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Candidate Species for Florida Aquaculture: Almaco Jack, *Seriola rivoliana*[1]

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Purpose

The target audience for this publication is current and potential aquaculture producers. The purpose of this publication is to summarize accurate information available about how to culture the almaco jack so that current and potential producers can make informed business decisions.

General Description

Almaco jack, *Seriola rivoliana*, is a fish within the Order Perciformes, family Carangidae; which includes jacks and pompanos (Figure 1). There is worldwide interest in culturing species in the genus *Seriola*. Like other commercially farmed *Seriola* species, almaco jack (also known as longfin yellowtail and Kampachi) are fast growers, have a high market value, and are increasingly well-regarded among chefs for their versatility in both cooked and raw preparations. These characteristics, among others, have made them favorable candidates for both land-based and offshore aquaculture.

Almaco jack are characterized by a compressed body, a dark diagonal stripe through the eyes to the nape, the lack of a keel on the ventral side, and a truncated upper jaw with the broad end terminating below, at, or before the anterior margin of the pupil. They can further be differentiated by their darker color and their second dorsal fin being much higher than the dorsal fins of other *Seriola* spp. In adults, the length of the dorsal-fin lobe is about 1.3 to 1.6 times longer than the pectoral fins and 18% to 22% of the fork length. Generally, they have a brown or silvery blue-green body with faint amber or olive stripes down their sides. The ventral side is much lighter and appears brassy or lavender on adults, whereas the fins and colored bar on the head region are dark and extend from the eye to the rear of the head. Almaco jack is commonly reported to be 90 cm (35 inches) long and to weigh approximately 4.5 kg (10 lbs) (Florida Fish and Wildlife Conservation).

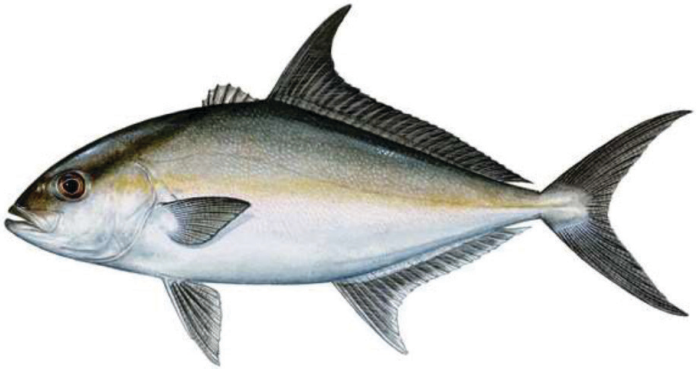

Figure 1. Almaco Jack.
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Geographic Distribution and Habitat

Almaco jack (Figure 1) are circumglobally distributed, located in the Gulf of Mexico and intertropical regions throughout the Pacific and Atlantic oceans. They can be found frequenting depths between 3 and 35 m in subtropical regions (43°N–38°S) and on artificial reefs, wrecks, and higher relief structures at depths up to 245 m (800 ft) (Figure 2).

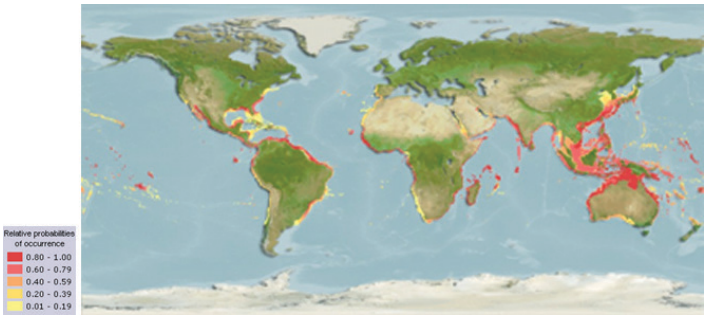

Figure 2. Distribution map for *Seriola rivoliana*. Credits: https://www.aquamaps.org

Culture Methods: Husbandry and System Requirements

Broodstock:

There is little published information on the reproductive biology and spawning of almaco jack in wild populations. Histological studies indicate that ovarian development occurs according to a multiple-batch, group-synchronous pattern similar to greater amberjack *Seriola dumerilli* (Marino et al. 1995). This means these fish spawn in groups and spawn more than once during the spawning events. Almaco jack spawn from April to November with fish spawning aggregations congregating near the Dry Tortugas, Pulley Ridge, and Flower Garden Banks (Grüss et al. 2018).

Almaco jack and other members of the genus *Seriolia* have been successfully spawned in captivity using photo-thermal conditioning alone or in combination with the aid of exogenous hormone induction (Rottman et al. 1991). Almaco jack broodstock initially captured from the Gulf of Mexico were conditioned to spawn naturally (26°C; 35 g/L; 12 h light) within 16 weeks of acclimation while being housed in an indoor recirculating aquaculture system. Newly acclimated broodstock were held under photo-thermally controlled conditions in 28 m^3 tanks and fed a diet of squid (50%) and Atlantic thread herring (50%) daily at 3% of the total tank biomass (Figure 3). Spawning cohorts with 7 females and 4 to 5 males spawned 3–4 times weekly over three months with an average spawn size of 322,000 eggs with a 58.6% fertilization (Patrick et al. 2019). Similar results were reported using hormonal induction methods (GnRHa, 20 µg/kg) administered to both male and female broodstock, where 10 successful spawns occurred with a mean of 275,000 eggs per spawn with 92% fertilization (Roo et al. 2014). In Hawaii, under natural photoperiod and temperature cycles, F1 broodstock spawned uninterrupted for over two years. Tanks containing 20 adults with 13 spawns/month had a mean fecundity of 154,000 eggs/spawn and mean fertilization of 43% (Laidley et al. 2004). Males were actively producing sperm at 21–22 months of age, whereas females matured more slowly than males, spawning at 24 months of age. Quiñones-Arreola et al. (2015) found that reproductive performance of wild-caught broodstock was better in terms of fertilization rate, total number of spawns, monthly spawn frequency, and total number of eggs produced when compared to first-generation, domesticated broodstock (Table 1).

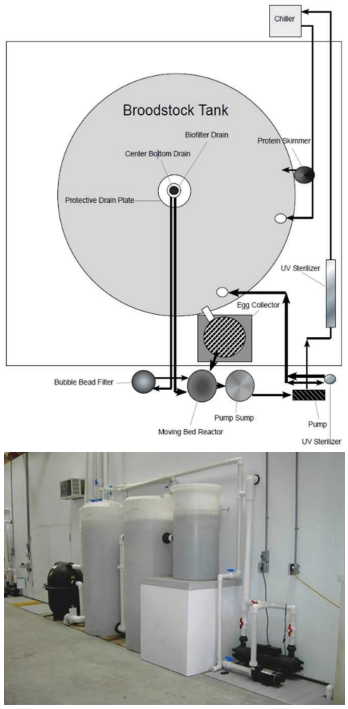

Figure 3. Broodstock holding tank design (28 m^3) and filtration components. Mote Marine Laboratory, Sarasota, Florida. Credits: Victor Blanco, UF/IFAS

Hatchery and Nursery

Hatchery technology for *Seriola* spp. has progressed over the last two decades with production in Japan, Ecuador, Australia, Chile, Mexico, Europe, and the United States. However, large variations in egg quality and larval survival have been reported for volitional (natural) and hormone-induced spawns, a challenge likely attributed to nutritional deficiencies among broodstock and larval diets). At 4 days post-hatch, larvae were ready to start first feeding as yolk sac reserves were completely absorbed, eye pigmentation

was developed, and the mouth and anus were open (Blacio et al. 2003; Fernández-Palacios et al. 2015; Roo et al. 2014; Roo et al. 2015).

In Ecuador, larval survival in 500 L tanks was reported to be ≤ 2.5% by 21 to 25 days post-hatch (DPH). At 27°C, viable eggs hatched 24 hours post fertilization. Larvae were stocked into 5000 L rectangular tanks. Larvae were fed enriched rotifers and *Artemia* followed by two dry diets (formulated for trout). Fingerlings weighing approximately 5 g were transferred to outdoor nursery tanks until they reached 10–20 g (Blacio et al. 2003; Laidley et al., 2004).

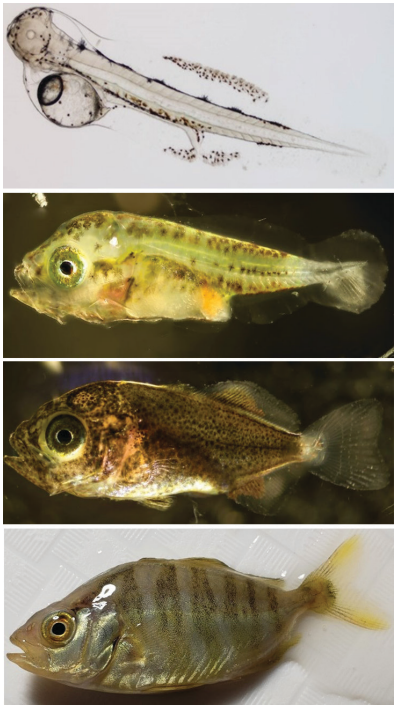

Figure 4. Almaco jack development: Top 2 DPH larvae; second, 10 DPH larvae; third, 15 DPH larvae; bottom, 40 DPH.
Credits: Ronald Hans, Mote Marine Laboratory

Larvae cultured in semi-intensive conditions in the Canary Islands had a mean survival of 2.5% at 30 DPH (Roo et al. 2010). At 90 DPH juveniles from semi-intensive systems reached 26.7 ± 4.7 g, while culturing in intensive systems yielded 14.2 ± 5.2 g. A total of 500,000 almaco jack were graded and vaccinated per year with transfer to offshore growout occurring when fish weighed 15-20 g.

Tank Growout

Based on gut content analysis, wild adult almaco jack are considered to be almost exclusively piscivorous, however, Ladley et al. (2004) reported the growout of an F1 progeny to maturation in 25 m^3 outdoor tanks exclusively feeding a pelleted diet. The fish showed good growth rates and reached weights of over 2 kg in year 1 and almost 5 kg in year 2 (Figure 6). Another study reported initial fish weight (1.76± 0.25 kg), was increased to 6.0 ± 1.1 kg in a thirty-six-month period (Roo et al. 2009). Every year, fish were sampled to measure their individual growth in weight and size (Figure 6).

Figure 5. Top, Almaco Jack larval tanks and bottom, broodstock tanks at Blue Ocean Mariculture.
Credits: Blue Ocean Mariculture

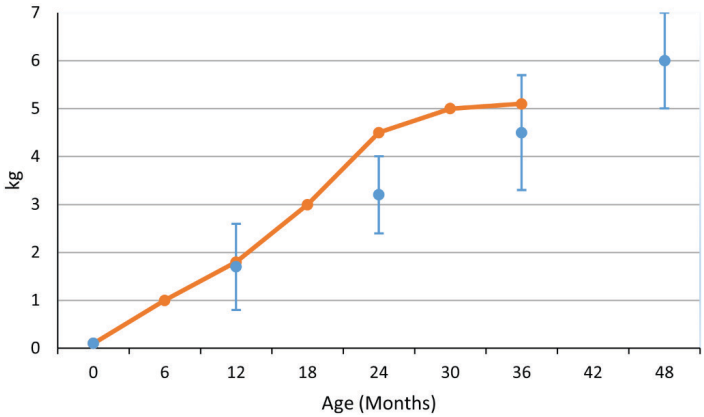

Figure 6. Growth rates of Almaco jacks cultured in outdoor tanks in Hawaii (Laidley et al. 2004), orange solid line; cultured in 10 m^3 tanks in the Canary Islands (Roo et al. 2009), blue points with error bars representing size variation.
Credits: undefined

Net Pen Growout

In a Hawaiian facility, Benetti et al. (2013) reported that during the husbandry period the operation used 5 SeaStation™ submersible net pens, with up to 8,000 m^3 growing volume per net pen. Fish were fed a diet incorporated with a high content of fish meal and taurine. Feed dispersal was achieved via a submerged (water-based) delivery technique.

The net pens were harvested twice weekly, and the fresh (non-frozen) product was delivered throughout the United States, with 500+ tons harvested in 2013. To ensure a quality product, H_2O_2 treatments were required to prevent monogenean skin flukes (*Benedenia seriolae*).

Current and Potential Markets

Almaco jack is an important member of the *Seriola* genus, a widely recognized commercial species with an international market. The only domestic commercial aquaculture production to date is in Hawaii, where Blue Ocean Mariculture has been producing hatchery-reared *S. rivoliana* (branded as Hawaiian Kampachi™) in offshore submersible net pens since 2005. Highly regarded for its flesh quality and high fat content (30%), their product is sashimi-grade and prized for its taste, versatility, and health benefits (Grubman 2014). Almaco jack produced by Blue Ocean Mariculture were cultured in pens for 10–12 months and were harvested at market size of 1.8–2.5 kilograms. The fish then were sent whole to a processor to be distributed through their marketing channels.

Successful worldwide culture of Almaco jack indicates that the species is well suited to captive production. In addition, almaco jack is a hardy species, with a fast growth rate and high market value. These attributes support current research and future interest in the development of almaco jack aquaculture for demanding markets.

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Table 1. Reproductive performance of wild-caught and first-generation domesticated almaco jack broodstock evaluated for 8 months. (Quiñones-Arreola et al. 2015).

	Broodstock Type	
	Wild-Caught	**Domesticated**
Total body weight (kg)	9.1	5.5
Survival to 8 months (%)	92.8	90.0
Fertilization (%)	94.5	75.3
Total number of spawns	57.0	28.0
Monthly spawning frequency (%)	9.2	5.5
Total number of eggs (1000s)	610.4	163.8
Total number of eggs per mL	612.3	164.4
Egg diameter (µm)	1044.9	1035.8