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Fish stocking activities undertaken by the Sepik River Fish Stock Enhancement Project (1987-1993) and the FISHAID Project (1993-1997)

prepared by

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TABLE OF CONTENTS

1. INTRODUCTION

This report lists the fish stocking/enhancement activities undertaken by the FISHAID project and its predecessor (the Sepik River Fish Stock Enhancement Project). During both projects stock enhancement activities were as approved by the Government of P.N.G. Each species selected (as listed below) was subject to a rigorous pre-appraisal for its suitability for P.N.G. This included adherence to an internationally recognised code of practice for the introduction of aquatic species. Each species selected was subject to a separate report (as listed below) including the reasons for its selection, a lengthy appraisal of its suitability and the approval procedure as per code recommendations.

The purpose of this report is to archive stock procurement and release details for each species so that their progress in the river basin can be monitored. Fish were released only into the Sepik-Ramu River basin by the two projects.

2. GENERAL STOCKING STRATEGY

The Sepik-Ramu basin covers an area of approximately 100,000 km^2 with over 150,000 km of rivers greater than 10.0 m wide and an unmeasured expanse of smaller tributaries. The floodplain area is about 35,000 km^2. There are a wide variety of aquatic habitats the nature of which are determined chiefly by river gradient and altitude. The basin itself extends from 4509 m elevation to sea level.

Fingerlings were either produced or reared at either Madang (for warm water species) or Yonki (for coldwater species). The way in which these hatcheries operated is described by Visser (1996).

The purpose of the release of fish into the basin was to improve the fish stocks. In theory, once the species are established in the river basin (i.e., they have started breeding and produced self-maintaining populations) the task is complete. There was no intention to recurrently stock fish into areas where they were already established.

Generally speaking the stocking could be divided into two programmes each with somewhat different requirements:

(i) in lowlands

To a large extent lowland habitats are relatively uniform, or at least are interconnected by a network of channels in which there is a fairly standard environment throughout the basin. Fish released at one suitable location (e.g. a lake in one corner of the basin) can, in theory, and given time, spread to all other lowland locations within the basin with similar environments, provided the species can move either through floodplain channels or along rivers. However, the time taken to spread throughout the basin can be large - depending on the speed by which the population spreads. This speed is influenced chiefly by the habits of the species. Those species with limited home ranges and parental care of the offspring (e.g., tilapias) disperse very slowly. Those species which migrate long distances, are highly fecund and/or have larvae which disperse through river channels can increase their range very rapidly. Previous fish introductions into the Sepik-Ramu have suggested that tilapia disperse at about 20 km per year and common carp at twice that rate (Coates 1989a). In theory, all that is required to establish a species throughout lowlands is to establish it in a single location and wait for it to disperse on its own (assuming it can reach the remainder of the habitats). However, in order to reduce the length of time taken

for the benefits of the introduction to be realised it is advantageous to release the fish at a number of widely dispersed locations.

(ii) at higher altitudes

Here considerations are quite different. For fish to get from one highlands tributary to another (in a different sub-catchment) the fish need to travel through lowland environments; i.e., tributary rivers are only connected in their lower reaches. In order to do this the fish must enter warmer water (water temperature is inversely proportional to altitude). Coldwater species therefore will disperse to neighbouring sub-catchments only as far as their warm-water tolerance allows. This is precisely why the previous stockings of salmonid trout in P.N.G. have resulted in limited dispersal of the species. Such trout stay where they are put (or move into an even smaller catchment upstream) because they will not move downstream, into warmer water. The severity of this problem depends upon the nature of the species in question. The higher the water temperature that is tolerated by the species, the fewer is the number of loci required to establish the species throughout the basin.

Unfortunately, it is not known how many fish of a particular species need to be released in order to establish the species at any particular site. Neither is it known, for certain, which particular sites, irrespective of numbers of individuals released, are certain to support populations. The options for stocking strategies available are also influenced by the availability of stocking material. Where small numbers of fingerlings are available there is a debate whether to put them all in one place or spread them between two or more places.

Yet another factor is accessibility of required stocking sites. Deciding on an "ideal" release site is one thing, getting there can be quite another. The road network into the Sepik-Ramu is very limited and charter rates for fixed wing aircraft expensive, helicopters even more so.

A further constraint is the lack of a competent aquaculture facility in P.N.G. Under more favourable circumstances all of the stocking activities could have been completed with a single importation of broodstock and the development of domestic based breeding programmes. Unfortunately, the only aquaculture facility in the country (at Aiyura) was not reliable enough to base the introduction programme on such a strategy. Of course, for each species imported a number of fingerlings were held back to form the basis of future domestic breeding programmes but this approach could not be relied upon. Experiences with valuable broodstock placed at Aiyura by the project have reinforced this view (details below).

All of the fingerlings stocked by this programme were produced and/or raised in the project's own modest hatcheries at Yonki and Madang.

In view of the above the following principles applied:

Priority # 1 - establishment of the species in <u>any</u> location in the wild

Obviously the first priority was to get the species established anywhere in the river basin - if necessary at the expense of all other stocking considerations. The reasoning for this was that it was thought unlikely that the import of stocking material could be facilitated after the end of the project. Establishment in one place in P.N.G. would at least give the species a chance to disperse in the longer term on its own or give P.N.G. authorities access to the stock at a later date in order to eventually commence a breeding and distribution programme. However, because of the above mentioned uncertainties this generally meant releasing at more than one site

Priority # 2 - establishment of the species in more widely dispersed locations in the wild

Priority # 3 - rearing broodstock for future domestic breeding programmes

Although a lower priority, because of the low numbers of fish required, this was actually achieved for all species (except *Osphronemus gouramy* which is already available locally). Because of the time taken to maturity, or the space required, broodstock material had to be transferred to Aiyura at various times. The husbandry of the species after leaving project control was not impressive.

The choice of release sites was influenced by a combination of factors including:

(i) accessibility

In general, if release sites are accessible by road or fixed wing aircraft they are in locations with relatively large populations of people.

(ii) fishing pressure

Obviously, for priority # 1 releases the lowest fishing mortality possible is desirable. Unfortunately, almost by definition, such sites are the most inaccessible. The disadvantage of such sites is that they are difficult to return to and/or obtain feed-back on the progress of the species.

Needless to say, the selection of release sites was always based on a compromise approach. In general, and according to the number of fingerlings available for a particular species, early activities concentrated on releasing larger numbers of fingerlings - preferably at least at three sites. Later activities focused on more widely dispersed smaller releases.

Yonki reservoir was a major release site for most species. The dam is located across the upper Ramu river (altitude about 1300 m) and was constructed in 1991. This site offered several advantages mainly relating to its accessibility. The site is strategically located both for release and for potential re-capture of stock at a later date if required (e.g. for future breeding programmes). The ecosystem is also relatively enclosed and it was thought that some species, having their movements restricted, might establish better at this location. Most species were released there and it formed the primary site of a number of these (particularly the Mahseers). Major drawbacks of the site are the high fishing pressure, although as of early 1997 this arises mainly from hook & line and nets are not abundant, and the less than optimum environmental conditions for a number of species.

The size of fish at release was generally determined by hatchery operation considerations. In general, fingerlings as big as possible were released. In practice, this was usually a minimum of 25-40mm total length and often larger (details below). The Sepik-Ramu has no piscivorous fishes so a relatively small stocking size is acceptable. There are, however, a great number of predatory insects and it was to attempt to avoid these that the release of very small fish was generally avoided.

3. STOCKING ACTIVITIES BY SPECIES

Brief details and a diagram of each species are provided in appendix 1.

3.1 Tilapia rendalli

For details of this species see Coates 1990b.

(a) source of stock

Approximately 900 fingerlings (to 20mm) were imported from the Institute of Aquaculture, University of Stirling, Scotland in August 1990. These were from a certified disease free stock. These were from 16 parents, hence 8 identifiable stocks arrived, although the history of the parents is not known. The 8 stocks were combined to produce 4 groups, and males and females for each were reared in separate tanks at Madang. These 4 groups were later cross bred to produce fingerlings for stocking. Breeding size was reached after 4 months but the breeding programme proper started in June 1991. All released stock was produced from an intensive breeding programme at the Madang hatchery. All fish were bred and reared in a closed circuit system based on galvanised iron water tanks of various dimensions. After a while the production system became highly efficient considering the limited space. Productivity was enhanced by placing paired fish in small breeding tanks and leaving them for a maximum of 10 days to spawn (after which pairs were changed). Immediately after eggs hatched, larvae were siphoned off and placed in nursery tanks. This system greatly increased productivity as it avoided having to wait for juveniles to become big enough to move. At the benthic stage the larvae are easily collected (by siphon). Once free swimming they are too delicate to handle or catch.

(b) releases

Table 1 lists all of the releases of *T. rendalli*.

A total of 173,118 fish were stocked in 52 individual releases. Release sites were widely dispersed throughout both the Sepik and Ramu catchments.

(c) feedback/monitoring

Confirmation of breeding by the population in Yonki reservoir was obtained by mid-1992 (6-8 months after first release). Confirmation of breeding was also reported at a similar stage for releases in the lower Ramu River area (Bunapas). Most stocking sites have not been revisited but reports from villagers confirm that *T. rendalli* is now well established although its range may be still expanding and the population has yet to stabilise. The fish is highly regarded in regions where it is now caught. It is preferred over the already resident *O. mossambicus* due to its superior taste. *T. rendalli* is performing remarkably well in Yonki reservoir where conditions were considered sub-optimal due to the scarcity of macrophytes. It already accounted for approximately 25% of landings by 1993 (only 18 months after first release). Its contribution to catches appeared similar in 1995 although total landings had increased significantly by then (the remainder of the catch at these times was common carp 50%, *O. mossambicus* 25%).

(d) future requirements

The species can be considered well-stocked. Follow-on stocking activities should not be required.

3.2 Osphronemus gouramy (Giant Gouramy)

For details of this species see Coates 1990b.

(a) source of stock

A total of 37 adult fish (450 to 950 mm, approx. 1.5 to 6.0 kg) were collected from Brown River area on the outskirts of Port Moresby in February 1993 (which required considerable effort and logistical support). These were then flown to Madang. Fish were placed in the largest tanks available (only 5.0 m^3) with shade and plenty of nesting material. The fish survived well and were fed on a diet of various forms of vegetable matter the bulk of which was avocado. The fish grew well and were in good condition after one month. Despite trying various methods (e.g. changing water levels etc.) the fish could not be persuaded to breed. Without ponds, this was known to be a long-shot to say the least. Eventually space was required for *Puntius gonionotus* and the fish were released in November 1993.

(b) releases

All 37 adults were released into a small ox-bow lake (approx. 10 hectares) in the upper Ramu floodplain area near Brahman Mission (Table 2). This lake is surrounded by dense forest and has a connection with the main Ramu River. It is quite remote, no villages are nearby, and probably is lightly fished. Fish were released from a helicopter and all survived. It is hoped that given time these fish may breed and the species will spread into the Ramu. However, 37 is a very small number to release although they were all of breeding size and it was a good release site.

(c) feedback/monitoring

Nil - the area is deliberately inaccessible and difficult to get to for monitoring purposes.

(d) future requirements

Obviously, monitoring programmes should first determine if juveniles of this species appear in the lakes and backwaters in the Brahman area (Table 2). If it breeds there it can be assumed that the species will eventually disperse widely. Dispersal of this species will be very slow (the fish tends to avoid running water; i.e., it is not keen on travelling through rivers). Future attempts should be made to breed this fish in P.N.G. and release it in a more appropriate fashion. However, this will require the use of warm water ponds (currently unavailable).

3.3 Trichogaster pectoralis (snake-skin gouramy)

For details of this species see Coates 1990b. The species is available from the vicinity of Port Moresby.

No attempts were made to introduce this fish into the Sepik-Ramu. At the time it was deemed more of a priority to work on the species that needed to be imported to P.N.G.. In theory, this species should be stocked into the Sepik-Ramu by the relevant fisheries authority/department (at the time of writing it is unclear which this is) by obtaining a small number of adults and breeding them in ponds.

3.4 Puntius gonionotus (Java Carp)

For details of this species see Coates 1991a.

(a) source of stock

The fish was obtained from the Faculty of Fisheries & Marine Science, Universiti Pertanian, Darul Ehsan, Selangor, Malaysia (this faculty has now moved to Kuala Trengganu). The key contact person was Dr. Mohamed Shariff (who was also co-ordinator of the Asian Fish Health Network). Adult fish were already available there. These were screened for diseases, then bred. The project imported only fertilised and disinfected eggs (which hatched in transit). After ascertaining the correct shipping and packing technique (including stopping the airlines x-raying the eggs which causes mass mortalities) the system proved highly efficient. Unfortunately, just as the project was ready to import large numbers the problems over control of quarantine for fish in P.N.G. erupted (this was dispute between the Dept. of Fisheries and the Dept. of Agriculture). Initial imports were eventually destroyed by the Dept. of Agriculture (despite the aforementioned thorough quarantine process) and there was a one year delay before the dispute was resolved.

The stocking programme for *Puntius gonionotus* was halted early because space was required for other species. However, broodstock were deposited at the government fish hatchery at Aiyura. Since the species has aquaculture potential in P.N.G., and is relatively easy to reproduce and rear, it was thought that the chances of a breeding programme being established by the government were reasonably good. The species also breeds quite early. On this basis, the species was put aside for more difficult species with the hope that it would be bred domestically.

(b) releases

Releases are shown in Table 3.

A total of only 27,750 fingerlings were released at 8 different sites. One of these, Bunam, is in an area of good *Puntius* habitat (shallow swampy/weedy area with many river channels in the middle Sepik). About 12,000 fingerlings were released there. Two other sites were stocked reasonably well - Bunapas and the Brahman region (in the upper and lower Ramu floodplain respectively) (Table 3). A few small scattered releases occurred at a number of other sites.

(c) feedback/monitoring

According to verbal interviews with villagers at Bunapas the fish was breeding there in late 1995 (less than 12 months after release). The fish is also reportedly breeding in the Brahman area. These reports are not confirmed by direct observations of project staff but villagers in these regions are usually reliable and have a good understanding of fish stocks. The fish is appreciated in both regions, if a little bony. No feedback has yet been obtained from the other areas.

The fish is well liked at Aiyura and the staff there are impressed with its performance in aquaculture (good growth rate, easy to feed). Project broodstock were spawned there in early 1996. Unfortunately, due to poor management a full spawning produced only 32 fingerlings. A second successful spawning was undertaken in August 1996. The project requested Aiyura supply 500,000 fingerlings to complete the stocking programme in the Sepik-Ramu. This was a modest request considering the fecundity of the species and the extent of the facilities available there.

At the close of the project the policy of the management of Aiyura was that fingerlings of *P. gonionotus* were only available for stocking village ponds and not for supporting the FISHAID programme. As of March 1997 the FISHAID project was also informed that Aiyura staff had difficulties rearing the species because the larvae were "too small" and "smaller than the food available". The species is in fact one of the most commonly and easily reared of all the Asian carps. The FISHAID project actually imported fertilised eggs and reared the fish at Madang, without any ponds available and without any source of natural food, with a survival

rate of 80%. The experiences with the fish at Aiyura illustrate the considerable scope for improved management at that facility.

If the species is adopted for aquaculture in P.N.G. it will eventually be distributed widely. Further releases into the wild can be considered an inevitable consequence of this. A large proportion of fingerlings produced at Aiyura are actually released into the wild by their "customers", apart from regular escapes from ponds.

(d) future requirements

Breeding at Bunapas and Brahman should be confirmed by direct observations. Monitoring should also occur at Bunam. This should be done now (in 1997). Irrespective of the result of these surveys, about 500,000 more fingerlings should be stocked widely throughout the Sepik-Ramu. Even if the previous releases were successful, it will take a long time for the benefits of this species to be fully felt throughout the basin. Releases can occur anywhere but preferably in large numbers in the upper Sepik, middle Sepik (upstream of Angoram in the Pagwi area) and the lower Sepik (near Angoram). *Puntius* tolerates relatively cold water and will survive well in rivers. It can, therefore, be stocked in highland rivers leading down into the main Sepik or Ramu floodplains. This has the advantage of easy access by car from Aiyura. Release sites might include Jimmi River, Baiyer River or the Lai River near Wapenemanda. The fish can also be released in any of the Sepik tributaries along the Torricelli Mountains running across the north coast from Wewak.

At the time of writing, and despite written requests and instructions from the NFA at executive level, no *Puntius gonionotus* had been released into Yonki Reservoir. The species should be released there (5000 should be enough).

3.5 Tor putitora (Golden Mahseer)

For details of this species see Coates 1991b.

The species is endangered in its native range and quite difficult to obtain in large numbers. Considering the logistical problems of supply and transport from either northern India or Nepal it was quite an achievement that the project was able to stock as many as it did.

Tor putitora prefers warmer water than anticipated (at least under hatchery conditions). Its performance at the Yonki hatchery (water temp. 19 °C) was poor (poor growth, high mortality). It did much better at Madang where water temperatures can reach over 30 °C.

(a) source of stock

From India: the government fish hatchery at Haldwani, Uttar Pradesh. From Nepal: the government fish hatchery at Trishuli. Both founder stocks originate from the same river system - the upper Ganges. Of the two, supply from Nepal proved more reliable.

(b) releases

Details of releases are shown in Table 4. A total of 29,827 fingerlings were released at 9 different locations. The main release site was Yonki reservoir where 11,391 individuals were released. Other major release sites were at Marea River (5090), a tributary of the upper/middle Ramu at Brahman, the Urom River (5000) which is a tributary of the Keram River (a major Sepik River tributary) and the Clay River (3865) which is also a tributary of the Keram River. Both of the latter sites are in the Sepik foothills and very remote. Release was by helicopter. Both appeared to be excellent *Tor* sites and fishing pressure should be low (if the fish stay there until breeding age).

506 individuals of good size and quality were placed at the Aiyura fish farm in three batches. These were kept in a single pond together with the *Acrossocheilus hexagonolepis*. These were to be raised as broodstock. Despite the very low numbers of fish available for stocking, the endangered nature of the species in the wild, the enormous cost of procuring these stocks and their transport to P.N.G., the management at Aiyura managed to kill 90% of the first two batches within the first year. The main problem was lack of vigilance and poor pond management. These mahseers are river fish and will not withstand low oxygen levels. As of September 1996 an estimated 100 only remained.

(c) feedback/monitoring

The species is not expected to breed until at least three years old. A good sized specimen was observed in a fish catch at Yonki reservoir on 17/12/95. This measured 230mm (SL), and weighed 215g (gutted). It was in good condition. (Fishermen had been asked to return these fish if caught but many people did not do this). This was assumed to be from the first batch stocked in February/March 1995. Therefore, at the most it was about one year old (9 months in the reservoir). This is a good growth rate for mahseers. A similar sized specimen was caught during experimental seine netting undertaken by project staff on 30/10/96 and released alive without weighing. A group of six specimens (undoubtedly caught by net - supposedly banned in the lake) were seen for sale in November 1996. These were approximately 450 mm (total length) and perhaps 750 grams. Although confirming the fish is doing well in the lake there are concerns of over-fishing and especially the growing use of nets. [At the time of writing there was no management infrastructure for this important growing fishery].

(d) future requirements

Yonki reservoir should be monitored for the appearance of small *Tor putitora* starting in early to mid 1998. If the species establishes there (i.e., starts breeding) then this population can be used as a founder stock for an extended domestic breeding programme should the stocks placed at Aiyura fail to survive. Further stocking is required in order to improve the chances of establishment elsewhere and promote more rapid colonisation of the river basin. None of the sites chosen by the project were stocked adequately due to a shortage of fingerlings.

The species prefers rivers and can be stocked easily from Aiyura by road at either the Ramu or Marea Rivers at Brahman. Since it will tolerate reasonably cold waters (to about 18-20 °C) the Jimmi River (Baiyer River or Lai River tributaries near Wapenemanda) can easily be stocked by road from Aiyura. If larger numbers are available stocks should be released in the Sepik tributaries along the Torricelli Mountains west of Wewak. A domestic breeding programme should aim to stock/release about 250,000 over a period of 3-4 years.

3.6 Acrossocheilus hexagonolepis (Chocolate Mahseer)

For details of this species see Coates 1991b.

Supplies of this fish were unavailable from India because of civil disturbances in its range there. From Nepal stocks were extremely limited because of the difficulties the Nepalese experience in breeding and rearing this species. This is possibly because they had poor broodstock. Very few were available in 1994, but more in 1995.

Acrossocheilus hexagonolepis prefers warmer water than anticipated (at least under hatchery conditions). Its performance at the Yonki hatchery (water temp. 19 °C) was poor

(poor growth, high mortality). It did much better at Madang where water temperatures can reach over 30 °C.

(a) source of stock

The government fish hatchery at Trishuli, Nepal (source of stock - the upper Ganges).

(b) releases

Releases are listed in Table 5. A total of 11,224 fingerlings were released in five different locations. Of these, 4085 were released in Yonki Reservoir. Of the initial 69 individuals placed at Aiyura in March 1995 it is assumed that most met the same fate as for the *Tor putitora* above. A further 250 fingerlings were placed at Aiyura in September 1996.

(c) feedback/monitoring

Nil - too early to expect any results. The fish is anticipated to breed at 3 years old at the earliest.

(d) future requirements

Yonki reservoir should be monitored for the appearance of small *Acrossocheilus hexagonolepis* starting in early to mid 1998. If the species establishes there (i.e., starts breeding) then this population can be used as a founder stock for an extended domestic breeding programme should the stocks placed at Aiyura fail to survive. Further stocking is required in order to improve the chances of establishment elsewhere and promote more rapid colonisation of the river basin. None of the sites chosen by the project were stocked adequately due to a shortage of fingerlings.

The species prefers rivers, but will live in relatively warm lakes, and can be stocked easily from Aiyura by road at either the Ramu or Marea Rivers at Brahman. Since it will tolerate reasonably cold waters (to about 20 °C) the Jimmi River area (alternatively the Baiyer River or Lai River tributaries near Wapenemanda) can easily be stocked by road from Aiyura. If larger numbers are available stocks should be released in the Sepik tributaries along the Torricelli Mountains west of Wewak. A domestic breeding programme should aim to stock/release about 250,000 over a period of 3-4 years.

3.7 Schizothorax richardsonii (snowtrout)

For details of this species see Coates 1991b.

The main snowtrout producing areas of India are Jammu, Kashmir and Uttar Pradesh. All of these areas were subject to civil disturbances during 1993-1996. Supply of snowtrout from India was therefore less than anticipated. Supplies from Nepal were more reliable.

Snowtrout prefer cold water and like clean well-oxygenated running water. They survived and grew well at the Yonki hatchery. Experiments were conducted with keeping the species in Madang (both with fry and larger fingerlings). Snowtrout did survive in Madang (water temp to about 30 °C), and for up to two months (thereafter they were moved), but with increased mortalities. To achieve this they have to be acclimatised fairly slowly (over a few hours). Sudden temperatures increase to this level are more lethal. They did not grow or feed well at Madang and tended to become emaciated. They also tended to undergo mass mortalities, for example, on particular hot days when water flows were reduced and tank temperatures rose above the 28-30 °C. It appears that 29-30 °C would be the upper limit of their temperature tolerance. However, the fact that they did at least survive under Madang conditions bodes well for the species in P.N.G. Their tolerance of higher temperatures than

salmonid trout was a major reason for the selection of the species since this will aid dispersal (the fish will travel further downstream and hence be able to colonise a greater area, see Coates 1991b). The temperature tolerance of the species is higher than originally thought, which is an advantage. Hopefully this will assist dispersal in P.N.G. although field studies must be undertaken to investigate whether the fish will enter warmer water in foothills under wild conditions.

Two "strains" of snowtrout were obtained from Nepal these were called in Nepal "Buche" and "Cuche" Asla (snowtrout). These are apparently regional variations of the same species within the same river basin, although the taxonomy of the group is in need of revision. Where these differences were labelled on arrival, stocks were kept separate and released at different locations.

(a) source of stock

From India: the government fish hatchery at Haldwani, Uttar Pradesh; but it is understood that supplies originated from Himal Pradesh. From Nepal: the government fish hatchery at Trishuli. As far as could be ascertained both stocks originated from the same river basin - the upper Ganges.

(b) releases

A total of 56,309 good sized fingerlings (25-75 mm, average about 50-60 mm) were released on 56 separate occasions; plus 14,000 younger fish released at Imbrum River. The number of different sites was about 40 but a number of these were in the same sub-catchments. Sub-catchments stocked more intensively were the rivers leading into the Brahman area at the Imbrum, Tauya and Marea Rivers (draining the eastern side of the central cordillera in the Bundi region), and the upper Jimmi River, a Sepik tributary, in the region of the Lai River, Mogulpin River, Kauil-Konsa, Baiyer River and tributaries near the upper Jimmi River itself. A good deal of scattered releases occurred in the upper Ramu valley (Arona valley) around Kainantu (the catchment of Yonki reservoir). Most release sites were fast flowing clear rivers (the assumed preferred habitat) but three lakes were stocked with modest numbers (Lake Imbia - near Maprik, East Sepik; Lake Sirunki or Lake Iviva, Enga; Lake Evadetton, Eastern Highlands).

About 150 fingerlings were placed as broodstock by the project at the Aiyura fish farm in March 1995. These were kept is a circular fibreglass tank under the JICA project managers house in running water from a local groundwater supply. These grew fairly well until a large mortality was experienced when (a) they ran out of feed and gave them chicken food instead, and (b) the water went very turbid after a local storm. Approximately 500 good sized (to 120mm TL) and healthy snowtrout were held at the Yonki hatchery for eventual breeding purposes. The effort put into this spanned over two years and the fish were thought within six months of breeding size at the close of the project. Due to lack of interest in continuing the programme by the management at Aiyura, these fish were released into rivers at the close of the project. This lack of support was widely regarded as a major mistake which P.N.G. will likely regret in the near future.

(c) feedback/monitoring

Nil - too early. The species is anticipated to breed at three years old.

(d) future requirements

It is essential that the progress of the snowtrout is monitored. The earliest that breeding in the wild can reasonably be expected is early to mid 1998 (although under P.N.G. conditions it would not be surprising if they breed early). Rivers in the vicinity of where major releases occurred (Table 6) should be sampled starting about this time and regularly thereafter. In view

of the lack of native species in these rivers "sampling" can be done visually. Fry or juveniles should be collected by seine net for confirmation. Under no circumstances should poisons be used to sample these sites. The next task (if local breeding is eventually confirmed) is to sample adjacent rivers for the presence of snowtrout. The potential for this species to disperse on its own needs to be ascertained. This information will greatly determine future stocking requirements.

The snowtrout was not stocked extensively at any location, nor were the release sites dispersed widely. Even if the species does extremely well from initial implants and colonises all of the sub-catchments already stocked these represent perhaps less than 10% of the river basin. In particular, non of the rivers to the west of Jimmi River running from the central cordillera (Highlands mountains) northwards towards the Sepik were stocked. These cover an area as the crow flies from Jimmi River to the border with Indonesia of approximately 600 km. The areas mainly involved are the central cordillera regions (highlands regions) of East and West Sepik Provinces and Western Highlands and Enga. In addition, the Torricelli-Bewani Range running along the northern rim of East and West Sepik and the Finnesterre and Adelbert Ranges (mainly in Madang Province) need stocking.

It is clear that P.N.G. needs to continue the stocking programme particularly for this species. These initial release need reinforcing with further releases. In view of the availability of snowtrout in captivity now, P.N.G. should not wait for results from this initial programme to become available but should continue to maintain the programme. The snowtrout is perhaps the most important of all of the species stocked simply because it is the species which will live in the rivers in the vicinity of the greatest number of people (i.e., in the highlands). Consideration in the future should also be given to extending the range of the species beyond the Sepik-Ramu, if experiences justify this and if based on sound prior evaluation. It is estimated that approximately 60% of P.N.G.'s population live in areas where snowtrout should establish (this includes all five highlands provinces, which together comprise 37% of the total population, plus people living at higher altitudes in non "highlands" provinces such as East and West Sepik, Madang, Morobe, Gulf, Western etc.). Unfortunately, these areas are, cumulatively, the most difficult to stock because the geology/geography of P.N.G. creates so many different, and often ecologically separate, river sub-catchments.

A domestic breeding programme for snowtrout needs to developed. A sound foundation of potential broodstock was supplied by the project but dumped in the river at the close of the project. The fish are easy to breed but require cool, clear, and clean running water. They also require good hatchery management with proper vigilance of environmental conditions. One solution to this problem may be to contract this work out to a private trout farm (two are available in country, both with spare capacity). Alternatively, the re-circulation system in operation at Yonki can be re-established either at Aiyura or, preferably, in a location with a clean running water supply. The Yonki facility was not designed to rear and breed snowtrout (only to quarantine them) and suffers from a poor water supply. Broodstock might hopefully be obtained from rivers where initial releases were made, if fish become available in the wild. But this is by no means a simple task.

A domestic breeding programme should aim to ultimately produce approximately 500,000 fingerlings per year. Initially these should be stocked in the same areas as initial releases undertaken by the project (Table 6) until such time as natural breeding and recruitment is confirmed there. Thereafter, further releases should be undertaken where required as outlined above.

3.8 Labeo dero

Labeo dero was not easily obtainable from either India or Nepal since the species is not kept in hatcheries there. None were imported. The project decided to concentrate its efforts on the snowtrout and mahseers (above). It is not a popular species in Nepal or India due to its

relatively small size, usually to about 1.0 kg. This, however, represents a big fish by P.N.G. highlands standards. This species remains a possibility for future stocking programmes in P.N.G. either as a replacement for snowtrout (should that species perform badly) or to supplement snowtrout stocks. It is also an excellent species for P.N.G. conditions.

3.9 Barilius bendelesis

Dr. K. L. Sehgal (Advisory Group Member), sent some *Barilius bendelesis* (presumably for trial purposes) in a shipment otherwise made up of *Tor putitora*. This was unsolicited by the project and the fish arrived in P.N.G. without notice. About 200 of these fish were received and placed in confinement in a separate tank at Madang. It was known that the fish had potential utility for the coldwater streams of the Sepik-Ramu and had been recommended earlier as a candidate species by Sehgal (see Coates 1991b). Stocks were therefore not destroyed immediately on arrival but held in confinement at Madang pending its full review as a substitute species for coldwater areas. The stock went through a full quarantine cycle at Madang. However, there was insufficient time to achieve a full review of its status. The remaining stock of this species was destroyed at the end on the project (150 fish were, in any case, considered too few to stock).

The lesser baril, *B. bendelesis*, is the most commonly available fish in the middle and lower Himalayan ranges. Although a small species, it contributes significantly to subsistence and artisanal fisheries in the region. The juveniles feed on planktonic organisms but with increase in length the feeding habits change to plant matter and especially filamentous algae. It grows to a maximum on 250 mm but is more commonly only about 150 mm. Further details are provided in Coates (1991b).

This species should certainly be considered for follow-on stocking activities for the Sepik-Ramu. The fish survived well in running water in Madang and grew fast. It would probably be easy to breed in P.N.G. It is however, susceptible to low oxygen levels and/or unclean water.

3.10 Prochilodus margravii (Emily's fish)

This is considered the most important species released by the project in view of its habits, potential production, eating qualities and potential contribution to both nutrition and income in the Sepik-Ramu.

The S. American name for this fish cannot be pronounced in local languages in P.N.G. Since it has no common name in P.N.G., and after discussion with villagers from the middle Sepik, it was named **"Emily's fish"** after Emily Coates (the project CTA's two year old daughter) who was the first to release the fish in the Sepik-Ramu, and in recognition of the hopeful benefits this magnificent species will bring to children throughout the river basin.

For details of this species see Coates 1992. The original intention, based on communications and recommendations from colleagues in S. America, was to introduce *P. lineatus*. On arriving in Brazil with the intention of obtaining that species, project staff encountered several problems. The species *P. lineatus* is native to the Rio de la Plata River basin in Brazil. However, the species *P. margravii* is native to the Sao Francisco River in the N. E. of the country. The latter species is preferred in Brazil for aquaculture and is reported to grow faster and taste better. It also has a better appearance (more colourful markings). Unfortunately, because of this, aquaculturists have cross bred *P. lineatus* and *P. margravii* in the native range of the former species in Brazil (releases into the wild as a result are certain to have occurred). Therefore the project was unsure of the identity of stocks available from the Rio de la Plata basin. In view of the local preference for *P. margravii*, the more certain identity

of the stock, and the greater ease by which it was available, it was decided to substitute *P. margravii*.

P. margravii is considered the ecological equivalent of *P. lineatus*. For the present purposes the species are considered to equivalent in relation to the review of suitability for the Sepik-Ramu undertaken by Coates (1992), including appraisals following the code of practice.

(a) source of stock

A small proportion came from fish farms in the locality of Sao Paulo, Brazil (where species identity and source of stock were known) but the majority originated from farms in the Sao Francisco River basin - N. E. Brazil, with assistance from CEPTA/IBAMA.

(b) releases

A total of 160,511 fingerlings were released at 16 different sites (Table 7). The chief release site was Chambri Lake with a good number also released at the Yimas lakes, both in the middle Sepik. Lakes Butandana and Virginia (middle Sepik) were also sites, both are quite remote and accessible only by helicopter.

(c) feedback/monitoring

The species will not breed until three years old and establishment is not expected to be confirmed before 1999. After that it will take further time for stocks to build up. In November 1996, villagers at Bunam reported that fish from the earlier releases (from March 1995) were still being caught in small numbers. The fish, therefore, are known to have survived and reports of sizes attained suggest they are growing well. In this region the fish was given the highest accolade of "tasting better than tinned fish". This was gratifying to hear as one of the reasons the fish was selected was for its eating qualities. Apart from the qualities of its flesh and taste the fish has the advantage of a high oil content (which is why it is compared to tinned fish).

(d) future requirements

This is considered by far the most important species for lowland floodplain environments. The fish is a highly specialised feeder consuming only detritus (the break down products of decomposing plants and algae) which is known to be a very productive food source in the Sepik-Ramu. The fish also migrates up rivers to spawn and is anticipated to bring benefits into the mid-altitude, foot-hill, communities living within the basin. The potential biological production of the species in the Sepik-Ramu was estimated at 90,000 tons per annum (Coates 1992). If successful, considerable commercial benefits are on offer, including export potential. The fish can be caught in large quantities due to its schooling habit when migrating (although villagers in the Sepik-Ramu do not presently possess the gears with which to do this).

There are concerns whether the project released enough fish to establish this species. The species is considered difficult to establish because of its migratory habit (it was however its very migratory habit that was an attraction of the species for the above mentioned reasons). The fish feeds in floodplain swamps and lakes and migrates up rivers to spawn. The eggs/larvae then drift downstream and are recruited to lowland floodplains. Therefore, after release and growth, to age three years at the earliest, sufficient adults have to migrate to the same place and spawn. The timing of spawning, and location, also have to coincide with optimal recruitment periods on floodplains (when waters are entering the floodplains during river flooding). In their native range it is also thought the fish breeds at specific sites and has a "homing instinct" although this is not confirmed.

Broodstock of this species were reared by the project. At the close of the project these were placed at Aiyura (where it is possibly too cold) and at Dylup (with PNG Aquaculture) - see Table 7. The fish will actually breed when it is quite small (300 mm) provided it is mature.

Breeding is undertaken using standard hormonal inducement techniques. The fish is highly fecund and even small fish produce hundreds of thousand of eggs. Details for rearing and breeding the species are provided in Visser (1996a, 1996b).

In view of the importance of this species further releases are required and these can be based on a domestic breeding programme. The release of more fingerlings can be undertaken in environments similar to those listed in Table 7. However, it would be perhaps better to release fertilised eggs (or newly hatched larvae) directly into rivers to simulate natural spawning processes. This is best, and easily, achieved by breeding the fish and releasing fertilised spawn (or newly hatch larvae) directly into the Ramu River at Brahman Mission (which can be reached easily by car the same day). That location is also similar to the natural breeding grounds of the species. The larvae can drift for up to four days, by which time, from Brahman, they would have reached the lower Ramu floodplains.

3.11 Colossoma bidens (= Piaractus brachypomum) (Pacu)

For details of this species see Coates 1994

(a) source of stock

The Faculty of Fisheries & Marine Science, Universiti Pertanian Malaysia (UPM). Forty adult fish were purchased from a local farm and placed in quarantine at UPM under the supervision of Dr. M. Shariff. They and their offspring were screened for diseases etc. at UPM prior to shipments for P.N.G. commencing. Preliminary shipments to P.N.G. involved trial shipments with duplicate populations screened for diseases at UPM in addition to after arrival in P.N.G. Unfortunately, after initial successful trial shipments UPM had difficulties obtaining export permits from Malaysia. Once that problem was resolved the Faculty Staff were moved to a different campus in the north of the country, but not the fish. Therefore, only a limited number were imported and much fewer than anticipated.

The fish originally entered Malaysia from Brazil, possibly via Taiwan. The genetic composition of the stock is dubious and is possibly already subject to in-breeding. At the time this was the only stock available with a reasonable degree of safety from a quarantine point of view.

(b) releases

14,511 individuals were released in 9 locations. A number of the sites were remote lakes in the lower and middle Sepik (by helicopter). Bunapas, in the lower Ramu, and Brahman area, in the middle Ramu, were the only two release sites readily accessible by road. Preferred release sites are lakes surrounded by forest in the vicinity of floodplain forest (seasonally flooded forest). This is because the species feeds on fruits and nuts etc. falling into the water from trees.

(c) feedback/monitoring

Nil. The fish was released in small numbers and is not anticipated to breed until 1999 at the earliest.

(d) future requirements

The number of releases of this species was considered inadequate. The fish feeds in lakes and enters river, where it migrates, to spawn. The fish will be highly prized by local communities due to its large size and it is relatively easy to catch by spearing as it lurks under trees waiting for food to drop (although some release sites were remote for this very reason).

On a more positive note it migrates in small schools and if it does spawn the fish is highly fecund.

More releases are required - a suggested target is 500,000 juveniles/fingerlings over two or three years. These should be put in remote lakes where fishing pressure is low. If this is not feasible, releases of larger fingerlings directly into the Ramu River at Bunapas or Brahman could be made (these sites are easily accessible). Fingerlings can be easily produced from domestic breeding programmes (see below).

This fish is considered to have significant aquaculture potential in P.N.G. It desirable features include:

(i) fast growth rate,

(ii) very attractive features for the consumer,

(iii) good flesh and taste with a small head to body ratio,

(iv) most importantly, feeds on fruits and nuts and will consume the waste products from tree crop plantations in P.N.G. (including cocoa, oil palm, rubber nuts, coconut, and possibly coffee waste). In its native range it feeds on Brazil nuts (etc.) which it crushes with its strong jaws and teeth. There is, therefore, little need to process most foods before feeding in aquaculture.

At the close of the project 120 small fish (2+ kg; the fish reaches 35 kg) were placed at Dylup with P.N.G. Aquaculture. Initially these were placed in fibreglass tanks to be later moved to ponds when these were constructed. P.N.G. Aquaculture are interested in the commercial culture of the fish. The project proposed a joint-venture between the National Fisheries Authority and P.N.G. Aquaculture whereby the company obtained these broodstock and a significant amount of aquaculture equipment. In return, apart from investigating the feasibility of commercial aquaculture of the species, fingerlings would be made available for further stocking into the Sepik-Ramu. The fish is highly fecund, producing at least 200,000 fry from even small females. The production of extra fish for stocking, therefore, should not be a problem.

In view of the potential of this fish in P.N.G., the effort and expense that went into its procurement, and the limited numbers stocked by the FISHAID project, the Government of P.N.G. is urged to ensure that the stock survives and a domestic breeding programme commences, followed by further releases.

The genetic status of the stock imported is unknown. If aquaculture of the species proves feasible, consideration should be given to the importation of a small number of fish from a suitable source in order to improve the genetic base of the P.N.G. fish. The eventual release of small numbers of the second stock would assist in safeguarding the eventual Sepik-Ramu feral population from the effects of a possible narrow genetic base.

4. REFERENCES

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Table 1: Releases of *T. rendalli*

Species	Date	Number stocked	size range	location	description	map	Grid. ref. or lat./long.	Altitude	Notes
Tilapia rendalli	12/06/91	28	50-80mm	Emma's creek, Ramu, Brahman floodplain		Bundi	55mcp214688		illegitimates from batch 1 x batch 1
Tilapia rendalli	28/07/91	2000	15-40mm	Lake Vargu	floodplain lake middle Ramu	Annanberg 7888	144deg41minE/4deg56minS	100	By helicopter with Nash, Bailey, Das
Tilapia rendalli	7/08/91	750	15-40mm	Emma's creek	floodplain Ramu/Marea River	Bundi	55mcp214688		
Tilapia rendalli	9/9/91	500	10-25mm	Yonki reservoir					
Tilapia rendalli	1/10/91	1000	20-40mm	Magendo 1	floodplain lake middle Sepik	Angoram		50m	via ANG to Wewak car/boat to Magendo
Tilapia rendalli	16/10/91	2000	15-60mm	Kokun lake	lake in lower Ramu		144-32E,4-10S	50m	On road to right just before Bunapas
Tilapia rendalli	21/10/91	750	15-60mm	Yonki reservoir					
Tilapia rendalli	18/11/91	1250	25-60mm	Roundwater - lower Ramu	lake floodplain lower Ramu			50m	lake just south of Bunapas mission - walk to it, delivered by mission people
Tilapia rendalli	20/11/91	3000	25-45mm	Brahman	creek on Ramu floodplain	Bundi	55mcp223693		2000 in creek just before Ramu River, 1000 close to Emma's creek
Tilapia rendalli	26/11/91	3000	25-60mm	Yonki reservoir					
Tilapia rendalli	31/12/91	3500	20-50mm	Samban	lake Ramu		144-5E,4-25S		
Tilapia rendalli	31/12/91	3500	20-50mm	Anangolo	lake - Ramu		143-51E, 4-36S	50m	close to Asangamut but E. side of river
Tilapia rendalli	31/12/91	3000	20-50mm	Tamo	lake - Ramu		144-9E, 4-44S	50m	
Tilapia rendalli	3/01/92	2000	20-60mm	Maprik Road	rivers draining hills into Sepik - between Wewak & Maprik				supposed to go via MAF but plane buggerup. 1500 put in Nagam River, and 500 in Kambagora creek - both P.van Zwieten sample sites
Tilapia rendalli	07/01/92	2000	20-60mm	Ambunti - Kasanam lake	floodplain lake middle Sepik	Ambunti	142-50E,4-10S	50m	3 km NE of Ambunti
Tilapia rendalli	14/01/92	2000	20-60mm	Ambunti-Kasanam lake	floodplain lake middle Sepik	Ambunti	142-50E,4-10S	50m	3 km NE Ambunti. Henry Gumanz reported he put 4 bags in Lake Paso on north side of Sepik River just westr of Timbunke; 2 bags in Lake Norway on south side of river west of Timbunke, 2 bags in Lake Yenmare S. side of Sepik R. next to Angriman, 1 bag in Lake Geigusan just west of Angriman (South side of S. River.
Tilapia rendalli	15/01/92	2000	20-60mm	Ambunti		Ambunti			1000 to lake near Sanchi River 14km W of Ambunti (delivered by Kiap - exact location unknown); 1000 to Kasanam Lake (3 km NE of Ambunti).
Tilapia rendalli	14/02/92	10,000	20-60mm	Chambri Lake	Sepik floodplain	Ambunti		50m	MAF/ landed near lake - 2km south of Kirinbit. stocked by Pullin.
Tilapia rendalli	20/02/92	4000	10-15mm	Yonki reservoir					
Tilapia rendalli	04/03/92	250	adults	Brahman mission	Ramu floodplain	Bundi	55mcp207674		5km down road towards Brahman mission - before Maram River
Tilapia rendalli	04/02/92	2000	10-45mm	Brahman Mission	Ramu floodplain	Bundi	55mcp207674		before Maram River

Table 1 cont.

Tilapia rendalli	05/03/92	2000	10-45mm	Magendo 1	Sepik floodplain	Angoram		50m	
Tilapia rendalli	06/03/92	4000	10-45mm	Kambaramba	Sepik floodplain	Angoram		50m	
Tilapia rendalli	06/03/92	6500	10-45mm	Bunam lake	Sepik floodplain			50m	by MAF, near Angisi, Keram River
Tilapia rendalli	21/03/92	15,000	10-50mm	Amboin	Sepik floodplain			50m	put in river next to Karawari airstrip
Tilapia rendalli	14/4/92	4,000	10-50mm	Pagwi	Sepik floodplain	Ambunti		50m	stocked into Kandige (Korogu) S. of Sepik River.
Tilapia rendalli	27/4/92	4,800	10-50mm	Timbunke	Sepik Floodplain			50m	stocked by several villages lakes N & S of Sepik River
Tilapia rendalli	01/05/92	350	10-50mm	Nagam river	Drains Maprik hills - into Sepik				
Tilapia rendalli	04/05/92	2500	10-50mm	Aiyura fish farm					not approved. Taken whilst project staff away. 80% mortality within one day due to incompetence at the farm
Tilapia rendalli	20/05/92	1500	10-50mm	Korogu	Sepik floodplain	Ambunti			Near Pagwi
Tilapia rendalli	20/05/92	750	10-45mm	Hayfield (Maprik)	Sepik foothills	Maprik			by MAF - final destination unknown
Tilapia rendalli	25/05/92	700	10-45mm	Nungwaia	Sepik	Maprik			ponds near Wosera
Tilapia rendalli	28/05/92	4000	10-45	Green River	upper Sepik				near villages: Abaru, Dioru, Hokru, Mukuays, Buna, Mahney, Ibru, Yabru 2, Yabru 1 - by MAF
Tilapia rendalli	04/06/92	5000	10-45mm	Aiyura fish farm					not approved
Tilapia rendalli	16/06/92	6000	10-45mm	Nagam River	Sepik foothills	Maprik			on road from Wewak to Maprik
Tilapia rendalli	24/6/92	5000	10-45mm	Bulwa	West Sepik foothills				near Bulwa near Lumi but close to Sepik floodplain
Tilapia rendalli	29/6/92	800	10-45mm	Wosera	Sepik foothills	Maprik			fish ponds near village
Tilapia rendalli	09/07/92	150	adults	Brahman	Ramu floodplain	Bundi			
Tilapia rendalli	20/07/92	9600	20-50mm	Bunapas	Ramu floodplain	Bundi	55mcp214688		Kokum lake same as above
Tilapia rendalli	21/07/92	2000	10-20mm	Maprik hills	Sepik foothills	Maprik			put in river 60km from Wewak on Maprik road
Tilapia rendalli	28/07/92	135	adults	Brahman	Ramu floodplain	Bundi	55mcp214688		Emma's Creek
Tilapia rendalli	28/07/92	1200	10-50mm	Ofri creek	Ramu foothills		55mcp207672		on Madang-Ramu highway
Tilapia rendalli	28/07/92	1200	10-50mm	Kesawari River (?) - not exactly where located on map, no name on map but Kesewari River nearby	Ramu foothills		CP406650 (?) 05deg42min12sec S; 145deg33min04sec E by GPS		on Madang-Ramu highway 15km from Brahman turn-off towards Ramu sugar
Tilapia rendalli	01/09/92	1500	10-25mm	Lake Varga	Ramu floodplain	Annanberg			repeat of above. Lake also known locally as Dodonso=Nadanso

Table 1 cont.

Tilapia rendalli	09/09/92	2000	10-50mm	Pagwi	Sepik floodplain				Sapandai village
Tilapia rendalli	14/09/92	1500	10-45mm	Green River	upper Sepik				by SIL via Wewak
Tilapia rendalli	15/09/92	1000	15-25mm	Maposi near April River	upper Sepik				near April river south side of main Sepik R., ESP but far to west close to WSP border. Between Leonard Schulz and Wongamush Rivers. See page 226 ESP population census book village # 14-04-50-005
Tilapia rendalli	24/09/92	10,000	25-60mm	Yonki reservoir					
Tilapia rendalli	04/10/92	18,000	25-60mm	Yonki reservoir					
Tilapia rendalli	27/10/92	10,000	20-75mm	Usino	Ramu foothills				On road to Ramu sugar at foot of Finesterres hills before Brahman - small creek traverses road and drains into Ramu floodplain just downstream of Brahman area
Tilapia rendalli	29/10/92	3000	20-60mm	Brahman area	Ramu floodplain	Bundi	55mcp214688		
Tilapia rendalli	29/10/92	405	adults	Brahman area	Ramu floodplain	Bundi	55mcp214688		getting rid of broodstock prior to Puntius gonionotus arriving
TOTAL		173,118							

Table 2: Release sites for *Osphronemus gouramy*

Species	Date	Number stocked	size range	location	description	map	Grid. ref. or lat./long.	Altitude	Notes
Osphronemus gouramy	November 1993	37	adults to 750mm	lake	Ramu floodplain			100 m	by helicopter, just downstream of junction with Marun River on west side of Ramu River in large ox-bow lake (not shown on map - may be new one) approx. position 145-5E, 5-23S, See Map - Musak. Originally brough as adults from Brown River (Port Moresby) Didn't breed in Madang hatchery so put in Ramu river as adults.

Table 3: Release sites for *Puntius gonionotus*

Species	Date	Number stocked	size range	location	description	map	Grid. ref. or lat./long.	Altitude	Notes
Puntius gonionotus	17/11/94	4000	30-50mm	Emma's creek	Brahman - Ramu floodplain	Bundi	55mcp214688		scattered in vicinity between Marea & Ramu rivers and between Marea & Brahman in various creeks/floodplain pools etc.
Puntius gonionotus	22/11/94	1500	30-50mm	Usino stream	drains to Ramu floodplain downstream of Brahman	Bundi			small creek/ford at foot of finnesteres before Brahman turn off - first stream in Ramu valley on Highway
Puntius gonionotus	22/11/94	1500	30-50mm	Ramu highway	stream 12km Lae side of Brahman turn-off				
Puntius gonionotus	22/11/94	1000	30-50mm	Ramu highway	river by bridge 32km Lae side of Brahman on highway.				
Puntius gonionotus	29/11/94	12,000	30-50mm	Bunam	Lake/swamp Sepik floodplain near Angisi etc.				MAF charter - 6000 in lake by airstrip, 6000 in stream leading to lakes.
Puntius gonionotus	7/12/94	1500	30-50mm	Bunapas	Ramu floodplain lake	Nubia	BP452368		first lake on right of road going towards Bunapas
Puntius gonionotus	7/12/94	1800	30-50mm	Bunapas	Ramu floodplain lake	Nubia	BP440355		second lake on right of road before Bunapas
Puntius gonionotus	7/12/94	1200	30-50mm	Bunapas	Ramu floodplain	Nubia	BP430295		lake near (S.) of Bunapas Mission
Puntius gonionotus	8/12/94	300	100-200g	Brahman	creeks in Ramu floodplain	Bundi	55mcp214688		
Puntius gonionotus	13/12/94	150	100-350g	Brahman	between Marea and Ramu River		55mcp214688		
Puntius gonionotus	13/12/94	2000	25-45mm	Brahman	between Marea and Ramu River		55mcp214688		
Puntius gonionotus	15/12/94	100	250-350g	Aiyura fish farm					As broodstock for DFMR
Puntius gonionotus	29/03/95	700	50-90 mm	Ganz River, Guny River	Near Timbunki. 25 km from upper catchment, 5 km from Jimmi River. Mountain stream with rainforest approx. 20-25 m width. temp approx. 23 °C. Clear water. Helicopter landed on gravel bed. Relatively isolated area.		BP193940	470 m	
TOTAL		27,750							

Table 4: Releases of *Tor putitora.*

Species	Date	Number stocked	size range	location	description	map	Grid. ref. or lat./long.	Altitude	Notes
Tor putitora	27/02/95	405	40-80mm (4-7 g)	Yonki Reservoir	Arona Rd. Put in by Tomi Petr				
Tor putitora	06/03/95	750	60-90 mm (4-7g)	Yonki Reservoir	Oxlade Rd.				
Tor putitora	13/03/95	813	60-90 mm (4-7g)	Yonki reservoir	Far end by boat				
Tor putitora	16/03/95	106	60-90mm (4-7g)	Aiyura carp hatchery pond	To raise as broodstock				mixed Nepal/India stock
Tor putitora	23/08/95	2000 (?)	40-75mm	Jimmi River	middle/upper Jimmi River, main channel	JIMMI	BQ217985	420m	fast flowing shallow 50 m wide - rocky, clearish water, by helicopter from M. Hagen, 24°C
Tor putitora	31/08/95	650	50-75mm	Lake Imbia	sm. lake drains to screw River near Maprik	Maprik	YB025305	280m	by helicopter - about 100 doa - mainly crippled specimens- stream out has 7.5m waterfall
Tor putitora	18/11/95	2200	25-45mm	Yonki Reservoir					ex shipment #1, 1995, from India
Tor putitora	18/11/95	200	35-45mm	Aiyura fish farm					ex shipment #1, 1995, from India
Tor putitora	5/12/95	3320	20-45mm	Yonki Reservoir	near ELCOM boatyard				
Tor putitora	22/12/95	847	25-60 mm	Yonki Reservoir	Crusher Rd.				ex shipment #2/95 - from India
Tor putitora	01/01/96	1056	40-75mm	Yonki reservoir	below main dam - i.e. between dam #1 & dam # 2				ex shipment #2&3/95 -from India
Tor putitora	09/01/96	1000	25-50mm	Savai River	drains Adelbert Range into Sogeram River - tributary of Ramu clear stream 0.25mdeep 4-5 m wide drains forested hills to 1200 m	Adelbert	approx. BQ976560 04deg56.74S/ 145deg12.69 E by GPS	120m	ex India position approx. GPS lat/long not compatible with map. Could be Omasa River by mistake.
Tor putitora	23/01/96	500	25 - 50mm	Clay River	tributary of Keram River - good clear river, about 30 m wide medium flowing, gravel bottom through forest	Rain	approx. AQ850705 4°47'06"S 144°09'58"E by GPS	100	by helicopter - excellent site

Table 4 continued.

Tor putitora	06/02/96	3365	25 - 50mm	Clay River	tributary of Keram River - good clear river, about 30 m wide medium flowing, gravel bottom through forest	Rain	approx. AQ850705 4°47'06"S 144°09'58"E by GPS	100	by helicopter - excellent site
Tor putitora	29/01/96	2000	25-45mm	Yonki Reservoir - crusher road					ex Nepal
Tor putitora	13/04/96	325	60-80mm	Lake Assiria (Dumpu lakes)	stocked together with Acrosso and Prochilodus, see description under Prochilodus	Dumpu	CP607553	480	by car, road extremely difficult to find
Tor putitora	13/08/96	5000	25-60 mm	Urom River	Urom River - tributary of Upper Keram River, leads to Sepik, at foothills - south west of Annanberg. Fast flowing pebbles, clear water.	Annanberg	05deg01min06secS; 144deg33min 40secE by GPS	200	by Helicopter
Tor putitora	22/08/96	3817	25-60mm	Marea River	trib. of Ramu at Brahman				
Tor putitora	04/09/96	1273	25-60mm	Marea River	trib. of Ramu at Brahman				
Tor putitora	04/09/96	200	50-80 mm	to Aiyura for broodstock					ex India
TOTAL		29,827							

Table 5: Releases of Acrossocheilus hexagonolepis.

Species	Date	Number stocked	size range	location	description	map	Grid. ref. or lat./long.	Altitude	Notes
Acrossocheilus hexagonolepis	06/03/95	250	40-80 mm	Yonki Reservoir	Oxlade Rd.				
Acrossocheilus hexagonolepis	13/03/95	250	40-80mm	Yonki Reservoir	Far end - by boat				
Acrossocheilus hexagonolepis	13/03/95	69	40-80mm	Aiyura carp hatchery pond	To raise as broodstock by DFMR				
Acrossocheilus hexagonolepis	22/12/95	585	25-60 mm	Yonki Reservoir					ex shipment # 3-95, Nepal
Acrossocheilus hexagonolepis	09/01/96	1000	25-50mm	Savai River	drains Adelbert Range into Sogeram River - tributary of Ramu clear stream 0.25mdeep 4-5 m wide drains forested hills to 1200 m	Adelbert	approx. BQ976560 04deg56.74S/145deg12.69 E by GPS	120m	position approx. GPS lat/long not compatible with map. Could be Omasa River by mistake.
Acrossocheilus hexagonolepis	19/01/96	1350	25-45mm	Yonki reservoir	crusher road				
Acrossocheilus hexagonolepis	19/01/96	650	25-45mm	Yonki reservoir - below dam	between dam # 1 & dam # 2				
Acrossocheilus hexagonolepis	23/01/96	400	20-40mm	Clay River	tributary of Keram River - good clear river, about 30 m wide medium flowing, gravel bottom through forest	Rain	approx. AQ850705 4°47'06"S 144°09'58"E by GPS	100	by helicopter - excellent site
Acrossocheilus hexagonolepis	06/02/96	2095	20-40mm	Clay River	tributary of Keram River - good clear river, about 30 m wide medium flowing, gravel bottom through forest	Rain	approx. AQ850705 4°47'06"S 144°09'58"E by GPS	100	by helicopter - excellent site
Acrossocheilus hexagonolepis	29/01/96	1000	25-45mm	Yonki reservoir - crusher road					
Acrossocheilus hexagonolepis	13/04/96	325	40-60mm	Lake Assiria (Dumpu lakes)	stocked together with Tor and Prochilodus, see description with Prochilodus	Dumpu	CP607553	480	by car, road extremely difficult to find
Acrossocheilus hexagonolepis	4/09/96	250	40-75mm	to Aiyura for broodstock					
Acrossocheilus hexagonolepis	14/02/97	3,000	40-60 mm	Eram, Yuat River	- Yuat river just as it enters floodplain, upstream drains Jimi and Lai Rivers	Yimas	ZV235637	40	by helicopter
TOTAL		11,224							

Table 6: releases of *Schizothorax richardsonii*.

Species	Date	Number stocked	size range	location	description	map	Grid. ref. or lat./long.	Altitude	Notes
S. richardsonii	20/03/95	375	50-90 mm	Tapo river. 0.5 km past Tapo village up mountain. Wooden bridge over river.	River 2-3 m wide, boulders, medium flow, forest cover, steep ravine.	Kainantu			Type locality of *G. torrentis* Buche asla
S. richardsonii	20/03/95	401	50-90 mm	Aiyura/Ukarumpa	River half way between SIL and Aiyura N.H.S. 15m wide, slow flow, relatively warm	Kainantu			Buche Asla
S. richardsonii	20/3/95	265	50-75 mm	Lake Evadetton	2 ha lake drains towards Ramu (not Yonki reservoir). Mountain lake in rain forest. <20 deg. C. depth > 10 m. Grass growing in lake covered with light brown sediment (iron ?). Outflowing creek approx. 2-3 m wide, rocky covered with green algae. Dense covering vegetation	Kainantu	CP720159	1500 m	Cuche Asla. Reported previous introduction of tilapia & carp failed.
S. richardsonii	20/03/95	281	50-90 mm	Norikori river	medium fast, 3-4 m wide, in flood, Drains straight to Konki reservoir.	Kainantu	CN789925		Buche Asla
S. richardsonii	21/03/95	450	50-70 mm	Kesawari River (??) - not in same place as on map - no name on map	11.7km from Bundi turn off towards Lae. Long Bailey bridge. drains rainforest in Finnesterres. relatively cool. 10.0 m. wide (medium flood). clear. rocky/pebble bottom. 0.5 m deep.	Dumpu	CP406650 (?) 05deg42min12sec S; 145deg33min04sec E by GPS		
S. richardsonii	21/03/95	300	50-70mm	Faria River (?)	28.4 km from end of tarmac on Ramu highway towards Madang. Long Bailey Bridge. 20.4 km from Keswari. 5.0m wide. 0.5 m deep. rocky. drains very steep gorge in Finesterres, Grasslands to top of catchment as far as can see.	Dumpu	CP551522 (??) 05deg49min54sec S; 145deg40min30sec E by GPS		Not sure of location. quite small river/stream. Clean and in grasslands.
S. richardsonii	21/03/95	750	50-70 mm	no name	next main river past Imbrum River going straight on over Imbrum Bridge. (Not Imbrum river.) 10 km from Brahman/Bundi junction. 6.0 m wide moderate flow (in flood). Clear and cold. Drains forest. Down bad road through forest. First decent sized stream/river after Imbrum Bridge. No Bridge - ford (rough) through water.	Bundi	??????		Not sure of location - road moved since map made and location of Imbrum bridge not clear.
S. richardsonii	22/03/95	2040	25-80 mm	Lake Sirunki (Lake Iviva)	At top of Lai River catchment. Swamp Lake approx. 1.0 km^2. Dark brown water, heavy organic load. Visibility < 50 cm. Common carp present. By helicopter.		YV798002	2350m	

Table 6 continued.

S. richardsonii	22/03/95	960	25-80mm	Sau River	20 km from top of catchment. 50 km upstream from Lai River. Tributary of Lai River. 18.5 °C. Gravel beds rocks. By helicopter - landed on road by bridge.		ZV151042	1750	
S. richardsonii	29/03/95	1350	25-80mm	Ganz River, Guny River	Near Timbunki. 25 km from upper catchment, 5 km from Jimmi River. Mountain stream with rainforest approx. 20-25 m width. temp approx. 23 °C. Clear water. Helicopter landed on gravel bed. Relatively isolated area.		BP193940	470 m	
S. richardsonii	29/03/95	1350	25-80mm	Pint River	2 km from Jimmi River, mountain stream in rainforest. <20 °C. clear water Helicopter landed on gravel bed.		BP293940	560m	
S. richardsonii	29/03/95	1350	25-80mm	Mants River	10 km from Jimmi River. Mountain stream in rainforest. 10 m width. Clear water. <18°C. Helicopter landed on small meadow.		BP553667	1520m	
S. richardsonii	09/05/95	250	25-90mm	un-named	Top of catchment 30 km upstream from Jimmi River. Steep cliffs shrubs & trees. 1.0 m wide. clear water 15°C. By vehicle.		BP391681	2450m	
S. richardsonii	09/05/95	1000	25-80 mm	Kauil	Close to top of catchment 30 km upstream from Jimmi River. Mountain stream 4-5 m width. 18°C. Clear water. By vehicle.		BP402703	1520m	
S. richardsonii	09/05/95	750	25-80 mm	Kauil-Konsa	Close to top of catchment. 30km upstream from Jimmi River. Clear water, sessile algae. By car.		BP421707	1760m	
S. richardsonii	15/5/95	750	40-75mm	Baiyer River	Valley stream, 25 km from top of catchment. 10m wide. clear. 19°C.		AP887758	1420m	From Mount Hagen by Car - Police Escort, Zones Commander Paul Vanstaveren tel. 551222
S. richardsonii	15/03/95	1250	40-75mm	Baiyer River Sanctuary	2 km upstream from Baiyer River. 10m wide. clear. 24°C.		AP866901	1160m	From Mount Hagen by Car - Police Escort, Zones Commander Paul Vanstaveren tel. 551222. Check for results: David Kuri, Park Ranger, Baiyer River Sanctuary, P.O. Box 490 Mt. Hagen tel. 521482
S. richardsonii	01/08/95	600	50-75mm	Ramu River, Sonofi	on Ranu River 13 km from top.	Kainantu	CN605955	1880m	10m width. 17°C. clear water.
S. richardsonii	01/08/95	1000	50-75mm	Upper Ramu - Abanihofi No. 2	side stream of Ramu	Kainantu	CN589958	1880m	4 m width. 17°C. clear water.
S. richardsonii	01/08/95	200	50-75mm	Upper Ramu at Tibunofi	side stream of Ramu	Kainantu	CN579976	1920m	2 m width. 17°C.
S. richardsonii	01/08/95	200	50-75mm	Upper Ramu at Pomu no. 2	side stream of Ramu	Kainantu	CN574992	1930m	2 m width 17°C. forested.

Table 6 continued.

S. richardsonii	01/08/95	400	50-75mm	Upper Ramu - at Yonki Dam at Puri	side stream of Yonki Dam	Kainantu	CN910116	1310m	4m width. 19°C.
S. richardsonii	02/08/95	400	50-75mm	Upper Ramu at Amonita	side stream of Ramu	Kainantu	CN743110	1620 mm	4 m width 18°C
S. richardsonii	02/08/95	600	50-75mm	Upper Ramu - Ornapinka River	Ramu trib. 3km SW of Kainantu (towards Goroka)	Kainantu	CP713033	1600m	7m width. 18°C
S. richardsonii	02/08/95	400	50-75mm	Upper Ramu at Onerunka	side stream of Ramu	Kainantu	CN650979	1800m	4 m width. 18°C
S. richardsonii	02/08/95	400	50-75mm	Upper Ramu at Korona Plantation	side stream of Ramu	Kainantu	CN734877	1780m	3 m width 20°C
S. richardsonii	02/08/95	400	50-75mm	Upper Ramu at Bararanda	side stream of Ramu	Kainantu	CN738910	1750m	8 m width 20°C
S. richardsonii	02/08/95	400	50-75mm	Upper Ramu	side stream of Ramu no name	Kainantu	CN719925	1710m	8 m width 20°C by bridge (collapsed) south of SIL
S. richardsonii	04/08/95	1200	50-75mm	Tauya River	side stream of Marea River - leads to Ramu at Brahman	Bundi	CP228600		23°C 20m wide.
S. richardsonii	04/08/95	1350	50-75mm	Imbrum River	leads to Ramu below Brahman - by bridge on main road.	Bundi	CP150659		22.5°C 25m wide
S. richardsonii	07/08/95	750	50-75mm	Imbrum River	leads to Ramu below Brahman by bridge on main road	Bundi			
S. richardsonii	24/08/95	900	50-75mm	Imbrum River	leads to Ramu below Brahman - by bridge on main road	Bundi	CP150659		
S. richardsonii	07/08/95	750	50-75mm	Marea River	above Brahman - drains to Ramu	Bundi	CP210670		on road after Tauya River. 25°C50 m wide
S. richardsonii	21/08/95	450	50-75mm	Lai River - Sigor village	subcatchment of Lai River	Wapenamanda	ZU234723	1760m	mountain stream, 7 m wide, torrential
S. richardsonii	21/08/95	900	50-75	Lai River at Tari River at Arumanda	tributary of Lai River	Wapenamanda	ZU152717	1860m	valley stream, torrential,10m wide, 17°C
S. richardsonii	21/08/95	900	50-75 mm	Lai River at sidestream of Tare River at Arumanda	tributary of Lai River	Wapenamanda	ZU160713	1860m	7 m wide, 17°C
S. richardsonii	21/08/95	300	50-75mm	Lai River - side stream of Wakema river	tributary of Lai river at Yogos Agriculture station (Enga)	Wapenamanda	ZU120745	2040m	7m wide, 18°C
S. richardsonii	21/08/95	300	50-75mm	Lai River - Wakema trib.	at Saposa village	Wapenamanda	ZU113760	2080m	5 m wide, 19°C
S. richardsonii	21/08/95	900	50-75mm	Lai River - Aria trib.		Wapenamanda	ZU109829	1750m	10m wide, 18°C
S. richardsonii	23/08/95	1800	50-75mm	Mogulpin River	tributary of upper Jimmi River	Jimmi	BP060895	720m	by helicopter from M. Hagen. 8m width, 20°C
S. richardsonii	31/08/95	1800	50-75mm	Simbai River	drains central range towards Ramu - other side of Jimmi	Aiome	BQ635110	200	by helicopter

Table 6 continued.

S. richardsonii	31/08/95	200	50-75mm	Lake Imbia	sm. lake drains to screw River near Maprik	Maprik	YB025305	280m	by helicopter - good stream running in from 100 m but stream draining has 7.5m waterfall
S. richardsonii	06/09/95	2200	50-75mm	Lai River	Mukulamanda Mission, Enga	Wapenamanda	ZU182788	1710m	15m width 20°C. Trout also present.
S. richardsonii	07/01/96	1500	40-60mm	Faria River (?) same sit as Faria above.	28.4 km from end of tarmac on Ramu highway towards Madang. Long Bailey Bridge. 20.4 km from Keswari. 5.0m wide. 0.5 m deep. rocky. drains very steep gorge in Finesterres, Grasslands to top of catchment as far as can see. (33 km from Mobil service at Ramu Sugar)	Dumpu	CP551522 (??) 05deg49min54sec S; 145deg40min30sec E by GPS		Not sure of location. quite small river/stream. Clean and in grasslands. - India fish.
S. richardsonii	07/01/96	1500	40-60mm	No name Upper Middle Ramu valley draining Finesterres.	12 km towards Ramu Sugar from Faria (?) - 8 km from second big galvanised bridge (not Bailey but girder type - square type) after Tarmac at Ramu Sugar towards Brahman. Sm. river - rocky, drains Finesterre grasslands. PVZ sample site. No bridge - runs through culverts under road. Difficult to spot.(19.3 km from Mobil Service at Ramu Sugar)	Dumpu	05deg52min15sec S; 145deg45min82secE by GPS - probably CP623503		- all India fish.
S. richardsonii	07/01/96	4500	40-60mm	Marea River.	By bridge on Brahman Rd.	Bundi	CP210670		- all India fish.
S. richardsonii	09/01/96	1500	25-50mm	Savai River	drains Adelbert Range into Sogeram River - tributary of Ramu clear stream 0.25mdeep 4-5 m wide drains forested hills to 1200 m	Adelbert	approx. BQ976560 04deg56.74S/145deg12.69 E by GPS	120m	- all India fish position approx. GPS lat/long not compatible with map. Could be Omasa River by mistake.
S. richardsonii	23/01/96	800	25-55mm	Clay River	tributary of Keram River - good clear river, about 30 m wide medium flowing, gravel bottom through forest	Rain	approx. AQ850705 4°47'06"S 144°09'58"E by GPS	100	by helicopter- all ex India - but poor quality, ex. trial in Madang, thin specimens. Good spot.
S. richardsonii	06/02/96	356	25-60mm	Clay River	tributary of Keram River - good clear river, about 30 m wide medium flowing, gravel bottom through forest	Rain	approx. AQ850705 4°47'06"S 144°09'58"E by GPS	100	by helicopter - all ex India Good spot - same as above
S. richardsonii	28/02/96	3081	50-75mm	Aiyura/Ukarumpa	River half way between SIL and Aiyura N.H.S. 15m wide, slow flow, relatively warm	Kainantu			
S. richardsonii	29/03/96	2000	50-75mm	Imbrum River	leads to Ramu below Brahman - by bridge on main road	Bundi	CP150659	160	
S. richardsonii	29/03/96	1500	50-75mm	Tauya River	leads to Ramu, next to footbridge	Bundi	CP228599	200	

Table 6 continued.

S. richardsonii	01/04/96	1000	50-75mm	Baia River	Tributary of Ramu	Bundi	CP100803		by helicopter, road from Brahman impassable
S. richardsonii	26/04/96	2100	50-75mm	Wamum (Avin) River	tributary of Ramu , 10 meters wide, clear greenish water, Forest cover, medium to fast flowing relatively cold water 20-25 ^{0}C, river spreads into at least 5 different channels down stream, onto floodplain before entering Ramu, nice spot!	Aiome	BQ370370	100	by helicopter
S. richardsonii	26/04/96	2800	50-75mm	Asai River	tributary of Ramu, 10-15 meters wide, medium to fast flowing relatively cold water, clear-green water, with forstcover, deeper than Wamum River, flows out onto floodplain before entering Ramu	Aiome	BQ482236	220	by helicopter
S. richardsonii	13/08/96	100	25-60 mm	Urom River	Urom River - tributary of Upper Keram River, leads to Sepik, at foothills - south west of Annanberg. Fast flowing pebbles, clear water.	Annanberg	05deg01min06secS; 144deg33min40secE by GPS	200	by Helicopter
S. richardsonii	26/11/96	7,000	10-15mm	Imbrum River	see above	see above	see above	see above	hatch from Nepal stocked immediately after quarantine period due to lack of space & shutting down of hatchery at end of project.
S. richardsonii	04/12/96	7,000	10-15mm	Imbrum River	see above	see above	see above	see above	batch from Nepal stocked immediately after quarantine period due to lack of space & shutting down of hatchery at end of project.
S. richardsonii	7/03/97	267	100-160mm	upper Ramu past Kainantu					broodstock from Aiyura dumped on finish of project
TOTAL		70,576							

Table 7: Releases of *Prochilodus margravii*

Species	Date	Number stocked	size range	location	description	map	Grid. ref. or lat./long.	Altitude	Notes
Prochilodus	22/03/95	750	25-80mm	Ramu highway - Usino	small stream/ford bottom of Finisterres just before road levels off to Brahman, just before Usino. V. small stream but drains into floodplain	Bundi	approx. CP881240		
Prochilodus	22/03/95	1500	25-80mm	Brahman	First river past Marea Bridge towards Brahman Mission, Floodplain stream. drains to Marea River	Bundi	approx. CP205670		
Prochilodus	22/03/95	1500	25-80	Brahman	Marea/Ramu floodplain. streams between Marea and Ramu River	Bundi	in region of CP215685		
Prochilodus	22/03/95	750	25-80	Brahman	Ramu floodplain. Clear water small stream draining through forest into Ramu - just before Ramu river on Brahman Road.	Bundi	in region of CP230705		
Prochilodus	23/03/95	7000	25-80	Bunam	Sepik floodplain by Keram River. 4000 in Barat (stream) at west end of airstrip, 3000 in lake adjacent to airstrip	Rain	in region of AQ945845		
Prochilodus	27/03/95	981	25-80 mm	Yonki Reservoir	By Boat.				
Prochilodus	09/01/96	1000	25-50mm	Savai River	drains Adelbert Range into Sogeram River - tributary of Ramu clear stream 0.25mdeep 4-5 m wide drains forested hills to 1200 m	Adelbert	approx. BQ976560 04deg56.74 S/145deg12. 69 E by GPS	120m	position approx. GPS lat/long not compatible with map. Could be Omasa River by mistake.
Prochilodus	09/01/96	3000	25-50mm	no name Ramu Floodplain	swamps to east of Chungrebu drain into Guam river and Sogeram River - both then into Ramu. Shallow depression lake - lots of lillys etc. limited forest but streams/connections run through flooded forest. Not as big as on map - but good place. Limited (but existing) connections to rivers. No villages but one net seen in lake.	Annanberg	approx. BQ535725	80	by helicopter
Prochilodus	19/01/96	1350	25-45mm	Yonki Reservoir	crusher road				ex Fazenda
Prochilodus	19/01/96	650	25-45mm	Yonki Reservoir below dam	between dam #1 and dam # 2				ex Fazenda
Prochilodus	23/01/96	2200	20-40mm	Yimas Lakes - drains to Karawari River - to Sepik	shallow lakes on floodplain. no trees near but barats to over lakes with trees	Yimas	YV845835	40	by helicopter
Prochilodus	23/01/96	1760	20-40mm	Lake Virginia	lovely lake surrounded by trees with lilies etc. small outlet to Karawari River probably only in big floods	Yimas	ZV030910	40	by helicopter

Table 7 continued.

Prochilodus	01/02/96	5,920	20-50mm	Chambri Lake	adjacent Kilimbit airstrip	Chambri	YA385265	40	by airplane
Prochilodus	06/02/96	2,000	20-50mm	Imbuando Lagoon	adjacent lower Sepik below Angoram	Angoram	Ar925505	40	by helicopter
Prochilodus	26/03/96	6,000	30-60mm	Bunapas	Ramu floodplain lake	Nubia	BP452368		first lake on right of road going towards Bunapas
Prochilodus	26/03/96	5,000	30-60mm	Bunapas	Ramu floodplain lake	Nubia	BP440355		second lake on right of road before Bunapas
Prochilodus	01/04/96	2,000	30-60mm	oxbow-lake near Sogram	next to Ramu, with high-water connection to main river channel	Bundi	CP093849	80	by helicopter
Prochilodus	02/04/96	7,500	20-100mm	Yonki reservoir	Crusher road				
Prochilodus	12/04/96	24,000	30/100mm	Chambri lake	adjacent Kilimbit airstrip, with boats onto the lake	Chambri	YA385265	40	by airplane
Prochilodus	13/04/96	1200	20-40mm	Lake Assiria (Dumpu lakes)	lake up in the foothills, nice deep lake, lots of waterplants, snails and dragonflies, outflow to Faria river, no clear inflow, only (introduced) mosquito fish, cormorants and herons present, albeit in small numbers, of the 3 Dumpu lakes only 2 left, other smaller one very shallow and prone to drying out. stocked together with Choco andTor	Dumpu	CP607553	480	by car, road extremely difficult to find
Prochilodus	19/04/96	35,000	20-50mm	Chambri lake	adjacent Kilimbit airstrip, far end of the airstrip with boats	Chambri	YA385265	40	by airplane
Prochilodus	26/04/96	4000	25-70mm	Wamum (Avin) River	tributary of Ramu , 10 meters wide, clear greenish water, Forest cover, medium to fast flowing relatively cold water 20-25 ^{0}C, river spreads into at least 5 different channels down stream, onto floodplain before entering Ramu, nice spot!	Aiome	BQ370370	100	by helicopter
Prochilodus	26/04/96	5000	25-70mm	Asai River	tributary of Ramu, 10-15 meters wide, medium to fast flowing relatively cold water, clear-green water, with forstcover, deeper than Wamum River, flows out onto floodplain before entering Ramu.	Aiome	BQ482236	220	by helicopter
Prochilodus	13/08/96	1000	25-60mm	Roundwatrer/middle Ramu	Roundwater/ox-bow east side of Ramu River downstream of Aiome - not on map. New one - no village	Aiome	05deg59min S; 144deg41min52secE by GPS		by helicopter
Prochilodus	27/08/96	350	25-80mm	Roundwater-Brahman	Roundwater at side of Marea River near Brahman. Turn left just before Marea bridge - small lake on right surrounded by forest. No exit during dry season. Between Marea and Ramu Rivers.	Bundi			by car
Prochilodus	14/02/97	12,000	15-40mm	Lake Virginia	lovely lake surrounded by trees with lilies etc. small outlet to Karawari River probably only in big floods	Yimas	ZV030910	40	by helicopter

Table 7 continued.

Prochilodus	14/02/97	18,000	15-40mm	Yimas Lakes - drains to Karawari River - to Sepik	shallow lakes on floodplain. no trees near but barats to over lakes with trees, put in three groups in three different lakes in same area	Yimas	YV845835	40	by helicopter
Prochilodus	14/02/97	4,000	15-40mm	Lake Butandana	oval lake surrounded by forest - limited exits, probaly only through flooded forest at high water, lovely isolated lake, no villages	Yimas	YA900820	40	by helicopter
Prochilodus	17/02/97	5,000	25-80	Brahman	Marea/Ramu floodplain. streams between Marea and Ramu River	Bundi	in region of CP215685		
Prochilodus	28/02/97	100	200-300mm	PNG. Aquaculture Dylup Plantation, N. Coast Road, Madang					to be grown on as broodstock for further stock enhancement and aquaculture
TOTAL		160,511							

Table 8: releases of *Colossoma bidens (Piaractus brachypomum)*

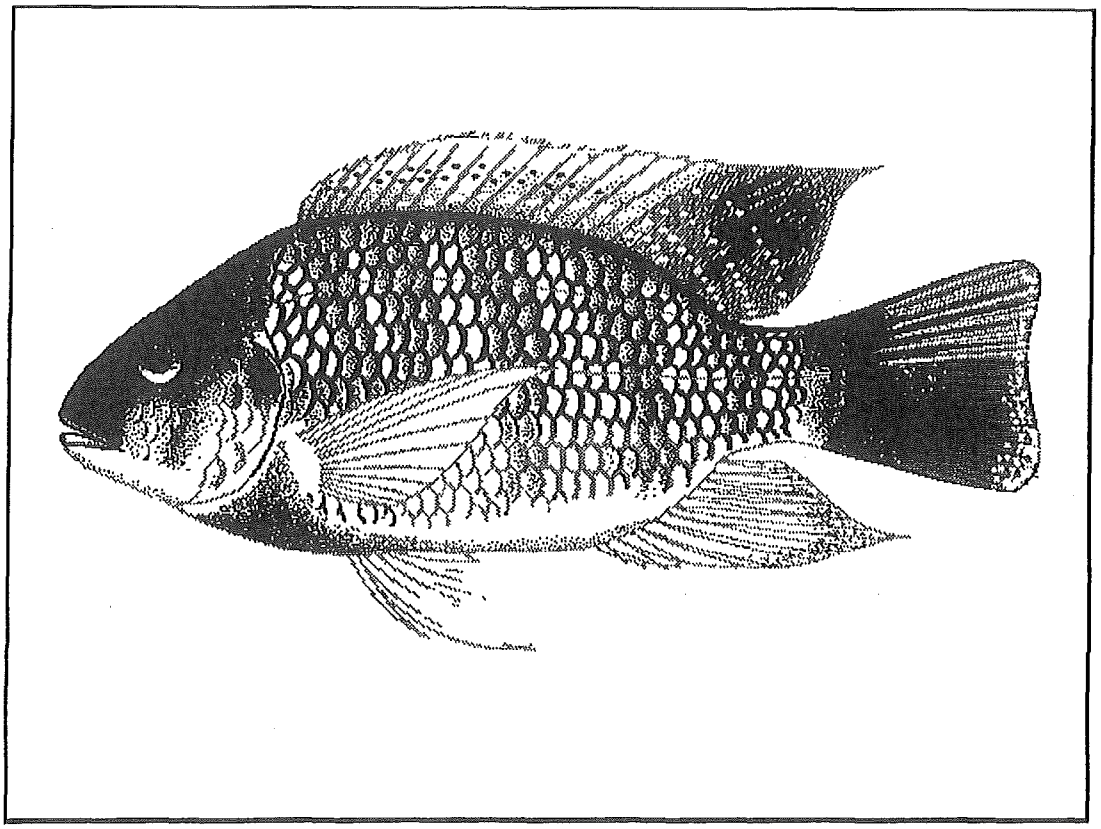
Species	Date	Number stocked	size range	location	description	map	Grid. ref. or lat./long.	Altitude	Notes
Colossoma bidens	31/08/95	950	15-60 mm	Lake Virginia	floodplain lake drains into Yuat River	Yimas	ZV920030	50	by helicopter
Colossoma bidens	31/08/95	400	15-60 mm	Lake Imbia	sm. lake drains to screw River near Maprik	Maprik	YB025305	280	by helicopter - stream out has 7.5 m waterfall
Colossoma bidens	16/11/95	2650	25-45mm	Bunapas	Ramu floodplain lake	Nubia	BP452368	10	first lake on right of road going towards Bunapas - don't use nets
Colossoma bidens	16/11/95	1450	25-45mm	Bunapas	Ramu floodplain lake	Nubia	BP440355	10	second lake on right of road before Bunapas - don't use nets
Colossoma bidens	16/11/95	900	25-45mm	Bunapas	Ramu floodplain	Nubia	BP430295	10	lake near (S.) of Bunapas Mission - use nets/heavy fishing pressure
Colossoma bidens	5/12/95	1000	40- 60 mm	Yonki Reservoir	ELCOM boatyard				
Colossoma bidens	09/01/96	2050	25-50mm	no name Ramu Floodplain	swamps to east of Chungrebu drain into Guam river and Sogeram River - both then into Ramu. Shallow depression lake - lots of lillys etc. limited forest but streams/connections run through flooded forest. Not as big as on map - but good place. Limited (but existing) connections to rivers. No villages but one net seen in lake.	Annanberg	approx. BQ535725	80	by helicopter
Colossoma bidens	23/01/96	1811	60-100mm	Yimas Lakes - drains to Karawari River - to Sepik	shallow lakes on floodplain. no trees near but barats to over lakes with trees	Yimas	YV845835	40	by helicopter
Colossoma bidens	01/02/96	1750	60-100mm	Chambri Lake	adjacent Kilimbit airstrip	Chambri	YA385265	40	by airplane
Colossoma bidens	06/02/96	1000	50-100mm	Imbuando Lagoon	adjacent lower Sepik below Angoram	Angoram	Ar925505	40	by helicopter, surrounded by forest but large expanse of grass before edge. 10% coverage with Eichornia (not perfect site for Colossoma)
Colossoma bidens	1/04/96	320	150-215mm(!)	oxbowlake near Sogram	next to Ramu, with high-water connection to main river channel only one side of lake covered with forest, small stream through forest connecting with Ramu	Bundi	CP093849	80	by helicopter, "Aiyura" broodstock at 20 fish per bag, no deaths.
Colossoma	Sept. 96	100	250mm + (1yr old)	Roundwater-Brahman	Roundwater at side of Marea River near Brahman. Turn left just before Marea bridge - small lake on right surrounded by forest. No exit during dry season. Between Marea and Ramu Rivers.	Bundi			by car
Colossoma	Jan/Feb 97	130	300-400 mm (2+kg)	Brahman	floodplain swamps/creeks between Ramu and Marea Rivers and on Brahman side of Marea adjacent to Marea River	Bundi			by car with large esky on back. 2+ year old broodstock put in river because of lack of alternative site as project came to a close.
TOTAL		14,511							

Appendix 1: Brief details and sketches of the species of fish released

Relatively non-technical details for each species are provided in order that local administrators, teachers, workers etc. can translate the information into local languages.

RED MAKAU

Tilapia rendalli - redbreast tilapia



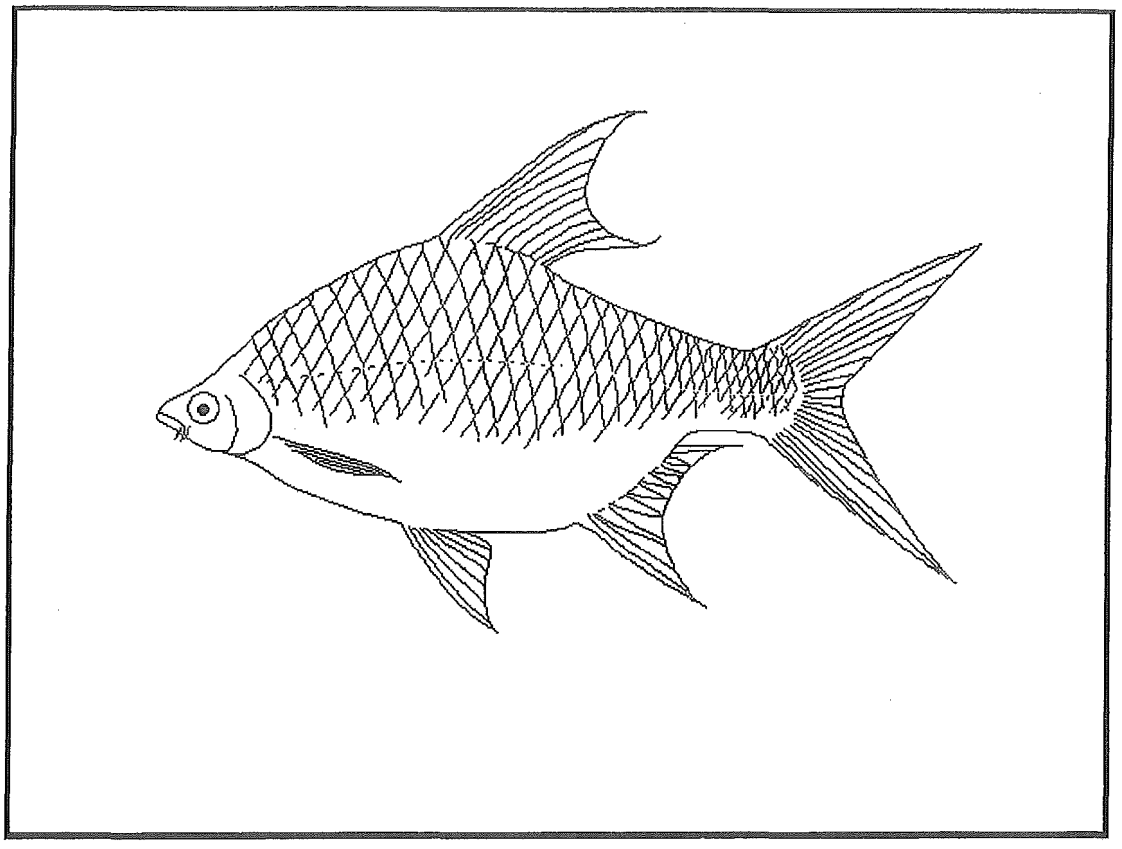
The red makau lives in lowland and highland lakes and swamps. The adults feed on plants. The young eat insect larvae and algae. It can grow up to 30 - 40 cm length and become over 1 kg in weight. It can reach maturity after only 6 months. Originally it is from southern Africa.

The red makau has a deeper body, smaller mouth and is more red than the other tilapia (*Oreochromis mossambicus*) which is now referred to as the black makau.

The red makau was introduced in 1991-1992 by FISHAID Project in the Sepik/Ramu catchment to supply protein and income.

Java Carp

Puntius gonionotus



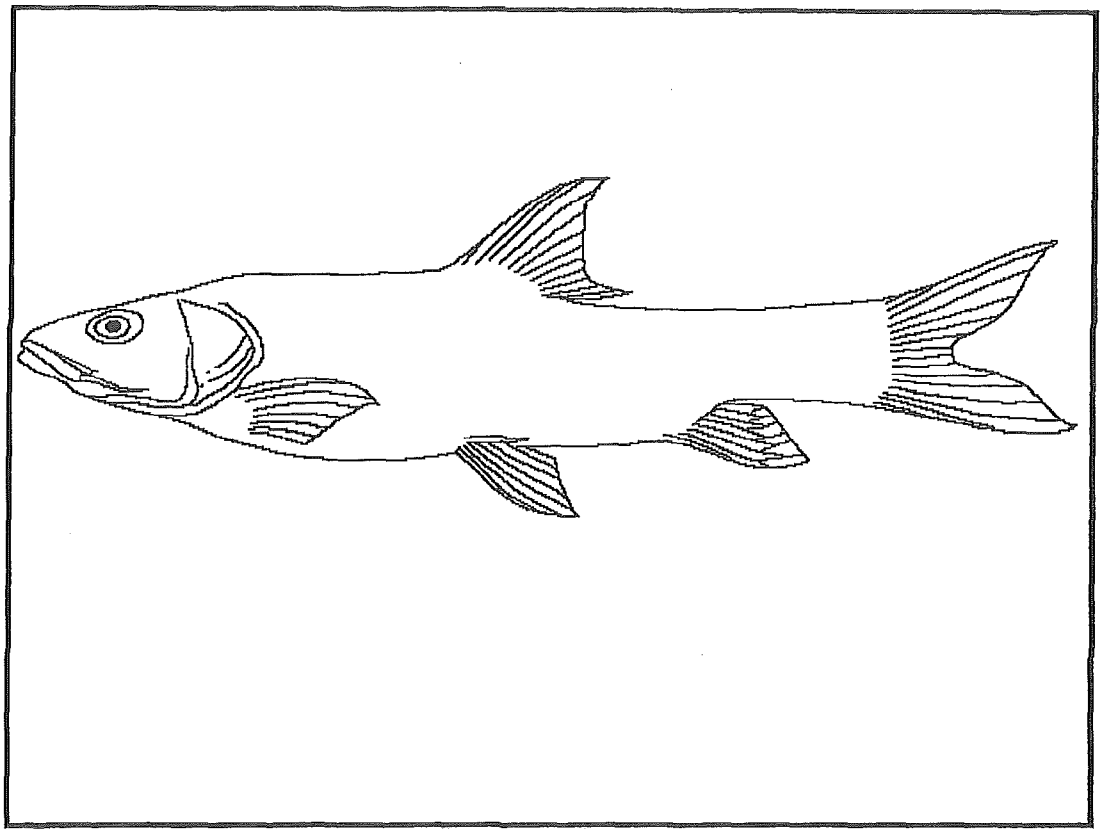
The Java Carp lives in rivers, lakes and swamps from highlands to lowlands. It feeds on a wide variety of food - chiefly aquatic plants (including water hyacinth) and insects.

The Java Carp can reach about 2.0 kg. Originally it comes from South-East Asia.

It was introduced by the FISHAID project in 1992 to boost fish stocks.

TOR PIS

Tor putitora - Golden Mahseer



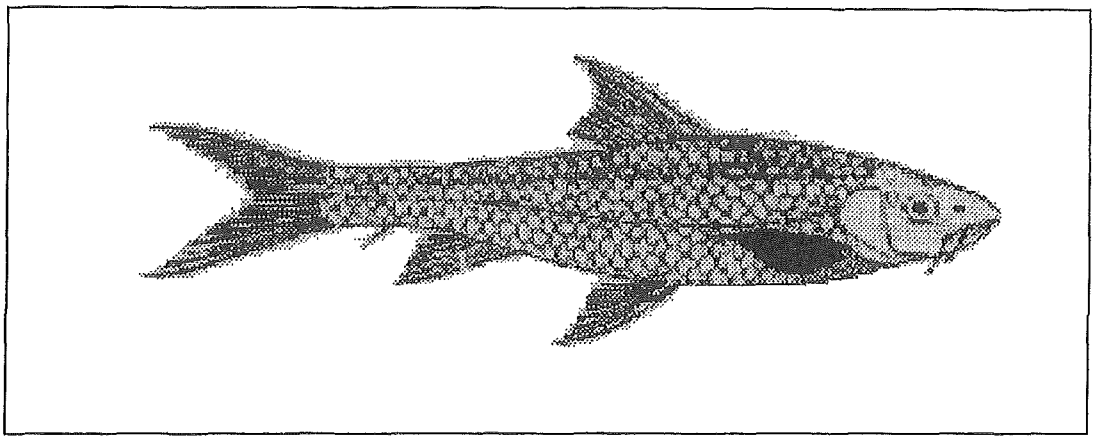
The Golden Mahseer lives in fast flowing rivers in both lowlands and at mid-altitudes extending up into the highlands. It is a long thin "carp" with large scales and a large mouth. It can live in warmer rivers than the Snowtrout and colder than the Chocolate Mahseer. It feeds on a variety of foods based mainly on aquatic insects and plant materials. The fish originally came from the Himalaya mountains of India and Nepal.

The largest Golden Mahseer ever caught weighed 80 kg. It grows much bigger than the Chocolate Mahseer. It takes at least 3 years to mature and produces relatively few eggs at a time. The fish is highly regarded in its native country as a sport or game fish due to its fast swimming and jumping abilities.

The Golden Mahseer was brought to P.N.G. for the benefit of people living near larger fast flowing rivers in the Sepik-Ramu for both food and to start tourist/game fishing businesses. The fish is now very rare in its native range and only small numbers were brought to P.N.G.

TOR PIS

Acrossocheilus hexagonolepis - Chocolate mahseer



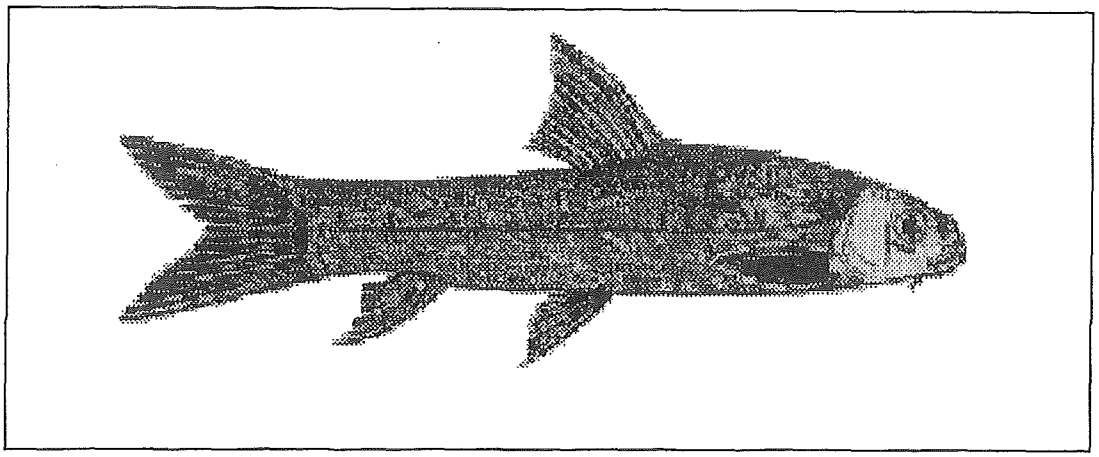
The Chocolate Mahseer is a migratory species living in fast flowing, torrential rivers and streams with temperatures ranging from 17 °C to 30 °C. It comes from the Himalaya region of Nepal and India.

The Chocolate Mahseer eats insects and plant material including algae growing on stones in streams. It is smaller then the Golden Mahseer and can grow to about 5 kg. It has very similar habits to the Golden Mahseer and produces relatively few eggs at a time.

FISHAID started introduction of the Chocolate Mahseer in 1993-1994.

SNOWTROUT

Schizothorax richardsonii



The snowtrout lives in fast flowing streams and rivers with temperatures ranging from freezing to about 25 °C. It is migratory, to some extent. The snowtrout comes from the Himalaya mountains of India and Nepal.

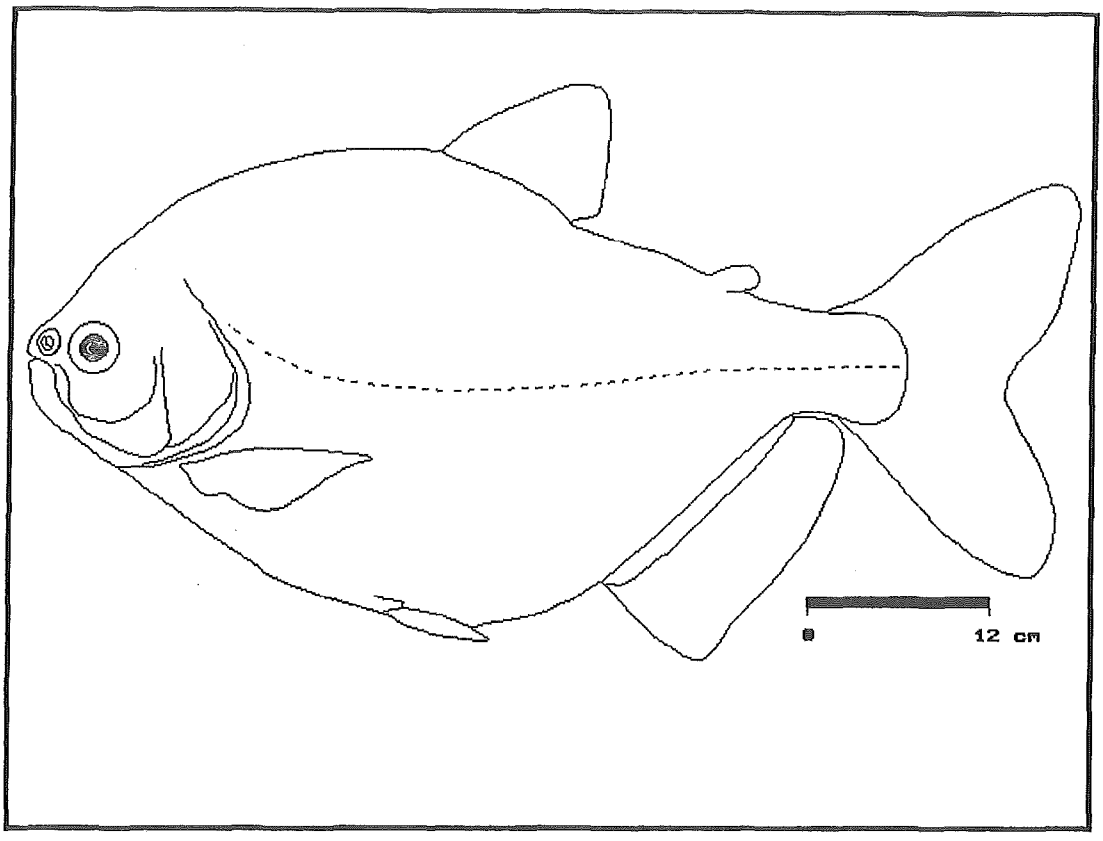
Adults feed mainly on algae and diatoms on rocks/boulders in rivers. It can also eat detritus and plant fragments. Grows to about 2.0 kg and it takes over 3 years to mature.

There is one "trout" already in P.N.G. - the salmonid trout imported a long time ago from Australia but originating from N. America (the one used in trout farms and with very limited distribution in rivers). The snowtrout looks similar to this "ordinary" trout but can be distinguished from that fish because it is a species of carp. This means that the mouth of the snowtrout has barbels ("whiskers") whereas ordinary trout do not. The habits of the snowtrout, except for feeding and water temperature preferences, are similar to trout. The snowtrout is considered a greatly superior fish to ordinary trout for P.N.G. conditions because it will tolerate warmer water and has a much more environmentally friendly feeding habit (the salmonid trout from Australia is a predator and eats other fish).

FISHAID started introductions in 1995, high up in cool torrential hillstreams (above 1000 m a.s.l) of the Sepik/Ramu catchment area.

PACU

Colossoma bidens (=Piaractus brachypomum)



The pacu lives in lowland floodplains and rivers, especially near flooded forest. Young pacu eat a range of food items including zooplankton. As they mature it changes to a diet based exclusively on plant material. Adults feed especially on nuts and seeds which fall into the water from the surrounding forest. It comes originally from South America.

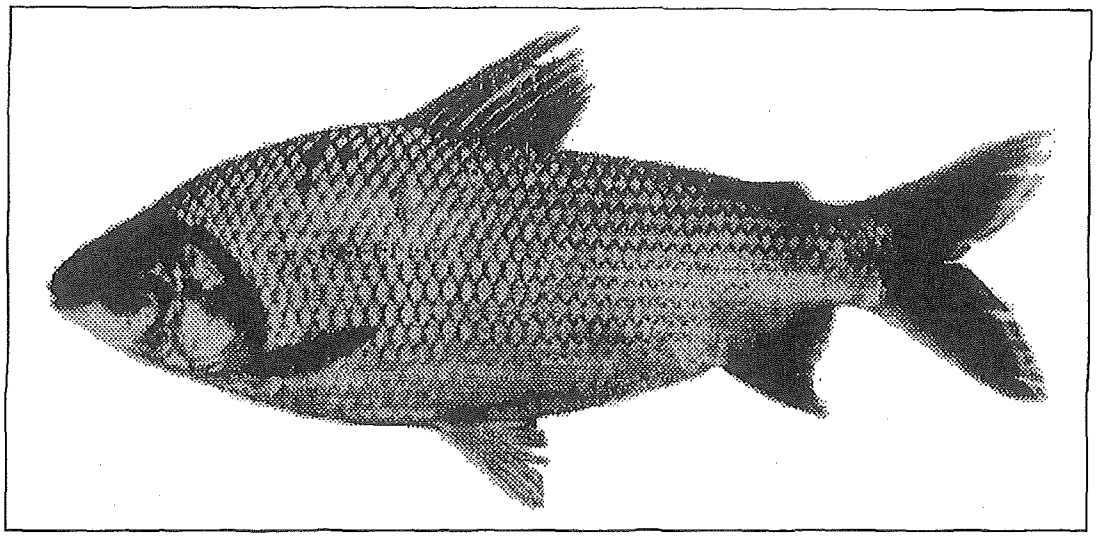
The pacu is easily recognised by its shape (see picture above). It has very small scales and smaller fish have a very attractive red belly which turns darker with age. The fish has very strong teeth which can easily be seen if the lips are pushed back. The teeth are flat and strong for crushing nuts. The fish is not aggressive but may give a nasty bite when being handled.

The pacu is a fast growing fish. In nature it can reach 25 kg (1 metre), and adults will commonly be 5 - 8 kg. Adults migrate great distances to spawning grounds, and can produce many eggs. It starts reproducing after at least three years. A highly valuable fish on commercial markets and expected to command a very high market price.

The pacu was introduced by FISHAID in the Sepik-Ramu river system between 1995 and 1997.

Emily's fish

Prochilodus margravii



Emily's fish lives in warm water lowland areas but will migrate into mountain regions for spawning. This fish feeds only on detritus/mud. It is a fast growing fish which can reach 12 - 14 kg. It migrates great distances to spawning grounds upstream, and can produce many eggs. Reproduction starts after 2 years for males and 3 years for females.

Easily recognised by its shape (above) and it has a strange shaped mouth which is modified for sucking at the surface of rocks/plants etc. The colour is silver with faint red/yellow/brown markings on the bottom fins and sometimes black stripes along the body.

The fish is famous for its jumping habit when frightened or when migrating over barriers such as rocks etc. when going up rivers to spawn. During the breeding season males make a clearly heard noise (a clicking, whistling or singing kind of sound) in order to attract females.

FISHAID started introductions in 1996. The fish did not have a name that can be used in PNG and was named "Emily's Fish" after the first person to introduce it, a two year old girl, on behalf of all the children of the Sepik-Ramu who will hopefully derive great benefits from this fish.