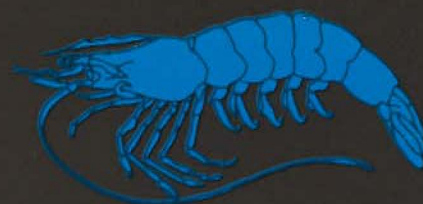
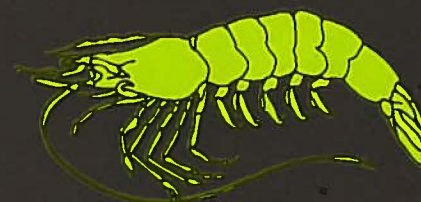
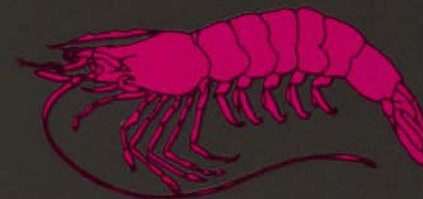


AQUACULTURE

Guam Cooperative Extension
College of Agriculture & Life Sciences
University of Guam



Most commonly asked questions about aquaculture on Guam
and a description of some species commonly grown on Guam.

By David P. Crisostomo, Extension Aquaculture Agent

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What is aquaculture?

Aquaculture is the raising of plants and animals in water. This includes freshwater, saltwater, and brackish water (a mixture of freshwater and saltwater). This does not include hydroponics. The term *Mariculture* is often used to describe aquaculture in saltwater or brackish water.

What is the Size of Guam's Aquaculture Industry?

By 1985, there were 12 aqua-farms constructed on Guam. However, as of 1989, only three farms were actively producing. Production in 1989 totalled 483,350 pounds with a value of approximately \$1.3 million.

What benefits do the people of Guam receive from the aquaculture industry?

Aquaculture provides job opportunities in the private sector and in government. It also provides additional tax revenues, provides fresh, nutritious seafood products, and decreases imports, thereby contributing to a healthy economy.

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When did aquaculture begin on Guam?

The Government of Guam Department of Agriculture first constructed aquaculture ponds in 1973 to demonstrate pond culture techniques for several species, including catfish, eels, tilapia, freshwater prawns, carps, milkfish, mangrove crabs, and oysters.

What types of plants and animals are currently being raised on Guam?

The species that are commercially produced at the present time include a hybrid tilapia, two species of Asian (walking) catfish, the Thai catfish,

Jumbo Tiger Prawn, milkfish, and carps. Seaweeds, rabbitfish, and giant clams are being examined for local aquaculture, but there is currently no commercial production.

Which species is being produced in greatest abundance?

Tilapia production was in greatest abundance in 1989, totalling 299,000 pounds with an estimated market value of \$747,500.00. Tilapia production will probably see little expansion because the existing markets are nearly saturated. However, there are possibilities for new markets to develop in the future.

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Which species has the greatest potential for expansion?

There are several species that are in demand, but farmers are experiencing very low production due to a lack of seedstock. These include marine shrimp, freshwater prawns, milkfish, and rabbitfish.

Where are Guam's aquaculture farms located?

The majority of farms are located in the southern portion of the island, where freshwater and suitable soil and topography exist.

Is there a ready market for Guam's aquaculture products?

Yes. With imported seafood costing \$7 million in 1986, there is a large volume that can be substituted with local aquaculture products. In addition, our proximity to Japan offers the potential for export.

Where are these products sold?

The majority of aquaculture products are sold at the Harmon flea market on Saturdays and Sundays and at two retail outlets owned by aquaculturists. Other outlets include roadside truck sales in Dededo and Agat, various restaurants, the IAE Mart in Harmon, Numero Uno fish mart in Dededo, and occasionally larger retail markets. There are occasional exports to other islands.

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How much money is required to get started in aquaculture?

The amount of money needed to get started in aquaculture can vary from a few hundred dollars for a small backyard set-up to one million dollars or more for a large farm.

What kind of land is suitable for aquaculture?

The preferred land for aquaculture is relatively flat land with soil that contains a least 25 percent clay and is free from too many rocks. Avoid soils that may have been contaminated with industrial wastes or other contaminants. Construction and operation costs will be higher on hillside land.

How much land do I need for aquaculture?

The amount of land you will need depends on your plans. A small backyard pond can produce up to hundreds of pounds a year. An economical commercial farm may require at least 10 acres of ponds.

Where can I obtain financing for an aquaculture project?

Commerical loans are available through local banks, but the repayment period for the loan is usually too short to be economically feasible. Loans specifically for aquaculture operations are available. However, the Government of Guam Department of Agriculture administers agricultural development loans; while the Guam Economic

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Development Authority (GEDA) has two loan programs where aquaculture operations would qualify. The Small Business Administration (SBA) provides loans for small operations. Specifics can be obtained through the local offices of the agencies named.

Are there any permits required for operating aquaculture farms?

There are several permits needed before one can start an aquaculture farm. The most common ones are for pond construction and importation of live animals for stocking. Farms located near the coast may need additional permits. Additional information on permits is contained in a pamphlet entitled "An

Introduction to Aquaculture on Guam: Prospects, Permits and Assistance," from the Government of Guam Department of Commerce located on the sixth floor of the GITC building on Marine Drive in Tamuning.

What are the employment opportunities in aquaculture on Guam?

Some possible employment opportunities are in positions of hatchery technician, training specialists, researcher, farm helper, extension agent, laboratory technician, information specialist, marketing manager, farm manager, and others.

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What are some requirements to work in aquaculture?

The qualifications range from unskilled laborer to positions requiring doctoral degrees. Most positions require an interest in aquaculture and an awareness of the needs of the farm or the industry.

Where can I learn more about aquaculture?

There are many institutions offering formal courses, through various mainland and foreign universities. Many certificate-training programs are also available. The University of Guam offers an introductory course in tropical aquaculture and periodic workshops are conducted by the University's Guam Cooperative Extension (GCE). Practical experience in aquaculture and an official

University of Guam certificate can be gained through the Marine Option Program (MOP) at UOG's Marine Lab. Information on training opportunities in Asia or the United States is available through the Guam Cooperative Extension office.

What government agencies can help me get started in aquaculture?

The University of Guam has several components that can assist with aquaculture. The College of Agriculture and Life Sciences can provide training, technical assistance and soil analysis through the Guam Cooperative Extension and the Guam Agricultural Experiment Station. The Water and Energy Research Institute (WERI) can provide detailed water analysis.

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The Sea-Grant Extension Service can provide information on certain areas. The Marine Laboratory conducts experiments with various aquaculture species and may be of assistance.

The United States Department of Agriculture Soil Conservation Service (USDA-SCS) can provide assistance in pond construction and erosion control.

The Department of Agriculture can assist in obtaining permits and advice for operations. The Department of Commerce can provide assistance on economic aspects.

The Guam Aquaculture Development & Training Center provides seedstock of some species for producers, conducts some training and can provide technical assistance.

What is the future of aquaculture on Guam?

Aquaculture is playing an expanding role in the economy of Guam. Increased interest in aquaculture on a national level, as well as an international level, gives aquaculture a bright future. The establishment of five regional aquaculture centers with federal funds for research is evidence of governments' support of aquaculture. As world food needs continue to grow, aquaculture products will be in greater demand.

Japanese Eel

Scientific Name: *Anguilla Japonica*

Chamorro Name: Hasuli

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Description: The Japanese eel spawns in the ocean near Okinawa. They enter freshwater lakes and rivers as elvers (juvenile eels) in December to April and live there five to 10 years, at which time they migrate back to the sea to spawn and die. Adult females are much heavier than males. When they reach 30 cm in size their sex can be distinguished for the first time. Eels reach adult size when males are 35 cm long and weigh 70 grams, while females will be 57 to 60 cm long and weigh 300 to 350 grams.

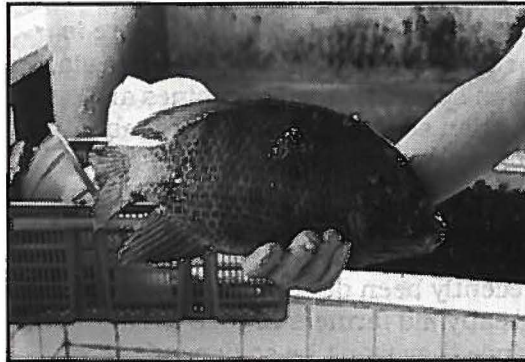
Culture Practice: Eels were cultured on Guam from 1979 to 1982. Eel ponds are usually constructed with earthen bottoms and concrete walls or other impenetrable material, since eels have a habit of burrowing, which can cause leaks. Young eels (elvers) are imported and placed in small (900 ft²) concrete ponds where they are trained to feed out of a feeding basket. They are fed early in the morning while it is still cool (approximately 6 a.m.). A special eel food mix is used. This powdered feed is combined with water, vitamins, and oil, then mixed to a dough-like consistency. This food mass, up to 100 pounds, is placed into the feeding baskets in each pond. A daily water exchange of 5-10% of the pond volume will maintain good water quality. Dissolved oxygen levels are kept high with the use of mechanical aerators (usually a paddlewheel type). Suitable temperatures for commercial eel culture is 23-30°C. The culture period to reach market size of 200-250 grams is 12-18 months on Guam.

Tilapia

Scientific Name: *Oreochromis mossambicus* x *O. niloticus*
Chamorro Name: None

Description: The tilapias are represented by many species. However, only a handful are used in commercial aquaculture. Several species of the genus *Sarotherodon* (*Oreochromis*) are preferred, including *O. mossambicus*, *O. aureus*, *O. niloticus*, and others. These species are mouthbrooders, incubating their eggs in their mouths until they hatch and are about one week old. Spawning occurs in small depression nests in the pond bottom.

Culture Practice: Some species of tilapia grow much faster and reproduce at a larger size than others. A common problem in tilapia culture is overcrowding of ponds due to the prolific reproductive nature of this fish. To overcome this aquaculturists use one of several management strategies, including selective breeding to yield all-male offspring, use of chemicals to sterilize or influence male sex characteristics in the fry, or the use of hybrids.



The use of hybrids is more commonly used, since these fish show fast growth, low reproduction up to the harvest size, and good marketability. Some aquaculturists prefer the different colored tilapias developed through selective breeding. However, most of the production and consumer preference on Guam is for the natural gray-black color type. The culture period for tilapia is 4-7 months. Production in 1989 totalled 299,000 pounds.

Milkfish

Scientific Name: *Chanos chanos*

Chamorro Name: None

Description: Milkfish culture is believed to have started in Indonesia, then spread to the Philippines and Taiwan so that today it is probably the most commonly cultured fish in all of Southeast Asia. A mass production technique for successfully inducing milkfish to spawn in captivity has recently been developed. This will greatly aid farmers in their production, since they won't be so dependent on natural stocks. Milkfish are not abundant in Guam's surrounding waters, so local farmers must import the fry. The warm climate here is conducive to the rapid growth of this fish, and there is a market demand for it. In 1981, over 670,000 pounds of fresh, whole milkfish from Philippine fish ponds were imported to Guam.

Culture Practice: Milkfish are found in coastal areas and freshwater river inlets. Wild Milkfish fry are caught in specially made fine mesh nets and later stocked in ponds where they are raised to market size.

They are usually raised in fresh or brackish water. It is common to find milkfish ponds also stocked with the marine prawn, *Penaeus monodon* (also known as tiger prawns or "sugpo") in many parts of Southeast Asia. Milkfish feed mostly on algae, but on Guam they are fed heavily with commercially prepared diets to increase their growth rates. Culture period of this fish is 6-10 months. In 1989, production of milkfish peaked at 155,600 pounds. This fish is also occasionally exported in small quantities.



Giant Malaysian Prawn

Scientific Name: *Macrobrachium rosenbergii*

Chamorro Name: Uhang



Description: This prawn is native to the river systems of the Indo-Pacific from Thailand to Australia. In 1962, the first laboratory reared prawn post-larvae of this specie were successfully produced. In 1966 a mass culture technique was developed in Hawaii and since then the popularity of the Giant Malaysian Prawn for aquaculture has grown. Hatcheries throughout the world began producing this prawn. Commercial efforts in Hawaii proved to be uneconomical to most and marginal to some. Guam has environmental

conditions that will permit year-round culture of this prawn, unlike the seasonal conditions of Hawaii. With the recent government acquisition of a hatchery facility on Guam, production of the Malaysian prawn is expected to increase and become a regular item on the market.

Cultural Practice: Giant Malaysian Prawns are usually raised in freshwater ponds, although brackish water is not uncommon during the dry season. Some farmers raise their prawns with tilapia or carp to better utilize the water column since prawns are bottom dwellers. These prawns are very aggressive and will eat almost anything, including each other. However, pond raised prawns are fed daily with a commercial feed thereby minimizing the need to scavenge for food. The culture period for this prawn is 5-10 months. The growth rate is very variable. Restocking on a monthly basis or longer can be practiced to obtain year-round harvesting. Production in 1989 was 250 pounds.

Jumbo Tiger Prawn

Scientific Name: *Penaeus monodon*

Chamorro Name: Uhang

Description: This is one of the largest of the Indo-Pacific penaeid prawns and one of the most suitable for Guam aquaculture. It has a wide tolerance for salinity. They are not found naturally around Guam. Where they do occur naturally they can be found in estuarine environments. When they mature they swim offshore to spawn. They can be manipulated in artificial conditions to achieve spawning and can reach a size of about 250 grams in the wild.

Cultural Practice: *Penaeus monodon* was successfully propagated for the first time in 1968. The largest of the penaeid prawns, it has been cultured in ponds for about 300 years. The optimal salinity for raising these prawns is 5-25 ppt and the optimal temperature is 25-30 C. Ponds are usually earthen and about 0.2-0.5 hectares in size. Stocking rates are 20-30 juveniles per square meter. The culture period for *P. monodon* is 4-6 months.

Production on Guam in 1986 was 2,355 pounds, and negligible since then. A worldwide problem exists with a virus that causes high mortality in this species. Although not a threat to humans, the disease has reduced production of this prawn worldwide and much effort is underway to find a cure and stocks that are free of this virus.



Chinese Carp

Scientific Name: *Hypohthalmichthys molitrix*
Ctenopharyngodon idellus, *Artisticthys nobilis*,
Cyprinus carpio

Description: The culture of carps has been practiced in China for thousands of years and has since spread to many countries of the world. In some parts of Germany, carp is a traditional Christmas meal much like



turkey is to any American Thanksgiving dinner. Mass production techniques for hatching carp fry are well developed and can potentially be produced in Guam's hatchery when the need arises.

Culture Practice: Silver, Grass, Common, and Bighead carps are freshwater fishes which are commonly raised together in the same enclosure. This method, known as polyculture, takes advantage of the preference in feeding habits that is a characteristic in the three species. For example, bighead & silver carp generally feed on microscopic animals and algae, and grass carp eat larger plants from algae to terrestrial weeds. On Guam, the diets of these fish are supplemented with commercial fish feed to increase their growth rates. The culture period is 6-12 months. Current demand is not great for these fish.

Asian(walking)catfish

Scientific Name: *Clarias batrachus*

Clarias macrocephalus

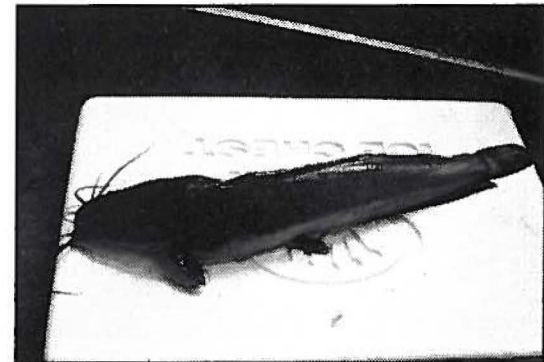
Chamorro Name: Hito

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Description: Interest in the culture of clarid catfish originated in East Africa. Recently, the culture of clarid catfish has spread into Southeast Asia and has been very successful. These catfish make nests in the pond bottom or in the grass along its banks. The female lays her sticky eggs in the nest and the male will then fertilize them. The male guards the nest until the eggs hatch, in about 17-30 hours. Our local catfish, *Clarias macrocephalus*, is a highly desired fish in the market, though it does not grow as fast or as large as its cousin *C. batrachus*. The Guam hatchery is currently able to reproduce *C. batrachus* to supply local aquaculture needs.

Culture Practice: *Clarias* catfish are very hardy animals and are easy to raise. They can be stocked at high densities and can survive under poor pond conditions that would not be tolerable by other fish. If conditions become unbearable, they can actually

crawl or jump out of the pond and make their way through wet vegetation until they reach another body of water where conditions may be more favorable. Catfish are usually raised in freshwater and fed a high protein commercial diet. The culture period for these catfish is 3-6 months. Production on Guam for catfish in 1989 was 28,500.

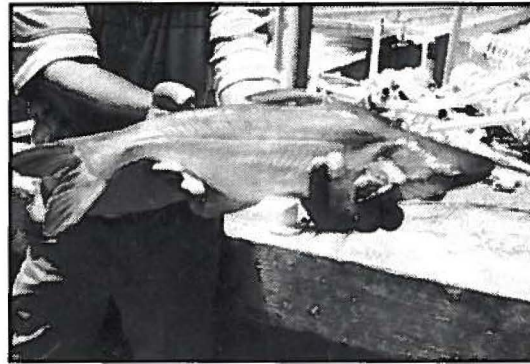


Thai Catfish

Scientific Name: *Pangastus sutchi*

Chamorro Name: None

Description: The Thai catfish is a large catfish, with some species in this group growing over 300 pounds. *P. sutchi* can reach 70 pounds in nature. They are omnivores, feeding on plant as well as animal matter. They can grow up to three pounds in the first year and seven to 10 pounds by the second year. They are a warm water fish and cannot tolerate temperatures below 15°celsius. They are hardy fish and are air breathers.



Culture Practice: The Thai catfish is usually raised in freshwater, however they can tolerate low salinities. Fry are imported from foreign hatcheries, usually Taiwan. They are stocked in relatively low densities, about 10,000 per acre. They will readily accept artificial commercial diets. The culture period is 6-12 months. There was no production of this fish in 1989. Future plans to attempt reproduction of this fish at the Guam hatchery exist.

References

An Introduction to Aquaculture on Guam: Prospects, Permits and Assistance, 1985. Guam Department of Commerce, GITC, Tamuning, Guam 96911.

Aquaculture & Fisheries Development in the Western Pacific. Newsletter. David P. Crisostomo and Barry Smith, editors., College of Agriculture & Life Sciences, University of Guam Station, Mangilao, Guam 96923.

Aquaculture Development Plan for the Territory of Guam, 1982. Guam Department of Commerce, GITC, Tamuning, Guam 96911.

Aquaculture Practices in Taiwan, 1976, T.P. Chen, editor., Fishing News Books, Farnham, Surrey, England.

CRC Handbook of Mariculture: Volume I-Crustacean Aquaculture, 1983, J.P. McVey and J. Moore, editors, CRC Press Inc, Boca Raton, Florida.

Eel Culture, 1979, by Atsushi Usui, Fishing News Books Limited, Farnham, Surrey, England.

Freshwater Prawn Farming, 1985, FAO Fisheries Technical Paper 225, FAO, Rome.

Giant Prawn Farming, 1982, Michael New, editor, Elsevier Scientific Publishing Company, New York.

Reproduction & Culture of Milkfish, 1985. Cheng-Sheng Lee and I-Chin Liao, eds. Oceanic Institute. Makapuu Point, Waimanalo, Hawaii 96795.

Soil Survey of the Territory of Guam, 1988, USDA Soil Conservation Service.

The Biology and Culture of Tilapias. 1982, R.S.V. Pullin and R.H. Lower McConnell, editors, ICLARM, MCC P.O. Box 1501, Makati, Metro Manila, Philippines.

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