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Mullet Resource and Aquaculture in Tonga
Background of Mullet Pen Culture Trial

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Introduction

The decline of the mullet resource has been a concern to the people since the early 1970s in Tonga (Wilkinson 1977, Ludwig 1979, Zann *et al.* 1984). The Ministry of Fisheries had conducted several research projects for the mullet resource, such as a biological survey and pond culture trial, as well as conservation programs, however, no effective results had been confirmed. In 1991 Fisheries started the Aquaculture Research and Development Project and a trial of mullet aquaculture has been adopted as one of the main objectives. This paper shows the background of the trial. In addition, a mullet release trial was also introduced.

Background

Mullet is a very special fish in the Tongan diet and is known as "the king of fish". According to the interview survey in 1992, many consumer prefer mullet and fishermen also highly regarded the taste of this fish (Udagawa *et al.* 1994). People like the oily texture and strong taste of mullet meat. The roe of the fish is also an important reason for their preference of mullet. A number of mullet are caught during their spawning season and sold at fish markets. Large fish with ripe gonads have a great value at the market and are sold quickly even if at a high price compared to

other species. Table 1. shows the price of fish at the local fish market.

Table 1. Price of fish at the local fish market (T$/kg)

	average	minimum	maximum
mullet*	4.23	2.11	7.58
other species**	2.81	1.44	14.25***

* calculated by samples from fishermen between July and December in 1994
** estimated by the data of 1993 Statistics Annual Report (Tulua *etal.*, 1994)
*** The maximum price for Hump-Headed Maori Wrass *Chilinus undulatus*

The average price of mullet sampled at fish markets in 1994 was T$4.23 per kilogram and the highest price was T$7.58 per kilogram, while the average price of other species was T$2.81 per kilogram (estimated from Inshore Fisheries Statistic Annual Report 1993). This high price reflects the great local demand for mullet.

There are at least 8 species of mullet found in Tongan waters. They are:

1) ***Mugil cephalus,***
2) ***Valamugil seheli,***
3) ***V. engeli,***
4) ***Liza macrolepis,***
5) ***L. melinoptera,***
6) ***L. vaigiensis,***
7) ***Crenimugil crenilabis*** and
8) ***Neomyxus leuciscus.***

Fishermen primarily catch *M. cephalus, V. seheli* and *L. macrolepis.*

State of the Mullet Resource in Tonga

Decline of the Mullet Resource

Tongan people had caught mullet for a long time and mullet catch often comprised 40% of the fish marketed at Nuku'alofa during the 1960s (Zann *et al.*, 1984). Although people strongly prefer the mullet meat, mullet catch decreased rapidly between the 1980s and early 1990s. The landing of mullet was estimated to be 110 mt in 1982 which was 5% of total fish consumption in that year (Kunatuba and Uwate 1983). Fisheries statistics data showed only 3.65 mt of mullet was landed in 1993 and 2.75 mt in 1994 (Table 2 estimated from Inshore Fisheries Statistics Annual Report 1993 and 1994).

Table 2. Landing of mullet to local fish market

Year	mullet landing to local fish market	
1960s		(40% of fish marketed*)
1982	110**	(5% of total fish consumption)
1993	3.65***	(0.76% of annual fish landing)
1994	2.75****	(0.86% of annual fish landing)

*data from Zann *et al.*, 1984
** data from Kunatuba and Uwate, 1983
*** estimated from Inshore Fisheries Statistics Annual Report 1993
****estimated from Inshore Fisheries Statistics Annual Report 1994

This decline of the mullet resource has been a concern to the people since the early 1970s in Tonga (Wilkinson, 1977; Ludwig, 1979; Zann *et al.* 1984). Overfishing was widely believed to be the cause of the declining mullet catch. Wire net fence trapping (paa) has been a most popular fishing method, targeting mullet since wire netting was introduced as a material for the fence trap in the early 1950s. Its usage boomed in the middle of 1960s when all the strategic locations were covered by the fish fence (Zann *et al.* 1984,

Udagawa *et al.* 1994). The fence trapped schools of mullet when they migrated during the spawning season. One fisherman in Ha'atafu remembered that he sometimes caught one track of mullet which had mature gonads. The catching of berried mullet in large numbers could lead to the reduction of the mullet resource.

A severe decline of mullet resource occurred mainly on the species *Mugil cephalus*, which was one of the target species of fence fishing until the 1980s (Fa'anunu *et al.* 1993). Almost 75% of mullet sampled from fishermen in 1987 was *M. cephalus* (Langi *et al.*, 1992), however, the percentage of *M. cephalus* in sampled mullet dropped dramatically to 5.4% in 1994 (Table 3).

Table 3. Percentage of *Mugil cephalus* in mullet sampled from fishermen

Year	Period	% of *M. cephalus*
1987	July - September	75.0
1994	July - September	12.8

History of Conservation Program for Mullet Resource

To stop the decline of the mullet resource, the government tried to conserve the resource, however, prior to 1974 there were no restrictions on catching of fish/shellfish and netting of mullets and prawns was commonly practised by local fishermen from Fanga'uta lagoon .

(1) Lagoon Preservation Act (No.24 of 1974)
In 1974, a commercial trawl fishery was established by a local entrepreneur. Apprehensions about possible serious damage to the lagoon led to enactment of the "Birds and Fish Preservation (Amendment) Act", 1974, which prohibited any commercial exploitation of the lagoon fish/shellfish resources by trapping, trawling, netting, or other means. The Act also prohibits discharge into the lagoon of polluting substances,

prohibits construction of any piers or other facilities in the lagoon, and prohibits any boring/drilling/dredging (Ludwing, 1979).

(2) The 1974 ban of commercial fishing and activity in the lagoon was repealed by parliament in 1981 because many villagers relied on the lagoon for their livelihood and were finding it increasingly difficult to find or afford enough protein. A Tongatapu representative said that "It was widely believed that the legislation was unnecessary and against God's laws of nature " (Zann *et al.*, 1984).

(3) Framed by the Fisheries Act 1989 (Section 59), The Fisheries (Conservation and Management) Regulation was approved by the cabinet in 1994. The regulation prohibits mullet fishing from 1 June to 31 July in Fanga'uta lagoon, but has no seasonal closure for wire fence trapping. Some fishermen still fished in the lagoon during closed season and some even fished using dynamite.

Mullet Aquaculture Trial for Conservation of Mullet Resource

To conserve the broodstock of mullet, the closed season of mullet fishing needs to be extended. The mature mullet appears mainly from June to October, although the closed season of mullet fishing is only between June and July. The period should therefore be extended to October. Also, the area where mullet fishing is prohibited needs extending to cover the whole of Tongatapu Island's coastal area because during the spawning season, a large number of the mature mullet are caught by fish fence at the mouth of the lagoon and along the west coast of the main island.

Looking at the history of the ban, people may have rebelled the prohibition as they were given no alternatives. Mullet culture should help enforce the prohibition and gain support from fishermen by providing an alternative income source. The

introduction of mullet culture should therefore reduce the fishing pressure on the mullet resource.

Consumers will still have a strong desire for mullet and to meet this demand, cultured mullet will be supplied to the local market during the prohibition period.

Also, mullet culture could protect the environment of Fanga'uta lagoon. Some people already use shallow areas in the lagoon for commercial and private activities. They cut the mangroves, dredge, reclaim part of the lagoon and build houses. The pen culture could put a stop to these activities and prevent the destruction of the environment in the lagoon.

Based on this background information, a trial of mullet culture was started in 1991 as one of the main objectives in the Five Year Aquaculture Research and Development Project. The project aims are:

1) construction of pen culture trial site,
2) establishment of pen culture system,
3) economical feasibility study of mullet pen culture.

During the first three years of the project, a mullet seed collection survey, a water quality survey and mullet market research were conducted and an experimental pen was constructed in Fanga'uta lagoon for several culture experiments. The mullet culture experiment in1994 is detailed in Paongo and Kimura, 1995.

Mullet Release in a Low Productivity Lake

Ministry of Fisheries conducted a mullet release trial in Lake Ano on Vava'u Island in 1990. The trial aimed to develop a local fishery resource in the lake for the villagers. There are inland waters in some islands of the kingdom, such as Nomuka island, Tofua island, Vava'u island and Niuafo'ou island. These islands had limited resources and the inland water is a low productive

fishery. Lake Ano is one of those inland waters whose area is 2.84 km² and salinity is around 10 ‰. Only gobies, eels and shrimp were inhabiting the lake. *Tilapia mosambica* was introduced to the lake in the1950s. The introduced tilapia have been propagating well in the lake and villagers enjoy the fish on a family consumption level.

In 1990, 9,000 of *M. cephalus* fry which was produced at the Oceanic Institute, were introduced to the lake from Hawaii with financial support of FAO. These *M. cephalus* fry grew quite fast in the lake (Table 4). Fifteen months after release, six mullet were caught in the lake and the average size of the samples was 309.0 mm in total length, 243.5 mm in standard length and 302.3 g in body weight (M. Kume, pers. comm.).

Table 4. The growth of *Mugil cephalus* released in Lake Ano, Vava'u

Year	Month	Notes		TL(mm)	SL(mm)	BW(g)
1990	June-July	9,000 fry were released		33.1	-	-
1991	September	6 mullets sampled	avg	309.0	243.5	302.3
	(15 months after release)		max	335.0	260.0	390.0
			min	290.0	227.0	235.0
1993	August	2 mullets sampled	avg	-	326.0	646.0
	(3 years after release)		max		342.0	802.0
			min	-	310.0	490.0
1994	July-December	5 mullets sampled	avg	394.0	307.0	557.9
	(4 years after release)		max	455.0	353.0	990.0
			min	343.3	270.0	376.0

The mullet showed the same maturation pattern in the lake to wild mullet in Tongatapu. The Gonad Somatic Index (GSI)[1] peaked in July and September (Fig. 1) and female samples had large eggs in these periods. Due to their fast growth and maturation of gonads, the release of *M. cephalus* should provide a good local fishery resource.

[1] GSI = (gonad weight/body weight) x 100

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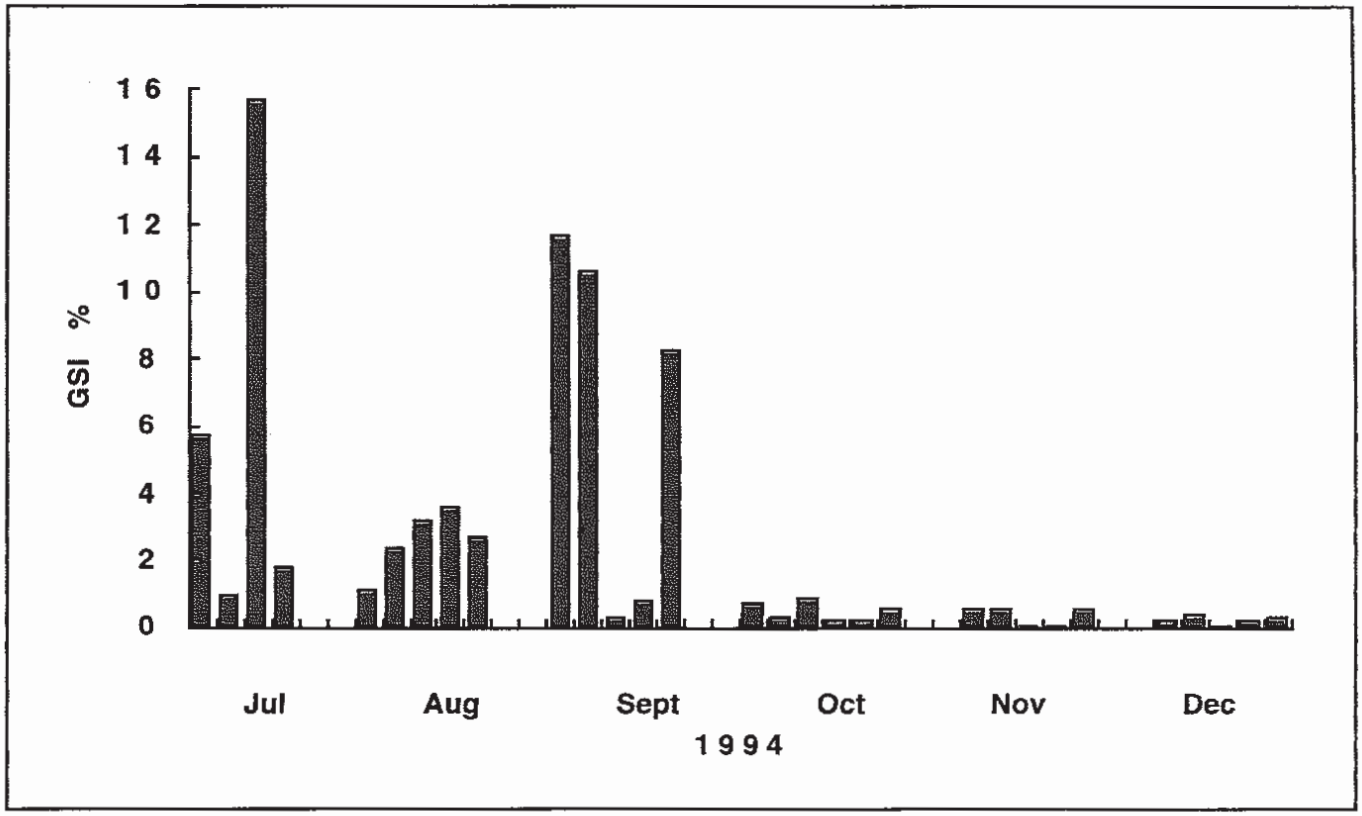

Figure 1. Gonad Somatic Index (GSI) of mullet sampled in Lake Ano in 1994