WATER HARVESTING AND AQUACULTURE
FOR RURAL DEVELOPMENT

INTRODUCTION TO POLYCULTURE OF FISH

INTERNATIONAL CENTER FOR AQUACULTURE
AND AQUATIC ENVIRONMENTS
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INTRODUCTION

Polyculture is the practice of culturing more than one species of aquatic organism in the same pond. The motivating principle is that fish production in ponds may be maximized by raising a combination of species having different food habits. The mixture of fish gives better utilization of available natural food produced in a pond. Polyculture began in China more than 1000 years ago. The practice has spread throughout southeast Asia, and into other parts of the world.

HOW DOES POLYCULTURE WORK?

Ponds that have been enriched through chemical fertilization, manuring or feeding practices contain abundant natural fish food organisms living at different depths and locations in the water column. Most fish feed predominantly on selected groups of these organisms. Polyculture should combine fish having different feeding habits in proportions that effectively utilize these natural foods (Figure 1). As a result, higher yields are obtained. Efficient polyculture systems in tropical climates may produce up to 8,000 kg of fish per hectare per year.

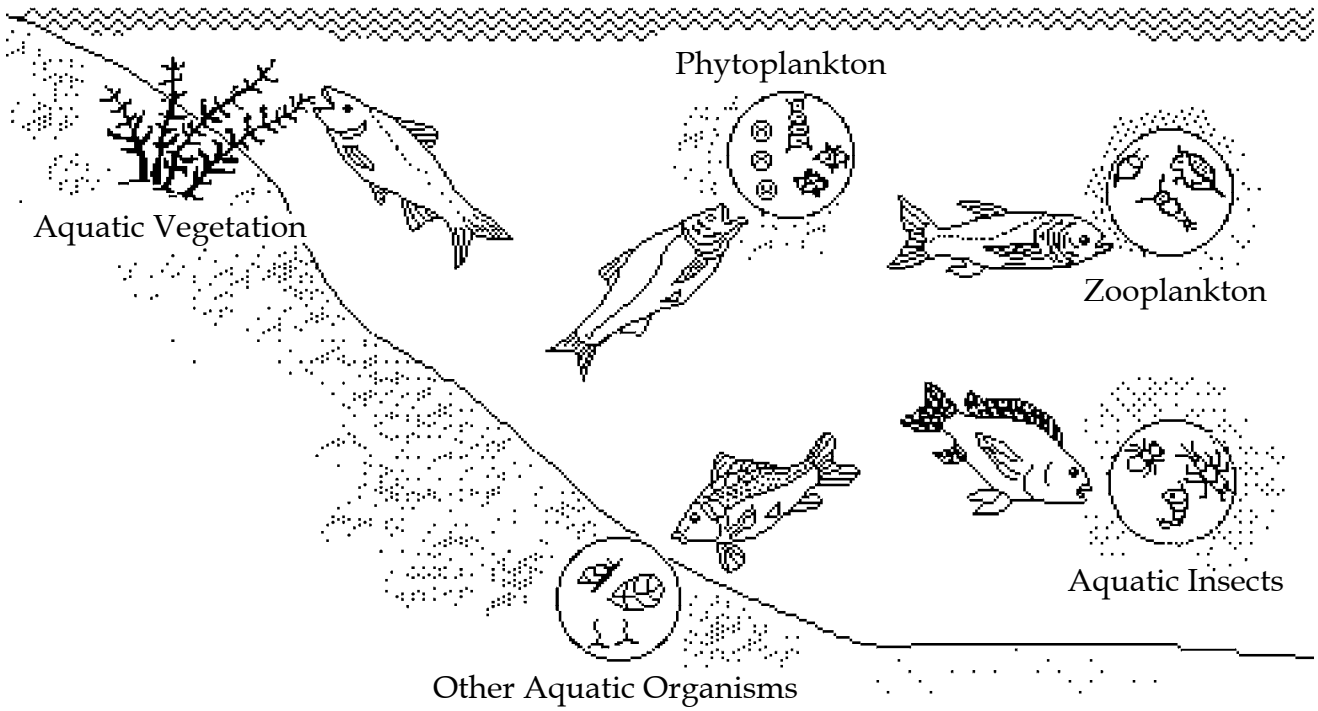


Figure 1: Polyculture utilizes natural foods efficiently.

FISH USED IN POLYCULTURE

Combinations of three Chinese carps (bighead, silver and grass carp) and the common carp are most common in polyculture. Other species may also be used. While fish may be grouped into broad categories based on their feeding habits, some overlap does occur. Descriptions of the feeding habit categories and examples of fish from each category follow.

Plankton Feeders

Plankton is normally the most plentiful food in a pond so it is very important to include a plankton feeding fish in a polyculture system. This group of fish feeds on the tiny, free floating plants (phytoplankton) and animals (zooplankton) which multiply abundantly in fertilized ponds. Two fish typical of this group are the silver carp, *Hypophthalmichthys molitrix* (Figure 2), and the bighead carp, *Aristichthys nobilis* (Figure 3). Other plankton feeders include:

Country/Region	Local Name	Scientific Name
China	ma lang yu	*Squaliobarbus curriculus*
	ca choi	*Labeo collaris*
	striped mullet	*Mugil cephalus*
India	catla	*Catla catla*
	fringe lipped carp	*Labeo fimbriatus*
	white carp	*Cirrhinus cirrhosa*
	Cauvery carp	*Labeo kontius*
	bata	*Labeo bata*
Indochina	sandkhol carp	*Thynnichthys sandkhol*
Vietnam	ca duong	*Hypophthalmichthys harmandi*
Worldwide	blue tilapia	*Oreochromis aureus*
	nile tilapia	*Oreochromis niloticus*

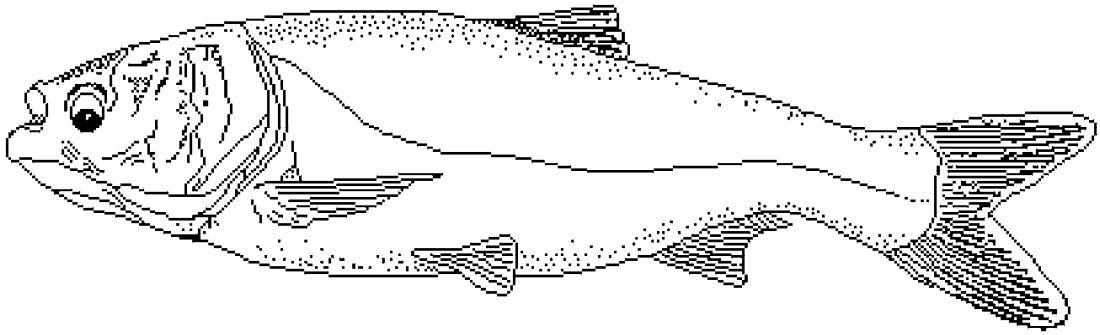


Figure 2: Silver carp feed primarily on phytoplankton.

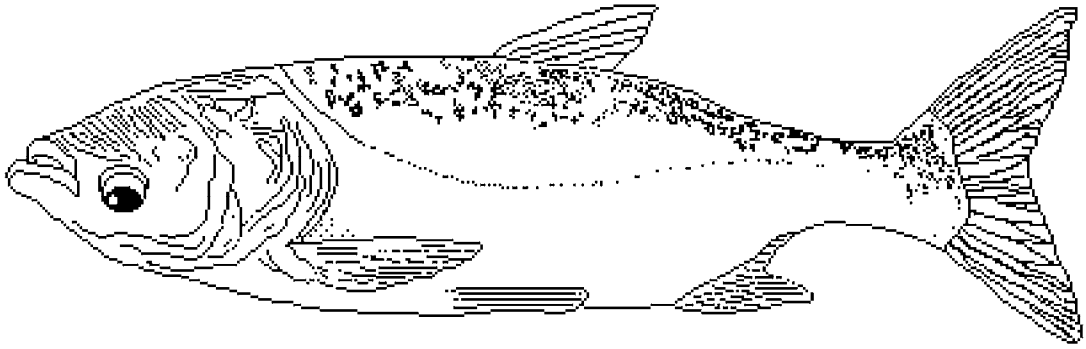


Figure 3: Bighead carp feed primarily on zooplankton.

Herbivores

This group of fish feeds on aquatic vegetation. The grass carp, *Ctenopharyngodon idella* (Figure 4), is most noted for this behavior and is stocked in ponds for the purpose of weed control. Other herbivores include:

Country/Region	Local Name	Scientific Name
Africa	tilapia	*Tilapia rendalli*
India	rohu	*Labeo rohita*
	Cauvery carp	*Labeo kontius*
	reba	*Cirrhinus reba*
Indochina	ca ven	*Megalobrama bramula*
Indonesia	giant gourami	*Osphronemus goramy*
SE Asia	tawes	*Puntius gonionotus*
world wide	Zillis tilapia	*Tilapia zillii*

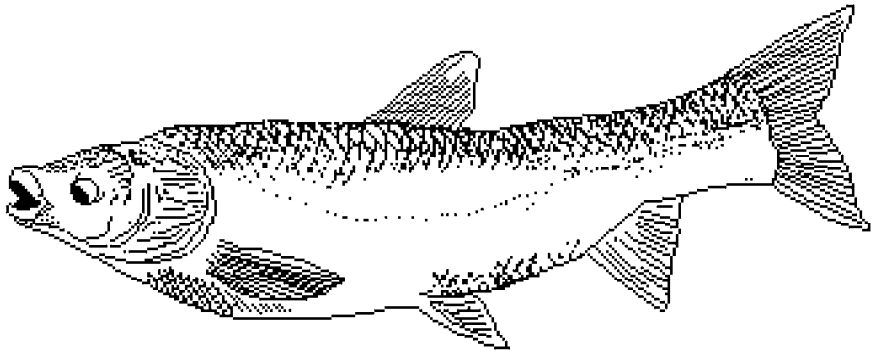


Figure 4: Grass carp feed on aquatic vegetation.

Bottom Feeders

Fish in this group feed primarily at the pond bottom. They consume a variety of decaying organic matter, aquatic organisms such as clams, insects, worms, snails, and bacteria living in or on the sediments. The common carp, *Cyprinus carpio* (Figure 5), is well noted for this behavior. Other bottom feeders include:

Country/Region	Local Name	Scientific Name
China	mud carp	*Cirrhinus molitorella*
	black carp	*Mylopharyngodon piceus*
	cha cham	*Mylopharyngodon aethiops*
	striped mullet	*Mugil cephalus*
India	mrigal	*Cirrhinus mrigal*
	Cauvery carp	*Labeo kontius*
	reba	*Cirrhinus reba*
	nagendram fish	*Oteochilus thomassi*
SE Asia	belinka	*Barbus belinka*
	lampai	*Barbus lampai*
	mata merah	*Barbus orphoides*
	tambra	*Labeobarbus tambroides*
Taiwan	milkfish	*Chanos chanos*
Worldwide	nile tilapia	*Oreochromis niloticus*
	blue tilapia	*Oreochromis aureus*
	black tilapia	*Oreochromis mossambicus*

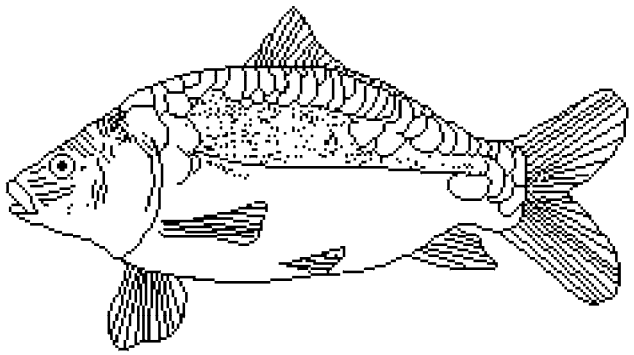
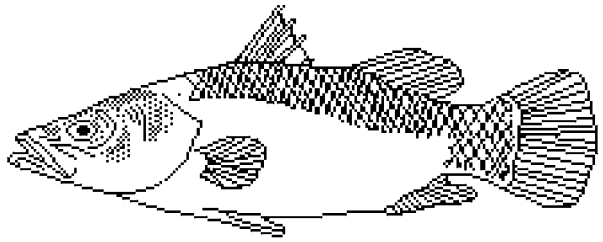


Figure 5: Common carp are bottom feeders.

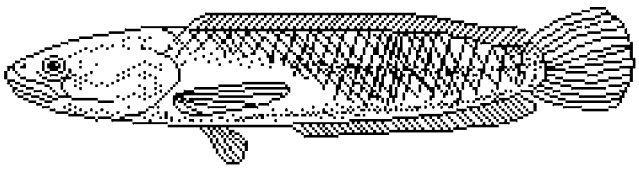
Piscivorous Fish

These predatory fish feed on other fish, and must consume about 5 to 7 g of prey in order to grow 1 g. They are frequently stocked in ponds to control unwanted reproduction, particularly

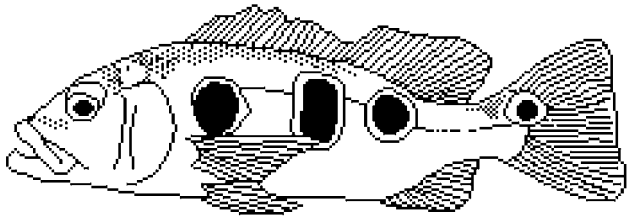
in tilapia, and other fish that enter the pond with the water supply and compete for food with the stocked fish. Commonly used predator fish include the sea bass, *Lates* spp.; catfish, *Clarius* spp. and *Silurus* spp.; snakeheads, *Ophicephalus* spp.; cichlids, *Cichla* spp.; *Hemichromis fasciatus* and *Cichlasoma managuense*; knife fish, *Notopterus* spp.; and largemouth bass *Micropterus salmoides* (Figure 6).



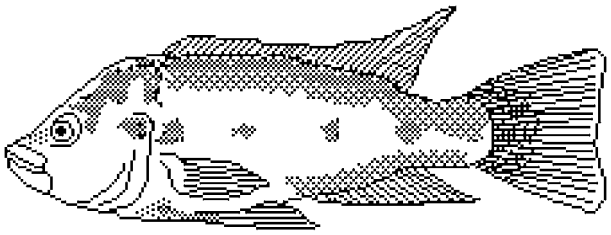
Lates



Ophicephalus



Cichla



Hemichromis fasciatus

Clarius

Figure 6: Various predator fishes used in polyculture.

Adding predator fish to a polyculture system increases the average weight of prey species. It is most efficient to use a predator fish that consumes small prey. This prevents the prey from growing large enough to compete for food with larger fish of its species. Use of predator fish in polyculture systems is experimental in most areas of the world. In small ponds, it is almost impossible to stock the exact number of predator fish to achieve the same predator/prey balance occurring in nature. In small scale aquaculture, predator fish are usually stocked at rates of 5 to 20 fish per 100 m^2 of pond surface area to completely control reproduction of the prey species.

FACTORS AFFECTING SPECIES SELECTION AND STOCKING RATES

1) Water temperature

Many fish can not survive or grow well in cold water. Systems using cold-tolerant fish such as common carp and Chinese carps must be used if temperatures drop below 18°C.

2) Market value of fish

The market price and demand should be considered before a fish species is chosen for culture. When two or more fish can fill the same feeding niche in a pond, the choice should be based on which will maximize economic returns to the farmer.

3) Pond fertilization practices

Most polyculture systems are based on fertilization. Manures and chemical fertilizers increase production of natural fish food organisms in ponds. Thus, more food is made available to fish. Fertilized ponds may be stocked at higher rates than unfertilized ponds.

4) Feeding habits of fish

Supplemental feeds are commonly given to fish. Manure may serve as a food source for some fish by supplementing the nutrition available from natural food organisms in the pond. A wide variety of agricultural by-products may serve as supplemental feed. When fish are fed, ponds can be stocked at higher rates. Stocking bottom feeding fish such as common carp prevents sinking foods from being wasted.

5) Tolerance to pond conditions

Polyculture ponds are usually heavily fertilized or manured. This practice may cause low oxygen levels and other conditions in the water that are stressful to fish.

6) Potential of uncontrolled spawning in grow-out ponds

Certain fish, like tilapia, reproduce easily in ponds. Tilapia may become so overpopulated that their growth stops and they become stunted. Predator fish are often stocked in tilapia ponds to control reproduction.

STOCKING RATES FOR POLYCULTURE SYSTEMS

Examples of stocking rates for polyculture systems used in various countries are presented in Table 1, and are intended as general guidelines. Modification to suit conditions in other locations may be necessary.

Table 1: Number of fish stocked per 100 m^2 of pond surface area in polyculture systems used in various countries.

Species	CHINA	INDIA	MALAYSIA	T H A I L A N D				PANAMA	SIERRA LEONE
Bighead carp	1	-	1	3	-	-	-	10	-
Silver carp	12	-	1	3	-	-	-	-	-
Grass carp	2	-	3	3	-	-	-	-	-
Common carp	17	-	1	6	32	31	-	10	-
Tawes	-	-	-	63	63	63	-	-	-
Rohu	-	38	-	6	-	-	-	-	-
Mrigal	-	6	-	-	-	-	-	-	-
Catla	-	19	-	-	-	-	-	-	-
Tilapia	-	-	-	63	63	63	125	100	160
Ophicephalus	-	-	-	-	-	-	3	-	-
Cichlasoma	-	-	-	-	-	-	-	20	-
Notopterus	-	-	-	-	-	-	-	-	16

POTENTIAL PROBLEMS IN POLYCULTURE

Polyculture is an effective way to maximize benefit from available natural food in a pond. But, pond management becomes more difficult when stocking fish species having specialized feeding habits in the same pond because good fertilization and feeding practices must be followed. If inadequate fingerling supply severely limits the choice of species available for polyculture, at least one species should have general rather than specialized feeding behavior. This will allow more of the available natural food to be utilized.

GLOSSARY OF TERMS

bottom feeder - fish that prefers feeding on the pond bottom.

chemical fertilizers - manufactured fertilizers containing nitrogen, phosphorous and/or potassium in varying proportions.

feeding niche - role a fish plays in a culture system with regard to food consumption.

fertilizer - substance added to water to increase availablity of nutrients for the production of natural fish food organisms.

herbivore - animal which feeds on vegetation.

natural fish food organisms - plankton, insects and other aquatic organisms that fish eat.

phytoplankton - plant component of plankton.

plankton - microscopic organisms suspended in the water column that serve as food for larger aquatic animals.

plankton feeder - animal which feeds on plankton.

polyculture - simultaneous culture of two or more species with different food habits.

predator fish - fish that eats other fish.

supplemental feed - feed that does not contain all the vitamins and nutrients essential for growth, but which supplements natural nutrients available in a pond.

zooplankton - animal component of plankton.

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