A FEASIBILITY STUDY OF THE FISHERIES RESOURCES OF THE MURIK LAKES AREA AND RECOMMENDATIONS FOR DEVELOPMENT

by

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2.0 FOREWORD

This original objectives of the Murik Lakes study were to compile a series of very detailed reports about the various fisheries and resources of this region. These individual reports were to be published together with an overall summary paper which is the basis of this present paper. Sadly, this ambitious objective was never realised and only drafts of the crab resources paper and the overall summary paper were completed in 1986. Since that time several of the personnel involved in the study have either left Papua New Guinea or become involved in other work. The other individual reports are thus unlikely to be produced.

The value of the Murik Lakes study is not just limited to one area of the East Sepik Province but is relevant to the development of estuarine resources in the rest of PNG. For this reason the South Pacific Commission's Fisheries Programme was asked to assist in producing a final draft of the summary paper for the Department of Fisheries and Marine Resources technical paper series.

The major problem with completing this work was the time elapsed since the resource survey was carried out and the final publication of the results. The figures on costs in this paper are those from 1985 and should be inflated to 1991 levels through the cost of living index. Some of the infrastructure discussed in the report has changed in the intervening period, however, change in PNG is usually slow and much of what is contained here is still relevant. The lack of detailed reports on each resource meant that it was sometimes difficult to check the validity of the data contained in the report, however, every effort was made to ensure that the information was correct.

3.0 EXECUTIVE SUMMARY

This report contains a summary of the results of a three month fisheries resources survey in the estuarine Murik Lakes region of the East Sepik Province of Papua New Guinea. A estimated total population of about 1500 people live in the Murik Lakes and maintained largely by subsistence harvests of fish and other organisms. Limited employment opportunities and severe land shortages have focused development initiatives on increasing commercial production of fish, crabs and molluscs.

Fish and other marine organisms are the main source of animal protein for the Murik Lakes villagers and average annual per capita consumption of fish (53.5 kg), crabs (16.6 kg) and molluscs (3.9 kg) amounts to 74 kg. Observations were made on the catch rates of men and women fishermen involved in gillnetting, handlining and collecting crabs and molluscs. Fishing trials were also carried out to assess the commercial potential of prawn trawling in the coastal waters adjacent to the Murik Lakes. The potential for trawling with a small scale beam trawl within the lagoons of the Murik Lakes was also assessed.

Estimates were made of the potential yields above subsistence harvests for finfish, crabs and molluscs. The total standing stock of mudcrabs in the Murik Lakes was estimated to be 108t of which 18t is harvested annually for subsistence use by the Murik Lakes people. Based on empirical methods and comparisons with stocks from elsewhere the potential yield of mudcrabs from the Murik Lakes was thought to lie within the range of 40 to 134 t/yr Commercial harvests could be increased but initial harvests should be modest and accurately monitored given the

nutritional importance of mudcrabs to the Murik Lakes villagers.

Based on catch rates and maximum fishing activity by villagers then it was thought that the annual potential finfish yield of the Murik Lakes was about 360 t/yr or a yield of about 40 kg/ha of lagoon. No information is available on the sustainability of the finfish resource; current subsistence catch is estimated at about 67 t/yr. Increase of the finfish catch for commercial sales should proceed cautiously with continuous monitoring for changes in catch rates and catch composition. Mollusc harvests were concerned mainly with the mudclams and to a lesser extent mangrove oysters. Present subsistence harvests are estimated to be about 5 t/yr, whilst theoretical yields of 95.5 t/yr were computed from the resource survey observations.

As with the other resources great stress is placed on the fact that yield estimates for molluscs are probably inflated due to excessive fishing effort to take advantage of ready cash from the survey collection vessel. Further unlike many other coastal communities in PNG the Murik Lakes people rely mainly on fresh fisheries produce for their animal protein intake and thus any commercial fishing for any or all the resources discussed here must proceed mindful of the need to safeguard subsistence harvests.

Average catches of prawns by commercial scale trawling amounted to 3.0 kg/hr for prawns and 28.2 kg/hr for fish. The average catch rate of trawlers in the Gulf of Papua is about 15 kg/hr. The prawn resource of the Sepik Delta region does not appear to be abundant enough to support commercial fishing. Similarly, the catch rates of the small beam trawl inside (0.12 kg/hr) and outside the Murik Lakes (0.87 kg/hr) were not encouraging and suggest that the potential for such a fishery is severely limited.

The costs of different methods of transporting fish to and from the WAMA MARINE processing plant in Wewak were investigated. The most economical method of transporting fish to Wewak was in an 8.5m collection vessel with a 5 t icebox. Transporting fish by large canoes was shown to incur a higher unit cost per kilo for bringing the fish to Wewak. Further, canoe transport would not be possible for up to five months of the year due to bad weather and rough seas. The most desirable method of transport to Wewak was by road but this would require major upgrading of the roads to the Murik Lakes region and of boat channels to pick up points.

The most desirable product for the consumer was fresh iced fish but, given the present fisheries infrastructure, storage of such a product without freezing, would not be possible given commercial levels of production. Transporting frozen fish to other provinces by air was found to be prohibitively expensive but might be partially ameliorated by arranging for planes flying fish to the PNG highlands to return with fresh vegetables. Sea transport on existing commercial vessels is probably the only way to send fish to other coastal provinces not linked by road to the East Sepik. The costs of transporting fish by road to urban centres in the East and West Sepik were favourable, particularly if some form of return load could be arranged after the fish was delivered.

4.0 ACKNOWLEDGEMENTS

The Co-ordinator of the survey extends his gratitude on behalf of the Fisheries Division to the Small-holders Agricultural Development Programme (SADP) for funding the survey and costs of producing this report. Messrs Joel Opnai, Charles Tenakanai, David Miller, Tilly Noweiya and Fisheries Staff for their valuable time in the field carrying out the survey work. Stanley Abola conducted the inland market survey, Dominic Huaiari carried out the Nutrition Survey

and John Kiapin undertook the task of ice production. To the crew of F.R.V. "Melisa", Staff of Fisheries Research at (Wewak) the Provincial Fisheries Officers and the people of Murik lakes, the crews of MV "Yauwiga", who willingly worked around the clock and surviving the constant on onslaught of the north west monsoon, the Division owes you many thanks.

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The Division is grateful to Mr S. Frusher, Mr A. Wright, Mr. P. Lili, Mr. J. Opnai, Mr. C.Tenakanai, Mr.A. Richards and Mr.R. Kuk for providing valuable comments on this work. I am grateful to the Fisheries Programme of the South Pacific Commission and to Mr P.Dalzell for editing and finalising this report. Finally, special thanks to my family for putting up with my continuous absence from home and my escaping the daily share of the domestic chores.

5.0 PROJECT BACKGROUND

The Small Holder Agricultural Development Programme (SADP) was initiated in 1983 to help farmers and fishermen[1] develop their land and marine resources. To qualify for the SADP loans,farmers and fishermen had to form small manageable groups with no less then 10 members. Each group was eligible to apply for the maximum SADP soft loan of K10,000 to be repaid over a 10 year period. The loan repayment interest varied from 5-7%, depending on the prevailing socio-economic conditions of region that requested the loan.

Seventeen fishing units from seven villages in the Murik lakes area of East Sepik Province (ESP) applied for SADP loans through the Department of Primary Industry (DPI) in 1984. The Murik Lakes people sought funds from the SADP scheme to harvest, process and market their fisheries resources. The SADP accepted their loan application in principal and approved a feasibility study to determine the economic realities of developing these resources.

As part of the scheme, a pilot study of the fisheries for mudcrabs, prawns, fish and shellfish in the Murik Lake was initiated. With the successful development of these resources was the potential for increasing cash income earning opportunities and employment in linked industries for Murik lakes residents. Quantifying the socio-economic benefits, resulting from the development of these resources was one of the main terms of reference for this survey.

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[1]. The term fisherman is used generically in this paper to describe both men and women who participate in fishing.

6.0 INTRODUCTION

The Murik Lakes area is situated in the lower Sepik River region of the Angoram District in the East Sepik Province. For the purpose of this project, the Murik Lakes area (Fig 1) covers 7 villages. Big Murik, Darapap, Karau, Mendam, Kopar, Watam and Singarin. The estimated population of the seven villages in 1986 was 1,538 persons. The extensive mangrove and nippa forests make communications with the Murik Lakes difficult and the region is one of the least developed coastal areas in Papua New Guinea. Minor cash income earning opportunities come from basket making and carving. From time to time people receive small cash contributions from relatives working in Wewak and other urban centres.

Marine and estuarine fisheries resources in the Murik Lakes are considered to be plentiful but, because of the isolation of the area from suitable markets they have been exploited only for subsistence purposes. Recently, the introduction of gillnets, monofilament lines and steel hooks has increased the general level of fishing activity in the area.

Recent improvements in land and water transportation have provided the people of the Murik Lakes area access to markets for fisheries produce. Iced fish have been sent to markets in Wewak and Angoram (Fig.2). Towards the end of the 1970's a major fisheries development initiative, The Coastal Fishing Development Plan (Anon 1980) commenced in Papua New Guinea to stimulate greater fisheries production through the provision of an improved services to fishermen in the form of preservation and marketing. On the basis of these catch records, collected between 1978 to 1984, it was clear that the Murik Lakes area had potentially the most valuable sea food resources in the East Sepik Province and was a natural target for such a development programme.

In 1984, Officers from the Resources Development Section of DPI Fisheries Division completed a field trip to Karau and Darapap. A report was submitted to the Fisheries Division in which was recognised the need to develop the marine and estuarine resources of the area. Strong emphasis was placed on mud-crabs and prawns and plans were proposed for local fishermen to harvest these using simple and efficient trawling methods. It was recommended to the Department of Primary Industry that the small-scale harvesting of mudcrabs and prawns would be an acceptable project for funding under the SADP Scheme.

Liaison between the East Sepik Provincial Government and the National Government was initiated to establish the terms of reference for the project. A project proposal titled the "Murik Lakes Development Project" was subsequently submitted by the National Fisheries Division, which contained a project description, the main objectives of the project and the implementation phase. After discussion between the East Sepik Provincial Government and the National Government, it was clear that a detailed resource and feasibility survey of the Murik lakes region was essential prior to the implementation of any development project. The feasibility study was conducted jointly by the East Sepik Provincial DPI and National Fisheries Division[2]. The National Fisheries Division assisted by donating the services of one PNG's Fisheries Research vessels, the FRV "Melisa" as well as funds for her operating costs during the study.

Three Biologist, two Resource Development Officers and staff of the Fisheries Research Laboratory at Wewak were designated to assist in the survey. The East Sepik Provincial

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[2]. In 1986, the Fisheries Division of the Dept of Primary Industry was made into a separate Department with its own Minister and Secretary.

Government allocated the MV "Yauwiga" as a collection vessel for transporting ice and iced fish between Wewak and the project site. Provincial Marine Fisheries (Wewak) supplied manpower, the services of an ice making machine and an 8m catamaran (the 'Akule') to serve as a fishing platform. Wama Marine Products (PTY LTD)[3] offered to buy all the products and were to be responsible for the marketing and processing arrangements as well as undertaking marketing trials.

A working guideline (Appendix 1) was put together and a final public relations exercise was conducted in the Murik Lakes area which finalised survey strategies before the implementation phase stated in January 1985. The survey was planned for 9 weeks but unforeseeable market and storage problems limited the survey to 8 weeks.

7.0 GEOGRAPHICAL DESCRIPTION

For the purpose of this report the Murik Lakes (Fig 1) is the area approximately bounded by latitudes 144°05' and 144°35' East, and, longitudes 3°41' and 5°4' South covering an area of about 1,400 square kilometres. Much of the area is covered by mangrove, nipa palm forest, salt marshes and swamp.

The various water bodies in the Murik Lakes system cover approximately 9,000 hectares while the mangrove area amounts to 18,500 hectares. The Karau Lagoon was chosen as the major sampling site although there also exist other water bodies in the area such as the Watam Lagoon. These two lake areas were considered to be similar in their water movement pattern. High saline water enters the lagoon from the sea through Murik entrance. Darapap Passage and Watam Passage. During the rainy season and flood periods, fresh water from the Sepik River enters Murik Lake through Majop Canal and into the Watam Lake through the Singarin canoe passage. Water circulation in the lake appears to be governed by tidal movements.

There are seven main villages in the area, however the length of time allocated to undertake the survey permitted work to be carried out at only four of the villages; Big Murik, Darapap, Karau and Mendam. The three other villages in and around the Watam Lagoon; Kopar, Watam and Singarin were visited during the survey but not included in the sampling and data collection exercises.

The north coast of Papua New Guinea experiences S.E tradewinds (March-September) and N.W. monsoon (October-February) season each year. During the period when the S.E. tradewinds prevail the weather is generally calm. This allows outboard motor powered outrigger canoes to operate between the Murik Lakes and Wewak. The North-West monsoon however, is associated with very rough conditions which makes it impossible for canoes to travel over the sand bar entrances in and out of the Murik Lakes. Periods of persistently high winds are frequently experienced during this time.

All the seven villages in the lakes are separated by water bodies. Transportation and communications can often be difficult. In order to communicate with the next village, messages and goods are sent by small canoes paddle-powered canoes or large monohull canoes (5-7

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[3]. Wama Marine (PTY LTD) was a commercial fish buying and processing company established by the East Sepik Provincial Government. This company was formally dissolved in 1988 and has not been replaced by any other Provincial Government sponsored buisness.

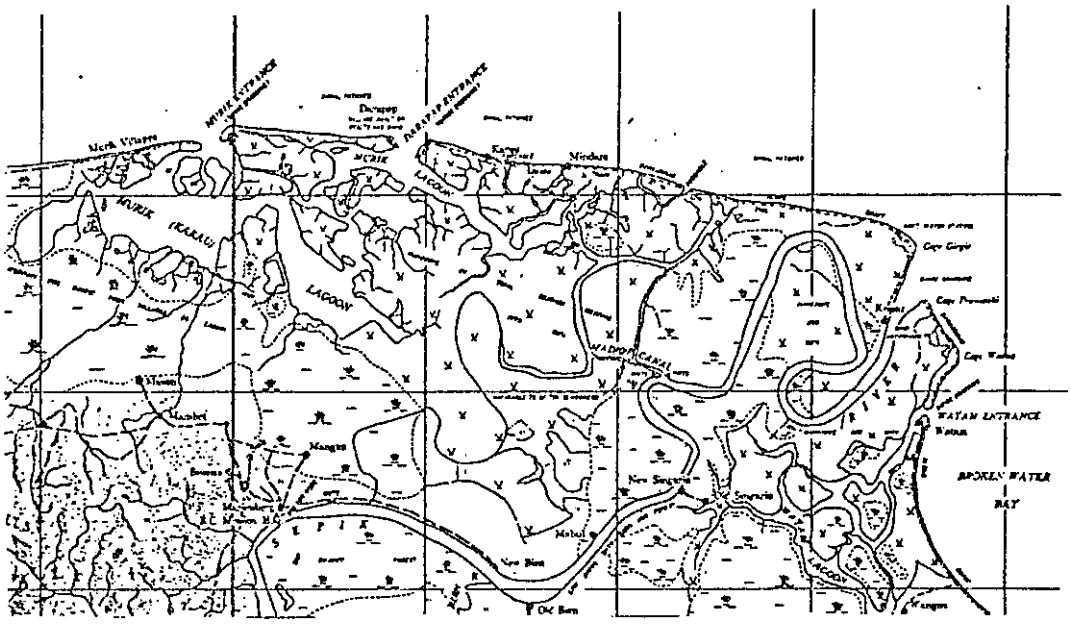

Fig. 1. Map of the Murik Lakes showing places named in the text.

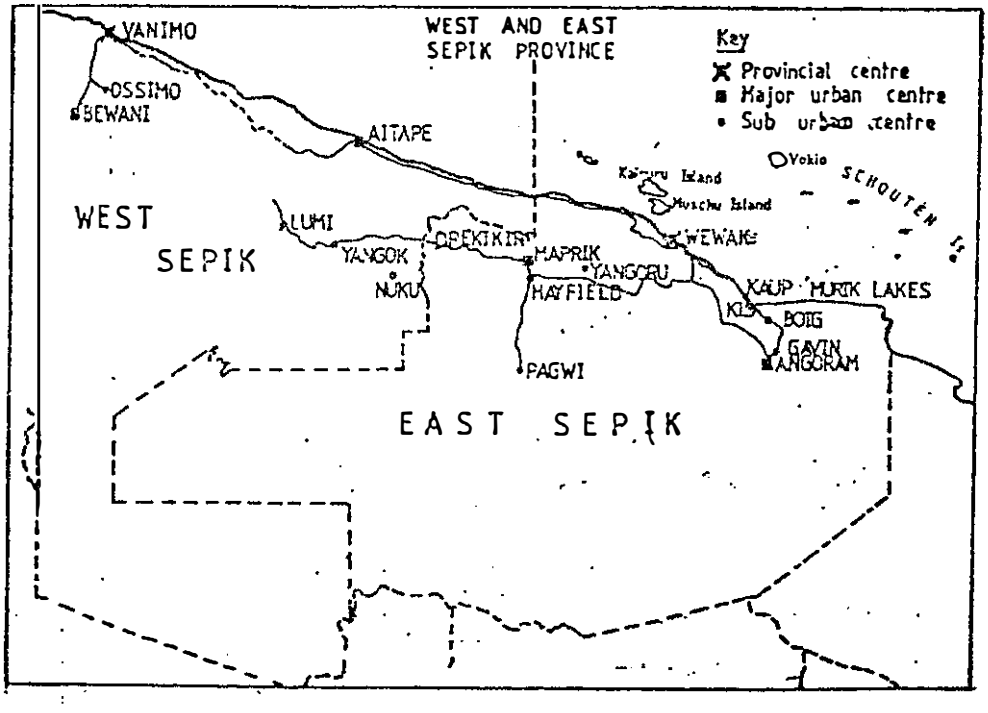

Fig. 2. Map of the East and West Sepik Provinces showing places named in the text.

metres) powered by out-board motors. In order to get to the urban centres villagers travel either up the Sepik River in outboard motor canoes to Angoram) or along the coast to Wewak, some 60 kilometres to the west of the Murik Lakes. The closest road linking Wewak and Angoram to the nearest point in Murik lakes stops at Boig and Kaup (Fig 2).

8.0 HEALTH AND EDUCATION

A major problem in the Murik area is the lack of good drinking water. There is a need to provide villages with community water tanks and train the people to maintain and service them. During the survey period only one medical aid-post was operating at Mendam village. Another aid-post was available at Darapap however there was no medical orderly in attendance. Major health cases were sent to Marienberg, Wewak or handled by village "doctors" who use traditional healing methods.

Educational opportunities are very limited in the area. There are two community schools in the Murik Lakes, one run by the Seventh Day Adventist Mission based at Darapap and a Government school at Karau village. Only a limited number of students can attend, so there are a large number of children and youth, especially at Big Murik and Mendam, who do not have the opportunity to go to school. Most of these children and youths stay at home and fish for a living.

9.0 POPULATION

According to the 1980 census figures the total population for the seven villages was 1,322. The 1985 population projection was based on the 1980 census figure and adjusted by the annual 2.5% population growth figure for the East Sepik Province (Table 1). Frielink (1983) reported that the 18-45 years age group were the potential economically active sector of the total population in PNG. This age group comprises about 33.8% of the PNG coastal population. From the present survey data it was found that 61.2% of the Murik Lakes population were engaged in the artisanal fishery. Of these fishermen, 55.4% were males.

Table 1. Estimated population of the Murik Lakes Villages in 1985

Village	1985 Population (estimated)	% by No
Big Murik	444	28.9
Darapap	275	17.9
Mendam	272	17.7
Karau	126	8.2
Kopar	115	7.5
Watam	171	11.1
Singirin	135	8.8
TOTAL	1538	

During the nutrition sub-project of this survey it was observed that on average 6 persons comprised a nuclear family; using this mean family size it was estimated that 256 families live

in the seven villages. A total of 170 families representing 66.4% of the estimate family groups in the area applied for S.A.D.P. Loan. Table 2 shows population and family structure for each of the 7 villages.

Table 2. The population and family structure for the seven villages in the Murik Lakes

Population and family structure	Big Murik	Darapap	Mendam	Watam	Singarin	Karau	Kopar
Total population	444	275	272	171	135	126	115
Male	241	149	148	93	73	68	63
Female	203	126	124	78	62	58	52
Number of families	89	34	45	29	23	18	19
Average family size	5	8	6	6	6	7	6
No of fishing units requesting loan	6	2	2	2	1	2	2
No of family in one fishing unit	10	10	10	10	10	10	9

10.0 EXISTING EMPLOYMENT OPPORTUNITIES

During the feasibility study the names and number of fishermen who fished and sold catches to the collection vessel were recorded. A mean of 61.2% of the population from 4 villages in the Murik Lakes were employed in the artisanal fishery during the eight week period. The high rate of fishermen engaged in fishing during this period was partly due to school children being home for the Christmas holidays and unemployed youths, who normally resided in Wewak, making themselves available during the survey.

The proportion of the population considered to be economically active fishermen reported during the survey is significantly higher than those reported by Frielink (1983). This high incidence of active fishermen in the Murik Lakes area is a consequence of the lack of alternative sources of income and emphasises the need to develop fisheries as an income opportunity for the people.

11.0 SOCIO-ECONOMIC ASPECTS

Government establishments concerned with the exploitation of fisheries resources normally place emphasis on the biology of fish populations and the requirements for the efficient exploitation and management of these stocks. There is a growing awareness that in developing countries that there is also a need to compliment such information with social and economic studies of the communities involved in the catching and consumption of these resources.

In the coastal and island provinces of Papua New Guinea subsistence and barter fishing is by tradition an integral part of the communal activity of coastal villages. The level of involvement in fishing is influenced by the degree of commitment to alternative agriculture activities. In most coastal areas the tending of gardens and plantations takes precedence over fishing. Further, in many instances agricultural development probably offers easier and greater opportunities for increasing income than fisheries development. In the Murik Lakes, however, people depend largely on the marine and estuarine resources for their survival as very little land is available for agriculture. The mangrove areas provide shelter and nutrient to support marine life. Mangrove logs are used for firewood and building houses whilst nipa palm leaves also provide housing materials.

Within the Murik community, womenfolk collect water, firewood, shellfish and mud-crabs. They also weave baskets and carry out much of the daily work relating to the family. The men are engaged in building houses, mending nets, net fishing, canoe making or carving. Council days are held twice a week when the council committee in the village directs community members to carry out village community services. Approximately five days per week are available to a community member to carry out his or her own activities with the exception of the S.D.A. Mission followers at Darapap who respect their Sabbath Day from 1800 hours each Friday to 1800 hours on Saturday. This gives the Murik Community 3-5 days a week in which fishing can be carried out.

In the Murik lakes region estuarine fish and clams are smoked and bartered for sago and vegetables from inland villages. Smoked fish, clams and live mud clams are also sold at local markets in Wewak. Some cash income is also received from the sale of carvings, baskets and fares from passengers travelling by canoes between Murik and Wewak. Fishing is the main activity in the Murik Lakes that generates income. Each village has one to three small trade stores which supply food items fishing gear, and other supplies.

There are seventeen fishing groups in the seven villages. These are based on clan groups comprising eight to thirteen nuclear families, and each family has an average of six members. It has been demonstrated in the past that large family units are difficult to manage by clan leaders, unless they are of exceptional calibre, and usually fail because of inter-family problems. Nuclear family groups have been shown to be more manageable group. The father or the eldest son directs and manages the daily family activities.

In the Murik Lakes there are four improved traditional methods of catching or collecting marine and estuarine species. In the past each method had certain taboos and rituals. These practises have gradually ceased during the last ten years, although the social structure within the community which governs who does what type of fishing, is still evident in present-day Murik society. The sharing of daily activities works well within the nuclear family where the mother and her daughter(s) would go out handlining and crab and shellfish collecting during the day, whilst from dusk to dawn, the father and his son(s) would go gillnetting and handlining. This intensive fishing activity, however, was observed only when a fish collection vessel was in the Lakes.

12.0 FISHERIES RESOURCES

12.1 INTRODUCTION

The principal fisheries resources in the Murik Lakes are fish, mudcrabs, molluscs and prawns. These resources, other then prawns, have been harvested for their subsistence use and any excess was marketed as iced and smoked fish in urban centres or bartered with neighbouring villages. The study concentrated its effort on determining the viability of the artisanal fishery which includes fish caught by gillnet and handline, and harvesting of mud-crabs and shellfish.

12.2 FISHING GEAR AND METHODS

The numbers of each type of fishing gear and vessels available in the four villages in this study are shown in Table 3. From the gear survey, it was evident that over half the number of nets

reported from villages were in poor condition. Most nets were hung on net racks out in racks exposed to the effects sun and rain which accelerates the deterioration of the gear. Of the 26 outboard motors reported in the survey only 9 were working. Most of the board motors that were not working have only minor faults, or missing parts. Due to the high cost of labour and spare parts needed to repair engines many are left to rust away.

Table 3. Gear and vessels recorded from four villages in the Murik Lakes during January to March 1985.

Gear & vessel	Big Murik	Darapap	Mendam	Karau	Total
40hp outboard		1	1		2
25hp outboard	2	9	6	4	21
15hp outboard		1	2	1	4
Large outrigger canoe	3	4	2	4	13
Large monohull canoe		9	1		10
Small fishing canoe	101	47	42	34	224
Monofilament gillnet	11	15	22	4	52
Multifilament gillnet	25	29	9	10	73
Seine nets		3		1	4

Most commonly used are 5.08 - 10.16 cm stretched mesh mono and multifilament gillnets, monofilament lines (10.50 kg breaking strain), multipronged spears, beach seines (200- 300 metres) with cod-ends, hooks of varying sizes and hooked sticks for collecting crabs. Transportation is usually by mono-hulled and canoes (5-8 metres) powered by outboard engines usually of 15-25 hp capacities.

The Murik Lakes social system requires that gillnets only be handled by men although women occasionally today take the place of their husbands.The employment of men and women in fishing is evenly distributed. The men use gillnets and seine nets, while women use handlines and are the main collections of crabs and shellfish. Spears are used by both men and women.

12.3 PRESENT FISHERIES INFRASTRUCTURE

13.3.1 Murik Lakes

During 1985 there were 3 unserviceable portable freezers known as "bush boxes", provided under a New Zealand aid programme, located at Mendam, Karau and Big Murik. When the "bush boxes" were operating fishermen would bring fish to be stored in them. The fish were then transported to Wewak in large outrigger canoes and sold at the DPI fish plant. Since the demise of these three freezer boxes there has been no existing infrastructure in the Murik Lakes to cope with any expansion of commercial fishing activity. The study noted that a suitably designed village level scheme would be needed to handle the distribution of ice, and the collecting and transportation of fisheries products between villages and Wewak.

12.3.2 Wewak

The East Sepik Province has two main organisations that provide services to the fishermen. These are the DPI Fisheries Extension unit which provides extension services to fishermen and the Government owned fish plant, Wama Marine Pty Ltd which purchases, processes and markets fisheries products.

12.4 FISHERIES EXTENSION

12.4.1 Staff

There are nine field technicians who are organised to take charge of various fishing communities. The Murik Lakes area is under the responsibility of the Extension Officer In Charge of Wewak East Coast Region.

12.4.2 Vessels

At the time of the 1985 survey the full complement of vessels operated by Fisheries Extension included a 10m collection vessel with a 5t capacity ice box, a 6m plywood dory, a 6m catamaran and an outrigger canoe built from plywood. Both the 10m collection vessel and the 6m dory were under repair between January to March 1985.

12.4.3 Freezers and ice machines

In early 1985 Fisheries Extension was equipped with a 5t freezer which was used to store ice blocks. Also present were two chest freezers and an ice machine that produced ice at a rate of 120kgs per day.

12.5 WAMA MARINE PTY LTD.

Wama Marine is a fish plant wholly owned by the East Sepik Provincial Government established to service villages by buying fisheries products, processing and then marketing them to local wholesalers and retailers.

12.5.1 Vessels

Besides a truck for bringing marine produce to Wewak by road, the plant operated a small twin rigged prawn trawler that was under repair at the time of the survey. This vessel was subsequently declared irreparable.

12.5.2 Freezers and ice machines

During 1985 the WAMA Marine plant contained a 20 tonne cold storage freezer, a 2.5 tonne chiller, and two ice machines.

12.6 PRESENT UTILIZATION OF THE CATCH.

Previous fisheries development initiatives in the Murik Lakes area had resulted in the annual export of between 1.3 to 13.2 t of fish to the Government Fish Plant[4] at Wewak. Between 1978 and 1984 fish from the Murik lakes accounted for 39% of the annual fresh fish production marketed through the fish plant (Table 4).

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[4]. This became Wama Marine (PTY LTD) in 1983

Table 4. Iced fish landings into Wewak from the Murik Lakes and other coastal villages in the East Sepik province between 1978 to 1984.

Year	Fish Landings (kg)		
	Murik Lakes	Other coastal villages	Total production for East Sepik Province
1978	5,047	2,804	7,871
1979	13,150	4,934	18,084
1980	7,118	7,673	14,891
1981	4,685	8,246	12,931
1982	2,303	6,142	8,445
1983	1,314	14,828	16,142
1984	7,109	19,129	26,238
Total	40,766	63,756	104,502

During the period 1981-83 fish catches from the Murik Lakes started to decline and only 8.3 tonnes was sold as iced fish. The continuous break down of the ice machine and the collection vessel were responsible for the low production of fish during this period.

13.0 NUTRITION SURVEY

The objective of the nutritional survey was to estimate the fish consumption by the Murik people and hence to quantify the subsistence harvest of fish, crab and clams. Houses were visited randomly during breakfast lunch and dinner periods. Each house was visited once and the following data recorded:

the food being eaten,

the number of people living in the house and

the number of people eating.

The whole weight of fish, clams and crabs at each meal were weighed to the nearest gram prior to consumption.

Seven to eight days were spent in each village and in five weeks four villages were visited. The same sampling procedure was carried out at each village. The data was analyzed to determine the daily average per capita consumption of fish, crabs and clams. This data was then extrapolated to give the expected annual consumption. The total estimated harvest was calculated as the product of the annual consumption and the numbers of the estimated 1985 population older than 6 years [1,252, based on Freilink, (1983)].

13.1 RESULTS AND DISCUSSION

A summary of the numbers of family groups and people contacted in the nutrition survey is

given in Table 5. Altogether, 56.5% of the population of four survey villages were interviewed in the survey, which represents 41% of the total Murik Lakes population.

Table 5. The percentage of the population of four Murik Lakes villages interviewed in the nutrition survey.

Village	No of family groups interviewed at home	No of people interviewed at meal times	% of population interviewed
Big Murik	36	184	41.4
Darapap	16	130	47.3
Mendam	23	134	49.3
Karau	14	94	74.6
Total	89	631	56.5

13.1.1 Crab consumption

The estimates of average daily crab consumption are given in Table 6. It is apparent from these results that only a small percentage of the Darapap community ate crabs. This was because 69% of the Darapap population are Seventh Day Adventists (SDA). The simple overall daily crab consumption by Murik Lakes people was 45.4 grams.

Table 6. Daily per capita crab consumption at four villages in the Murik Lakes.

Village	Mean daily consumption
Big Murik	42.6
Darapap	17.9
Mendam	52.6
Karau	68.6
Overall mean	45.4

This estimate of daily per capita crab consumption in the Murik Lakes is similar to that in the Gulf of Papua (40.0 grams per person) reported by Haines (1978/79). The total annual estimated subsistence harvest of mudcrabs for the Murik Lakes was 20.8 tonnes estimated from the product of the daily per capita consumption, days in the year and number of persons over 6 yrs old in the population.

13.1.2 Fish consumption

The mean daily fish consumption over the study period in the four villages is given in Table 7. A mean of 146.6 grams daily was eaten and amounted to an annual fish subsistence harvest of 67.0 tonnes for the whole population following the method outlined in the previous section.

Table 7. Average daily per capita consumption of fresh fish in four Murik Lakes villages.

Village	Mean daily consumption (g)
Big Murik	200.0
Darapap	188.3
Mendam	119.0
Karau	79.1
Overall mean	146.6

13.1.3 Clam consumption

The average daily clam consumption in the survey villages is shown in Table 8. Clams are a common item in the diet of many Murik Lakes villagers, particularly those in Mendam and Karau where clam stocks are abundant. Although the volume of clams consumed is less than fish and crabs, they are eaten frequently, sometimes with each meal. Evidence from the importance of clams is evident from the large number of discarded shells around most villages which are used to fill in between mangrove roots to act as substrate for further land deposition. The overall mean daily per capita consumption of clam meat was 10.8 g thus the annual subsistence harvest for the Murik Lakes is estimated to be 4.9 tonnes of clam meat.

Table 8. Average daily per capita consumption of mud-clams in four Murik Lakes villages.

Village	Mean daily consumption (g)
Big Murik	3.5
Darapap	2.0
Mendam	18.4
Karau	19.3
Overall mean	10.8

14.0 ARTISANAL FISHING

14.1 BACKGROUND

From the point of view of costs, the fishery can be divided into two separate fishing components:

1. Gillnet fishing combined with some handline fishing.

2. Handline fishing combined with crab and shellfish collecting.

The first type of fishing activity is carried out predominantly by males whilst the second is generally the preserve of the females. The operations of a nuclear family as a fishing group are considered for the purposes of estimating costs and incomes from fishing.

It is assumed in the cost analysis that a nuclear family owns one canoe, one gillnet, and several sets of handlining gear. It is also assumed that the mother and one daughter go handlining, crab and/or clam collecting during the day whilst the father and one son go gillnetting and possibly handlining at night. The income from the day and night fishing will be the gross cash income of the nuclear family.

14.2 GILLNETTING AND PART-TIME HANDLINE FISHING

It is anticipated that families would have a combined day catch irrespective of gear used. The capital costs of canoe, gillnet and handline gear are shown in Table 9, whilst the lifespan and depreciation of this equipment is given in Table 10.

Table 9. Minimum gear and vessel requirements for a family to participate in artisanal fishing in the Murik Lakes.

Item	Cost (Kina)	Quantity (Kina)	Total cost (Kina)
Canoe (4-6m)	70[a]	1	70.00
4" monofilament gillnet	100	1	100.00
Repair kit	20	set	20.00
Handline gear	30	set	30.00
Total			230.00

a. Costs of canoes are extremely variable in PNG and are based on the relationship of the buyer and canoe maker. The price may include not only cash but bulk items of food such as sugar and rice. An estimate of the cost of a canoe was made here as the product of the 1985 minimum rural wage (35 Kina/fortnight) and the average construction time (four weeks).

Table 10. Depreciation costs of canoe and fishing gear in the Murik Lakes artisanal fishery.

Item	Cost (Kina/yr)	Lifespan (yrs)	Capital depreciation (Kina/yr)
Paddle canoe	70	4	17.50
4" monofilament gillnet	100	2	50.00
Repair kit	20	2	10.00
Handline gear	30	2	15.00
Total			92.50

Operational costs of fishing consist mainly of ice purchase, and some day to day maintenance of gear. Based on observations made during this survey it is assumed that Murik Lake villagers devote about one third of their time to fishing activities. On an annual basis this amounts to 120

days spent fishing. Due to the very simple methods employed and the lack of mechanised transport employed the main operational cost incurred by fishing is purchase of ice. Two blocks of ice are normally required for a fishing trip at a cost of K 0.60 per block. Total costs for a years fishing after the initial outlay of K 230 will thus amount depreciation plus operational costs, which gives a grand total of K 236.00. This can be reasonably rounded up to K 270 to account for other sundry expenses incurred through maintaining canoe an fishing gear. The cost per day's fishing for a family group is thus thought to lie in the region of K 2.25.

The income for one day's fishing by a family unit could be estimated based on average catch rates of fish and shellfish observed in this survey (Table 11). Incomes from these catches were estimated, assuming sales of fish etc to Wama Marine for an agreed unit price per kilogramme.

Table 11. Estimated daily catch and income from harvests of fish and shellfish by one family fishing unit in the Murik Lakes.

Food	Average daily catch (kg)	Unit value (Kina/kg)	Total daily income (Kina)
Fish	8.2	1.00	8.20
Crab	3.6	1.00	3.60
Molluscs	1.8	0.50	0.90
Total			12.70

Given an estimated the trip operating cost of K2.25 and the mean combined landed catch of 13.6 kg then it costs a family K0.17 to harvest a kilo of fishery produce. A simple cost-benefit analysis of fishing by a Murik Lakes family unit is given in Table 12.

For a family unit to commence fishing in the Murik Lakes a minimum capital outlay of K230 will required for a canoe and gear. A further K 270 will be necessary to cover gear and vessel depreciation and to pay operating expenses through the year, although these costs would ultimately be discounted from catch revenues.

Table 12. Annual costs and income from artisanal fishing for a family fishing unit in the Murik Lakes.

Costs and returns	Value (Kina)
Initial capital	230.00
Operating costs	270.00
Value of estimated fish and shellfish landings of 1632 kg/yr	1524.00
Income to family after operating costs deducted	1254.00
Gross income from trip	12.70
Net income per trip	10.45

15.0 PROFILES OF THE FISHERIES RESOURCES OF THE MURIK LAKES.

15.1 INTRODUCTION

The objectives of this aspect of the resource survey were to record contemporary levels of catch per unit effort for the different stocks, observe the species composition of different fishing gears, estimate the standing stocks where possible and to comment on the economic viability of harvesting the different resource.

15.2 MUD CRABS

The people of Murik lakes collect mud crabs for their own consumption and to sell at the Wewak Local Market and some hotels. The only data available shows that one tonne of mud-crabs were sold through Wama Marine fish plant in 1984. During the first three weeks of the survey 552 kilograms of mudcrabs were collected by Murik lakes fishermen. Due to the variety of private outlets for mud-crabs such as hotels and restaurants and the inconsistent supply of mud-crabs it was impossible to determine the amount of mudcrabs harvested over the last two years.

15.2.1 Fishing methods

Crabs are found either half buried in soft mud, amongst mangrove roots or inside permanent burrows during low tide. The method of harvesting mud crabs is very simple. On location of a crab hole a hooked stick is driven into the hole and the hook drags the crab out of the hole. Fishing for crabs is done during low tide when most of the crab holes are exposed or water levels are less than 0.5m in depth (knee level). Fishing for crabs is usually carried out by one or two women fishing from a canoe of 3-4m in length. They would fish for mud crabs during low tide and then handline during the high tide of the same day. On most day trips women would combine mud crab, mud clam collecting and or handlining. This reduces the operating cost and maximises income per day trip.

15.2.2 Results

15.2.2.1 Species composition

There are two types of mud crabs found in the Murik Lakes area. These are the brown mud-crab *Scylla serrata* and the newly described green mud crab *S. serrata* var. *paramamosain.* It should be noted that there were some discrepancies between the published taxonomic descriptions of *S. serrata* and *S. serrata* var. *paramamosain*, and the specimens from the Murik Lakes which were separated based on a single morphological characteristic. The brown mud crab forms 95.7% by weight of the Murik Lake catch and the green mud crab comprising the remaining 4.3%. For the purpose of this report the mud crab species were combined, however, and emphasis is placed on the brown mud-crab which is the dominant type.

15.2.2.2 Length & weight

The mean weight of the brown mud crab is 260.3 grams which ranged from 214.4 g (Darapap) to 331.9 (Big Murik). The mean carapace length for *S. serrata* was 108.4 mm (range 75. to 140 mm) for males and 103.3 mm for females (range 70 mm to 134 mm). The larger variety (*S.serrata* var. *paramamosain*) measured 80 mm to 180 mm with a mean of 139.4 mm.

15.2.2.3 Sex ratio

The sex ratio of *S.serrata* in the Murik Lakes was 3.3 males to 1 female.

15.2.2.4 Population density

From quadrat samples, it was calculated that there was a mean density of 23 crabs per hectare with an average weight of 260.3 g/crab or unit standing stock of 6.0 kg/ha. The total standing stock of mud crabs for the 18500 ha of mangrove forest in the Murik Lakes was estimated at 108 tonnes with a possible range of 68.4 to 147.6 tonnes based on the 95% confidence limits ($\pm$2.2) of the mean estimate of abundance from quadrat sampling. Frusher 1983 reported that the average density of mud crabs in the Purari River was 21.4 crabs/ha, similar to the Murik Lakes, whilst in the delta of the Aird River the relative abundance was lower at 10.4 crabs/ha.

Table 13. The number of fishermen in each village who sold mud-crabs to the DPI collection vessel during the period of the resource survey.

Village	Total no of crab collectors	Female crab collectors	Male crab collectors	Total number of collecting days
Big Murik	57	42	15	6
Darapap	32	23	9	6
Mendam	21	20	1	6
Karau	10	5	5	6

15.2.2.5 Catch and fishing effort

For 6 days of mud crab buying, spread over six weeks of the resource survey, 95 women and 30 men sold crabs to the DPI collection vessel (Table 13). The crab collectors came from Big Murik, Darapap, Karau and Mendam. This represents 11.2% of the 1985 estimated population for the four villages. The catch and effort data was obtained from two sources; the sales by women to the collection vessel and samples from transects. The mean catch rate of the samples sold to the collection vessel was 3.6 ($\pm$ 1.4) kg per woman/day. The catch rate from the transects as 4.56 ($\pm$ 0.6) kg per woman/day. The later catch rate was higher because it included unsaleable small sized crabs (<200 g.).

15.2.2.6 Potential yields

Gulland (1971) suggested that the maximum sustainable yield (MSY) of an exploited population could be approximated from:

$$MSY = 0.5 \times M \times B_0$$

where M is the natural mortality rate and B_0 is the virgin biomass. Growth and mortality parameters for *S.serrata* in the Murik Lakes are unknown but Brown (I. Brown, DPI Queensland, *pers comm*) suggested that the constants of the von Bertalanffy growth curve for the same species from Southern Queensland were L_{oo} = 239mm and K = 0.48. The maximum size of *S.serrata* from the Murik Lakes was 140mm suggesting a asymptotic length of about 150mm cm, based on the approximation:

$$L_{oo} = L_{max}/0.95$$

The growth constant K was estimated from the method of Pauly & Munro (1984) where the constants of the von Bertalanffy curve can be used to compute a growth performance index, ϕ', where:

$$\phi' = \text{Log}_{10}K + 2.\text{Log}_{10}L_{\infty}$$

An estimate of ϕ' of 2.438 was estimated for the Queensland mud crab then the L_{∞} value for the Murik Lakes population substituted into the equation to obtain K = 1.219. Finally an estimate of M = 2.48 was determined from Pauly's (1980) formulation:

$$\text{Log}_{10}M = -0.0066 - 0.279\log_{10}L_{\infty} + 0.6543\text{Log}_{10}K + 0.4643\text{Log}_{10}T$$

which relates growth parameters (K, L_{∞}) and mean environmental temperature (T) with natural mortality (M). A mean annual temperature of 28°C was used with the for the Murik Lakes to generate an empirical estimate of M for *S.serrata*.

In the Murik Lakes mudcrabs are a traditional subsistence food with an estimated annual harvest of 18.2t/yr. As such the standing stock biomass estimated from the quadrat sampling is not to be confused with virgin biomass. However, it is likely that the standing stocks in the Murik lakes region is in equilibrium with the level of removals due to natural and subsistence catches. Substituting the standing stock and M value into Gulland's equation gives an MSY estimate of 133.9 t/yr which 115.7 t/yr could be regarded as the commercial harvest assuming subsistence catch does not increase. The estimated MSY represents a theoretical yield of mudcrabs of 7.4 kg/ha/yr from the 18,000 ha of mangrove swamp, or about 28.6 crabs/ha/yr.

Given some of the uncertainty surrounding the identity of the two types of mudcrab it is prudent to perform the above computations using a higher estimate of L_{∞}, based on the larger maximum size of 18.0 cm for *S.serrata* var. *paramamosain*. Following the proccedure outlined above this results in an estimate of M = 1.7 which in turn generates a predicted MSY of 91.9 t/yr. Finally, Hill (1975), estimated the annual mortality rates of *S.serrata* in a South African estuary to lie between 0.53 to 0.92 (mean = 0.73) based on a times series of monthly trapping experiments. Assuming that this represents a possible lower limit of M for the Murik Lakes population, then the resultant predicted MSY is 39.4 t/yr.

No information is available on the size of the commercial harvest apart from sales to Wama Marine in 1984 (see above). From the catch rates encountered in the survey it is possible to estimate a theoretical yield. It was assumed that females will be the principal harvesters of mud crabs and from the records of the survey the average production per day was 3.6 kg/woman/day. A total of 30 males and 90 females from the four study villages harvested crabs during this survey. This represented 5.0% and 17.6% of the male and female populations of these four villages. If these percentages are extrapolated to the total Murik Lakes population then this suggests that about 165 persons, mainly females, would regularly harvest mud crabs. As stated above fishing is thought to occupy 120 days of the year for persons in the Murik Lakes, thus the total potential yield from the area is 71.3 t/yr.

The estimated potential yield based on fishermen catch data lies about midway between the lower and upper empirical estimates of MSY from growth and mortality data. However, the estimate of MSY for mudcrabs from the Murik Lakes is entirely based on empirical methodologies and comparisons with stocks elsewhere, around which there are very wide confidence limits. Further, the underlying assumption that the population of mudcrabs in the Murik Lakes is in an equilibrium state with respect to subsistence harvests also remains to be examined. The catch rates of mud-crabs by the Murik Lakes villagers during the time of the survey were probably unrealistically high and stimulated by the presence of the DPI collection vessel that was guaranteeing purchase of every crab produced above the legal size limit of 200 g. However, in the absence of other more precise data the results do represent a first estimate of the sustainability and yield potential of the resource and may also be applicable to other areas of PNG with large areas of mangrove cover.

If the subsistence production figure is about 18 t/yr then this itself represents a substantial yield from the standing stock. Attempts to increase commercial yields must bear in mind the importance of subsistence production to the Murik Lakes people and that over-harvesting does ultimately deplete the stock and deprive indigenous people of a food source. Given the caveats about the yield estimates it is recommended that attempts to stimulate greater commercial production are initially modest, particularly since the level of existing commercial harvesting is unknown, although thought to be small.

15.3 FIN FISH

Recorded commercial production of fin fish from the Murik Lakes between 1978 to 1984 amounted to 40.8 t (range 1.3 to 13.2 t; mean 5.8 t) and was marketed through Wama Marine facility in Wewak (Table 4). During the study period, 7.4 tonnes of fish were harvested from 659 gillnet and 661 handlining trips. Although before the survey commercial catch records from the Murik Lakes were available, there was no data on fishing effort and catch per unit effort (CPUE). Given the very different natures of gillnet and handline gears the finfish section is divided into two parts

15.3.1 Fishing methods

Gillnets of between 50 m to 100 m were used by the Murik lakes fishermen with mesh sizes ranging from 2 to 4.5" (5.1 to 11.4 cm). The fishermen would set net at dusk and would clear 2 to 6 times per night. Handlining is the most common fishing method in the Murik Lakes and is carried out from small dug out canoes inside the lagoon. The handline gear usually employed by Murik Lakes fishermen is monofilament line of 20 to 50 lbs (9.1 to 22.7 kg) breaking-strain, about 30 to 60m in length and with a variety of different hook sizes depending on the target fishes. Fishing is done in the middle of the lake or close to deeper channels and barrat openings, with most effort being expended in the afternoon or at night.

15.3.2 Results

15.3.2.1 Species Composition from Gillnetting.

The species composition of the Murik Lake gillnet fishery is shown in Table 14. Six families of fish caught comprised 90% of the gillnet landings by weight and numbers. The most dominant feature of the gill net catch were the carangids, mainly trevallies (*Caranx* spp, *Carangoides* spp) and leather skins (*Scomberoides* spp).

Table 14. The composition of fish caught in the Murik lakes using gill nets during January to March 1985.

Family	Common name	%No	%Wt
Carangidae	Trevallies, Leatherskins	38.8	37.3
Lutjanidae	Snappers	16.5	14.5
Chanidae	Milk fish	13.0	12.9
Pomadasyidae	Grunters	11.7	13.1
Mugilidae	Mullet	11.0	12.9
Scatophagidae	Bat fish	4.0	5.3
Others		5.0	4.0

15.3.2.2 Catch rates from gillnetting

A total of 3,301 kg of fish were caught in the Murik lakes by gill nets. Gillnet catch rates varied between villages ranging from 3.5 kg per net per day at Mendam, to 6.5 kg per net per day at Big Murik. The mean catch rate for the area was estimated to be 5.3 kg per net/day (Table 15). As the nets used for fishing during the survey period were not standardised comparisons between catch rates for different villages are not meaningful. However, the gillnets employed were representative of those used throughout the Murik Lakes by fishermen and the observed catch rates are likely to reflect the levels of production from this gear type.

Table 15. Average catch rates (kg/net day) by gillnet fishing from four villages in the Murik Lakes during the six weeks of the survey period (January to March 1985).

Village	Week during survey period						
	1	2	3	4	5	6	Mean
Big Murik	7.4	6.2	7.0	6.7	6.4	5.6	6.6
Darapap	6.1	6.2	4.5	3.4	4.4	4.6	4.9
Mendam	3.2	4.6	3.8	3.2	3.5	2.9	3.5
Karau	10.8	3.6	4.3	5.9	9.1	4.2	6.3

15.3.2.3 Gillnet fishing effort

Approximately 81% of the male population (326) which participated in the six weeks fishing were recorded using gillnets. The use of gillnets as a harvesting method by fishermen varied between the four villages (Table 16), ranging from 50.8% of fishermen at Karau to 100% at Big Murik.

Table 16. The percentage of fishermen using gillnets at the four villages in the Murik Lakes from January to March 1985.

Village	No of fishermen per village	No of fishermen using gillnets	% of fishermen using gillnets
Big Murik	80	80	100.0
Darapap	103	78	75.7
Mendam	80	74	82.7
Karau	63	32	50.8
Total	326	264	81.8

15.3.2.4 Species composition from handline fishing

The composition of the handline catch by family is shown in Table 17. Fishes from three

families, Pomadasyidae, Carangidae and Lutjanidae account for three quarters of the landings by handline fishing. Carangids amounted to nearly 40% of the gill net catch but account for only 13% of handline caught fishes. The most dominant feature of the handline fishery are the grunters (Pomadasyidae) which make up nearly 50% of the catch.

Table 17. Catch composition of fish caught by handlines at the Murik Lakes between January to March 1985.

Family	Common names	%No	%Wt
Pomadasyidae	Grunters	49.8	48.0
Carangidae	Trevallies	13.0	12.9
Lutjanidae	Snappers	14.5	14.1
Plectorhynchidae	Sweetlips	2.7	7.6
Serranidae	Rock cods	4.0	5.1
Scatophagidae	Bat fish	2.9	3.8
Gerridae	Silver biddies	2.9	1.9
Lethrinidae	Emperors	3.8	1.7
Sparidae	Sea breams	1.3	1.2
Tachysuridae	Cat fish	1.1	0.9
Megalopidae	Ox eye herring	0.4	0.7
Sphyraenidae	Barracuda	0.4	0.6
Others		3.2	1.5

15.3.2.5 Catch rates from handline fishing

Table 18. Average catch rates (kg/canoe day) for four villages in the Murik Lakes between January to March 1985.

Village	Week during survey period								
	1	2	3	4	5	6	7	8	Mean
Big Murik	3.2	2.7	3.2	3.4	4.1	4.1	3.0	3.4	3.4
Darapap	3.5	3.3	2.5	2.6	3.2	2.8	2.5	3.6	3.0
Mendam	N/A	1.3	3.8	N/A	2.6	2.2	2.1	2.1	2.4
Karau	N/A	4.9	2.8	2.4	2.2	2.1	2.7	3.0	2.9

During the survey 1,958.4 kg of fish were caught from the Murik Lakes with handlines. The handline catch rates for each village over the eight sampling weeks are given in Table 18. A total number of 661 canoe day trips generated the handline catch, giving overall average catch per canoe day of 3.0 kg for the region. Average catch rates during the period of the survey ranged from 1.3 to 4.9 kg/canoe/day but overall between the four villages the CPUEs were

similar with a range of average catch rates between 2.4 to 3.4 kg/canoe/day.

15.3.2.6 Handline fishing effort

The average number of handlines used per day in each village is given Table 19. The effort varied from village to village and from week to week. Over the period of observations the weekly fishing effort ranged from 0 to 115 handline days. The calculated mean weekly fishing effort for the area is 33 handline days per village. Although men do fish with handlines, the majority of the handline catch is made by female fishermen.

Table 19. Handline fishing effort over eight weeks for four Murik Lakes villages between January to March 1985.

Village	Weeks during survey period								
	1	2	3	4	5	6	7	8	Mean
Big Murik	35	28	24	29	34	29	18	50	31
Darapap	19	27	30	67	40	57	27	42	39
Mendam	0	10	15	N/A	26	48	26	115	40
Karau	0	19	14	18	22	28	18	41	23

15.3.2.7 Potential yields

The average catch rates for gillnet and handline fishing in the Murik Lakes observed during this survey were 5.2 kg/day and 2.9 kg/day respectively. There were 264 fishermen operating gill nets in the four villages included in this survey, or 81% of the total fishermen in these villages (Table 16). Extrapolating this to the entire Murik Lakes population gives an estimated 350 fishermen operating gill nets. If each fishermen is fishing on average for 120 days of the year then the total yield would be 218 t/yr.

During the period of the fisheries survey 683 persons or 61.2% of the population of the four survey villages sold fish to the DPI collection vessel. There were 304 female fishermen participating in this fishing effort or 27.3% of the surveyed population. Extrapolating to the entire population of the Murik Lakes gives 419 potential female fishermen (Table 2). If female fishermen fish for 120 days of the year then the total potential yield would be 145.8 t/yr.

The total potential finfish harvest is estimated to be 363.8 t/yr. The subsistence harvest for the Murik Lakes region was estimated as 67.5 t/yr. Based on this data a surplus of about 300 t/yr would be generated if each fisherman (male and female) in the Murik Lakes devoted about one third of their annual activities to fishing. This amounts to a yield from the 9000 ha of open water of 40kg/ha/yr. The same caveats apply, however, to these computations as to those for crabs. The catch rates and participation in fishing may be inflated due to the ease with which persons could sell their catch to the DPI collection vessel during this survey.

15.4 PRAWNS

15.4.1 Introduction

Information on the prawn resources of the Sepik River delta adjacent to the Murik Lakes is limited to two short surveys by the fisheries research vessels F.R.V. "Tagula,"(Rapson and Macintosh 1971, Campbell 1981) and FRV "Cee B" (Frusher 1985) The first was aimed at determining the existence of stocks of penaeid prawns adjacent to the Sepik and Ramu River mouths whilst the second survey concentrated on fishing for prawns in the waters immediately adjacent to the Murik Lakes. The objectives of the present survey were to determine the spatial distribution of the different prawn species within the trawl grounds, the quantity and quality of the fish by-catch and the robustness of each of these resources to sustained fishing pressure. A novel feature of the present survey was the use of a small beam trawl to investigate the prawn stocks within the Murik Lakes as well as undertaking more conventional 'industrial scale' prawn trawling in the coastal waters adjacent to the Lakes.

15.4.2 **Fishing methods**

The commercial trawl survey was conducted using the research vessel F.R.V. "Melisa" an 18 m single rigged trawler. The Melisa fished with a 40 m Gungrey prawn trawl net between the Sepik River mouth and North of Murik entrance. The Melisa made 85 separate trawls over 21 days with an average trawl time of 118 minutes and fished at an average depth of 14 metres. The artisanal trawl survey was conducted using an 7.6 m sandskipper and a 8.3 alia-catamaran, each towing a 3m beam trawl of 5m length. Trawls were conducted in Karau Lagoon between Mendam to Big Murik. Similar trials were carried out outside the Murik Lakes in the immediate coastal waters, between Mendam coast to Girgir point north of Watam Lake entrance, in depths ranging between 4 and 6 m depth.

15.4.3 **Results**

15.4.3.1 Species composition & distribution

The prawn catch was divided into four categories: Banana prawns (*Penaeus merguiensis* & *P.indicus*), Tiger prawns (mainly *P.monodon* with less than 1% *P.japonicus* and *P.semisulcatus*), medium sized Endeavour prawns (mainly *Metapanaeus affinis* with some *M.ensis*) and small Endeavour prawns (*M.dobsoni*. *M.demani* and juvenile *M.affinis* and *M.ensis*). The overall species composition for the Murik Lakes area based on the different trawling surveys is shown in Table 2. The composition of prawn catches varies with depth and salinity of the trawling grounds. Frusher (1983) showed in the Gulf of Papua that the distribution of different prawn species was correlated with salinity or a salinity related factor. Banana prawns were found to prefer regions of salinities > 10ppt while Endeavour prawns prefer lower salinities between 1 to 7ppt.

Table 20. Composition of prawn trawl catches from the Murik Lakes region.

Species group	% Total prawn catch	% Total catch
Banana prawns	75.8	13.1
Tiger prawns	11.8	2.0
Medium sized endeavour prawns	1.7	0.3
Small endeavour prawns	10.7	1.9
Fish by catch		82.6

The Murik Lakes area would be expected to be reasonably saline as salinity is influenced primarily by tidal ingress, run off and a canal (Manjop baret) entering into the south east corner

of the lakes system from the Sepik River (Fig.1). Salinity would be expected to be high except during the wet season where Sepik River flood water would enter the lakes and depress the salinity particularly the eastern section around Mendam. In contrast the Sepik River is entirely freshwater to its mouth as strong outward flowing currents are observed throughout the year. Thus the mouth of the Sepik River and regions adjacent to it would be more suited to endeavour prawns. Table 21 compares the species composition of prawn catches at Girgir point, situated at the entrance of the Sepik River mouth, with those from waters adjacent to Mendam. In the very low salinity waters of the Sepik river mouth Endeavour prawns dominate the catch, whilst in the Murik Lakes with higher salinity water Banana prawns are more abundant.

Table 21 Prawn trawl catch composition at two locations in the Murik Lakes region with respect to salinity.

Prawn species	Location & salinity	
	Mendam (10-20 ppt)	Girgir Point (1 ppt)
Banana	88.2	15.8
Endeavour	11.8	73.7
Others	0.0	10.5

15.4.3.2 Catch rates

15.4.3.2.1 Commercial trawling

A summary of the mean catch rates of fish and prawns for trawls made by the FRVs Tagula, Cee B and the Melisa given in Table 22. Comparisons of the differences in catch rate are difficult variation in gears and vessels employed. Both the Tagula and the Melisa used single trawl nets, whilst the CEE B is a pair trawler. There may also be a seasonal component in the variations in the CPUEs as the Tagula and the Cee B fished mainly between October to December, whilst the Melisa was fishing between January to March. Further, the time period separating the surveys of the Cee B and the Melisa was only two years, whilst approximately 20 years separates the results of fishing with the Tagula and the other two vessels.

Table 22. Ranges and CPUEs for commercial prawn trawling in the coastal waters adjacent to the Murik Lakes.

Vessel	Fishing dates	Catch	Average CPUE (kg/hr)	Range (kg/hr)
Tagula	Oct-Dec 1965	Prawns	7.6	0.0-15.6
		Fish	207.1	38.1-599.6
Cee-B	Oct 1982-Jan 1983	Prawns	8.58	5.0-11.0
		Fish	40.94	N/A
Melisa	Jan-Mar 1985	Prawns	3.0	0.0-7.7
		Fish	28.2	11.6-58.6

Given the variation inherent in the data it is probably reasonable to state that commercial catch rates of prawns in the Murik Lakes coastal waters are initially likely to range from about 3 to

8 kg/hr. However, as these are virgin stocks then the CPUE would be expected to decline appreciably if commercial levels exploitation was sustained and could conceivably drop to between one third to one half of the range quoted above.

There is a substantial by catch of fish taken by prawn trawlers, much of which may be discarded. The ratio of fish : prawn by catch ranged from 4.8 for the Cee B to 27.2 for the Tagula. In this survey the overall ratio was 9.4 and the mean from the three surveys was 13.8. The composition of the fish by-catch was to be recorded in the present survey but problems with identification by project personnel meant that the results were unreliable and this was abandoned. Frusher (1985) reported that about 95% of the fish brought to the WAMA Marine plant in the 1982 to 1983 survey was the croaker *Otolithes argentus*, with the balance comprising the black pomfret (*Parastromateus niger*) and the common pony fish (*Equula equula*).

15.4.3.2.2 Small scale beam trawling

The mean catch rates and ranges of CPUE from fishing with the 3m beam trawl in the Karau Lagoon area Murik Lakes and in the nearshore coastal waters are given in Table 23. Catches of prawns in the Murik Lakes were very low with an average CPUE of about 0.1 kg/hr. Fishing in the coastal waters immediately adjacent to the north of Murik Lakes was more successful with catch rates approximating to 0.9 kg/hr. However, the results do suggest that there is little or no potential for small scale prawn trawling in the region.

Table 23. Mean and range of CPUE (kg/hr) for small scale prawn trawling in the Murik Lakes.

Region	Mean CPUE (kg/hr)	Range (kg/hr)
COASTAL WATERS		
Prawns	0.87	0.04-1.89
Fish	1.60	0.15-4.24
MURIK LAKES		
Prawns	0.12	0.0-0.53
Fish	0.70	0.0-5.52

The composition of the beam trawl catch from Karau Lagoon and from the nearshore coastal waters is shown in Table 24. The percentage of fish in the catch ranged from 64 to 76% with an overall average of 70% or a by-catch to prawn ratio of 2.3.

Table 24. Percent composition by weight of small scale prawn catches made within the Murik Lakes and adjacent coastal waters.

Trawl catch	Near shore	Murik Lakes	Mean
Prawns	35.9	24.0	30.0
Trawl fish	64.1	76.0	70.0

15.4.3.3 Economics of prawn trawling in the Murik Lakes region

Based on these results the economic potential of harvesting prawns with a small scale beam trawl in and around the Murik Lakes is very limited. Using an average price for prawns in 1985 of K 7.5/kg and for fish 1.30 K/kg for fish this gives a theoretical income of K 8.60/hr for fishing in the coastal waters and K 1.80 for fishing in the Murik Lakes. This assumes that all fish are equally saleable but this will not be the case since the bulk of the catch from the northern estuarine systems of PNG consists principally of low value species such as clupeoids (Engraulidae, Clupeidae) and pony fish (Leiognathidae) (Quinn & Kojis 1985)

Similarly, commercial trawl fishing around the coast of the Murik Lakes region is likely to yield marginal returns. Given the difficulties in comparing the results from the three separate surveys a simple mean of 6.4 kg/hr was used for computing returns from prawns, whilst a CPUE of fish by catch was set at about 88 kg/hr or a prawn to fish ratio of 1 : 13.8 (see above). Following the same procedure for artisanal trawling results in a theoretical income of about 162 K/hr. However, as stated earlier, disposal of all fish is unlikely and may be as little as 2-3% of the total fin fish catch. Some of the fish unsuitable for human consumption could be disposed of to crocodile farms if the economics of retaining it onboard were favourable. It is difficult to comment further in this due to the lack of information on the catch composition of the by-catch.

15.5 MOLLUSCS

15.5.1 Introduction

In most PNG rural coastal area, villagers harvest a variety of shellfish for subsistence purposes. The people of Murik Lakes are no exception, several different species of molluscs are collected from the lake daily for food. Besides yielding animal protein, the empty shells of two species are burnt to produce calcium oxide powder (lime) for mixing with betel nut. A small amount of shellfish meat is smoked and sold in local markets.

15.5.2 Species composition and collection methods

Molluscs are easily harvested during low tide. Different methods are employed to harvest different types of shellfish. Mangrove oysters are found growing on mangrove roots are hence are required to be chipped off or a section of the root cut, access to the oysters. The cockles *Anadara* spp are half buried in soft mud. They are found in depth ranging from about 2 feet to 6 feet depending on tide level. To harvest this species of bivalve, collectors walk on mudflats in depths between 1-1.5 m depth using their feet to feel for bivalves in the mud. Once found, they are picked by hand. Two species of mud clam (*Periglypta puerpera* and *Batissa violacea*) are found half buried in a mixed substrate of coarse sand and strong mud. They are normally found buried between mangrove roots in intertidal areas. At low tide, these bivalves are dug out of the ground with wooden sticks, knives and fingers. Two minor gastropod species are also harvested, these species are found in intertidal mangrove areas. They live in large colonies, they are quick to locate, and be collected with a use of shovel. The collectors normally go through a colony picking only the larger ones.

15.5.3 Survey methods

The objective of the mollusc survey were to determine the common shellfish harvested in the Murik Lakes and potential annual harvest from the area. In order to achieve this objective, catch and effort data was collected from collectors who sold shellfish to the DPI collection boat. While the common shellfish species harvested were noted, no record were made of the species catch composition.

15.5.4 Results

There were seven species of molluscs from families; these are two species of oyster two species of gastropod, and 3 species of mud-clam. The three species of the mud-clams are commonly

harvested for subsistence use. Large mangrove oysters are harvested seasonally and the 2 species of gastropods are collected only occasionally. Economically, the most important shellfish species are the mud clams and mangrove oysters. During the survey period, mud clams were sold by weight and mangrove oysters were sold in units of a dozen. Thus estimates of CPUE and potential harvest refer solely to mud-clams.

15.5.4.1 Catch & catch rates

The total effort during the 6 collecting days in January was 159 man-days in which 283 kilograms of mud clam meat was harvested (Table 25). The market for mud-clam meat in Wewak was limited since all product was sold through Wama Marine, rather than the local produce market. Further, the selling price for clam meat agreed upon between the resident villagers and the collection vessel was unrealistically high, given the low demand. This in turn limited the volume that could be easily disposed of easily and this ultimately affected effort for mollusc harvesting as no more would be purchased.

Table 25. Catch, effort and CPUE for mollusc harvesting in Murik Lakes during January 1985.

Village	Effort (man-day)	Catch (kg)	CPUE (kg/man-day)
Big Murik	147	57	1.0
Darapap	73	140	1.9
Mendam	14	37	2.8
Karau	25	49	2.0
Total	159	283	1.9

The catch and effort for collecting molluscs by four villages in the Murik Lakes during the first 3 weeks of the survey period is summarised in Table 25. The CPUE in for the study period ranged from 1.0 to 2.8 kg/man-day with a mean catch rate for the area of 1.9 kg/man-day. This figure would be expected to be lower than normal as during the survey most of the women fishermen devoted time to harvesting crabs and hand line fishing, as well as collecting mud clams. Catch rate would be expected to be a lot higher if the collectors were targeting solely for shellfish.

15.5.4.2 Effort

The data available is not sufficient to estimate the potential number of mud clam collectors in the area. It is however understood that women usually collect mudclams when they go handlining and crab collecting.It can therefore be assumed that the same calculated effort for handlining of (419 fishermen) can be applied here.

15.5.4.3 Potential yield

The potential harvest for mud clams in the two lakes is estimated to be 95.5 tonnes. This calculation is based on a potential effort of the product of 419 x 120 women fishermen days and the average catch rate of 1.9 kg/man-days. Of this total, 4.9 tonnes is harvested for subsistence consumption. The caveats applied to all the yield estimates made here apply equally to this computation for molluscs. Further, the estimate of potential yield is based solely on harvest rates for mud-clams and not on the total production of molluscs from the Murik Lakes. The study did not have time to study the size of the resource, or collect data to work out standing stock. Should markets for mud-clams start to expand, it would be important to estimate the safe level

of harvests to preserve subsistence production.

16.0 TRANSPORT

The main communications link between the Murik Lakes people and Wewak is sea transport. Existing roads in the Murik Lakes region are in fairly poor condition, especially during the rainy season. Sea transport will remain important to the Murik Lakes inhabitants until a good road net work is developed. Wewak is linked to the inland urban centres of the East and West Sepik by road and air routes. Weekly coastal shipping is available between Wewak, Aitape, Vanimo, Madang, Lae and other main ports. There are also regular flights by Air Niugini, Talair, Douglas Airways and Missionary Aviation Fellowship (MAF) connecting Wewak to the major populated urban centres in the interior of P.N.G. Wewak is therefore ideally located in regard to connection with all other provincial centres whether by road, sea or air transport.

During the survey, two methods of fish transportation by sea between the central village (Darapap) of Murik Lake and Wewak were considered: by collection vessel and by local outrigger canoes. The survey carried out a number of trials transporting fish by vehicle to inland urban areas (Murik, Lumi etc) and the results are summarised in this report. No test shipments of fish by air were made to highlands provinces or by coastal shipping to coastal provincial towns.

16.1 COLLECTION VESSEL

Table 26. Expenditure per trip of the collection vessel MV Yauwiga during January to March 1985.

Item	Unit cost (Kina)	Quantity	Cost per trip (Kina)
Capital depreciation on vessel			125.00
Fuel	0.52	145	78.80
Wages & allowances	86.80	3 crew	260.40
Victualling	18.75	3 crew	56.25
Ice block	1.50	140 blocks	210.00
Maintenance & repair			31.00
Miscellaneous			20.00
			777.45

This method requires a vessel capable of transporting iced fish back to Wewak. Collection vessels are normally run by an organisation such as the D.P.I., Fisheries Extension Section or a private company. During the survey, the M.V. Yauwiga, a 14m Provincial Government work boat was used as a collector vessel. The Yauwiga was not designed as a fisheries vessel and could carry a maximum of about 2.5 to 3 t of fish in ice chests packed in the holds. A summary of the operational costs of the Yauwiga during the period of the resource survey is given in Table 26. Depreciation costs of the vessel are based on an initial capital cost for a new boat of K 50,000, an average life span of this type of vessel of 10 yrs and a estimated 40 trips per year to the Murik Lakes.

The unit cost per trip of running a collection vessel between the Murik lakes and Wewak was K 777. This assumes that the vessel maintains operations without any major breakdowns that involve extra capital expenditure. During the survey the collection vessel was landing an average of 900 kg of fishery products per trip. This gives a high transport cost of 86t/per kilogram of fishery product transported between the Murik Lakes and the Wewak Fish Plant. The Yauwiga is a coastal cargo boat and not ideally suited to fish collection. By comparison if a smaller 8.5m dory was used with a similar fish carrying capacity then the transport costs would be considerably lower. Similar cost estimates were made based on the performance of such a dory, the Didiman II, using the same volume of fish transported in this survey. The estimated unit cost per trip for the Didiman II was K 255, which would have reduce the costs of fish transported in the survey to 0.28/kg.

16.2 OUTRIGGER CANOE

Table 27. Estimated operating costs for an outboard powered outrigger canoe transporting fish to Wewak.

Item	Quantity	Unit cost	Cost per trip
Depreciation of 8-11m canoe	1	500	3.60[a]
Depreciation of 25hp outboard motor	1	1200	14.29[b]
Depreciation of 500kg ice boxes	2	1000	7.14[c]
Fuel	102 litres	0.58 K/l	59.40
Trip allowance	5 x 8 man days	1.00 K/man/day	40.00
Ice blocks	50 blocks	1.50/block	75.00
Maintenance			20.00
Miscellaneous			10.00
Total			

a. Assumes life span of 5 yrs for large canoe travelling regularly between Murik Lakes and Wewak.
b. Assumes life span of 25hp outboard motor under these conditions would be about 3 yrs.
c. Assumes that life span of plastic or fibreglass iceboxes under these conditions would be about 3 yrs.

If each village was responsible for transporting their own catches to the Wewak Fish Plant, they would use large 8-12 m outrigger canoes driven by 25hp outboard motors. Twelve trips to Wewak were carried out by the S.D.A. fishing group at Darapap in late 1984 and a summary of the running costs are shown in Table 27. It is assumed that each canoe would transport 500 kg of fishery products per trip to Wewak at a cost 0.46/kg/trip. The cost of transportation by canoe appears to be more expensive than by an 8.5m dory but still considerably cheaper than by the Provincial Government work boat. While transporting fish by canoe is relatively expensive, the advantage is that the fishermen are employed and are responsible for organising trips to and from the Murik Lakes. The main limiting factor is that canoes can only make an estimated 28 trips in a year, as the weather is too rough for five months during the northwest monsoon. This in turn could affect the continuity of supply of fishery products to markets.

16.3 LAND TRANSPORT OF FISH TO THE WEWAK PLANT

The only road which could be used to transport fish from the Murik Lake goes from Wewak to Kaup via Angoram. The road is impassable during the 5 month period of the wet season each year. There is a possibility that monohull canoes could transport catches to Boig (Fig.2) but to maintain such operations for twelve months of the year, major improvements would be needed to sections of the road and some of the waterways leading to the pick up points. However, if there were suitable roads to and from this region then fisheries products from the Murik Lakes could be landed in Wewak faster and cheaper than by sea transport.

16.4 FISH TRANSPORT FROM PLANT TO EAST SEPIK INLAND MARKETS

During the survey, three trial trips were conducted transporting iced fish from Wama Marine to Nuku (120 km) and Lumi (180 km) in the West Sepik Province, and Maprik (65 km) in the East Sepik.

Table 28. Running costs of using a 4 wheel drive utility truck to transport fish to Nuku and Lumi in the West Sepik Province.

Item	Quantity	Unit cost (Kina)	Cost per trip (Kina)
Depreciation of truck	1	10,000	50.00[a]
Depreciation of ice box	1	500	3.30
Fuel	72 litres	0.61/l	44.00
Allowances & victualling	6 man days	13.0/man day	78.00
Ice blocks	25	1.50/block	37.50
Maintenance			25.00
Total			237.80

a. Based on 4yr period before replacement, in common with PNG Government practice.
b. Assumes that life span of plastic or fibreglass iceboxes under these conditions would be about 3 yrs.

During each trip an average of 400 kg of fish was carried by the truck. The details of costs of transporting fish to inland markets by road is shown in Table 28. Based on the figures in Table 28, the unit costs of sending 500kg of fish to Lumi or Nuku is 48t/kg

If some other produce could be carried on the return trip then overall costs would be reduced. The cost of transporting 1kg of iced fish by road to Lumi, Nuku and other urban centres in the East and West Sepik Province are shown in Table 29. These costs are based on Table 28 but with different fuel costs according to distance from Wewak.

Table 29. Costs of transporting 500 kg of fresh iced fish to urban areas of the East and West Sepik Provinces. Each trip is assumed to last for three days.

Urban area	Transport costs (500kg) (Kina/kg)
Angoram	0.43
Maprik	0.43
Aitape	0.48
Lumi & Nuku	0.48

16.5 AIR TRANSPORT

Table 30. The unit cost of airfreighting frozen fish from Wewak to other provincial capitals in mainland PNG.

Provincial capital	Unit cost of airfreight (Kina/kg)
Madang	0.73
Lae	1.08
Goroka	0.86
Mount Hagen	0.68

Before the Murik Lakes survey, Wama Marine arranged marketing outlets for fisheries produce in Madang, Goroka and Mount Hagen. Although an effort was made in 1984 to market fish from Wewak to these towns, the cost of transport became prohibitive. The figures summarised in Table 30 show that air transport does not encourage fish trade between the inland provinces and coastal towns where there is no road link.

Due to the high purchase price of fish in villages and high air freight costs Murik Lakes fishery produce cannot compete with imported frozen fish in other centres unless an agreement can be made between the airlines to decrease the freight costs. There is the alternative of sending fish to other provincial centres on the coast such as Lae and Madang via commercial cargo vessel as the costs are not prohibitive. Freight costs between Wewak and Lae, for example, are 0.14 K/kg on the regular Lutheran Shipping service.

17.0 PROCESSING

17.1 INTRODUCTION

There are a number of different types of fish processing carried out by either the fishermen themselves or by the staff of the Wama Marine fish plant. In the village fish is mainly preserved by smoking and icing. Crabs are sold live while clams are either par-boiled or smoked. The fish plant at Wewak receives and freezes iced fish. These are sold frozen to wholesalers or in small quantities to retailers as iced fish.

Experience of marketing at the Wama fish plant has shown that Wewak and East Sepik inland markets greatly prefer good quality iced fish rather then frozen fish. The same consumer demand for iced rather than frozen fish is apparent throughout the coastal regions of PNG. During the Murik Lakes survey utilized this information to aimed at producing iced fish. It investigations were made on the length of time that good quality iced fish can last in an ice box and the cost in processing and transporting this product to market.

17.2 FISH ICING

During the survey 4 x 500kg capacity ice boxes were carried on the collecting vessel using 1500kg of ice per trip each week. One of these 500kg ice box with 375kg of ice was located at each of the four villages. Fish were brought in gilled and gutted and packed in crushed ice at a 1:1 fish to ice ratio. The collection vessel remained 2 to 3 days at the Murik Lakes before returning to Wewak. At the plant, the fish were sorted out into family groups and size, washed in iced water, packed in crushed ice (1:1 ratio) and stored in a 2.5 tonne chiller. The advantage of iced fish is a product geared to a local demand with relatively low over-heads. However, whilst handling a small quantities of iced fish is relatively simple but a storage of large volumes of fish requires that it is frozen if immediate sale to markets is not possible.

17.2.1 Cost of processing frozen and iced fish.

The costs of processing a kilo of iced or frozen fish, from the period it enters the plant to the time it is received by a consumer, are shown in Table 31. The estimated cost is based on the data made available during the survey. It was assumed that the plant operates 52 weeks of a year and that an average of 1.5 tonnes of fresh fish were landed weekly. The unit cost of processing fish under these conditions is 0.19 kina/kg.

Table 31 The unit costs of producing a kilogramme of iced and frozen fish in the WAMA Marine fish plant.

Item	Cost (Kina)
Depreciation of capital[a]	16.58
Labour	348.00
1500 kg of ice	195.00
Electrical power (7 days)	50.40
Total	291.98

a. Based on weekly depreciation of capital value of machinery in WAMA marine fish plant

17.2.2 Frozen fish

Approximately sixty percent of fish landed were frozen. As a small blast freezer was not available, the quality of frozen fish was poor and was not well received by the main stores and consumers. In the absence of a blast freezer, fish were stored in a 20 tonne cold store. This practise prevented the survey team from maintaining a good quality product. This resulted in the termination of the investigation by the survey into frozen fish products, and testing its acceptability in the local and P.N.G. domestic market.

17.3 FISH SMOKING

During the study period very little smoked fish product from the Murik Lakes was sold at Wewak Council markets. It has been noted that there is a market for smoked fish in Wewak and in the inland areas, although the survey did not investigate this market potential. Information collected by D.P.I. Fisheries Extension does suggest that current smoked fish products are of low quality.

18.0 MARKETING OF FISH FROM THE MURIK LAKES

18.1 INTRODUCTION

The East Sepik Province is in an ideal situation setting up a local market for iced fish. It has a good road network to most of the major inland and coastal districts. Improvement of roads to inland area of the East Sepik has attracted a large percentage of the rural population engaged in cash crop farming to either settle along the road side, or make road or water-ways which connect to main highways. New settlement schemes such as at Gavien are contributing to the concentration of the population to areas accessible by roads.

These new developments are creating good local market opportunities for fresh fish within the Province which is preferable to the export of fish to other provinces as this is prohibitively expensive. Provided that the East Sepik Provincial Government develops an aggressive marketing policy for freshly iced fish, then any increased fish production arising from the development of Murik Lake fisheries and the Turubu/Wewak islands deep slope handline fishery (Chapau 1986) could be marketed within the province. To maintain quality with iced fish marketing the product should reach the consumers within 7-10 days from the time it was caught. It will take sometime to develop a marketing system of this nature, and for the time being a large volume of fish will have to be frozen and marketed as such.

18.2 LOCAL MARKETS

The local market is here defined as the East Sepik province, including some centres in the West Sepik. In 1985 it was estimated that there were about 250,000 people living in the East Sepik Province. A rough estimate of the potential demand for fish can be determined from the population figure and the average per capita consumption of fish in the East Sepik region. The per capita consumption of fish at the Murik lakes is about 53.5 kg/person/yr and is probably unrealistically high for the Province as a whole. In the Tigak Islands of New Ireland Province, Wright & Richards (1985) observed that coastal villagers consumed only 8.3 kg/person/yr and this is thought to be representative of much of lowland and coastal PNG. Applying this figure in the case of the East Sepik Province gives a total potential demand for fish of 2,075 t of fish.

Given that the majority of this population is scattered over wide area, it would be prudent to concentrate development of local markets in urban areas where the demand for fish will be concentrated. The populations of the four principal urban centres in the East Sepik and the

potential demand for fish are shown in Table 32.

Table 32. Populations and potential fish demand for four major urban centres in the East Sepik Province.

Urban centre	Population	Potential fish consumption (t)
Wewak	22,503	198.0
Angoram	2,088	18.4
Maprik	1,273	11.2
Ambunti	1,172	10.3

18.4 P.N.G. DOMESTIC MARKETS

A lucrative P.N.G. domestic market may be developed in Tabubil, Kiunga and some towns of the highlands provinces like Mount Hagen, Goroka and Wapenamanda. These areas have recently shown interest in high value fish such as the deep slope species of red snappers (*Pristopomoides* spp, *Paracaesio* spp & *Etelis* spp). Due to the high risk in sending perishable items by air, fish needs to be frozen for transportation. The main constraint to developing these Highland markets is, as shown earlier, the high cost of air freight (Table 31). There are a number of arranged charter flights between Wewak and the Highlands region bringing back vegetables. It might be possible to arrange with these charter agents to make return flights laden with frozen fish.

18.5 EXPORT MARKETS

As a fish market develops and matures in the Province, investigation into the possibility of export markets for prime fish such as snapper fillets is warranted. Initially the first priority will be the development of local markets followed by P.N.G. domestic markets. There could however be fisheries products not acceptable or economical in the local or P.N.G.domestic markets and these could be exported to available overseas markets. It is felt that an export market for high value fisheries products will develop as fish production increases, when the quality improves to export standard. As far as the Murik Lakes fisheries produce is concerned, the only high value resource is large mud crabs.

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