it is reasonable to assume that most of the small pelagic landings are absorbed by the lower income groups. Swift collapse or even steady decline of these fisheries will have a deleterious effect on social and economic aspects of Philippine life, since the lower income groups comprise over two-thirds of the population. Management intervention is therefore timely, but until the advent of the Small Pelagics Management Program (1986-1987), collection of data on these species had been fragmentary and

Table 2. Fish market wholesale price of small pelagics and other selected marine species, 1986.

Fish Species	Price (PHP/kg)
Small pelagics	
Roundscads	15.93
Anchovies	12.12
Sardines	13.56
Mackerels	19.65
Big-eye scads	17.01
Round herrings	7.57
Fusiliers	21.56
Other species	
Tuna	15.47
Slipmouths	13.92
Breams	22.21
Milkfish	24.65
Hairtails	16.89
Groupers	29.93
Tilapia	21.43
Cavallas	26.71

Source: Bureau of Agricultural Statistics, 1987.

uncoordinated. The aims of the project were chiefly to review secondary data on Philippine small pelagics and to establish a sampling program for contemporary estimation of fisheries, biological and economic parameters. It soon became clear that any attempts at expanding the small pelagic fisheries would be futile and not lead to increased fish production; therefore, the project focused on improved management steps.

THE PHILIPPINE SMALL PELAGIC FISHERIES

Economic Profile

The average annual landings of small pelagic fishes in the Philippines between 1982 and 1986 amounted to about 500,000 tons. During 1986, 267,000 tons (53.2%), worth PHP4.34 B (US$213 M) were landed by commercial (or industrial) fishermen, while 238,000 tons (46.8%) worth PHP3.08 B (US$151 M) were landed by municipal (or small-scale artisanal) fishermen. In the Philippines, boats of three gross tons or greater are designated as commercial fishing vessels, while those of less than 3 GT are termed municipal vessels. The resource and gross benefits from the small pelagic fishery are split more or less evenly between the two sectors. However, within the commercial fishing sector, there are around 45,000 to 50,000 fishermen, while by present estimates (Dalzell *et al.*, 1987) there are about 1.1 million small-scale artisanal fishermen in the Philippines. Thus, the total value of the catch from the small pelagic fishery is divided very disproportionately between the entire fishing community.

Five types of commercial fishing vessels catch 98% of the industrial small pelagic catch. Of these, three gear/vessel combinations (i.e., purse seines, ring nets and basnigs) are designed to catch pelagic species, whereas trawlers generally catch demersal or bottom-dwelling fishes. The muro-ami or drive-in net is designed to capture coral reef fishes. However, 75% of all fish captured by muro-ami nets in the Philippines are fusiliers, small reef associated pelagic fishes (Dalzell and Lewis, 1988). The fleet sizes of the different commercial fishing vessels catching small pelagics in 1948-1986, including those of ancillary carrier vessels, are shown in Table 3. These vessels service the ring net, trawl and purse seine fleet, carrying fish to shore and bringing water and victuals to the crew of the fishing vessels. Dalzell and Ganaden (1987b) and Dalzell *et al.* (1987) suggested that the carrier vessel fleet should grow in response to declining catch rates in the Philippine small pelagic and other fisheries. Carrier vessels relieve fishing vessels of the need to return to port frequently and thus maximize fishing time. The estimated value of the different fleet was based on surveys carried out by the Small Pelagics Management (SPM) project (Table 4). In all, a total of PHP5 B (US$45 M) is tied up within commercial small pelagic fishing.

Another innovation that has acted to maximize fishing time for small pelagic fishing is the development of the *payaw* which is essentially an anchored floating raft that acts as a fish aggregating device. Simple forms of payaw constructed of bamboo and palm fronds have been deployed in the Philippines for many years (Murdy, 1980) by small-

Table 3. Annual numbers of the five principal commercial fishing vessels for small pelagic fish and carrier vessels from 1948 to 1986.

Year	Purse Seine	Basnig	Otter Trawl	Ring Netter	Muro-ami	Total	Carrier Vessel	Grand Total
1948	9	168	15	no data	9	201	no data	201
1949	10	242	58	—	2	312	—	312
1950	16	333	129	—	2	480	—	480
1951	26	502	190	—	2	718	—	718
1952	35	648	234	—	1	918	—	918
1953	29	643	227	—	5	904	—	904
1954	49	653	309	—	3	969	—	969
1955	38	670	301	—	10	1,019	—	1,019
1956	76	574	313	—	21	984	—	984
1957	65	540	283	—	22	910	—	910
1958	57	733	349	—	31	1,170	—	1,170
1959	77	717	423	—	33	1,250	—	1,250
1960	79	673	445	—	47	1,244	—	1,244
1961	75	680	462	—	48	1,265	—	1,265
1962	89	742	490	—	46	1,367	—	1,367
1963	109	892	513	—	48	1,562	—	1,562
1964	152	841	494	—	42	1,529	36	1,565
1965	168	1,009	578	—	79	1,834	99	1,933
1966	226	1,006	596	—	47	1,875	159	2,034
1967	176	1,002	593	—	37	1,808	190	1,998
1968	196	883	653	—	25	1,732	175	1,907
1969	223	796	667	—	24	1,710	217	1,927
1970	215	858	653	—	26	1,752	193	1,945
1971	265	743	652	—	37	1,697	258	1,955
1972	320	650	690	—	39	1,699	290	1,989
1973	470	791	794	—	37	2,092	155	2,247
1974	280	584	767	—	37	1,668	297	1,965
1975	313	713	763	58	35	1,882	278	2,160
1976	342	656	786	58	36	1,878	268	2,146
1977	280	504	684	61	34	1,563	241	1,804
1978	331	639	769	150	5	1,894	269	2,163
1979	408	641	877	143	41	2,110	260	2,370
1980	412	624	848	158	7	2,049	346	2,395
1981	450	552	764	222	45	2,033	415	2,448
1982	516	603	829	269	39	2,256	496	2,752
1983	403	573	932	310	43	2,261	516	2,777
1984	318	652	884	394	37	2,285	521	2,806
1985	306	602	763	418	37	2,126	513	2,639
1986	280	565	702	404	34	1,985	465	2,450

scale fishermen. More recently, commercial purse seine and ring net operators have structured their fishing operations around payaws. Payaws in the waters between Southern Luzon and Northern Mindanao are an elaboration of traditional bamboo raft designs. A typical unit costs from PHP1,500 to PHP2,500 (US$75-125). Off the south coast of Mindanao, payaws deployed in the deep waters of the Moro Gulf and Celebes Sea are built from welded steel tubes and anchored in water up to 5000 m in depth. These structures cost about PHP72,500 (US$3,600) to construct, about 80% of which is the cost of the anchor rope. There are no regulations governing the deployment of payaws, which may number from 5,000 to 10,000 units set around the Philippine coast.

Table 4. Estimated value of Philippine commercial vessels and gears catching small pelagic fishes during 1987.

Commercial Small Pelagic Vessels[a]	Number[b]	GRT[c]	Mean Capital Cost (PHP)[d]	Total Cost (PHP x 10^6)
Basnig	565	8,952	104,000	58.76
Purse seiner	280	37,800	15,169,500	4,247.46
Ring netter[e]	404	7,819	174,000	70.30
Trawler	702	19,269	840,000	589.68
Muro-ami	34	9,461	1,575,000	53.55
Total	1,985	83,301	17,862,500	5,019.75

[a] These five commercial gears account for 98.5% of commercial small pelagic catch (Dalzell and Ganaden, 1987).
[b,c] Obtained from BFAR (1988).
[d] From SPM project sample data.
[e] Contains municipal ring netters since those encountered by SPM project which were classified as municipal were in fact > 3 GT.

Less precise information is available on the total size of the municipal fishing fleet which captures small pelagic fishes. Data provided by Dalzell *et al.* (1987) suggest that the size of the motorized municipal fleet in 1986 was about 246,000 vessels. The average price of a municipal fishing banca during 1986-1987 was PHP34,569 (US$1,730) (Canuela *et al.*, 1987). This gives an approximate fleet value of PHP6.9 B (US$348 M). Small pelagic fishes account for about 30% of the total municipal landings during 1986. Using this as rough conversion factor, about 74,000 vessels worth approximately PHP2.6 B (US$128 M) were involved in catching small pelagic fishes. Clearly, this is not a very satisfactory method of estimating municipal small pelagic fleet value. However, in the absence of recent census data, there is little alternative. The individual values of the principal municipal small pelagic vessel/gear combinations have been estimated from the SPM project (Table 5). Apart from the cost of the lawag (round-haul seine), these values are in general consistent with that of Canuela *et al.* (1987) for a municipal fishing vessel.

Table 5. Estimated cost of municipal fishing vessels catching small pelagic fishes in the Philippines, 1987.

Municipal Small Pelagic Vessels[a]	Mean Capital Cost (PHP)[b]
Lawag/Round-haul seine	269,000
Encircling gill net	55,000
Surface gill net	24,609
Beach seine	18,365
Hook and line	16,000
Fish corral	37,000
Drive-in net	30,000

a These seven municipal gears account for 97.6% of the municipal small pelagic catch.
b From SPM project sample data.

About 80,000 tons of fisheries and aquatic products were exported annually from the Philippines from 1982 to 1986 (Table 6). Of this volume, 60% or 49,000 tons were in the form of fish products, worth on the average PHP1.9 B (US$93 M). Until 1986, the breakdown of fish exports was not particularly detailed in the BFAR annual reports. However, the 1985 and 1986 reports (BFAR, 1987 and unpublished) give the annual breakdown of fisheries exports in much greater detail than earlier reports. From this, a total of 520 tons of processed small pelagic fish, worth PHP23 M (US$1.1 M), were exported during 1986 to various parts of the world. Small pelagic fishes account for about one percent of the weight and of the value of fish products exported from the Philippines. They are thus of little importance in the export trade of the country. The figures, however, serve to emphasize the importance of small pelagic fishes within the Philippines since virtually all production of these species is absorbed by domestic markets and consumers. The major fish export of the Philippines is tuna, either canned or frozen. Between 1982 and 1986, tuna exports averaged 38,000 tons per year or 77% of the total fish exports. This was worth an annual average of PHP950 M (US$46.6 M) or about 50% of the value of fish exports.

Table 6. Exports of fisheries products from the Philippines from 1982 to 1986.

Fisheries Exports	1982	1983	1984	1985	1986
Total fishery exports (t)	68,265	75,589	63,055	95,077	101,453
Value (PHP x 10^6)	1,120	1,593	2,179	3,496	4,863
Fish exports only (t)	41,667	47,039	39,488	58,958	60,662
Value (PHP x 10^6)	611	894	1,117	2,752	3,985
Tuna exports only (t)	37,141	42,070	35,984	37,365	36,925
Value (PHP x 10^6)	538	799	995	1,132	1,278
Small pelagic exports (t)	n.a.	n.a.	n.a.	238.2	520
Value (PHP x 10^6)				11.0	23

Less detailed information is available on importation of fish products into the Philippines. Prior to 1986, the fish canning industry was not allowed to import frozen fish for packaging and had to rely solely on domestic production. After the change of government in 1986, new policies were implemented which permitted the importation of frozen fish from abroad for processing and packaging in the Philippines to recompensate for supplies from the domestic fisheries. A quota of 14,000 tons was set on tuna imports, although during 1986 only 3,400 tons of frozen tuna were brought into the country. A total of 28,000 tons of other frozen fish were also imported into the Philippines during 1986, among which were small pelagic fishes such as the Japanese sardine *Sardinops melanosticus*.

A substantial proportion of small pelagic fish in the Philippines is processed as fish paste (bagoong), fish sauce (patis), dried fish, canned fish (consisting of species such as roundscad, sardine and mackerel). Unfortunately, the precise amounts of small pelagic fish that are destined for production as any of the above category are unknown. Guevara (1978, 1987) mentioned that 40% of Philippine fisheries production is destined for processing, 38% of which is turned into dried fish. In specific locations, the proportion of dried fish to another form of processing may be quite different. Data from the National Capital Region fish port at Navotas suggest that about 40% of the landed catch goes for canning, with 1% fermented and 1% dried or made into fish meal (J. Sapinoso, Navotas Port Authority, Manila, pers. comm.). Alternatively, about 50% of the small pelagic landings sampled by the SPM project at Zamboanga were sardines and anchovies, all of which were salted and dried.

Biological and Fisheries Profile

Small pelagic fishes can be defined as mackerel or herring-like fishes that generally live in the upper surface layers of the water column, in waters not exceeding 200 m in depth. Small pelagics are usually limited to the water above the continental shelf. Thus, the area of shelf around a land mass can determine the size of the small pelagic standing stock. Although the Philippines is an archipelago, the shelf area between and around the various islands extends over 225,000 sq km. It is not surprising, therefore, that there are heavily developed fisheries for both demersal and pelagic fishes in the Philippines.

Descriptions of the biology and composition of Philippine small pelagic fishes are given in various SPM project documents (Dalzell and Ganaden, 1987a; Dalzell and Ganaden, 1987b; Calvelo and Dalzell, 1987; Jabat and Dalzell (1988); Dalzell and Pauly, 1987). However, a brief synopsis of the relevant information is given here for reference. The composition of small pelagic landings between 1982 and 1986 is shown in Table 7. The most important component species groups in the small pelagic landings are roundscads, anchovies, sardines and mackerels. These four familial groupings comprise about 80% of the total landings of small pelagic fishes. In all, about 40 species belonging to eight families make regular contributions to small pelagic landings.

Small pelagic fishes are usually short-lived, fast-growing species. For example, the anchovies of the genus *Stolephorus* typically have a life span in the Philippines of about 1-2 years. Even shorter-lived species are the sprats of the genus *Spratelloides*, with a life span of about six months. Species such as the big-eye scads and roundscads may live for up to 3-5 years. Concomittant with a short life span is a high natural mortality rate. Conventional theory suggests that where much of the stock dies before completing much of their growth, it will pay to fish relatively hard and with a low size at first capture, so as to catch the fish before they die of natural causes (Gulland, 1983).

This is, in fact, the fishing strategy which has been adopted in the Philippines, although not from a rational approach to fishing. The steady rise in fishing effort has caused a decline in both catch rate and the average size in the catch. Fishermen have reduced mesh sizes to cope with this problem, and now they catch fish that are, on the average, smaller than the size which generates optimum yield.

Although well within the tropics, the Philippines has a distinctly seasonal climate. This is based more on rainfall brought by typhoons and tropical storms during the latter half of the year, rather than on temperature. The mean annual rainfall is 1680 mm, of which 80% is precipitated in the southwest monsoon season between June and November. The northeast monsoon season which occurs from January to May is marked by low rainfall in many parts of the country. As might be expected, such a strongly seasonal cycle markedly influences the production of fishes such as small pelagics which live close to the water surface.

Table 7. Annual landings (mt) of small pelagics by the Philippine municipal and commercial fisheries, 1982 to 1986.

Species	1982		1983		1984		1985		1986		Mean		%	
	M	C	M	C	M	C	M	C	M	C	M	C	M	C
Fusiliers	9,878	8,483	9,604	7,991	6,950	12,867	6,669	9,609	6,008	9,005	7,822	9,601	3.0	3.60
Big-eye scads	15,710	1,522	14,765	7,737	20,717	16,796	20,390	13,091	20,092	14,315	18,335	12,692	7.0	4.70
Roundscads	32,987	150,266	33,762	131,261	26,570	105,013	25,446	106,262	24,557	151,298	28,664	128,820	11.0	48.20
Flyingfish	21,530	113	14,444	67	24,323	610	20,610	164	17,013	47	19,584	80	7.5	0.01
Half-beaks	3,658	221	3,243	65	6,569	125	6,599	107	5,368	77	5,087	119	2.0	0.04
Round herrings	13,663	7,503	12,745	7,762	23,118	12,007	18,078	10,761	18,349	9,667	17,191	9,540	6.6	3.60
Sardines	92,517	55,299	92,377	59,107	70,467	38,560	49,580	32,347	45,031	28,272	69,994	42,717	26.9	16.00
Anchovies	47,777	29,718	65,995	25,425	63,387	36,158	70,781	39,104	68,978	30,709	63,384	32,223	24.4	12.10
Mackerels	23,933	24,089	28,910	34,969	32,113	29,263	32,804	34,107	32,631	33,810	30,078	31,242	11.6	11.70
Total	261,653	287,214	275,845	274,354	274,214	251,399	250,157	245,552	238,027	277,250	260,139	267,034		

The major production peak for roundscads occurs over the period of the dry season and then declines as the wet season continues (Fig. 1). By contrast, the peak production of big-eye scads and clupeoid fishes (anchovies, herrings, sardines) occurs through the period of maximum rainfall. Certain species such as fusiliers and mackerels do not appear to have production peaks in concert with the rainfall cycle.

There appears, in general, to be a major peak in fish landings between March and May in the Philippines (Fig. 2). This is based on recorded monthly landings of fish in 1980-1986 at the Navotas Fish Port Complex (NFPC) which services Manila. About 35% of all fish caught by commercial fishing vessels from all over the Philippines are landed at the NFPC. Thus, these records represent a major sample of the fishery.

Seasonal cycles of this kind are not unique to the Philippines. However, they can have marked effects on prices of fish. Data from the NFPC for roundscads show that the price for these fishes is highly sensitive to changes in supply (Fig. 3). Thus, prices drop markedly during the peak of landings between March and May. Similarly at Cebu, the peak in landings of bullet tunas during June results in a drastic cut in value from PHP13/kg to about PHP2/kg on average (Jabat and Dalzell, 1988). Fish is disposed of to fish meal factories.

Historic Trends in the Fishery

Before the second world war, the level of industrial commercial fishing in the Philippines was limited to Japanese fishermen using beam trawls, introduced during the 1920s and 1930s. These nets, called "utase," were pulled by sail and motor-powered sampans. The expansion of commercial fishing in the Philippines is thus a post-war phenomenon. The increase in the commercial fishing fleet is well illustrated by Pauly (1982) for San Miguel Bay where, from 1935 to 1980, the total fleet horsepower in the Bay rose from around 120 hp to 18,000 hp. The fleet size has increased from 201 to 2,285 vessels. Such an increased fleet size will naturally generate a greatly increased fishing pressure.

Similarly, there have been large increases in the number of municipal fishermen in the Philippines over the same period. Further, the pressure exerted on fish stocks by small-scale fishermen and its effects, were reported as long ago as the early years of the Spanish occupation during the 16th century (Blair and Robertson, 1973). Whether this was severe overfishing or not is now a moot point. Later, however, Martin (1938) described the relocation of small-scale fishermen from the southeast coast of Cebu to the northwest coast due to possible overfishing of flyingfish stocks during the 1930s.

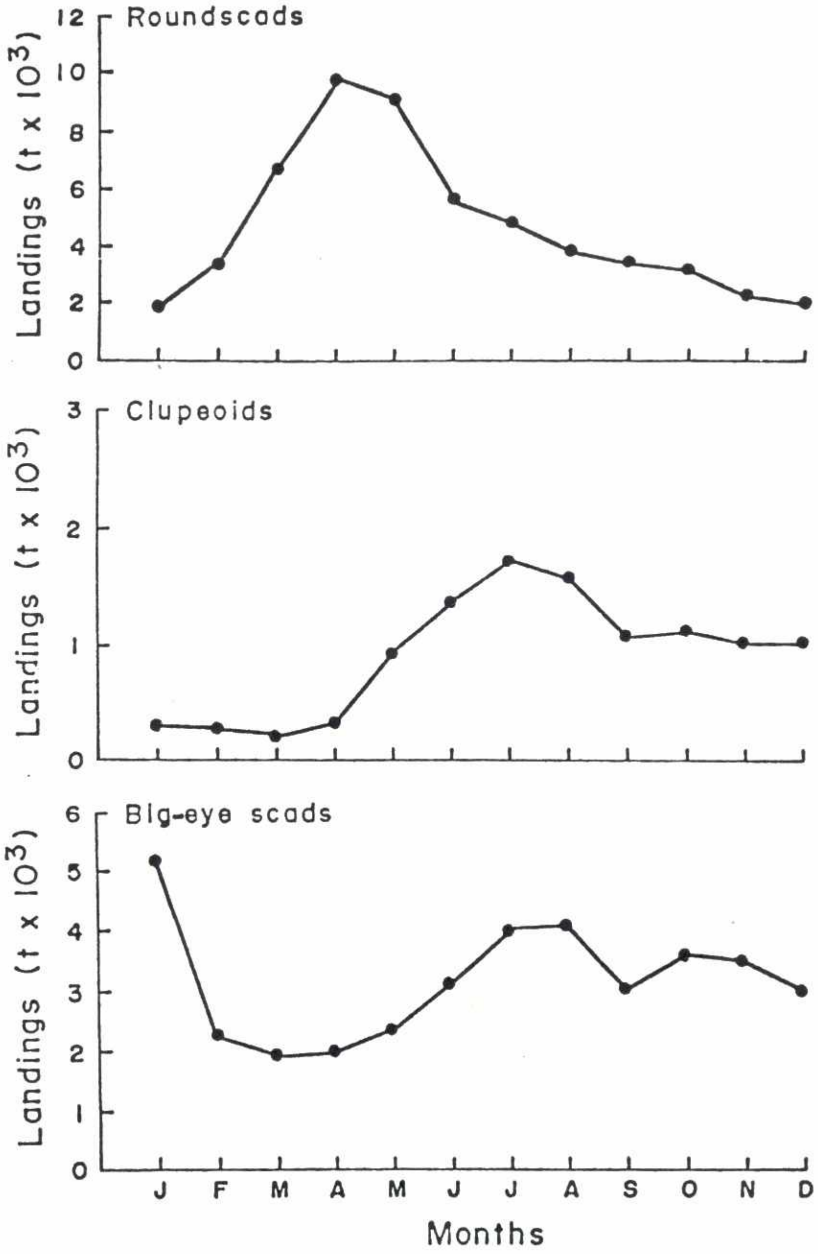

Fig. 1. **Mean monthly landings of roundscads, clupeoids (sardines, anchovies and round herrings) and big-eye scads at the Navotas Fish Port Complex between 1980 and 1986.**

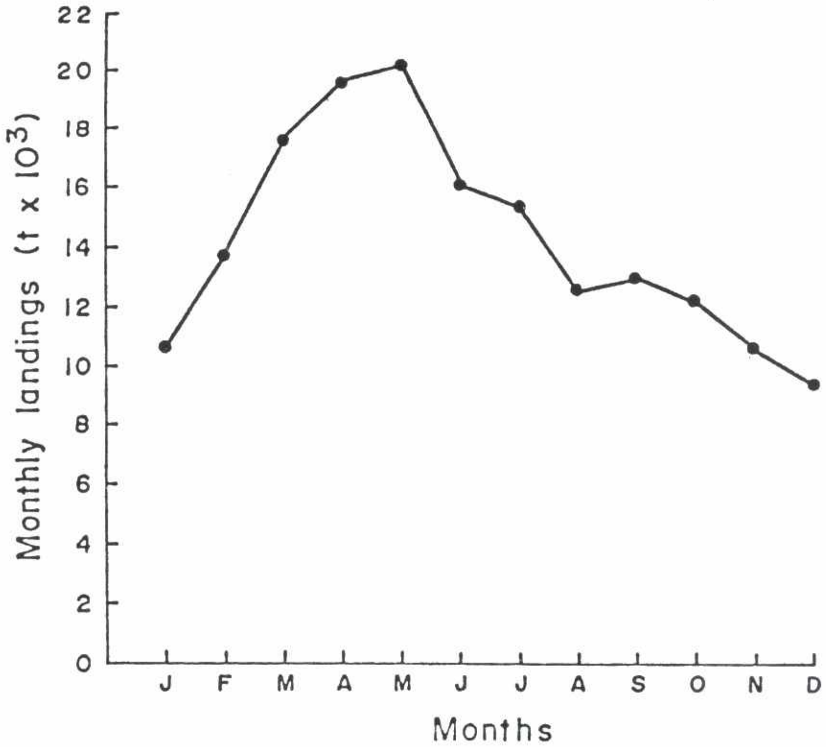

Fig. 2. **Mean monthly landings of all marine fishes at the Navotas Fish Port Complex between 1980 and 1986.**

The point here is that prior to the advent of widespread commercial fishing, the municipal fishing sector was already generating a substantial fishing pressure on Philippine fish stocks. During a census of the Philippines in 1903 (Bureau of Census, 1905), the number of fishermen in the country was estimated at 103,000. This rose to 264,000 people by 1939 and dropped to 141,500 in 1948 (Bureau of Census and Statistics, 1953) undoubtedly due to the effects of the war. Fishing effort was markedly reduced over the war years. Currently, the total number is estimated to be about 1.1 million.

Examining the effects of fishing on Philippine small pelagic stocks is not straightforward. In common with other Southeast Asian fisheries, Philippine small

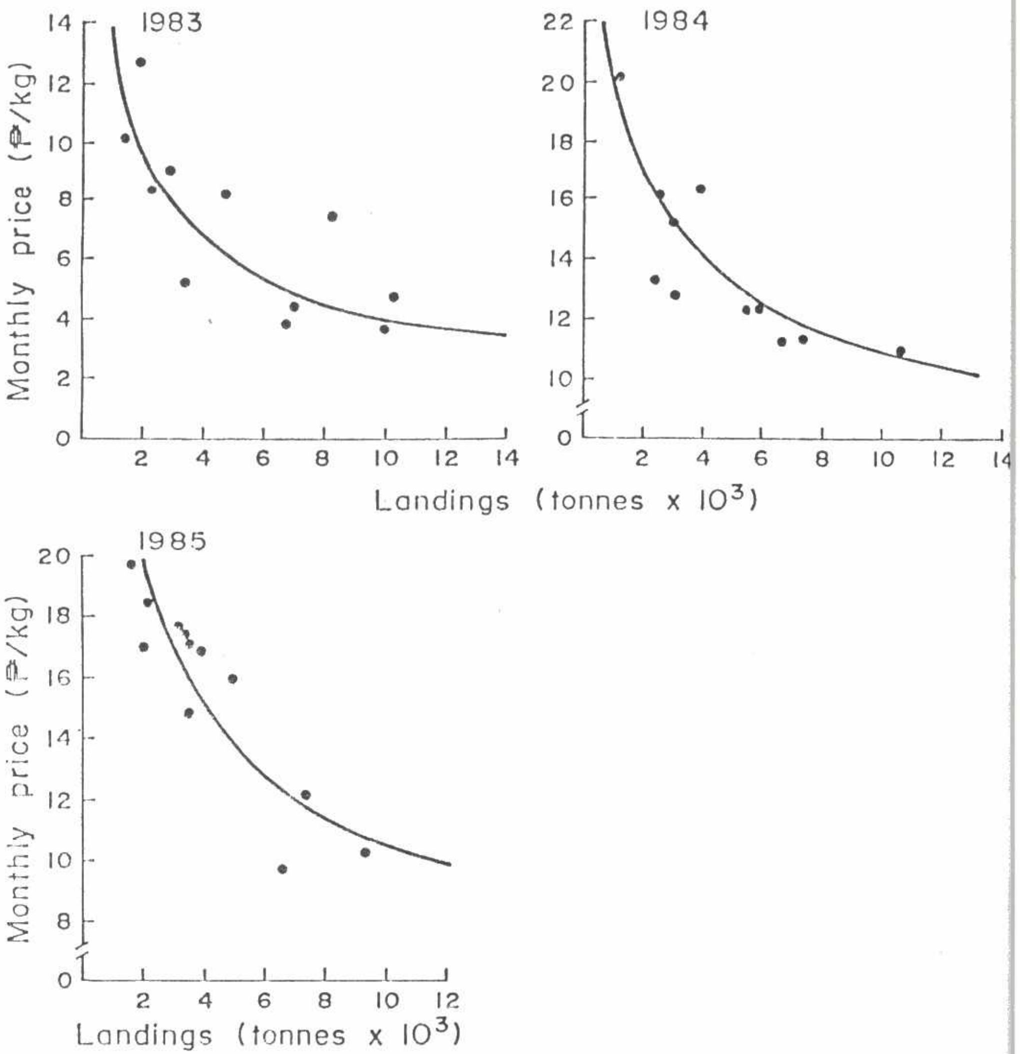

Fig. 3. Mean monthly price versus monthly total landings of roundscads at the Navotas Fish Port Complex, 1983 to 1985.

pelagic fisheries are multigear, multispecies fisheries. Before the effects of fishing can be examined on such fish stocks, it is necesary to compute a standard measure of fishing effort. In some fisheries investigations, the fishing powers of different gears on the same stocks can be measured and compared. This method then permits the conversion of the fishing power of different vessels to a single standard (Brown *et al.*, 1976). This was simply not possible in the short term for the multitude of different gears of various sizes used to capture Philippine small pelagics. Instead, Dalzell *et al.* (1987) proposed the use of adjusted fleet horsepower, where the catch per horsepower of small pelagics by the different fleet of vessels was adjusted to that of commercial purse seiners. An analogous approach was also adopted by Podesta (1987) for Argentinian fishing vessels catching hake (*Merluccius hubbsi*) in the South Atlantic.

The Evidence of Overfishing

Conventional theory of fishing in single species stocks rests on the fact that catch per unit of effort declines as fishing effort increases. The rate of increase of catch with increasing effort declines and the relationship between the two can be described by a parabolic function as was demonstrated by Schaefer (1954). A later modification of the model by Fox (1986) suggested that an asymmetrical curve may give a better fit to catch and effort data. The original model was conceived for single species stocks but variations have been applied successfully to multispecies stocks, mostly in tropical waters (Marten and Polovina, 1982; Ralston and Polovina, 1982; Munro and Williams, 1985).

Dalzell *et al.* (1987) reconstructed a time series of catch and fishing effort data for the Philippine small pelagic fisheries between 1948 and 1985 (Fig. 4). The data show quite clearly how rapidly fishing effort has increased, particularly since the mid 1960s. Catches also increased rapidly from the mid 1960s but did not continue to rise after the early 1970s. The overall trend from 1948 to the present in terms of catch per effort is one of continuing decline. This decline is evident both in the commercial fisheries and municipal fisheries whose catch rates at present are from 10 to 12 times less than those shortly after WW II; in other words, they have declined by one order of magnitude.

The Fox model fitted to the data points of catch and effort for the Philippine small pelagic fishery shows how catches have levelled off and declined somewhat with continued increase of fishing effort (Fig. 5). The points for the years 1981-1985 lie above the predicted yield from the model, due to the fishery taking not only surplus production but also depleting the standing stock biomass. From this model can be seen the consequences of such overfishing. The point of maximum sustainable yield (MSY) on a national basis was achieved during the mid 1970s. Present effort levels are more than double the effort necessary to generate MSY.

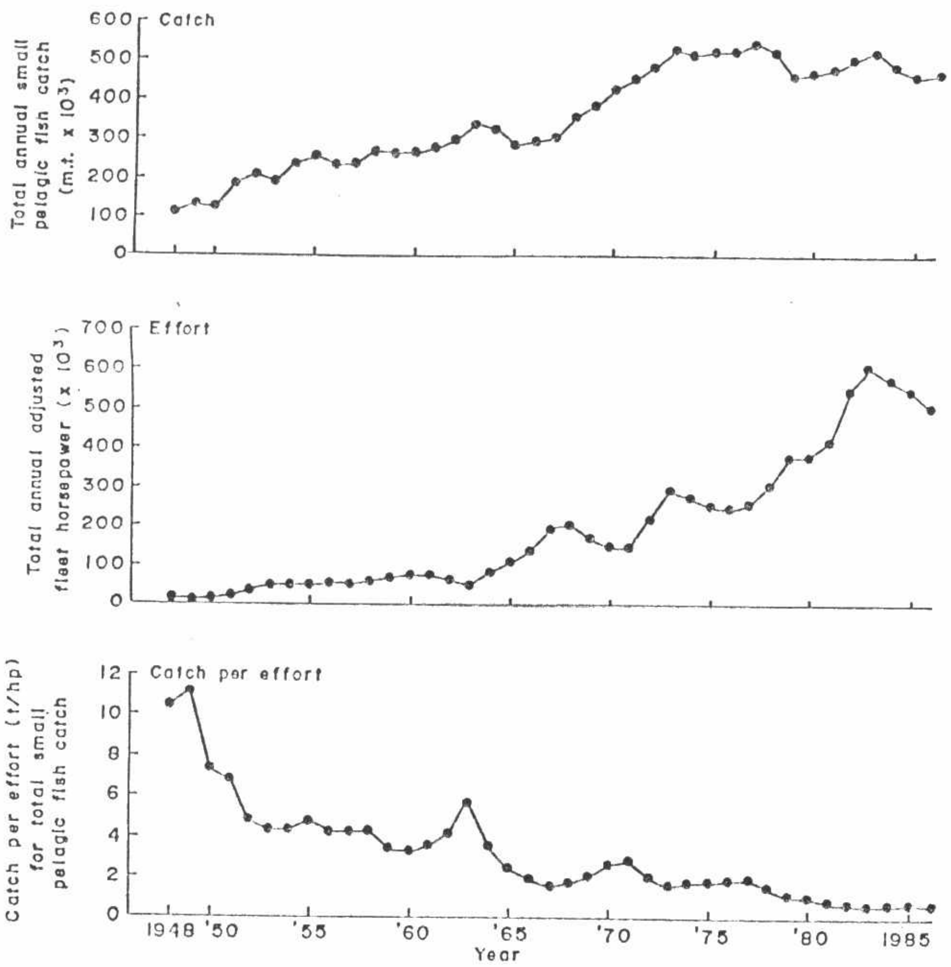

Fig. 4. **Time series of total small pelagic catch, fishing effort and cach per effort, 1948 to 1986.**

By assuming the fishery is at economic equilibrium, the model can be used to estimate the most profitable level of fishing effort for the fishery. If the point of economic equilibrium was achieved during the early 1980s, then a linear cost function could be derived. The difference between this and the yield curve, expressed in monetary units, represents the pure profit on resource rent from the fishery. The point

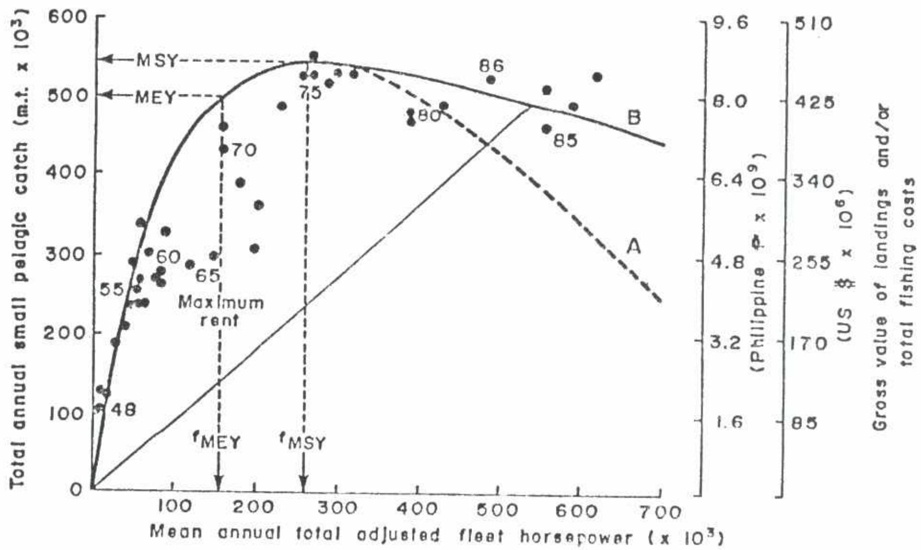

Fig. 5. **Total annual small pelagic catch versus mean annual fleet horsepower. Curve A is the Fox surplus production model fitted by conventional means; Curve B represents another interpretation of the data (see text). The f MEY and MEY are based on the assumption that the fishery achieved economic equilibrium between 1981 and 1985. Equation of the line fitted to the 1948 to 1985 points:**

$$y = x\, e^{1.751 - 3.89310^{-6} x}$$

The 1986 data point was added without recalculating the curve.

of maximum economic yield (MEY) was reached during the mid 1960s with a level of fishing effort that was 35% of the present effort level. Similar observations were made by Nahan (1982) for the demersal trawl fishery off the west coast of Malaysia. The economic rent (total revenue minus total costs including opportunity costs) from the Philippine small pelagic fishery is equivalent to 336,000 tons worth a total of US$250 million. The yield or catch at MEY is about the same as the present day levels of fishing pressure.

The very high levels of fishing effort may also have caused changes in the composition of the small pelagic catch. Data on total landings in the Philippines suggest that stolephorid anchovies have partially replaced roundscads and sardines in the fishery. Certainly by 1986, anchovies were being landed in greater quantities than sardines while roundscad landings between 1975 and 1986 are symptomatic of a gradual decline (Calvelo and Dalzell, 1987; Dalzell, unpub. data). This suggests that certain stocks may be collapsing. This phenomenon of species replacement under intense fishing pressure has also been observed for heavily fished demersal stocks in the Gulf of Thailand (Pauly, 1985) and for sub-tropical and temperate clupeoid fisheries of the Eastern Pacific (Murphy, 1983).

Management

The key issue with Philippine small pelagic fisheries management (and with the country's fisheries in general) is the need for a reduction of fishing effort. The gradual reduction of fishing effort, even by a substantial amount, should not lead to a reduction in small pelagic catch and may in fact lead to a slight increase (Fig. 5). The problem, however, is how and where to reduce fishing effort. Fishing effort might be selectively reduced in different locations by closed seasons or total ban for given periods of time. Such bans have been imposed in the past in the Philippines. Most notable of these is the ban on fishing with trawlers and purse seines within 7 km of the coast throughout the Philippines (Sagun and Bautista, 1982). Selective bans in specific areas have also been used in the past such as the moratorium on fishing in Malampaya Sound, Palawan, from 1973 to 1978.

Fishing bans require policing and enforcement to be effective, as does any piece of restrictive legislation. Unfortunately, such bans are not universally enforced in the Philippines and complaints about intrusions of commercial trawlers into municipal fishing grounds are common in the country. Trawlers, however, are responsible for only 8.3% of the small pelagic catch in the Philippines, although they do catch more small pelagics than ring netters which catch only pelagic species (5.7%). Commercial-sized basnigs or bagnetters which also catch only pelagic species are not covered by any ban and do fish well within municipal waters. This also has led to complaints from municipal fishermen about the decline of catch rates through depletion of stocks by basnigs (Philbrick, 1987).

Closure of fishing grounds should lead to fishermen relocating to other parts of the country where fishing pressures are not as intense. Most of the Philippine fishing grounds, however, are very heavily fished. One possible exception is the eastern Pacific coast of the Philippines. Coastal small pelagic and other fishing in this location is concentrated on the relatively large shelf area between Lamon Bay and Lagonoy Gulf which includes the highly productive San Miguel Bay. The shelf of the rest of the east coast is very narrow and descends very rapidly to great depths. The shelf between Lamon Bay and Lagonoy Gulf is already fished heavily by a variety of demersal and pelagic gears. The lack of suitable fishing grounds on the east coast is compounded by the exposed nature of this region, particularly to the seasonal typhoons (June-December). Thus, the east coast may offer some potential, but it is limited further by lack of fish landing sites and marketing infrastructure at many locations.

The most effective method of reducing fishing effort is to actually reduce fleet sizes and fisherman numbers. In countries such as the Philippines, where so many livelihoods depend on fishing and the population depends on fish as a staple, this is a contentious issue. Unfortunately, some form of intervention by the national and local governments is essential, and action must be taken to preserve stocks. The Philippines has a present population of around 60 million and with an estimated annual growth rate of 2.3% (some authors suggest a figure closer to 3%) (Fallows, 1987). This means that the population will lie somewhere between 78 to 85 million by the year 2000. The weighted mean annual per capita consumption of fish is about 36 kg/yr. If this rate of consumption is to be maintained, then demand for fish by the year 2000 shall range from 2.8 million to 3.0 million tons per year. Present landings have been steady at about 2.0 million tons since 1983, of which about 400,000 tons come from aquaculture.

The increase in production is unlikely to be achieved by increased fishing activity for the reasons outlined previously. The shortfall is also unlikely to be made up, in the near term, by aquacultural production. The figures depend on per capita consumption of fish at present extrapolated to the end of the century. Possible increased meat production may partially replace fish in the diet of Filipinos. However, meat and poultry are almost three times the value of fish and at present, fish account for about two-thirds of the animal protein intake in the Philippines (Table 8). Fish, therefore, is still likely to constitute a major dietary component in the future. Given these predictions, then it is essential to maintain the small pelagic stocks to ensure a widely available source of cheap protein.

Table 8. Percent contribution to animal protein in Philippine diet and price of protein sources.

Animal Protein Source	Price [a] (PHP/kg)	Percent of Animal Protein in Diet [b]
Meat and poultry	50.0	40
Fish	18.0	60

[a] Based on price data for 1986 from the Bureau of Agricultural Statistics.
[b] Based on Gonzales (1985) and FNRI (1984).

Real reductions in the numbers of both commercial fishermen and artisanal fishermen are required. The alternatives are either to actually expand fishing or do nothing or reduce effort (Fig. 6). Expansion of the small pelagic fisheries can be

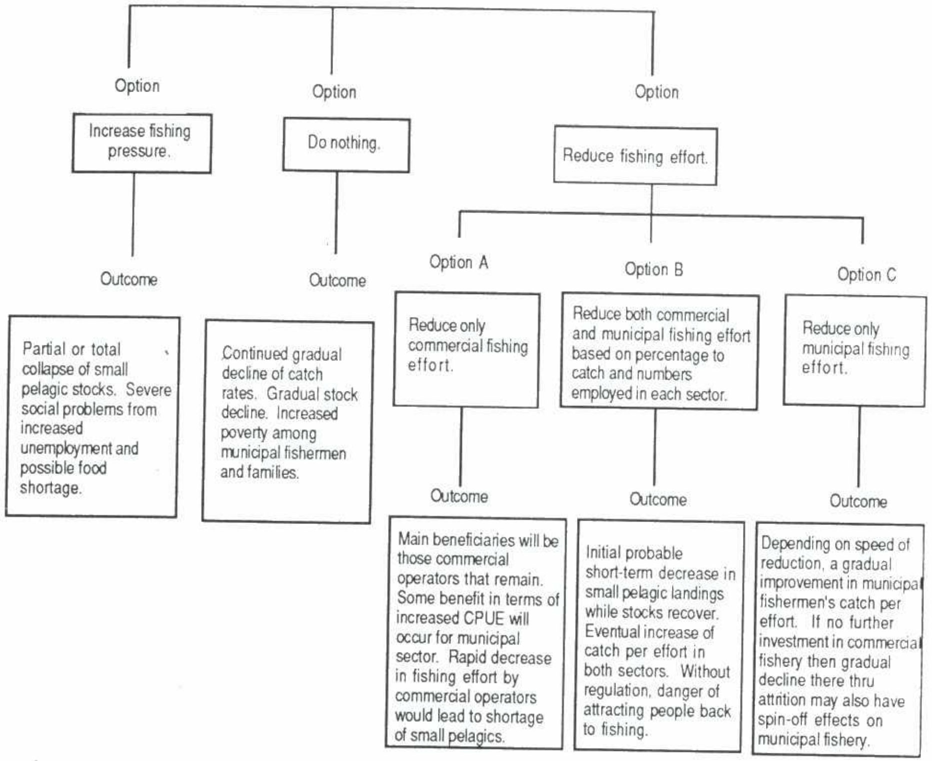

Fig. 6. Management options for Philippine small pelagic fisheries.

regarded as a suicidal option since investments in expansion will not be realized as profit. Fish stocks already under pressure will be depleted further with probable declines in biomass and catch rates. Species composition changes such as the relative increase in anchovy abundance would probably be accelerated. It is important to realize here that partial stock replacement of the small pelagics by stolephorid anchovies should not be construed as necessarily a good thing even though total small pelagic catches have stayed around the same level for the last 15 years in the Philippines. Anchovies have the least value of all the small pelagic fishes other than round herrings. The declining catches of roundscads and sardines are quite evident and suggest that these stocks are currently in a state of slow but steady decline. Should they decline markedly, they would not be totally replaced by anchovies.

The ultimate aim of effort reduction would be to lessen fishing pressure in both the commercial sector and the municipal sector. However, while both sectors make roughly the same catch contribution, the commercial sector comprises only 45,000 fishermen, less than one percent of the entire fishing population of the Philippines. Such a small number of people should be relatively easy to regulate, particularly when their activities are subject to licensing. The present system of licensing commercial fishing vessels in the Philippines is based on gross tonnage of the vessel and is open to anyone. That is, there are no quotas on number of licenses issued each year. Further, license fees are not particularly expensive, amounting at present to between PHP1,000 and PHP5,000, depending on vessel gross tonnage. A first regulatory step would be to put a moratorium on the issue of any further licenses and to increase the license fee.

Another step that can be taken is to reduce the number of licenses issued annually based on non-renewal. If, for example, a fishing operator no longer wishes to continue running a vessel, then the license would not return to a pool but be frozen. Thus, the total number of licenses issued each year should diminish. Recent events in the commercial small pelagic fishery suggest that the number and total adjusted fleet horsepower of the commercial fleet are already beginning to diminish. Both numbers and fleet horsepower declined between 1983 and 1986 by 11.0 and 22.0 percent, respectively.

The reasons for this may be the generally decrepit state of the Philippine commercial fishing fleet. No precise information are available on the average age of commercial fishing vessels in the Philippines, but a reasonable figure would be somewhere between 10 and 20 years based on sampling data from the Small Pelagics Management project. Observations of fishing vessels in general in the Philippines show that these vessels are mostly in a poor state of repair. Replacement costs for a new vessel are high. A new commercial-sized (30 GT) basnig, for example, costs about PHP1 million to build and a new net for such a vessel costs about PHP50,000.

Fishing vessels, like any other commercial maritime boats, are required to undergo an annual sea-worthiness inspection by the Coast Guard. This might also be used to expedite the removal of small pelagic commercial fishing vessels from the fishery. The issuance of sea-worthiness certificates can be enforced more strictly. The fee for such a certificate can be increased to act as discouragement for anyone contemplating to enter the fishery. In a similar manner, the license fee could be increased for the same purpose.

The aim here is not to be construed as victimizing the commercial operators, even though they receive a massively disproportionate share of the value of the catch. Rather, because the commercial operators are relatively few in number, immediate and effective steps can be taken to reduce the level of fishing effort generated by this sector of the fishery. The Government, however, should also resist any calls from the commercial fishing sector for preferential treatment, such as soft loans or reduced vessel import tariffs, if it wishes to modernize the commercial fishing fleet and diminish their number.

Any rapid large-scale withdrawal from fishing by the commercial operators would result in a short-term decline in total landed catch. The small pelagic catch composition of the municipal and commercial fishermen is quite different. Commercial small pelagic fishermen catch mainly roundscads, while the municipal fishery takes predominantly sardines and anchovies. Thus, although some benefits to municipal fishermen would result from a decrease in commercial fishing effort due to overlap of species caught, the main beneficiaries would be those commercial operators who stay in the fishery and experience improved catch rates. For municipal fishermen to continue to make a living out of small pelagics, there has to be a reduction here also in the level of fishing effort. Given the large number of people involved in municipal fishing of any kind and their impoverished condition, regulation and management of this sector are much more difficult.

Some solutions to the overfishing problem can be found within the commercial small pelagic fishery. Solutions to overfishing for the municipal sector are likely to be found outside the fishery. The growth of municipal fishing in general within the Philippines is not only a response to increased demand for fish but also of poverty. Fishing in the municipal sector is not just undertaken for generating revenue but also to feed families. No one knows precisely how many municipal fishermen there are in the Philippines. Dalzell *et al.* (1987) presented the results of census data which suggest exponential growth of the municipal fisherman population. According to their estimates, the number of people involved in fishing for a livelihood at present number about 1,100,000. The growth of the municipal fisherman population has been exacerbated by the poor economic performance in the Philippines, particularly during the mid 1980s. According to one estimate, for example, about 400,000 people were displaced from employment in 1984 (Anon., 1988).

Fox (1986) gave a detailed account of the dynamics of municipal fishing in the eastern Visayan Islands of the Philippines. Although Fox's study was confined to this area, the results are probably pertinent to municipal fisheries in most parts of the country. Quite clearly, there is a close relationship between average catch per effort and density of fisherman on a given coastline. Fox's study was concerned mainly with demersal species, which tend to be more residential than coastal small pelagics. Thus, the study showed that fish stock density increased with depth and distance from shore. This was due to the lower numbers of fishermen who ventured into distant deeper coastal waters due to fuel costs. Most fishermen were concentrated in the zone between 4 and 20 km from the shore, in about 50 m of water.

As Fox pointed out, not all municipal fisheries and those that are near areas of high population density are severely overfished. However, in areas where overfishing is acute, such as Manila Bay, then earnings from fishing may be as little as PHP5/fisherman/day (Callanta, 1988). Reduction of municipal fishing effort, however, cannot be brought about in the same manner discussed for the commercial fishery. In this instance, another approach is essential, namely, that suggested by Smith (1981) to increase opportunity costs for municipal fishermen outside the fishing sector. This is, therefore, not a fisheries specific problem and is related to the level of investment and job creation within the Philippines. Withdrawal of fishermen from municipal fishing would only likely occur if the return for labor is greater in alternative occupations and employment than their usual livelihood. As with the commercial sector, a wholesale reduction in effort should, according to present data, not result in a decreased catch. Rather, the catch per effort of those remaining municipal fishermen will increase. There is a danger that increased fishermen revenues might attract people back into the fishery. This might be dealt with by educating fishing community children away from fishing and establishing greater control of fishing grounds by the fishermen themselves.

The problems dealt with here, however, are social in nature rather than directly related to the municipal fishing sector. People are forced into small-scale fishing for small pelagics and other species by poverty rather than desire. Obviously, in certain areas, there is a tradition of fishing. However, studies by Smith *et al.* (1980) and Smith *et al.* (1983) showed that among municipal fishermen surveyed in the Philippines, about half would be willing to change occupation. Occupations would only be changed if there are other employment alternatives that offer more money and security than fishing. Such a situation would only arise if money is invested in the country, especially outside the capital, Manila.

Institutional Strengthening

Small pelagic fisheries are only one aspect of fisheries production in the Philippines. Discussion of institutional strengthening cannot simply consider these fisheries alone. As such, the following remarks are directed at Philippine fisheries as a whole.

The Philippines has a considerable body of fisheries legislation designed to conserve stocks and regulate fishing activities. Some, such as the ban on purposefully catching large wild milkfish, are promulgated to conserve fish stocks and protect recruitment of larval fish. Other laws, such as the ban on commercial trawlers and purse seiners of ≥ 3 GT in waters within 7 km of the coast, have also been legislated to protect stocks and municipal fishermen's livelihoods. In the latter case, as Pauly (1982) pointed out, the 3 GT classification between commercial vessels and municipal vessels is purely arbitrary and was only made for defining commercial fishing for taxation and licensing. This has now been drafted onto a piece of conservation legislation without considering that large fleet of small trawlers under 3 GT operating in the coastal zone may generate very high fishing mortalities. Pauly (1982) suggested that the differences between municipal and commercial vessels be re-defined, perhaps by a threshold as low as 1 GT.

Despite the need and ability to draft suitable laws and regulations, the power of legislation lies in effective policing. In a country such as the Philippines with an extensive coastline, policing problems are difficult. They are exacerbated by an undermanned, underbudgeted Coast Guard for whom fisheries are just one of a number of responsibilities, such as vessel surveys, immigration and customs matters. Further, the Filipino fishermen do face the very real threat of piracy, in certain parts of the country, due partially to the weaknesses of maritime policing in coastal waters. Theft of vessels and engines is a major loss to small-scale fishermen already faced with limited catches.

Presently, the Bureau of Fisheries and Aquatic Resources (BFAR) is contained within the Department of Agriculture (DA). Its function is now as a staff bureau, meaning that all BFAR activities and assets are confined to Manila. Within the DA regional offices, there appears to be no specific personnel infrastructure to deal with fisheries matters. As such, the attention to fisheries matters at a regional level, where it needs to be the most concentrated, is very varied between regions. This attitude towards fisheries in general appears to be pervasive at different echelons of government and is strange to comprehend, given that fish production is of paramount importance, both socially and economically. Admittedly, agriculture is a greater contributor to the GNP with a mean value between 1982 and 1986 of PHP61 B (US$3 B). However, the largest fraction of this was the most important crop, i.e., rice, at PHP18 B (US$ 0.9 B). Fisheries production amounted to PHP25 B (US$1.25 B) yet apparently, this does not justify recognition of this commodity's need for greater institutional strengthening.

Perhaps because of this, there has been recently considerable political activity to separate BFAR from DA to form a Fisheries Department. This plan and the background to it are outlined in Anon. (1988). Whether or not a separate Fisheries Department is created, the regional position of fisheries administration should be strengthened. That is, BFAR (or some future permutation) should have greater regional presence and powers. Each administrative region of the country has distinct and unique characteristics, including their fisheries. Regulation following attempts to lessen fishing effort must be at a community and regional basis. This is especially apt for small-scale fishermen exploiting fish stocks within their immediate environs since they are already the de-facto owners of the resource. Greater recognition must be given to this ownership, along with the responsibility to manage the resource.

Presently, decisions regarding regional fisheries legislation are either implemented through a bill passed by Congress and approved by the President or through a Fisheries Administrative Order signed by the Secretary of Agriculture. There should be no need for implementation of important legislation to be processed through bureaucratic channels, remote from the area of concern. If, as discussed earlier, fishing effort can be made to decline by the displacement of fishermen from both sectors, then there would be a need to regulate fishermen numbers and control new entries to the fisheries. Such effective control can only come from within the two sectors of the fishing industry. There would also be a need to review fishery and biological data with the intent of advising on such matters as mesh size regulations. Implementation of such regulations need not be the concern of a top heavy, centralized bureaucracy but could be dealt with by the BFAR or equivalent agency at the regional and sub-regional level. The central departmental authority would suggest guidelines for management regulation and perhaps act as arbiter in the case of inter-regional conflicts between fishermen.

REFERENCES

Anon. 1988. A survey of the Philippines. *The Economist* 307(7549): 1-18.

BFAR. 1986-87. Fisheries Statistics of the Philippines, Vol. 36. Bureau of Fisheries and Aquatic Resources (BFAR), Manila. 540 p.

Blair, E.H. and J.A. Robertson. 1973. The Philippine Islands, 1493-1898: exploration by early navigators, description of the islands and their peoples, their history and records of the Catholic mission as related in contemporaneous books and manuscripts showing the political, economic, commercial and religious conditions of those islands from their earliest relations with European nations to the beginning of the 19th century; translated from the original/edited and annotated by E.H. Blair and J.A. Robertson: with historical introduction and additional notes by E.G. Bourne; with maps, portraits and other illustrations. Cachos Hermanos, Inc., Mandaluyong, Rizal. 19 vols.

Brown, B.E., J.A. Brenan, M.D. Grosslier, E.G. Heyerdahl and R.C. Hennemuth. 1976. The effect of fishing on the marine finfish biomass in the Northwest Atlantic from the Gulf of Maine to Cape Halteras. *Int. Comm. Northwest Atl. Fish. Res. Bull.* 12:49-68.

Bureau of Census. 1905. Census of the Philippine Islands: 1903. Vol. IV. Agricultural, Social and Industrial Statistics. Washington.

Bureau of Census and Statistics. 1953. Census of the Philippines: 1948. Vol. IV. Economic Census Report.

Callanta, R.S. 1988. Poverty: The Philippine Scenario. Bookmark, Makati, Philippines: 145 p.

Calvelo, R. and P. Dalzell. 1987. A review of the recent status of exploited stocks of roundscads in the Philippines. Indo-Pacific Fishery Commission 1987 Symposium, Darwin, Australia, 16-19 Feb. Information Pap. 9: 27 p.

Canuela, P.S., E.S. Abaya and C. Gastador. 1987. Fishing Boat. BFAR, Fisheries Extension Series No. 11: 63 p.

Dalzell, P. and A.D. Lewis. 1988. Fisheries for small pelagics in the Pacific Islands and their potential yields. Presented at the South Pacific Commission Workshop on Inshore Fishery Resources, 14-25/3/88, SPC Inshore Fish. Res./WP9: 44 pp.

Dalzell, P. and D. Pauly. 1987. Assessment of the fish resources of Southeast Asia with emphasis on the Banda and Arafura Seas. Presented at the Snellius II Symposium, 23-29 November 1987, Jakarta, Indonesia. (in press).

Dalzell, P. and R. Ganaden. 1987a. The status of Philippine small pelagic fish stocks. Presented at the National Conference on Fisheries Planning and Policy, 16-20/3/87, Baguio, Philippines. Mimeo, pag. var.

_______ . 1987b. A review of the fisheries for small pelagic fishes in Philippine waters. BFAR, *Tech. Pap. Ser.*, 10(1): 58 p.

Dalzell, P., P. Corpuz, R. Ganaden, and D. Pauly. 1987. Estimation of maximum sustainable yield and maximum economic rent from the Philippine small pelagic fisheries. BFAR. *Tech. Pap. Ser.*, 10(3): 23 p.

Fallows, J. 1987. A damaged culture. *The Atlantic Monthly*, November 1987: 49-58

Fox, P. 1986. A manual of rapid appraisal techniques for Philippine coastal fisheries. BFAR, Research Division: 43 p.

Gonzales, L.A. 1985. Philippine tilapia marketing in the context of a structural demand for protein: a comment. *In:* I.R. Smith, E.B. Torres and E.O. Tan (eds.), Philippine Tilapia Economics. *ICLARM Conference Proceedings* 12. Philippine Council for Agriculture and Resources Research and Development (PCARRD), Los Baños, Laguna and International Center for Living Aquatic Resources Management (ICLARM), Manila, Philippines.

Guevara, G. 1978. Status and prospects of the fish processing industry in the Philippines. Proc. Indo-Pac. Fish Comm. 18th Session, Manila, Philippines, Section III: Symposium on Fish Utilization, Technology and Marketing in the IPTC Region: 23-37.

_______. 1987. The fish processing industry in the Philippines: status, problems and prospects. Presented at the National Conference on Fisheries Planning and Policy, 16-20/3/1987, Baguio, Philippines. Mimeo pag. var.

Gulland, J.A. 1983. Fish stock assessment, a manual of basic methods. FAO/Wiley Series on Food and Agriculture. John Wiley & Sons, New York. 223 p.

Jabat, M. and P. Dalzell. 1988. Preliminary stock assessment of the Danao ring net fishery for bullet tunas and small pelagic fishes in the Camotes Sea, Central Visayas, Philippines. BFAR, *Tech. Pap. Ser.*, 11(1): 34 p.

Librero, A.R. 1985. Marketing system for fish in the Philippines. *In:* T. Punyotou (ed.), Small-scale fisheries in Asia: socio-economic analysis and policy. IDRC-229e. Canada. pp. 197-204.

Marten, G.C. and J.J. Polovina. 1982. A comparative study of fish yields from various ecosystems, pp. 255-289. *In:* Pauly, D. and G.I. Murphy (eds.), Theory and management of tropical fisheries. *ICLARM Conference Proceedings* 9, 360 p. ICLARM, Manila, Philippines.

Martin, C. 1938. The flyingfish industry of the northwestern and southwestern coasts of Cebu. *Philipp. J. Sci.* 67(2): 177-187.

Munro, J.L. and D.M. Williams. 1985. Assessment and management of coral reel fisheries: biological, environmental and socio-economic aspects. Proc. 5th Int. Coral Reef Congr., Tahiti, 1985, Vol. 4: 545-581.

Murdy, E.O. The commercial harvesting of tuna attracting payaos: a possible boon for small-scale fishermen. *ICLARM Newsl.* 3(1): 10-13.

Murphy, G.I. 1973. Clupeoid fishes under exploitation with special reference to the Peruvian anchovy. University of Hawaii, Hawaii Institute of Marine Biology, Tech. Rep. 30: 73 p.

Nahan, M.D. 1982. Bionomic investigation of the Malaysian large-scale fishing sector: a case study of Kilak/Perlis. Ph.D. thesis, Australian National University, Canberra. 238 p.

NEDA. 1987. Philippine Statistical Yearbook. 1987. National Economic and Development Authority, Manila. 717 p.

Pauly, D. 1982. History and status of the San Miguel Bay fisheries. *In:* D. Pauly and A.N. Mines (eds.), Small-scale fisheries of San Miguel Bay, Philippines: biology and stock assessment. *ICLARM Tech. Rep.* 7: 124 p. Institute of Fisheries Development and Research (IFDR), College of Fisheries, University of the Philippines in the Visayas, Iloilo City, Philippines: ICLARM, Manila, Philippines and the United Nations University, Tokyo, Japan.

_______ . 1985. The population dynamics of short-lived species, with emphasis on squids. NAPO Scientific Council Studies No. 9, pp. 143-154.

Philbrick, C. 1987. Analysis of the commercial fishery of the Central Philippine province of Marinduque. Master's thesis, University of Rhode Island. 138 p.

Philipp. J. Fish. (1991)22: 29-37.

DETECTION OF INDICATOR ORGANISMS IN FAECAL CONTAMINATION USING THE API 20E SYSTEM AND CONVENTIONAL METHOD

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ABSTRACT

A study was carried out on shellfishes using the API (Analytical Profile Index) 20E system and the conventional method of detecting indicator organisms in faecal contamination. Results showed that the API 20E system is accurate, faster and easier to use than the conventional method. The API 20E system is a standardized, miniaturized version of conventional procedures for identification of Enterobacteriaceae and other gram-negative bacteria. It requires only 24 hours to detect the microflora present in the products. The conventional method, on the other hand, is laborious and time-consuming, requiring in most cases five days, and also subject to inaccuracies due to culture contamination.

INTRODUCTION

Shellfishes are filter feeders and, in the process of filtering large volume of water, they collect and concentrate the microorganisms present in the water. If these animals are thoroughly cooked and the microorganisms present are killed, health hazards would be lessened. However, in many Asian countries where shellfish, especially oysters, are eaten raw, the microorganisms present in aquatic animals become a potential health hazard.

In the Philippines, where large quantities of shellfish, especially oysters and mussels, are harvested from areas near highly populated places, health hazards from shellfish consumption are high. Bacterial infection and intoxication, due to ingestion of raw or insufficiently cooked contaminated shellfish, have been found as the causative agents of gastroenteritis, typhoid and paratyphoid diseases.

This study was undertaken to detect the indicator organisms in faecal contamination of some species of shellfishes.

MATERIALS AND METHODS

The study was conducted in 1989 using samples of oysters, mussels, surf clams, shrimps and crabs collected from Binakayan, Cavite; Pangasinan; Farmer's Market; Muñoz Market; and from a fish processing plant in Metro Manila.

The API 20E system (Aldridge and Hodges, 1981) and the conventional method (American Public Health, 1970) were both used to detect the indicator organisms in faecal contamination of the samples.

The API 20E system consists of microtubes containing dehydrated susbstrates. These susbstrates are reconstituted by adding a bacterial suspension, incubated so that the organisms react with the contents of the tubes and read when the various indicator systems are affected by the metabolites or added reagents, generally after 18-24 hours incubation at 35°C-37°C.

The conventional method consists of tubes incubated for 24 to 48 hours at 44°C and streaking positive *Escheridia coli* tubes onto eosin methylene blue agar and confirming by a series of biochemical tests such as indole, methyl red, Voges-Proskauer and citrate.

RESULTS AND DISCUSSION

Results of the biochemical tests for the presence of Family Enterobacteriaceae using the API 20E system are shown in Tables 1 to 4. Oyster samples taken from the Farmer's Market and Pangasinan were found positive of *E. coli* and *Salmonella* sp., while those from Cavite were found positive of *Enterobacter aerogenes* and *Serratia liquifaciens* (Table 1). Mussel samples from the Farmer's Market and Cavite were both found to be positive of *E. coli* (Table 2). Shrimp samples taken from a fish processing plant and the Farmer's Market were all found positive of *E. coli*. In addition to *E. coli*, *Kluvera* sp. was found in samples of pink shrimps, while *Citrobacter freundii* was found in the tiger shrimps (Table 3). Samples of surf clams taken from Muñoz Market were found positive of *Shigella* sp. (Table 4).

Table 5 summarizes the results for the various species of shellfish using the API 20E system, including that for the mud crab and blue crab samples taken from the Farmer's Market which were found positive of *E. coli* and *C. freundii*. All samples taken from the markets were negative for oxidase test.

Results of the biochemical tests for the presence of Family Enterobacteriaceae using the conventional method showed the presence of *E. coli* in all samples (Table 6).

The API 20E system allows the rapid detection of indicator organisms particularly during the outbreak of foodborne diseases. Isolates were identified using this method (Analytab Products, 1980) which requires only 24 hours to detect the microflora present in the products and there is a great recovery of injured cells. It provides an adjunct for species identification.

Robertson and MacLowry (1974) applied a computer diagnostic model to estimate the relative accuracy of the various identifications included in the API data set. They confirmed that the API is accurate in identifying 99.4% of the isolates listed.

Table 1. Results of the biochemical test on oyster samples, using API 20E system, for the presence of Family Enterobacteriaceae. (Incubation period: 24 hours at 37°C.)

	Source of Samples		
Biochemical Test	Farmer's Market	Cavite	Pangasinan
ONPG	+	+	–
Arginine Dihyrolase	–	–	–
Lysine decarboxylase	–	+	+
Orinithine decarboxylase	–	+	+
Citrate	–	+	–
Hydrogen sulfide	–	–	–
Urease	–	+	–
Tryphtophane deaminase	–	–	–
Indole	–	–	+
Voges Proskauer	–	+	–
Gelatinase	–	–	–
Glucose	+	+	+
Mannitol	+	+	+
Innositol	–	+	–
Sorbitol	–	+	+
Rhamnose	–	+	+
Saccharose	+	+	–
Mellibiose	–	+	+
Amygdalin	–	+	–
Arabinose	+	+	+

Farmer's Market samples : (+) *E. coli* -- Acceptable identification
Cavite samples : (+) *Enterobacter aerogenes* and *Serratia liquifaciens*
Pangasinan samples : (+) *E. coli* and *Salmonella* sp. -- Acceptable identification

Table 2. Results of the biochemical test on mussel samples, using API 20E system, for the presence of Family Enterobacteriaceae. (Incubation period: 24 hours at 37°C.)

Biochemical Test	Source of Samples: Farmer's Market	Source of Samples: Cavite
ONPG	+	+
Arginine Dihyrolase	+	–
Lysine decarboxylase	+	+
Orinithine decarboxylase	–	–
Citrate	–	–
Hydrogen sulfide	–	–
Urease	–	–
Tryphtophane deaminase	–	–
Indole	+	+
Voges Proskauer	–	–
Gelatinase	–	–
Glucose	+	+
Mannitol	+	+
Innositol	–	+
Sorbitol	+	+
Rhamnose	+	+
Saccharose	+	+
Mellibiose	+	+
Amygdalin	–	+
Arabinose	+	+

Farmer's Market samples : (+) *E. coli* -- Excellent identification
Cavite samples : (+) *E. coli* -- Very good identification

Table 3. Results of the biochemical test on chilled shrimp samples, using API 20E system, for the presence of Family Enterobacteriaceae. (Incubation period: 24 hours at 37°C.)

Biochemical Test	Samples: Pink Shrimp	Samples: Tiger Shrimp	Samples: White Shrimp
ONPG	+	–	–
Arginine Dihyrolase	–	–	–
Lysine decarboxylase	–	–	–
Orinithine decarboxylase	–	–	–
Citrate	–	–	–
Hydrogen sulfide	–	+	–
Urease	–	–	–
Tryphtophane deaminase	–	–	–
Indole	+	–	+
Voges Proskauer	–	–	–
Gelatinase	–	–	–
Glucose	+	+	–
Mannitol	+	+	+
Innositol	–	–	–
Sorbitol	+	+	+
Rhamnose	+	+	–
Saccharose	–	+	+
Mellibiose	+	+	–
Amygdalin	–	–	–
Arabinose	+	+	–

Pink shrimp : (+) *E. coli* and *Kluvera* sp. -- Excellent identification
Tiger shrimp : (+) *E. coli* and *C. freundii* -- Excellent identification
White shrimp : (+) *E. coli* -- Excellent identification

Table 4. Results of the biochemical test on surf clam samples, using API 20E system, for the presence of Family Enterobacteriaceae.

Biochemical Test	Result
ONPG	–
Arginine Dihyrolase	–
Lysine decarboxylase	–
Orinithine decarboxylase	–
Citrate	–
Hydrogen sulfide	–
Urease	–
Tryphtophane deaminase	–
Indole	–
Voges Proskauer	–
Gelatinase	–
Glucose	+
Mannitol	+
Innositol	–
Sorbitol	+
Rhamnose	–
Saccharose	–
Mellibiose	–
Amygdalin	–
Arabinose	+

(+) *Shigella* sp.

Table 5. Summary of results for various species of shellfish using the API 20E system.

Sample	Source	Microorganisms
Oyster	Farmer's Market	*E. coli*
Oyster	Cavite Market	Enterobacteriaceae
Oyster	Pangasinan	*E. coli* and *Salmonella* sp.
Mussel	Farmer's Market	*E. coli*
Mussel	Cavite	*E. coli*
Pink shrimp	Fish Processing Establishment Metro Manila	*E. coli* and *Kluvera* sp.
Tiger shrimp	-- do --	*E. coli* and *C. freundii*
White shrimp	-- do --	*E. coli*
-- do --	Farmer's Market	*E. coli*
Surf clam	Muñoz Market	*Shigella* sp.
Mud crab and Blue crab	Farmer's Market	*E. coli* and *C. freundii*

Based on the results of the study, it is suggested that the API 20E system be adopted, especially on bacteriological examination of fishery products for export in which time element is always a constraint. Cost-wise, the method is not expensive, considering the costs of manpower, chemicals and time consumed in the analysis. On the other hand, the conventional method involves the use of different selective and differential media per organism, and is therefore laborious and time-consuming.

Table 6. Results of the biochemical tests for the presence of Family Enterobacteriaceae using the conventional method.

	IMVIC Test				
	Indole	M.R.	V.P.	S.C.	Indicator Organisms
Source: Fish Processing Plant					
Samples:					
Chilled pink shrimps (headless)	+	+	–	–	*E. coli*
	+	+	–	–	
Chilled white shrimps (headless)	+	+	–	+	Intermediates
	–	+	–	–	*E. coli*
Chilled tiger shrimps (headless)	+	+	–	–	
	–	+	–	–	
	–	+	–	–	*E. coli*
	–	+	–	+	Ent.
Source: Farmer's Market					
Samples:					
White shrimps	+	+	–	–	
	–	+	–	–	*E. coli*
Surf clam	+	+	–	–	
	+	+	–	–	*E. coli*
	+	+	–	+	Intermediates
Source: Pangasinan					
Samples:					
Oysters	+	+	–	–	
	+	+	–	–	*E. coli*
	+	+	–	–	
Source: Cavite					
Samples:					
Oysters	+	+	–	+	Intermediates
	+	+	–	–	
Mussels	+	+	–	–	*E. coli*
	+	+	–	+	Intermediates
	+	+	–	–	*E. coli*
	+	+	–	+	Intermediates

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REFERENCES

Aldridge, K.E., B.B. Gardner, S.J. Clark, and J.M. Matsen. 1978. Comparison of Micro-ID, API 20E, and conventional media system in identification of Enterobacteriaceae. *J. Clin. Microbiol.* 7:507-513.

Aldridge, K.E., and R.L. Hodges. 1981. Correlation studies of Entero-Set 20, API 20E, and conventional media systems for Enterobacteriaceae identification. *J. Clin. Microbiol.* 13:120-125.

American Public Health. 1970. Recommended procedures for the examination of sea water and shellfish. 4th ed. American Public Health Association, Washington, D.C.

Analytab Products. 1980. The analytical profile index. Analytab Products, Plainview, New York.

Palumbo, S.A., F.O. Maxino, A.C. Williams, R.D. Buchanan, and D.W. Thayer. 1985. Starch-ampicillin agar for the quantitative detection of *Aeromonas hydrophila*. *J. Appl. Environ. Microbiol.* 50(4):1027-1030.

Robertson, E.A. and J.D. MacLowry. 1974. Mathematical analysis of the API Enteric 20 profile register using a computer diagnostic model. *Appl. Microbiol.* 28:691-695.