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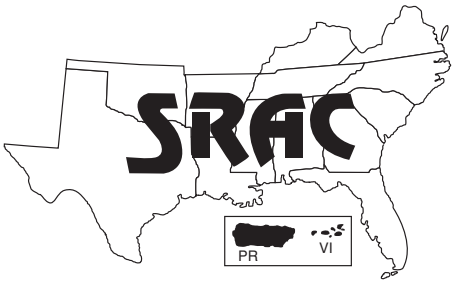

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Species Profile—Florida Pompano

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Florida pompano, *Trachinotus carolinus*, is a member of the jack family (Carangidae) and highly prized by recreational and commercial fishers. Other common names for this species are pompano, common pompano, Atlantic pompano, sunfish, pompaneau sole (French), and pompano amarillo (Spanish). Pompano is a great tasting fish with a mild flavor and flakey texture. It commands a high price in the seafood market and demand exceeds supply from the small and unpredictable commercial catches.

In the 1960s and 1970s, researchers and commercial producers examined the potential of Florida pompano as an aquaculture species. Although early spawning, larval rearing and juvenile growout trials were successful, reliable hatchery, nursery and growout methods were not developed. In the late 1990s, researchers and commercial farmers began to reevaluate the culture of pompano because of advances in techniques for captive broodstock maturation, spawning and larval rearing; the development of methods for producing new live foods; and new feed formulations for marine fish.

Natural history

The life history and ecological requirements of Florida pompano are not completely understood. What is known is mainly based on populations in southeastern U.S. coastal waters. Pompano is a deep, thin-bodied fish that is silver with green to grey dorsal and yellow ventral surfaces (Fig. 1). It is a coastal, shallow-water, pelagic species that grows to 25 inches total length (TL) (63.5 cm) and can weigh 8 pounds (3.6 kg). There are no obvious morphological differences between male and female pompano, other than the larger size of some mature females. Pompano is a warmwater species found from Massachusetts to Brazil. In the northern hemisphere, they migrate north in the spring and south in the winter. Pompano are commonly seen in schools along sandy beaches and in bays and estuaries. They are diurnal feeders that eat mollusks and crustaceans, such as coquina clams, mole crabs, shrimp and other invertebrates.

Juvenile and adult pompano tolerate a wide range of environmental conditions, including low levels of dissolved oxygen (≥4 mg/L) and salinities ranging from 0 to 50 ppt. Research has shown that, if acclimated properly, juvenile and adult pompano adjust well to lower salinities; however, in the hatchery phase higher salinities are necessary for buoyancy and survival of the eggs and young larvae.

Temperature is one environmental variable that may be a constraint on pompano culture. Pompano are cold intolerant and show stress at low temperatures, which may restrict their potential for outdoor culture. Research has shown that mortalities occur at temperatures of 50 to 53 °F (10 to 12 °C). Mortalities also occur when there are extreme changes in temperature over a short period of time. The optimal temperatures for juvenile growth appear to range from 77 to 86 °F (25 to 30 °C), although juveniles have thrived at temperatures as high as 93 °F (34 °C).

The exact size and age of maturity varies; however, most males and females are believed to mature by 14 inches TL (35.6 cm), with some maturing as small as 10 inches fork length (FL) (25.4 cm). About half of females mature during their first year, at a size of 11.8 to 12.8 inches FL (28.5 to 32.5 cm), with all females

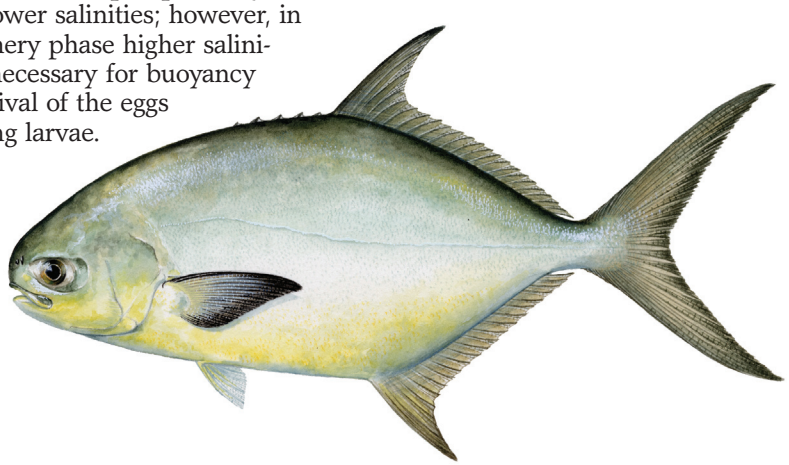

Figure 1. Illustration of Florida pompano (©Diane Rome Peebles).

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reaching maturity between 2 and 3 years at 14.8 to 15.7 inches FL (37.6 to 39.9 cm). Males are also believed to mature at approximately 1 year of age. Collections of sexually mature adult pompano for captive spawning in southwest Florida support these observations. Of 175 individuals collected from March through May in 2005 and 2006, mature males had a mean weight of 1.5 pounds (680.4 g) and a mean length of 12.1 inches FL (30.7 cm), whereas mature females had a mean weight of 1.7 pounds (771 g) and a mean length of 12.3 inches FL (31.2 cm). The smallest mature fish caught in this 2-year sampling period were a male at 10.8 inches FL (27.4 cm), weighing 1 pound (453.6 g), and a female at 10.6 inches FL (26.9 cm), weighing 1.3 pounds (589.7 g).

Pompano spawning is believed to occur from early spring through October. Reproductive seasonality varies among Atlantic and Gulf of Mexico populations. Those located in the tropical Gulf of Mexico and Caribbean Sea may spawn throughout the year. Seasonal spawning patterns of pompano have been verified by the abundance of small juveniles (10.9 to 20.1 mm standard length, SL) along exposed, sandy beaches and in the surf zone from late spring through fall. Large numbers of juveniles have been reported along the Atlantic Coasts of Florida and Georgia during April and May, North and South Carolina in June and July, and Delaware in July and August. In the Gulf of Mexico, most juvenile recruitment occurs in April and May, with a smaller "wave" of individuals reported in August and September.

The actual spawning location for pompano is unknown, but it has been suggested that spawning occurs offshore, where the transport and distribution of pelagic eggs and larvae are influenced by prevailing currents. Evidence for offshore spawning is based in part on the collection of specimens in the 1950s and 1960s off the Atlantic coast of north Florida. Additional evidence was collected in Florida waters when larvae measuring 3.1 and 4.6 mm SL were identified in plankton tows up to 14.9 miles (24 km) offshore over the continental shelf in the eastern Gulf of Mexico (Finucane, 1969). There are no documented accounts of spawning activity inshore or in estuarine waters and many questions remain regarding the reproductive biology and behavior of this species. However, recent studies indicate that there may be more inshore spawning habitats than previously thought.

Fecundity has been estimated to range from 133,000 to 800,000 eggs per season. Early authors examining ripe females reported one individual, weighing 1.3 pounds (590g), with an estimated 630,000 eggs. Others estimated 425,000 eggs in another mature female measuring 10 inches FL (25.4 cm). In a more recent collection of sexually mature adult female pompano, lower estimates of fecundity were reported, including three pompano measuring 10.7 to 10.8 inches TL (27.2 to 27.4 cm) with fecundity estimates ranging from 133,400 to 205,500 oocytes per female (Muller et al., 2002).

Culture techniques

Broodstock procurement

Pompano can generally be collected throughout the year in Florida's coastal and estuarine waters. Mature adults can be acquired for captive broodstock using trammel nets, hook-and-line, or gill nets, if special permitting is obtained. (Since 1995, the use of entangling-type nets has been prohibited within 1 mile of shore on Florida's Atlantic Coast and within 3 miles of shore on Florida's Gulf Coast.) Gill nets are the most efficient way to collect large numbers of adult pompano, but the species' small, deciduous scales and the extensive handling associated with gill netting can cause serious injury and death. Individuals caught with a hook-and-line are usually handled less and suffer less physical damage. However, this method can be more time consuming and a fish may be severely stressed unless it is landed quickly. Pompano collected offshore can be held for a short time in live wells on boats with the use of liquid oxygen. Then they are transported to shore and transferred to tanks and/or ponds to be used for spawning. Juveniles can be captured in the wild and reared in captivity until they reach sexual maturity. Viable broodstock also can be obtained from hatchery-reared pompano.

Spawning behavior

There is limited information on spawning behavior in captive pompano. Kloth (1980) described the spawning behavior of two females that were induced to spawn using hormones. One female began by swimming slowly around the bottom of the tank and then rose to the middle of the water column with one of four males following her. She remained stationary for 15 seconds, with the male positioned below her, and then returned to the bottom of the tank. Shortly afterward, eggs were seen floating on the surface. This female repeated the spawning behavior six times, with each event lasting 10 to 15 seconds and an interval of 4 to 10 minutes between each event. The second female exhibited similar behavior, completing two spawning acts with two different males; each event lasted about 15 seconds and there was an 8-minute interval between them.

Induced spawning

Scientists working independently of one another have produced pompano with varying degrees of success throughout the years. Research has primarily focused on developing techniques for the commercial culture of Florida pompano, including the consistent production of high-quality eggs. Captured pompano have been induced to spawn year-round using hormone injections coupled with photoperiod and temperature manipulation. Additional techniques for out-of-season gonadal maturation and successful spawning of pompano include photoperiod and temperature manipulations, followed by abrupt temperature shifts.

Successful hormone-induced spawning of Florida pompano, using both voluntary and strip spawning methods, was first reported in the 1970s by Hoff et al. (1972, 1978a, b). Spawning was induced by injecting females (oocyte diameter 580 to 718 µm) with two separate doses of human chorionic gonadotropin (HCG) (0.55 IU/g and 0.275 IU/g body weight) administered 24 to 48 hours apart. Spawning occurred approximately 30 to 40 hours after the primary injection at 73.9 °F (23.3 °C) and a salinity of 33 ppt. Fertilization rates were relatively low (0.05 to 18.0 percent) in these first successful spawns and eggs measured 0.87 to 1.0 mm at 1 hour post-fertilization. Incubation times

varied with temperature. The eggs developed abnormally, which was attributed to poor egg quality.

While researchers achieved the first successful captive spawns of Florida pompano in the lab, commercial culturists were not far behind. In the early 1970s commercial culturists at Oceanography Mariculture Industries, Inc.'s (OMI) Dominican Republic hatchery had success. Photo-thermal manipulation was used to induce gonadal maturation in captive broodstock. Spawning was induced in mature females with gonadotropin injections; however, the methodology from these commercial trials was not reported. In 1974, 10.4 million fertilized eggs were produced at an estimated 114,000 eggs per female and OMI reported the development of reliable hatchery methods capable of producing an average of 37,539 fry per month.

In a recent study, two wild-caught broodstock populations and two first-generation (F_1) hatchery-reared broodstock populations were induced to spawn to evaluate the effect of diet on egg quality. Captive broodstock (25 to 30 individuals per tank) were spawned multiple times in 2005 and 2006, while being maintained in large, indoor, fiberglass tanks (7,399 gallons; 28 m^3) with recirculating filtration systems. Pompano populations (sex ratio of 1:1) were held in four separate round, fiberglass tanks equipped with a heater/chiller unit large enough to manipulate and maintain water temperatures. These closed recirculating systems included filters for solids removal, biofiltration, sterilization, and denitrification processes. Two of the broodstock groups received a fresh frozen diet consisting of food-grade, farm-raised shrimp, herring and squid. The other two populations were fed a commercial broodstock diet containing a 45% crude protein level and 8% crude lipid.

Maturation and spawning of one wild pompano population was induced by manipulating photoperiod and water temperature. In this study, spawning activity was observed when temperatures ranging from 74 to 79 °F (24 to 26 °C) were shifted quickly to 86 to 88 °F (30 to 31 °C). In the conditioning cycle, photoperiod ranged from 11 (winter) to 13 (summer) hours of daylight and water temperatures ranged from 72 to 82 °F (22 to 28 °C). Eight natural spawning events occurred after an abrupt change in water temperature. These yielded a total of 289,225 eggs from one or more females, with fertilization rates of 0 to 91 percent.

Spawning was also induced with hormone injections (HCG), based on body weight, coupled with photothermal manipulation, to produce eggs in both wild-caught and hatchery-reared (F_1 generation) pompano. Fish were collected in a smaller tank and anesthetized using tricaine methanesulfonate (MS-222) (Fig. 2). A cannula tube (0.97 mm internal diameter) was used to check the state of gonadal maturation (Figs. 3 and 4). Both males and females were given a single intramuscular injection about halfway between the lateral line and first dorsal fin spine (Fig. 5). Females (mean weight = 3.8 lbs, 1.7 kg; mean FL = 15.8 in., 40.1 cm) with mature, vitellogenic and/or post-vitellogenic stage oocytes (diameters ranging from 450 to 650 µm) were injected with a single dose of HCG at 1000 IU/kg body weight. Males (mean weight = 2.6 lbs, 1.2 kg; mean FL = 14.3 in., 36.3 cm) received a single dose of HCG at 500 IU/kg body weight. Spawning occurred 40 to 48 hours after the first injection, followed by a smaller, less viable spawn up to 96 hours post-injection. From the seven documented induced spawning events for wild-caught and hatchery-reared pompano, a total of 5.3 million eggs were collected. Fertilization ranged from 19.3 to 48.2 percent.

Larval culture

Fertilized eggs are buoyant, transparent, about 1 mm in diameter, and have a single oil droplet. Newly hatched larvae measure approximately 2.0 mm standard length (SL), have little or no pigmentation, lack a functional mouth, and have a large yolk sac with a single oil globule. At 7 days post-hatch (DPH) and a temperature of 82 °F (28 °C), the oil droplet is reduced, the yolk is completely absorbed, eyes are fully pigmented, and the mouth is fully formed. Transformation from larval stage to juvenile begins approximately 24 DPH, at which time scales develop and pigmentation appears over the lateral surfaces of the body.

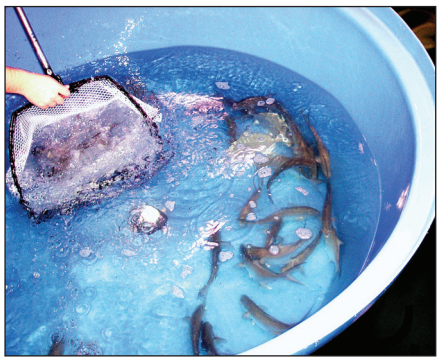

Figure 2. Placing pompano broodstock in a smaller tank for anesthetization prior to sampling.

Figure 3. Adult pompano ready for cannulation.

Figure 4. Cannulation of an adult female pompano.

Figure 5. Intramuscular injection of the hormone HCG into a wild-caught, sexually mature, adult female pompano.

In 2005, larval rearing trials with Florida pompano were conducted in recirculating aquaculture systems at Mote Marine Laboratory in Sarasota, Florida. The larval system consisted of three indoor round, high-density polyethylene tanks (872 gallons; 3.3 m^3) equipped with a bubble bead filter for solids filtration, a fluidized bed for biological filtration, a UV sterilizer, and a protein skimmer. A combination of aeration and liquid oxygen kept dissolved oxygen levels at 5 to 10 mg/L, while assisting in the dispersion of eggs and larvae throughout the water column. Temperatures in the system ranged from 72 to 79 °F (22 to 26 °C) and salinity was maintained at 35 to 36 ppt using artificial sea salt.

Fertilized eggs resulted from hormone-induced (HCG) natural spawns of wild-caught and F_1 pompano. On the day of spawning, fertilized eggs were stocked in three separate rearing tanks at densities of 50 to 75 eggs/L and incubated at 79 °F (26 °C). Hatching began 24 hours post-fertilization and hatch rates were estimated at 75.5 percent. Mean larval length at hatch was 2.3 mm SL. A 3 DPH pompano larva is shown in Figure 6. The feeding regime used during the trial is summarized in Figure 7. L-type rotifers (*Brachionus plicatilis*) were provided to larval pompano from 2 DPH through 12 DPH at a density of ten rotifers/mL. Rotifers were reared in high-density recirculating systems at 30 ppt salinity and fed a diet of concentrated algae paste (*Nanochloropsis*). Rotifers were enriched with a commercial enrichment product 24 hours before they were added to the larval rearing tanks. Rotifer concentrations in larval tanks were monitored twice daily (0900 and 1600) and additional rotifers were added to the tanks volumetrically to maintain the desired number of individuals.

By 10 DPH, *Artemia* were introduced to the pompano larval tanks as an additional live prey item. Rotifers, distributed in decreasing concentrations, were co-fed with *Artemia* until larvae were completely weaned onto a diet of *Artemia*. One-day-old Great Salt Lake strain *Artemia* were enriched for 22 to 24 hours and then added to larval tanks at a density of two *Artemia*/mL from day 10 to day 12. *Artemia* concentrations in larval tanks were monitored twice daily (0900 and 1600) and additional organisms were added to the tanks volumetrically to maintain the desired number of individuals. From 10 to 17 DPH, enriched *Artemia* were provided to larval pompano at densities ranging from two to four *Artemia*/mL. At the same time, an artificial micro-diet was introduced (55% protein, 14% lipid; particle size 80 to 200 µm). The micro-diet is very similar in color to *Artemia*, which helped with the transition from live prey to a commercial diet. From 18 to 21 DPH the ration of *Artemia* was steadily decreased and the micro-diet was continued until the larvae could be completely weaned off of live food at 22 DPH.

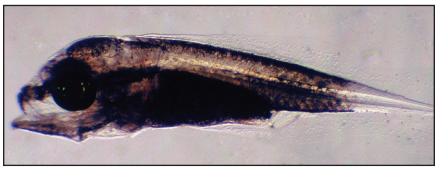

Figure 6. Three days post-hatch pompano larva. (Photography by Matthew L. Wittenrich)

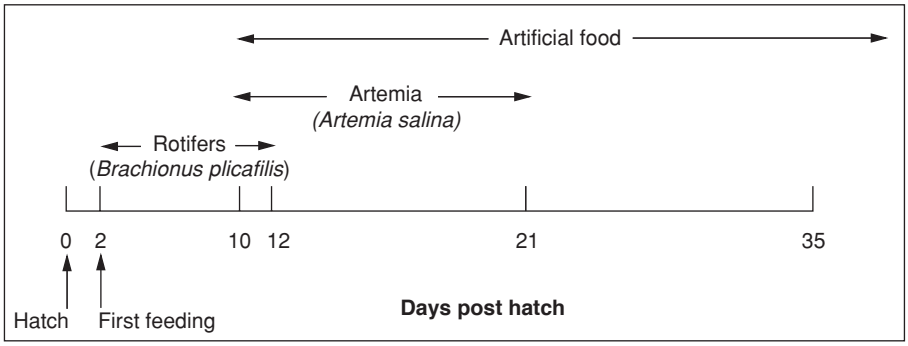

Figure 7. Summary of larval pompano feeding regime used at Mote Marine Laboratory throughout the 2005 spawning season.

Juvenile growout to market size

Florida pompano have been grown to market size in tanks, floating cages and ponds. With little information on the environmental (temperature, oxygen, etc.) and biological (stocking density, growth rate, food conversion ratio, survival) parameters for these different growout systems, it is difficult to evaluate the production efficiency and cost effectiveness. The initial weight at stocking and the length of time it took for individuals to reach market size varied greatly among the different culture systems. The typical market size is 1.0 to 1.5 pounds (453.6 to 680.4 g), with harvested fish measuring 9.8 to 14.2 inches TL (24.9 to 30.1 cm). Early studies, which estimated growth from length frequency data, showed that growth rates ranged from 0.8 to 1.2 inches per month (2.0 to 3.1 cm). More studies are needed to determine the growth rates of Florida pompano from juvenile to market size in tank, pond and cage systems.

Diseases

Broodstock and juveniles collected from the wild can carry parasites and should be quarantined and treated for several weeks before they are introduced to any culture system. *Amyloodinium* is a particular problem for both juveniles and adults reared in recirculating systems. This parasite has a high reproductive rate and many life stages, and tends to be quite resilient to treatment. *Amyloodinium* is typically found on the gills and can cause high mortality rates if left untreated. Individuals infected with this parasite often exhibit coughing or flashing behavior.

Marketing and economics

Florida pompano commands a relatively high price in local and regional seafood markets. The commercial dockside price for pompano in Florida is usually higher than for other marine food fish species (Florida Fish and Wildlife Conservation Commission, 2006). The nominal (not adjusted for inflation) dockside price for pompano averaged $3.30 per pound ($7.26 per kg) (whole weight, fresh) from 1994 to 2006. When commercial catches were large in 1994 and 1995, the dockside price declined (from $3.38 to $2.64 per pound, $7.44 to $5.81 per kg, in 1994 and from $3.38 to $2.66 per pound, $7.44 to $5.85 per kg, in 1995) (Fig. 8).

Dockside price then increased to $3.87 per pound ($8.51 per kg) in 2004. The preliminary 2006 average dockside price for Florida pompano was $3.65 per pound ($8.03 per kg). Regional prices for Florida pompano averaged $3.14 per pound ($6.91 per kg) from 1994 to 2004 (U.S. Department of Commerce, 2006). The regional dockside prices were slightly lower than the Florida dockside prices, but followed the same market trends (Fig. 8).

Data on wholesale and retail prices beyond the dockside market are scarce. However, there are some proxy data that are useful. The Fulton Fish Market primary wholesale price for Florida pompano are periodically reported via the National Marine Fisheries Service's Market News Reports (U.S. Department of Commerce, 2005). These data describe a "spot price" for Florida pompano as they are sold into the wholesale market in the New York region. The reported prices typically apply to "large" fish (1.25 to 2.5 pounds; 0.567 to 1.1 kg) that are sold in whole, fresh form. However, data for "medium" (0.75 to 1.25 lbs; 0.340 to 0.567 kg) and "small" (< 0.75 lbs; 0.340 kg) fish are also reported, though less often. Prices reported for 2005 are shown in Figure 9. The per pound prices for large, medium and small fish averaged $4.95, $4.23 and $3.75 ($10.89, $9.31 and $8.25 per kg), respectively, during 2005. The prices for large fish do show some seasonal patterns, with higher prices being recorded during the August-September period.

Retail market prices are not readily available, although anecdotal observations indicate that major grocery stores sell whole, fresh pompano for about $8.00 per pound ($17.60 per kg).

At this time, there are not enough data to evaluate the production economics for pompano. This is an important area for future research.

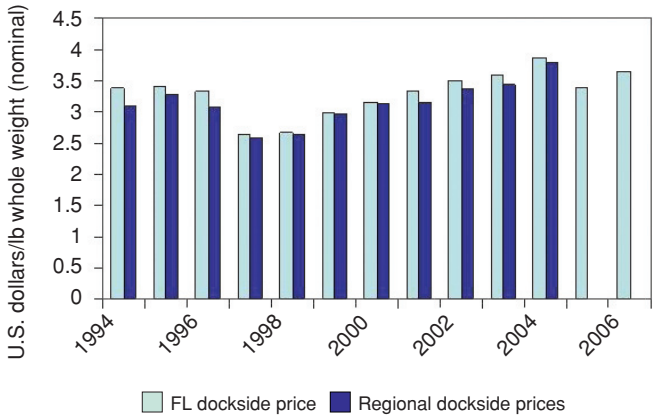

Figure 8. Gulf and South Atlantic Pompano Dockside Prices from 1994 to 1996.

Conclusions

Florida pompano is a promising new marine finfish species for aquaculture in the U.S.; however, the culture technology is still under development. Maturation and spawning techniques have been developed for year-round production of high-quality eggs. Larvae are hearty and easily transition from

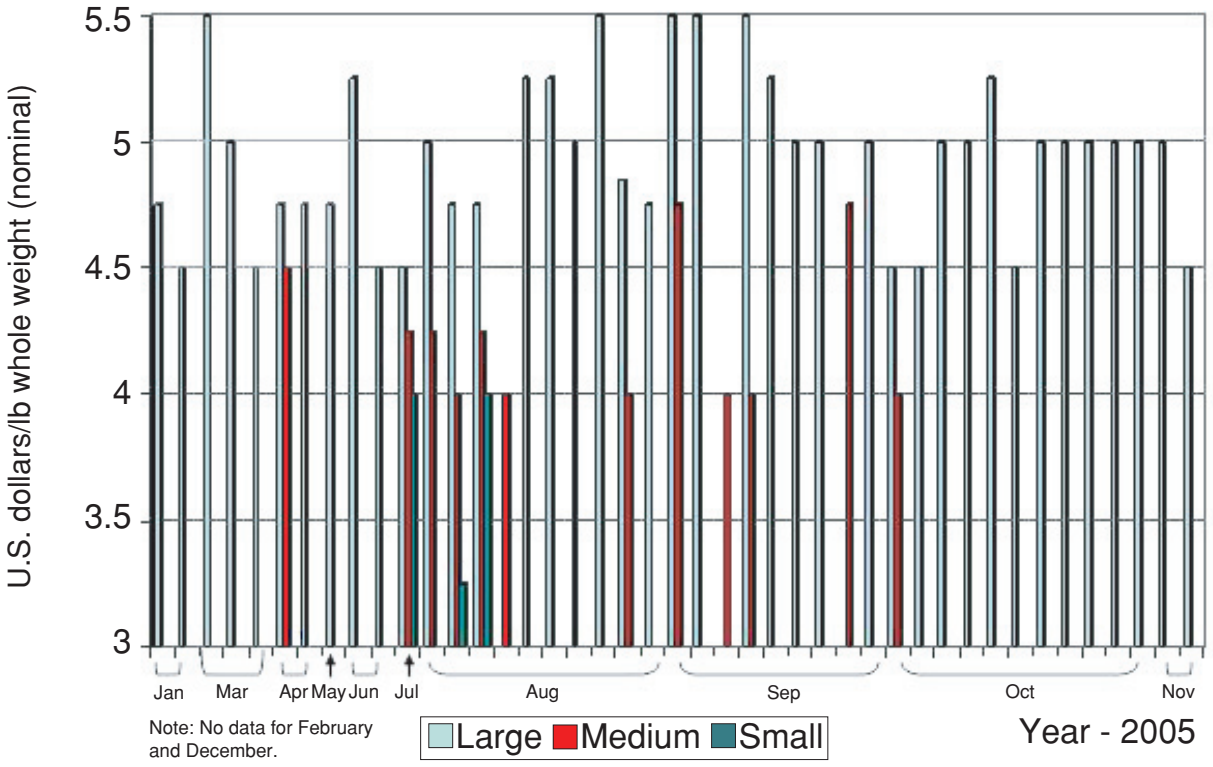

Figure 9. Fulton Fish Market Primary Wholesale Selling Price for Florida Pompano.

rotifers to *Artemia* to an artificial micro-diet. Additional data is needed on the environmental and biological requirements for the growout of fingerlings to market size in tank, pond and cage systems. With this data it will be possible to evaluate the production economics of pompano aquaculture.

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