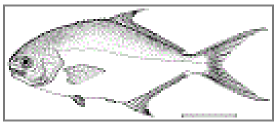
Cultured Aquatic Species Information Programme

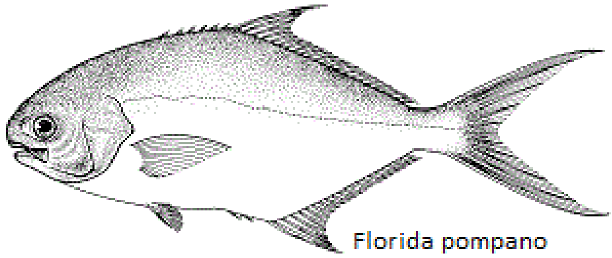
Trachinotus spp (T. carolinus, T. blochii)



Identity

Trachinotus spp [Carangidae]

FAO Names: En - Pompanos nei, Fr - Pompaneaux nca, Es - Pámpanos(=Palometas) nep



Biological features

Both the snubnose pompano and the Florida pompano are members of the jack family, Carangidae. Body shape is generally fusiform, exhibiting a general oval shape and elongated towards the posterior end.

Snubnose pompano: Dorsal spine I, fin rays V–VI;I (usually 18 to 23); anal fin rays II, I, 16 to 20; Gill rakers 9-12; depth 5 cm, deep ovate body, golden tinge on silvery body, darker above; fins golden yellow with dusky tips; pectorals darker in fish greater than 75 cm. Body ovate in young to subovate in large adults and compressed; profile of snout broadly rounded, in adults becoming nearly straight to interorbital region; both jaws with bands of small villiform teeth; tongue toothless (except 2 or 3 slender teeth rarely on small specimens); at the gill rakers (including rudiments 5 to 8 upper and 8 to 10 lower on first gill arch; two separate dorsal fins, first with six short spines (the anterior spins often becoming completely embedded in large adults), followed by one spine and 18 to 20 soft rays; anal fin with two detached spines (becoming embedded in large adults), followed by one spine and 16 to 18 soft rays; height of second dorsal fin lobe 35 to 60 percent of fork length in specimens of 10–40 cm fork length; pelvic fins shorter than pectoral fins, lateral line only slightly irregular, weakly convex above pectoral fin, becoming straight posteriorly. No scutes or caudal peduncle groves. First pre-dorsal lobe shaped like an inverted tear-drop or oval shaped, this character is easily observed by a simple dissection along mid line of nap, supra occipital bone of skull thin and blade like in adults.

Vertebrae 10 + 14. Colour: head and body generally silvery, blue grey above, paler below, large adults some time with most of body golden orange especially snout and lower half of body. Second dorsal fin dark, lobe of fin dusky orange; anal fin dusky dirty orange, lobe with a brownish anterior margin; caudal fin dark to dirty orange with leading edges of fin darkest. Pelvic fins white to dirty orange, pectoral fins dark. Juveniles silvery with pale fins except lobes of median fins and anterior half of pelvic fins brownish to dirty orange. The maximum size of the largest specimen examined was 55.5 cm fork length, 65 cm total length and greater than five kg.

Florida pompano: Dorsal fin rays VI+I, 22 to 27 (usually 23 to 25); anal fin rays II+I, 20 to 24 (usually 21 or 22); anterior to the first elongated dorsal fin exist six rudimentary fin rays that protrude slightly in juveniles and are pronounced in adults; no teeth on tongue at any size; no enlargement of second to fourth ribs; no dark vertical bars on upper half of the body; anterior-most dorsal and anal rays notably elongated in adults and sub adults, not extending posterior to base of caudal fin; maximum total length (TL) and weight about 63.5 cm and 3.4 kg; in the wild individuals over 1.8 kg are considered rare. The record pompano caught by angling in Florida weighed 4.7 kg. The body is short and deep (depth is 2.0 to 2.8 times its fork length (FL) in adults but this metric varies widely depending on geographic location. The body is compressed, with upper and lower profiles similar and head profile sloping to a blunt snout; eyes small; upper jaw very narrow at end and extending to below mid-eye, lower jaw included; teeth in jaw small, conical and re-curved, disappearing completely by about 20 cm FL; gill rakers (including rudiments) 5 to 7 on upper limb of the outer gill arch, 8 to 14 on lower part of arch; anal-fin base shorter than second dorsal-fin base; pectoral fins short, contained 1.1 to 1.3 times in head length; scales small, cycloid (smooth), and partly embedded; lateral line slightly arched to below middle of second dorsal fin and straight thereafter; no scutes; vertebrae 10 + 14.

Profile

Historical background

The jack family is a large group of predatory near-shore and pelagic fishes widely distributed around the world. The family Carangidae includes horse-mackerels, queen fishes, scads, pompanos and darts, and is overall represented by 140 species divided in about 25 genera. The genus *Trachinotus* consists of about 20 species, most of which are recognized as food fish and recorded in commercial fisheries. Most are schooling fishes and occur primarily in coastal and brackish environments (especially juveniles), though others are oceanic. They occur abundantly in shallow waters up to 60 m depth. In the Indo-Pacific region their importance in the Indian fishery is highly significant as they constitute nearly 7 percent of the annual marine fish landings in India.

Among the many high value marine tropical finfish that could be farmed, the snubnose pompano, *Trachinotus blochii* is one of the topmost, mainly owing to its fast growth rate, good meat quality and high market demand. Snubnose pompano, also called snub nose pompano, are recorded in the catches of Indian coasts from 1956 onwards and caught only sporadically in the commercial fishery. The aquaculture of snubnose pompano has been successfully established in many Asia-Pacific countries including Taiwan and Indonesia. They can be successfully farmed in ponds, tanks and floating sea cages. The species is pelagic, very active and is able to acclimatize to lower salinities. Showing strong growth even at 10 ppt salinity, this species is suitable for farming in the low saline coastal waters as well as in sea cages.

In India, the Central Marine Fisheries Research Institute (CMFRI) has taken on aquaculture research of pompano since 2008 and the first successful broodstock development, induced breeding and larval production was achieved in 2011. Subsequently five more successful breeding and seed production trials were carried out. Following the successful seed production of snubnose pompano, standardization of farming protocols in brackishwater ponds was carried out by the CMFRI to popularize among the farmers regarding the suitability of this species for aquaculture. Economically viable farming methods were developed and the farming techniques were communicated among the farmers.

Similarly, the Florida pompano, *Trachinotus carolinus*, is a prized catch by recreational and commercial fishers for its mild taste and flaky texture. Wild caught supply does not meet market demand, and accordingly the price is relatively high. Interest in the commercial aquaculture of Florida pompano began in the United States (Florida) in the late 1960s following the report by Berry and Iverson on the potential for aquaculture. After this report, considerable industry interest evolved into many private research firms exploring the biological potential of controlled farming of this species. Initial efforts were to produce eggs with artificial spawning techniques and the subsequent larval husbandry. Concurrently, nutritional experiments were conducted using wild juvenile pompano. The state of Florida later prohibited the collection of juvenile pompano forcing companies to only use artificially raised juvenile pompano which limited research.

The Florida pompano is endemic to the eastern nearshore continental shelf of North, Central and South America. This species has been collected in summer months from as far north as Delaware (United States of America) to as far south as central Brazil. Prior to the early 1970s there were no reported sightings of the Florida pompano in the Bahamian shelf zone or any of the Caribbean Islands. It is assumed that neither the egg nor larval stages of this species, nor adults, were able to traverse the Gulf Stream, thus isolating them to the continental shelf boundaries. Since the mid-1970s there are records of the Florida pompano inhabiting the south shore of the Dominican Republic and Puerto Rico. It is assumed that this presence was a result of the escapees from the commercial pompano farm established there in 1972. The extensive range of this species would suggest that it is tolerant to varied habitats but it is primarily limited by water temperature and nearshore food availability.

In 1971, Oceanography Mariculture Industries, Inc. (OMI) initiated a commercial level expansion. The location of the first pompano farm was on the south coast of the Dominican Republic. The planned objective for this first phase farm was 455 000 kg per year. A key milestone was the year-round, reliable supply of fry at an average of 37 000 per month. As a result of a number of operational factors the project was not able to sustain its business interest starting in 1974. The primary obstacles to the continuation of the farming effort was the lack of fuel oil supply in the Dominican Republic as a result of the 1973 oil embargo, a dramatic increase in fish feed costs and the 1973-75 economic recession. Ocean Farming Systems, Inc. (OFS) in the Florida Keys began limited production from 1976 through the 1980s. After that, interest in Florida pompano aquaculture waned until around 2002 when several private companies and governmental research facilities started to investigate pompano aquaculture again. Only one company, Mariculture Technologies International, Inc. (MTI) continues to farm pompano in Florida.

In addition, basic hybridizations efforts have been tested, primarily selecting for fast growth and early fertility. These findings strongly demonstrate that selective crossbreeding can result in an improved variety that is better adapted to farming environments than the wild stock. Further, it was noted that the variation in size within a cohort became narrower in the hybrids. The second focus of the hybridization attempts was body confirmation. The market prefers a pompano that had greater body depth rather than the longer fusiform shape, resulting in rounder shaped fillets.

Main producer countries

Mariculture of snubnose pompano is conducted in open sea cages, brackishwater cages and ponds in China, India, Indonesia, Philippines, Taiwan, Thailand and Vietnam. Methods for open sea cage farming has been well established in Vietnam and commercial farming is being undertaken by small farmers and private companies.

On the other hand, the aquaculture of Florida pompano remains, after 40 years of development, a non-commercial species. The only source of marketable pompano is from wild caught fisheries. There have been limited reports of commercial activity in western Dominican Republic and in Panama. These efforts are by private companies and verified information is limited.

Habitat and biology

Juveniles of snubnose pompano inhabit sandy shorelines and shallow sandy or muddy bays near river mouths while juveniles move out in schools to clear seaward coral and rock reefs. Juveniles are in small schools, while adults are usually solitary. Adults feed primarily on sand molluscs and other hard-shelled invertebrates. During farming they can be weaned to feeds such as floating pellets, sinking pellets and bycatch waste. They can tolerate wide range of salinities from 0 ppt to 65 ppt. The species prefers warm tropical waters, with a tolerance from 25–29 °C. This species is broadly distributed throughout the Indian, western and central Pacific oceans.

The Florida pompano has a wide and elongated range from mid-eastern United States of America to southern Brazil. It is a coastal species, and is rarely found in waters deeper than 33 metres. This species inhabits both nearshore zones with ocean salinities to inshore bays and lagoons (estuaries) with reduced salinities. The Florida pompano has been found to survive, at least for short periods, in freshwater at the mouths of rivers. The effects of low salinity on growth and survivorship are not known at this time. Unpublished results suggest that the lower tolerance for normal growth and survival is 19 parts per thousand (ppt). Other investigators have suggested that salinities lower than 10 ppt are acceptable to this species.

Temperature tolerance is most likely the major environmental constraint on the natural range of this species. The lower temperature tolerance is 12 °C at which fish become inactive and risk mortality. The upper temperature tolerance is 33 °C and if left at that temperature for more than a few days mortalities will occur. The target farming temperature range is 24 to 28 °C, with an optimal temperature of 27 °C.

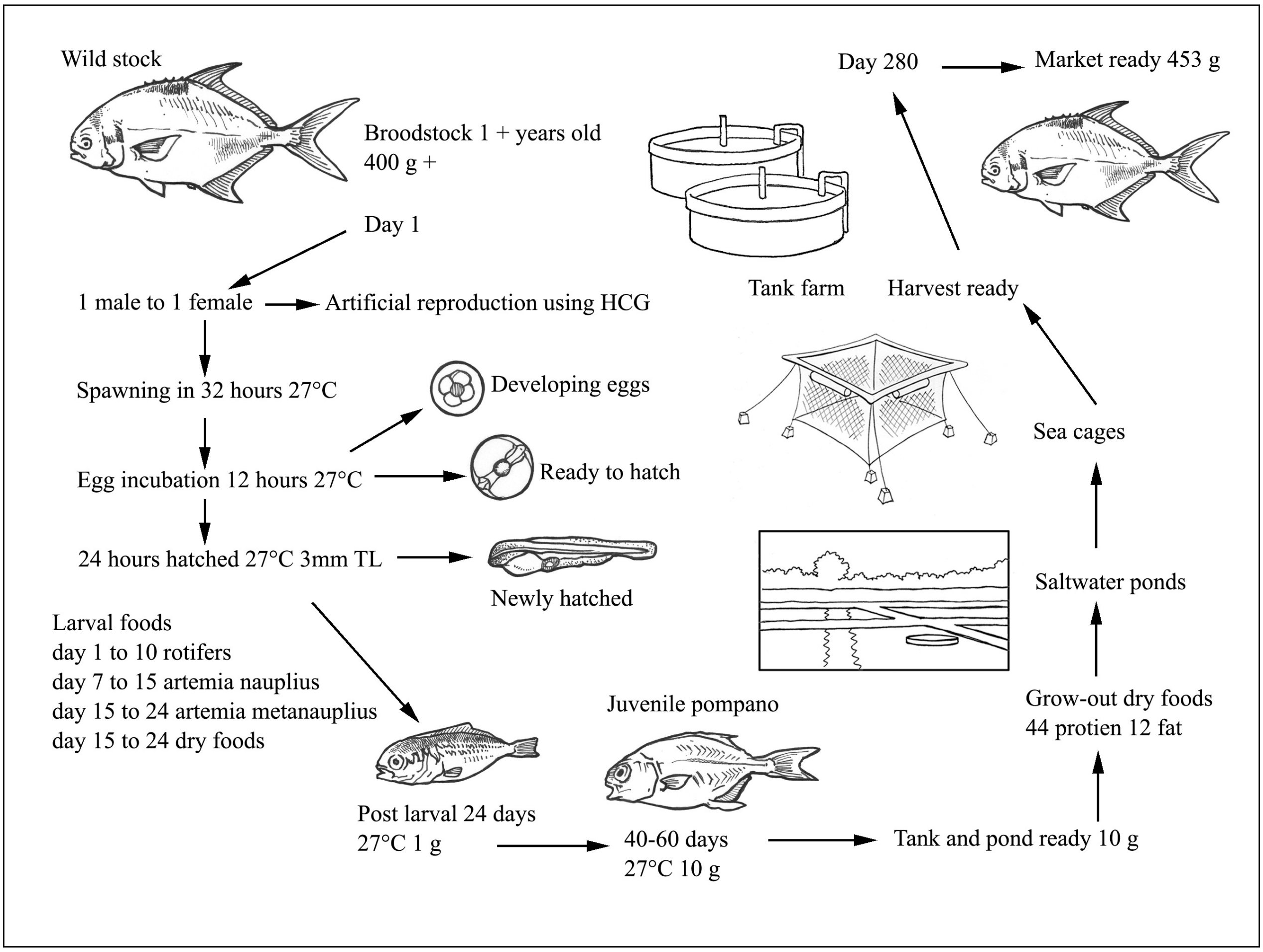
The Florida pompano is exclusively a benthic feeder. The primary diet is small shrimp, crabs and bivalves. This species has a specially adapted mouth that allows it to crush small prey (pharyngeal plates). The farming experience with feeding captive pompano demonstrates that this fish is not piscivorous at any time during its life cycle.

Florida pompano need to continuously swim and therefore need a high energy diet to support an active metabolism. The grow-out diets contain a proximate analysis of 40 to 50 percent protein and 7 to 10 percent fat. As with all fish, the sources of these nutrients affect digestibility and assimilation. The Florida pompano has a relatively short digestive tract compared to other fishes, and this morphometric characteristic suggests a short gastric retention time and therefore the feed should be easily digestible. Therefore, studies have shown that more frequent feeding of smaller volumes yield faster growth rates. In the United States of America there are no commercial fish feed manufacturers that have a specific diet for the Florida pompano.

Florida pompano spawn naturally in offshore waters between early spring to middle autumn, primary from April to June. The pelagic eggs are approximately 1 mm in diameter and hatch in 24 hours. The larvae feed on zooplankton and undergo metamorphosis after 15 days. Juvenile pompano are common in inshore beach waters during the early summer. Though questions still exist regarding the wild reproduction of pompano, most fish reach sexual maturity in one year at 350–450 grams. The estimated fecundity is 133 000 to 800 000 eggs per female each season.

Production

Production cycle



Production cycle of Trachinotus spp.

Production systems

Seed supply

Wild collected snubnose pompano broodstock above one kilogram can be conditioned through photo-thermal regulation to accelerate the maturity of the gonads. Gonadal maturation can be determined through cannulation biopsy of intra-ovarian eggs. Once the intra-ovarian eggs attain 450–500 µm (micron) size, fish can be induced to spawn by using hormones including gonadotropin-releasing hormone (GnRH) or human chorionic gonadotropin (HCG).

Spawning can be done either by natural or inducing with hormonal treatment. Induced breeding is commonly practiced in most commercial hatcheries. The hormonal treatment is intended to trigger the last phases in egg maturation, i.e. a strong egg hydration followed by their release. However, if eggs have not reached the late-vitellogenic (or post-vitellogenic) stage, the treatment does not work; hence ovarian biopsy is essential for assessing the ovarian development. The human chorionic gonadotropin (HCG) is used at a dosage of 350 IU per kg body weight is used for male and female. This dosage can be administered as a single dose on the dorsal muscles. The HCG can be successfully replaced by an analogue of the luteinizing hormone-releasing hormone [LH-RHa des-Gly10 (D-Ala6) LH-RH ethylamide, acetate salt]. It is a small molecule with 10 peptides and acts on the pituitary gland to induce the release of gonadotropins which, in turn, act on the gonads. Almost 100 percent of injected fish spawn eggs whose quality matches that of natural spawning.

Spawning will occur generally within 36–48 hours after hormone injection. The spawning takes place normally between late night and early morning hours. The number of eggs spawned by pompano brooders is around 50 000–150 000 eggs. The fertilized eggs float and are scooped gently using 500 µm net. To minimise the presence of poor quality eggs, which usually float deeper in the water, it is recommended to collect only the eggs found at the water surface. The egg samples must be thoroughly examined to assess their quality, number and development stage using a microscope. Incubation of eggs can be carried out in incubation tanks of 3–5 tonne capacity. Stocking density can be maintained at a level of 200 to 500 eggs per litre. After hatching, the fish larvae have to be moved to the larval rearing tanks filled with filtered seawater. Prior to this, the aeration should be stopped briefly to enable the debris and exuviae to settle at the bottom which can be removed by siphoning. The development of embryo can be observed at frequent intervals under a stereo/compound bionocular microscope. The hatching of eggs takes place from 18 to 24 hours after fertilization.

Florida pompano can be also be induced to spawn outside of the natural spawning season by manipulating environmental parameters (light photoperiod and water temperature) to mimic the natural spawning season with a longer light photoperiod inducing gonadal maturation. Pompano can be induced to spawn during the natural spawning season with either in-house broodstock fish or recently caught wild fish. Broodstock fish (450 grams or larger) are selected and checked for gonadal development. Fish are ready for induced spawning when oocytes are at least 500 µm in diameter and the milt contains motile sperm.

Induced spawning techniques have been researched by independent groups of researchers with varying success. One method of gonad maturation uses Human Chorionic Gonadotropin (HCG), injected as two doses: 0.55 IU/gram and 0.275 IU/gram body weight 24–48 hours apart. The average time from injection to spawning is 32 hours with 50 000–200 000 eggs (average of 100 000 eggs) being produced per female. Other researchers use a single dose of HCG at 1 000 IU/gram body weight for females and 500 IU/gram body weight for males. Another hormone, Salmon Gonadotropin Releasing Hormone Analogue (sGnRHa), can induce spawning when used at a dose of 75 micrograms/kg of body weight. The dose is administered using slow release implants. Results have been varied concerning the number of eggs produced, fertilization rates and number of developing eggs recovered from the breeding tank. However, sGnRHa can only be used for research purposes because in the United States it has not been approved for use on fish destined for human consumption. Photoperiod and water temperature manipulation techniques can encourage gonad development when used alone or in combination with hormonal treatments, and generally use abrupt shifts in temperature from 25 °C to 30 °C.

Once gonads are matured, eggs can be produced either by natural spawning (voluntary) or by manual stripping. Manual stripping is the preferred method as it provides a predictable spawning event and timing. Eggs and milt are stripped in batches into bowls, with a resulting fertilization rate that can reach 90 percent. Developing eggs are placed in incubator tanks and moved to the hatchery tanks prior to hatching (24 hours post fertilization). Gestation time is temperature dependent. Once fertilized, eggs are buoyant and transparent.

Hatchery production

The pompano larvae are raised, in general, the same way many other marine fish larvae are raised.

Newly hatched snubnose pompano larvae have to be checked to assess their viability and condition prior to stocking in the larviculture tanks. A sample of at least 10 to 20 fish larvae should be observed under the microscope for the shape, dimensions, deformities, erosions and abnormalities, appearance of internal organs, normal pigmentation, absence of external parasites and any other health indicators. The larvae hatched in the incubation tanks or larval rearing tanks need to be distributed in larviculture tanks to have stocking density of 20–30 larvae per litre. Care should be taken to avoid any mechanical stress or damage. Soon after hatching, the mouth remains closed and the digestive tract is not fully developed. During this period the larvae survive on its reserves in the yolk sac.

The newly hatched larvae are stocked at a density of 10 000 larvae in standard tanks of 2 m^3 capacity filled with 1.5 m^3 filtered seawater. Often Fibreglass Reinforced Plastic (FRP) tanks are used. The tanks are provided with mild aeration and green water at a cell density of 1 000 000/ml. The mouth of the larvae opens at 3 days post-hatching (dph) with a mouth size around 230 µm. The larvae are fed from 3 dph to 10 dph with enriched rotifers at a density of 5–6 rotifers/ml, wherever possible, though wild collected copepods can be added as supplements. Enriched Artemia nauplii are provided at a density of 1–2/ml starting from 8–19 dph. Weaning to larval inert feeds begins at 15 dph. From 25 dph onwards, feeding can be entirely on larval inert feeds. The metamorphosis of the larvae starts from 18 dph and all the larvae metamorphose into juveniles by 25 dph. Critical stage of mortality occurs during 3–5 dph and subsequent mortalities are negligible. The water exchange can be practically zero until 7 dph and it can be gradually increased from 10–100 percent daily starting at 8–14 dph.

Nursery rearing is initiated at 25–30 dph. At this stage, artificial feed of 800 µm size could be provided. Thereafter, fingerlings are fed with progressively larger size range of floating extruded larval feeds. Daily water exchange of 100 percent is recommended. Water quality parameters like salinity, temperature, pH, oxygen level and ammonia should be closely monitored during the entire larviculture period. After 55 dph, the fingerlings with size range from 2.5–3.8 cm size can be supplied to farmers for stocking in happas or tanks for further nursery rearing and ongrowing thereafter.

One common approach for Florida pompano is to use the green-water method where larvae are raised in waters with a high concentration of single cell green phytoplankton produced by the hatchery.

Fertilized eggs are about 1 mm in diameter and contain one oil droplet. Once hatched, the larvae are about 2 mm, are unpigmented and the mouths are non-functional. The large yolk sack is completely absorbed by 7 days post hatch (dph). Marine rotifers (Brachionus spp.) are offered until 10 dph. Starting at 7 dph the larvae are generally large enough to consume newly hatched Artemia, which are provided until 17 dph. Dry food preparations can be introduced at 12 dph. Hatchery managers have reportedly used a variety of hatchery tank sizes, but the most common are cone bottom tanks of 100–400 litres. Larval pompano move through metamorphosis starting at 15 dph and finishing at 22 dph with a water temperature of 27 °C. The highest survival rate from egg to fry was reported to be 35 percent.

Ongrowing techniques

Snubnose pompano (*Trachinotus blochii*) can be grown in cages, ponds and pens. In Vietnam, cage farming of snubnose pompano is well developed by feeding with trash fish and extruded pellet feeds. In India, the CMFRI has undertaken farming trials in freshwater ponds, brackishwater ponds and cages installed in the sea. Among all methods, farming of snubnose pompano in low saline brackish water ponds yielded good harvest. The experiences gained through farming in various systems are given below:

<u>Earthen pond farming in freshwater (zero salinity)</u> was first attempted in a freshwater fish farm located in Akkiveedu Village, West Godavari district of Andhra Pradesh, India. About 3 000 fingerlings of 2.5 to 3.0 cm size weighing 1.5 to 2.0 grams were stocked in an 0.4 ha pond. The fish were fed with floating pellet feed containing 32 percent crude protein and 6 percent crude fat . After 240 days of on-growing the fishes attained an average weight of 250 to 300 grams. Survival rate was only 45 percent.

<u>Earthen pond farming in brackishwater (low salinity)</u> was first attempted in a brackishwater fish pond located in Anthervedhi Village, West Godavari district of Andhra Pradesh, India. About 3 400 fingerlings of 2.5 to 3.0 cm size weighing 1.5 to 2.0 grams were stocked in a 0.4 ha pond. The fish were fed with floating pellet feed containing 32 percent crude protein and 6 percent crude fat was used. After 240 days of growing the fishes attained an average size of 450 to 500 grams with a survival of 94 percent. This has created tremendous interest among the brackishwater shrimp farmers to grow as an alternative species for shrimp in their abandoned farms which were hit by frequent outbreaks of diseases.

<u>Open sea cage farming</u> was attempted in the Gulf of Mannar side of Vedalai Village, Ramanathapuram District, Tamil Nadu, India. About 4 000 fingerlings of 2.5 to 3.0 cm size weighing 1.5 to 2.0 grams were stocked initially in the happa (10 m × 10 m) erected in the sea. Fish were fed with chopped low value marine fishes. Once the pompano fingerlings attained 25 grams they were shifted to galvanized iron cage of 4 m × 4 m × 3 m. Fish reared in the cage were also fed with chopped, low value fishes. After 240 days of culture the fishes attained only 250-275 grams with a survival rate of 72 percent.

Over the last 40 years of commercial and experimental trails for the farming of the Florida pompano, four types of aquaculture farming systems have been tested. They are:

1. Low salinity earthen pond culture.
2. Above ground tank culture.
3. Recirculating Aquaculture Systems (RAS) culture.
4. Floating sea cage culture.

Low salinity earthen pond culture was first attempted by Berry and Iverson (1967). This first method was blocking off natural estuarine tributaries to confine the wild caught pompano fry in a natural environment. The results were very poor. Later, Tatum & Trimble (1978) attempted the polyculture of Penaeus species and wild caught pompano fry in seawater ponds adjacent to a natural bay and using natural water of uncontrolled varying salinities from that bay. The results of these experiments were also very poor. Starting in 2004 a private firm has been extensively testing the Florida pompano's suitability to low salinity earthen pond culture. For the first time the testing of this method exclusively used hatchery produced fry and not wild fry. The results have been positive and have been reported in industry literature.

For this technique, pompano fry of about 1 gram are purchased from a hatchery and moved to a nursery where they are reared until they attain an average of 10 grams (40 to 60 days). Recommended nursery feeds are small dry pellets with a protein content of 54 percent and fat content of 16 percent. Diet supplementation with live brine shrimp (Artemia) can shorten this step by up to 20 days for a total nursery period of 40 days. The nursery should be supplied with saltwater of salinity between 20 and 30 ppt. and preferably from a groundwater well. Nursery tanks are suggested to be between 2.44 and 3.66 metres in diameter and no more than 0.91 meters deep. The fry stocking rate for these tanks is 2 000 to 5 000 fry per tank, respectively. Expected survival in the nursery system is about 99 percent.

Once the pompano fry attain an average weight of 10 grams they are moved to earthen ponds, tanks, or cages for ongrowing. In the case of the earthen ponds, the common size presently being used are 92 meters long, 15 metres wide, and 3 metres deep. The volume per pond is an average of 3.785 million litres. Current trials use 5 000 pompano fry per pond which gives rise to a density of one pompano per 750 litres. This density is considered the highest recommended without supplemental mechanical filtration. Low density trials have used 1 000 fry per pond. At this low density the pompano are encouraged to prey on naturally occurring and seeded benthic organisms as a major part of their diet. The results of these trials have been encouraging and widely reported. The growout diet is classified as a carnivore diet based on fishmeal and contains 41 percent protein and 12 percent fat.

For harvesting, the preferred method is to use gill nets (entanglement nets) with selective mesh sizes. The mesh size targets specific size fish while letting smaller fish escape to be caught once when they attain market size. Once most of the marketable pompano are harvested from the pond a new crop of fry can be stocked into the same pond without fear of cannibalism. In fact, entanglement nets can be towed through the production pond monthly in order to extract all marketable fish as needed.

In the United States of America the market for pompano prefers them to be whole, fresh iced and about 450 grams or larger. Only wild caught pompano exceeding 910 grams are used for the fillet market. As a result of those market demands the pompano farm must know specific market demands in order to keep a steady supply of the fresh fish considering the short shelf life. As of this time there is no value added processing of either wild or farmed pompano in the United States of America. The commercial fishery for the Florida pompano in other parts of its range is minor and it is often considered a recreational bycatch. Elements that determine pond productivity are water quality, water salinity, oxygen, temperature, food supply, avian predation and escapees. With 10 years of pond farming trials it has been concluded that production losses owing to the above mentioned parameters do not cause losses in excess of 10 percent. Therefore, the pond is originally stocked with 10 percent more fry.

The greatest risk is farm location and manmade chemicals. In selecting a satisfactory farm location there are a number of considerations that must be properly assessed. The most important consideration is geographic location which should be in tropical latitudes, if possible. However, pompano are being successfully raised in ponds in central Florida which has a more temperate climate. In this area, problems from occasional low winter temperatures can be mitigated with deeper ponds and adequate water flow. Public electrical interruption can be a serious risk in some locations because a high density pompano pond requires constant supplemental aeration, generally supplied from electric pumps. The offset to this risk is a backup generator and/or wind driven aerator pumps. Lastly, manmade chemicals, especially pesticides used for mosquito control, can have negative effects, both direct and indirect, on the success of a pompano pond business.

Above ground tank culture for the commercial production of the Florida pompano using natural seawater was first tested by OMI in the Dominican Republic in 1972. Natural seawater from nearshore intakes was judged not to be the best approach after a few years of operation. The problem was unwanted introductions, including fouling organisms and parasites. At the OMI project, tanks that were operated with well water did much better. If natural seawater is used it should be pre-treated.

The OMI pompano farm used round concrete above ground tanks that were 6 metres in diameter and 0.5 metres deep with a total volume of 7 570 litres. The fish density was 120 kg/1 000 litres , which is considered very high, though not detrimental to this species. Researchers have used from time to time above ground circular tanks for brood stock holding and inventory purposes. These systems have been both well water supplied and recirculated systems.

Recirculating Aquaculture Systems (RAS) are not used for commercial Florida pompano farms anywhere at this time. There have been some research projects undertaken in Florida by government laboratories, but currently there are no ongoing projects using the Florida pompano in RAS systems. However, over the last 40 years Florida pompano have been successfully reared in low densities in what now would be referred to as basic and somewhat primitive RAS designs. The RAS application has been primarily used for broodstock holding and hatchery support for many years. In general, the Florida pompano should be an excellent candidate for commercial RAS farming as long as the economics of production costs and market value support the investment. Costs of production were estimated by J. F. Coburn (2007) to be USD 17.75 per kg.

Sea cage culture has been a widely used method of fish farming for decades but has not been done with the Florida pompano in the United States because of regulations concerning the use of state and federal waters. There are no public published reports describing the Florida pompano's adaptability to open water sea cages. During the last 10 years, two private companies reportedly have used inshore floating sea cages to raise Florida pompano in the Bahamas, Panama and the Dominican Republic. Since these are private companies, details of the operations, including production amounts, are unknown. All indications are that Florida pompano should do well in the cage culture environment but further investigation is needed as to the cage design to meet their specific behavioural and environmental needs.

Diseases and control measures

Snubnose pompano hatchery operation and farming remains in the beginning stage in most countries. Many types of diseases associated with poor water quality management were noticed in the adults, juveniles and fingerlings. Among the microbial diseases, vibriosis is a bacterial disease causing significant losses of fish in farms. Vibriosis results in severe skin, muscle, fin, eye and internal organ damage of fish. Diagnosis of the disease requires bacteriological culture of kidney, spleen, skin or eye lesions. Diseases caused by protozoans and metazoan ectoparasites can cause severe health issues in juveniles and adult pompano. Proper treatment of hatchery and farm water and biosecurity measures can address most diseases. Mass mortalities in the farm can occur mainly due to the outbreak of vibriosis and protozoan parasites.

Florida pompano farming remains in its infancy as an industry and therefore farmers and fisheries scientists have had limited exposure to short and long term experiences with specific pompano disease issues. Therefore, exhaustive literature searches on diseases of the Florida pompano yields little to no specific assistance on this subject. Extreme caution must be exercised as to what if any chemical treatments are used and used in accordance with all industry and governmental regulations. The best practice therefore is prevention.

Common diseases of both species of pompano are illustrated below.

In some cases antibiotics and other pharmaceuticals have been used in treatment but their inclusion in this table does not imply an FAO recommendation.

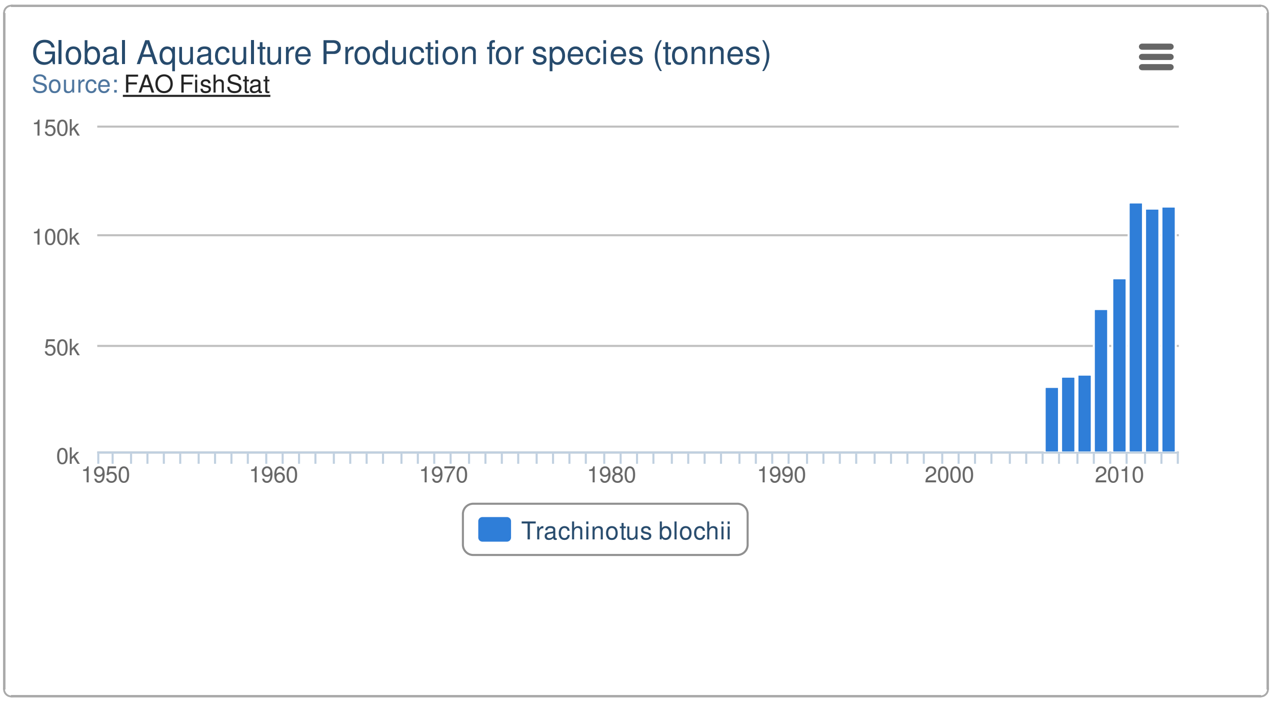
DISEASE	AGENT	TYPE	SYNDROME	MEASURES
Ectoparasite (white spot, marine ich)	*Cryptocaryon irritans*	Protozoan	Skin and fin necrosis causing white spots and excessive mucus production. Mortalities within 48 hours of on set.	Prevention: biosecurity and good water quality. Treatment: chelated copper sulfate solution used at 0.20 to 0.30 ppm continuously.
Ectoparasite (marine velvet)	*Amyloodinium ocellatum*	Dinoflagellate	Mostly affecting the gills. Excessive mucus production, fish stop feeding, frequents the surface. Mortalities within 48 hours of on set.	Prevention: biosecurity and good water quality. Treatment: chelated copper sulfate solution used at 0.30 ppm continuously.
Ectoparasite (flukes)	Gyrodactylidae sp.	Monogenean worms	Rough appearance of skin and fish rubbing surfaces. Excessive mucus production.	Prevention: biosecurity protocols, including formalin bath of introduced or infected fish
Ectoparasite (gill bacterium)	*Flexibacter* spp.	Bacteria	Usually affecting the gills. Notice fast breathing, open mouth, and frequenting the surface. Mortalities within 60 hours.	Often caused by handling stress. Prevention: good water quality. Treatment: Nitrofurazone at 10 ppm in closed systems.
Vibriosis	*Vibrio* spp.	Bacteria	Lesions in the skin surface and necrosis in internal organs.	Prevention: Regular dipping of fish in freshwater for 5 – 10 minutes. Treatment: Oxytretracycline 0.5 to 1 ppm exposure for 1–2 hours.
White spot disease	*Cryptocaryon irritans*	Protozoan	Necrosis in the skin and fin with the symptoms of white spots and excessive mucus production.	Prevention: Dipping of fish in freshwater for 5–10 minutes and proper treatment of hatchery water through chlorination.
Cardiac myxosporidiosis	*Henneguya* sp.	Myxosporidian protozoan	Necrosis in gills and heart muscles.	Prevention: Dipping of fish in freshwater for 5–10 minutes and proper treatment of hatchery water through chlorination.
Ectoparasite	*Bicotylophora Trachinoti Benedenia* sp.	Monogenean worms	Fish rubbing in tank surfaces and excessive mucus secretion.	Prevention: Dipping of fish in freshwater for 5–10 minutes and proper treatment of hatchery water through chlorination; dipping 1% Euginol for removal of ectoparasites.
Parasitic dermatitis	*Calligus elongatus*	Sea lice	Usually affecting the skin surface and gills. Erosion of skin and gill lamellae.	Prevention: Dipping of fish in freshwater for 5–10 minutes and proper treatment of hatchery water through chlorination; dipping 1% Euginol for removal of ectoparasites.

Statistics

Production statistics

Commercial production of snubnose pompano appears to have begun in Asia in the early 1990s in Singapore, with much of the production destined for markets in Hong Kong 1995. By the later part of the 2000s, production had expanded in China, and today is reported to be over 110 000 tonnes annually (chart below). In recent years, limited amounts of snubnose pompano production has occurred in other Asian countries, including Indonesia, Malaysia, India, the Philippines and Vietnam. Production outside of China may be most significant in Vietnam and Indonesia. In Vietnam, approximately 700 tonnes a year of Asian pompano have been produced by Marine Farms Vietnam.

Florida pompano aquaculture production is essentially zero. Minor amounts, less than five tonnes, have been produced by only one private farm in Florida, United States of America and only for demonstration purposes.



Market and trade

The market availability of snubnose pompano is rather scarce and irregular, so the growing demand can be met only through aquaculture. In the international market, the dockside price of snubnose pompano averaged to USD 8 per kg, though there is significant country variation. Indeed, in India, the current price of snubnose pompano is about USD 2.78 per kg at the fish landing centres and around USD 5.30 per kg in the retail markets.

In the United States of America there is a demand for farmed Florida pompano but a limited supply. There is a commercial supply of wild caught Florida pompano in the southern United States of America Gulf States. The vast majority of wild caught Florida pompano are marketed within the borders of the United States of America and it is therefore assumed that little is exported. The market desires the Florida pompano to be supplied whole, head on and eviscerated. Fish larger than 1 kg are generally filleted. Pompano smaller than 1 kg are generally served whole. Upscale restaurants prefer the fish to be fresh and never frozen. However, during peak wild harvest periods the fishery must flash freeze for later inventory. There is no value added presentations of this fish.

Ex-vessel value to the commercial fishers range between USD 8.88 to USD 1.11 per kg. The wholesale pompano supplier generally asks USD 13.33 to USD 17.77 per kg. The retail market generally ranges between USD 20.00 to USD 31.11 per kg. The highest value in 2014 seen for Florida pompano fillets was USD 60.00 per kg, recorded at a grocery store in north Florida, United States of America. This valuation should not be assumed to apply to all market levels and locations.

In the United States there are no size or market regulations for farmed Florida pompano and therefore, a farm can sell any size of pompano to meet the market demand. However, for the wild caught fishery the state of Florida imposes a size restriction on catchable and marketable pompano. The legal size for both wild caught recreational and commercial catch is no less than 27.94 cm FL and no greater than 50.80 cm FL.

Status and trends

Most snubnose pompano aquaculture is done in Indo-Pacific region countries, especially China, as well as Vietnam, Malaysia, India, and the Philippines. Total global production of all species of pompano is in excess of 11 000 tonnes and appears to be growing. A small amount of snubnose pompano produced in Indonesia (and perhaps in other countries in the region) is being sold to restaurants and higher end grocery stores in the USA The hatchery technologies have been transferred throughout the Indo-pacific Region. In addition to net cage farming, the good growth rates in low saline earthen ponds indicates its potential commercial expansion. The production in RAS also appears to be promising (Aron Welch, 2013).

Florida pompano remains a prospective species for commercial aquaculture. However, this species has been commercially farmed on a year round schedule and on a small developmental scale for 40 years. The major limiting factors in the USA for commercial development are not scientific issues. The two major road blocks are (1) government regulations are lacking for industrial use of nearshore open waters for cage culture and (2) the excessive cost of RAS production that limits profit opportunity in the United States of America. Recently, a technical/business paper A Sustainable Eco-Pond Approach to Profitable Farming was published which addresses the questions surrounding the commercialization of Florida pompano aquaculture and presents a novel approach that is low energy and low environmental impact especially if combined with RAS techniques.

Considering the regulatory status of cage farming in the United States of America, other countries should be considered for this species. Alternate locations would need to meet the environmental and business requirements. A further consideration is that non-native species must be introduced with caution, and therefore Caribbean and South American locations could be preferable.

A survey to identify countries with the required environmental and regulatory situation would support the further commercial development of pompano aquaculture.

Main issues

The commercialisation of production of snubnose pompano is yet to be achieved in many countries. The large scale seed production companies have to come up to meet the seed requirements.

Although the Florida pompano has been successfully bred and raised for more than 40 years, the technology for pompano aquaculture has not been widely disseminated. At least one company (MTI) and possibly others, currently possess the technology to raise pompano from egg to market. However, in the USA, government regulations prevent the use of state/federal waters for cage culture or coastal tank farms. That leaves RAS or pond culture as the only viable alternatives in the United States. The economic cost to operate a RAS plant profitably may preclude its use. The technology for Florida pompano aquaculture can be exported worldwide but regulations concerning the importation of non-indigenous species may prevent its introduction into many countries. Therefore Florida pompano aquaculture may be limited to the Atlantic Ocean and Gulf of Mexico regions of North, Central and South America.

Responsible aquaculture practices

Please see the FAO Code of Conduct for guidance. This document is similar in intent to Florida Department of Agriculture Best Management Practices.

These documents help to focus the design specifications for the development of new fish farms, fish handling practices, and many other issues including current regulations/laws managing operation of a fish farm.

References

Allen, K.O. and J.W. Avault, Jr. 1970. Effects of salinity and water quality on Survival and growth of the juvenile pompano, (Trachinotus carolinus). Coastal Studies Bulletin No. 5, pp.1147-155. Louisiana State University, Baton Rouge, La.

Armitage, T.M. and W.S. Alevizon. 1980. The diet of the Florida pompano (Trachinotus carolinus) along the east coast of central Florida. Florida Scientist 43 (1): 19-26

Bellinger, J.W. Seasonal Occurrence of the pompano (Trachinotus carolinus) And its Food Habits in Louisiana's Waters. M.S. Thesis, Louisiana State University, Baton Rouge, La.

Berry, F. and E.S. Iverson. 1967. Pompano: Biology, Fisheries and Farming Potential. Proceedings of the Gulf and Caribbean Fisheries Institute 19: 116-128.

Chavez, H.M., Fang, A.L. and Carandang, A.A. 2011. Effect of Stocking Density on Growth Performance, Survival and Production of Silver Pompano, Trachinotus blochii, (Lacepede, 1801) in Marine Floating Cages Asian Fisheries Science, 24: 321-330.

Cuevas, H.,Jr. 1978. Economic Feasibility of Florida Pompano (Trachinotus Carolinus) and Rainbow Trout (Salmo gairdneri) Production in Brackish Water Ponds. M.S. Thesis, Auburn University, Al.

Coburn, J.F., M.F. McMaster and T.C. Kloth, 2007. An Economic and Operational Model for the Grow-Out of Florida Pompano in Sea Cages. World Aquaculture Society 2007, San Antonio, Texas.

Coburn, J.F., M.F. McMaster and T.C. Kloth, 2007. An Economical and Operational Model for the Grow-Out of Florida Pompano in Recirculation Aquaculture Systems. Sustainable Marine Fish Culture Conference Harbor Branch Oceanographic Institution.

Coburn, J.F., M.F. McMaster and T.C. Kloth, 2008. Pompano Farming: Investment Criteria and Analysis. World Aquaculture Society, Aquaculture America 2008, Orlando, Florida.

Cremer, M.C., Jian, Z. and Lan, H.P. 2004. Growth Performance of Pompano on Extruded Feed in Coastal Cages at Hainan, China, Results of ASA/China Feeding Trials 35-01-138.

Fields, H.M. 1962. Pompanos (Trachinotus spp.) of South Atlantic Coast of the United States. U.S. Fish and Wildlife Service Fishery Bulletin 207 (62): 189-222

Finucane, J.H. 1969. Ecology of the Pompano (Trachinotus carolinus) and Permits (T. falcatus) in Florida. Transactions of the American Fisheries Society 98: 478-486.

Finucane, J.H. 1970. Progress in Pompano Mariculture in the United States. Proceedings of the World Mariculture Society 1: 69-72

Fischer, W. And G. Bianchi (eds), 1983. FAO Species 1984 Identification sheets for fishery purposes Western Indian Ocean (Fishing area 51). DANIDA, Rome, Food and Agricultural Organization of the United Nations, Vols. 1.

Florida Fish Commission, April 2002. Executive Summary – Pompano. Florida Fish and Wildlife Conservation Commission Division of Marine Fisheries, State Document.

Gilbert, C. and J. Parsons. 1986. Species profile: Life Histories and Environmental Requirements of Coastal Fishes and Invertebrates (South Florida): Florida Pompano. U.S. Fish and Wildlife Report 82 (11.42).

Gopakumar, G., A. K. Abdul Nazar, R. Jayakumar, G. Tamilmani, M. Sakthivel, C. Kalidas, P.Ramesh Kumar, Hanumantha Rao, R. Premjothi, V.Balamurugan, B.Ramkumar, M.Jayasingh and G. Syda Rao. 2012. Broodstock development through regulation of photoperiod and controlled breeding of silver pompano, Trachinotus blochii (Lacepede, 1801) in India. Indian Journal of Fisheries. 59 (1): 53-57.

Gopakumar, G., Abdul Nazar, A .K., Jayakumar, R., Tamilmani, G., Sakthivel, M., Ramesh Kumar, P. and Kalidas, C. (Eds.). 2012. "Hand book on breeding and seed production of Cobia and Pompano". Published by:

Central Marine Fisheries Research Institute, Mandapam, India. 48 pp.

Groat, D. R., 2006. Effects of Feeding Strategies on Growth of the Florida Pompano (T. Carolinus) in closed Recirculating Systems. M.S. Thesis, Louisiana State University

Heilman, M.J. and R.E. Spieler. 1999. The Daily Feeding Rhythm to Demand Feeders and the Effects of Timed Meal-Feeding on the Growth of Juvenile Florida pompano (Trachinotus carolinus). Aquaculture 180:53-64

Hoff, F., C. Rowell, and T. Pulver. 1972. Artificially Induced Spawning of the Florida pompano Under Controlled Conditions. Proceedings of the World Mariculture Society 9: 299-300

Hoff, F., J. Mountain, T. Frakes, and K. Halcott. 1978b. Spawning, Oocyte Development and Larvae Rearing of the Florida pompano (Trachinotus carolinus). Proceeding of the World Mariculture Society 9:279-297.

Hoff, F., T. pulver, and J. Mountain. 1978a. Conditioning Florida Pompano (Trachinotus carolinus) for Continuous Spawning. Proceedings of the World Mariculture Society 9: 299-309.

Hoff, F., J. Mountain, T. Frakes, and K. Halcott. 1978b. Spawning, Oocyte Development and Larvae Rearing of the Florida pompano (Trachinotus carolinus). Proceeding of the World Mariculture Society 9:279-297.

Iverson, E.S., and F.H. Berry. 1969. Fish Mariculture: Progress and Potential. Proceedings of the Gulf and Caribbean Fisheries Inst. 21: 163-176.

Jayakumar, R., Nazar, A K A., Tamilmani, G., Sakthivel, M., Kalidas, C., Ramesh Kumar, P., Rao, G Hanumanta and Gopakumar, G (2014) Evaluation of growth and production performance of hatchery produced silver pompano Trachinotus blochii (Lacépède, 1801) fingerlings under brackishwater pond farming in India. Indian Journal of Fisheries, 61 (3). pp. 58-62.

Jory, D.E., E.S. Iverson, and R.H. Lewis. 1985. Culture of Fishes of the Genus Trachinotus (Carangida) In the Western Atlantic: Prospects and Problems. Journal of the World Aquaculture Society 16: 87-94.

Kalidas, C., Sakthivel, M., Tamilmani, G., Ramesh Kumar, P., Abdul Nazar, A. K., Jayakumar, R., Balamurugan, V., Ramkumar, B., Jothi, Prem, R. and Gopakumar, G. (2012). Survival and growth of juvenile silver pompano Trachinotus blochii (Lacepède, 1801) at different salinities in tropical conditions. Indian Journal of Fisheries, 59 (3): 95-98.

Kloth, T.C., 1980. Observations on the Spawning Behavior of the Florida Pompano (Trachinotus carolinus). Cpoeia 1980 (4): 884-886.

Kumpf, H.E. 1971. Temperture-salinity Tolerance of the Florida Pompano. (Trachinotus carolinus). Ph.D. Dissertation, University of Miami, Miami, Florida.

Lazo, J.P., D.A. Davis and C.R. Arnold.1998.The effects of Dietary Protein Level On Growth, Feed Efficiency and Survival of Juvenile Florida Pompano (T. Carolinus). Aquaculture 169: 225-232.

Lee, S.W., Najiah, M. and Wendy, W. 2010. Bacteria associated with golden pompano (Trachinotus blochii) broodstock from commercial hatchery in Malaysia with emphasis on their antibiotic and heavy metal resistances. Front. Agric. China, 4(2): 251–256.

Liao, I.C., Su, H.M. and Chang, E.Y. 2001. Techniques in finfish larviculture in Taiwan. Aquaculture 200: 1–31

Main, K.L., N. Marcus, C. Brown. 2004. Developing Marine Fish Hatchery and Nursery Culture to Expand Florida's Aquaculture Industry –Year 1- Final Report. Mote Marine Laboratory. Florida.

Main, K.L., N. Rhody, M. Nystrom, M. Resley. 2007. Species Profile – Florida Pompano. Southern Regional Aquaculture Centre. No. 7206.

Marte, C.L. 2003. Larviculture of marine species in Southeast Asia: Current research and industry prospects. Aquaculture 227: 293–304.

McMaster, M.F., 1988. Pompano Aquaculture: Past success and Present Opportunities. Caribbean Aquaculture and Trade Expo & Conference. Puerto Rico. Aquaculture Magazine 14 (3) 28-34.

McMaster, M.F., T.C. Kloth and J.F. Coburn. 2003. Prospects for Commercial Pompano mariculture-2003. Aquaculture America 2003, Feb. 18-21. 2003, Louisville, Kentucky.

McMaster, M.F., T.C. Kloth and J.F. Coburn. 2004. Pompano Mariculture-2004.World Aquaculture Magazine 30 (4): 25-29.

McMaster, M.F., T.C. Kloth and J.F. Coburn. 2005. Pompano Mariculture in Low salinity ponds. 2nd. International Sustainable Marine Fish Culture Culture conference and workshop. Harbor Branch Oceanographic Institute, Fort Pierce, Florida, October 19-21. Proceedings in Press.

McMaster, M.F., T.C. Kloth, J.F. Coburn and N.E. Stolpe. 2006. Florida Pompano (Trachinotus carolinus)is an Alternative Species for Low Salinity Shrimp Pond Farming. Aquaculture America 2006, February14, 2006, Las Vegas, Nevada.

McMaster, M.F., 2013. Pompano (T. Carolinus): A Sustainable Eco-Pond Approach To Profitable Farming. In-House report (August 2013), published at www.PompanoFarms.com. 23 pages.

McMaster, M.F., 2103. Status of Pompano Farming Methodologies. In-House Report (December 2013), published at www.PompanoFarms.com . 5 pages.

Moe, M.A., Jr., R.H. Lewis, and R,M. Ingle. 1968. Pompano mariculture: Preliminary data and basic considerations. State of Florida Board of Conservation, Technical Series No. 55, 65 pp.

Mundro Ian, S.R., 2000. The marine and freshwater fishes of Cylone, Biotech books, Delhi, pp. 349.

Nazar, A. K.A., Jayakumar, R., Tamilmani, G., Sakthivel, M., Kalidas, C., Ramesh Kumar, P., Anbarasu, M., Sirajudeen, S., Balamurugan, V., Jayasingh, M. and Gopakumar, G. (2012) Larviculture and seed production of the silver pompano, Trachinotus blochii (Lacepede, 1801) for the first time in India. Indian Journal of Fisheries, 59 (3): 83-87.

Nelson, G. A. and M.D. Murphy. 2001. A preliminary assessment of Florida Pompano (Trachinotus carolinus) in Florida waters. Florida Fish and Wildlife Conservation Commission. St. Petersburg, Fl.

Pakingking, R., Mori, K.I. Bautista, N.B. Ayson, E.G.J. and Reyes, O. 2011.Susceptibility of hatchery-reared snubnose pompano Trachinotus blochii to natural betanodavirus infection and their immune responses to the inactivated causative virus. Aquaculture 311, 80–86

Pressman, A., 2006. Special Report: Fished Out. Business Week, Sept. 4,2006 Pages 56-64

Ramesh Kumar, P., Nazar, A K A., Jayakumar, R., Tamilmani, G., Sakthivel, M., Kalidas, C., Balamurugan, V., Sirajudeen, S., Thiagu, R and Gopakumar, G (2015) Amyloodinium ocellatum infestation in the broodstock of silver pompano Trachinotus blochii (Lacepede, 1801) and its therapeutic control. Indian Journal of Fisheries, 62 (1). pp. 131-134.

Ransangan, J., Manin, O., Abdullah, A., Roli, Z. and Sharudin, E.F. 2011. Betanodavirus infection in golden pompano, Trachinotus blochii, fingerlings cultured in deep-sea cage culture facility in Langkawi, Malaysia. Aquaculture 315: 327–334.

Samal, Amir Kumar., Nazar, A K A., Jayakumar, R., Tamilmani, G., Sakthivel, M., Rajendran, P and Gopakumar, G (2014) Musculoskeletal abnormalities in hatchery reared silver pompano, Trachinotus blochii (Lacépède, 1801). Indian Journal of Fisheries, 61 (3). pp. 122-124.

Smith,T.I.J. 1973. The Commercial Feasibility of Rearing Pompano (Trachinotus carolinus) in Cages. Florida Sea Grant Technical Bulletin No. 26, 62 pp.

Swingle, W.E. 1972. Alabama’s Marine Cage Culture Studies. Proceedings of the World Mariculture Society 3: 75-81

Tatum, W. M. 1972. Comparative Growth, Mortality and Efficiency of Pompano (Trachinotus carolinus)

Receiving a Diet of Ground Industrial Fish with Those Receiving a Diet of Trout Chow. Proceedings of the World Mariculure Society 3:65-74

Tatum, W. M. 1973. Comparative Growth of Pompano (Trachinotus carolinus) in Suspended Net Cages Receiving Diets of a Floating Trout Chow With Those Receiving a Mixture of 50% Chow and 50% Sinking Ration. Proceedings of The World Mariculture Society. 4:125-141

Tatum, W.M. and W.C. Trimble. 1978. Monoculture and polyculture pond Studies with pompano (Trachinotus carolinus) and shrimp (Penaeus aztecus, P. duorarum, and P. setiferus) in Alabama. 1975-1977. Proceedings of the World Mariculture Society 9: 440-446

Theilacker, G.H. and M.F. McMaster, 1971. Mass Culture of the Rotifer (Brachionus plicatilis) and its Evaluation as a Food for Larval Anchovies. Marine Biology10, No. 2, 183-188.

Trimble, W.C., 1980. Production Trials for monoculture and polyculture of White shrimp (P stylirostiris) with Florida Pompano (Trachinotus carolinus) in Alabama. 1978-1979. Proceedings of the World Mariculture Society 11: 44-59.

Wagstaff, R.K., 1975. Concept and Process of Growing Pompano in Confinement. Feedstuffs Magazine, June 1975. pp. 24-25.

Watanabe, W.O. 1994. Aquaculture of the Florida Pompano and other jacks (Family Carangida) in the Western Atlantic, Gulf of Mexico, and Caribbean basin: status and potential. In: K.L. Main and C. Rosenfeld (eds.). Culture of high value marine fishes, Oceanic Institute, Honolulu, HI.

Weirich, C.R. and M. Riche. 2006. Acute tolerance of juvenile Florida pompano (Trachinotus carolinus) to ammonia and nitrite at various salinities. Aquaculture Research, 37 (9), pp 855-861.

Weirich, C.R., Derek Groat, Robert Reigh, Edward Chesney, and Ronald Malone, 2006. Effect of Feeding Strategies on Production Characteristics and Body composition of Florida Pompano in Marine Recirculating Systems. North American Journal of Aquaculture. 68 (4): 330-338.

Weirich, C.R., Kenneth Riley, 2006. Volitional Spawning of Florida Pompano (T. carolinus) Induced via Administration of Gonadotropin Releasing Hormone Analogue (GNRHA). Journal of Applied Aquaculture. 19 (3): 47-60.

Williams, S., R.T. Lovell, and J.P. Hawke. 1985. Value of menhaden oil in the Diets of Florida pompano. Progressive Fish-Culturist 47: 159-165.

Related links

Aquafind

Aquatic Network

Database on Introductions of Aquatic Species - DIAS

European Aquaculture Society - EAS

FishBase

FAO FishStatJ – Universal software for fishery statistical time series

GLOBEFISH

Network of Aquaculture Centres in Asia-Pacific - NACA

World Aquaculture Society - WAS