Spotted rose snapper (*Lutjanus guttatus*) aquaculture research and development as socio-economic alternative for Costa Rican fishing communities

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In Costa Rica, fisheries are a small component of the national economy (< 0.5 percent GDP); 5.8 kg/person was the average seafood consumption by 2001 (FAO 2004). Figure 1 shows fish landings and freshwater aquaculture production in Costa Rica. Aquaculture showed an average growth of 26 percent from 1998 to 2004, and tilapia represented 80 percent of total production (19,000 t by 2004). At the same time, the artisanal fishing sector showed decreasing captures rates year by year (INCOPESCA 2006).

Spotted Rose Snapper

The spotted rose snapper (*Lutjanus guttatus*) is one of the main target coastal species, but landings are decreasing in quantity and size. Reports include a mean capture size of 50 cm with gill nets and 38 cm with bottom long lines, but mean capture size has diminished to 43 cm with gill nets. This shows that the fishing effort on the population is excessive and requires protection management for sustainable exploitation (Vargas 1999).

Distribution of spotted rose snapper extends from the Gulf of California to Peru; adults live on coastal reefs to a depth of 30 m (Fischer *et al.* 1995) or in rocky areas. The species has asynchronous development of the gonads with partial spawning (Arellano-Martínez *et al.* 2001). Spawning peaks in April and October (Rojas 1996). The fish is caught by artisanal fishermen using gill nets and bottom long lines and as by-catch by shrimp trawlers. Most landings of the spotted rose snapper occur in the Costa Rican northern Pacific and in the southern zone of the Gulf of Nicoya (Figure 2).

Spotted rose snapper have many attributes suitable for aquaculture, such as spontaneous reproduction under appropriate captive conditions, high value and an unsatisfied demand on international markets. Surveys of fish markets determined that dressed spotted rose snapper wholesale price ranged from US$2.91 to US$4.50/Kg. Official statistics show prices from US$2.33 by the fish receiver, up to US$5.14 in supermarkets (INCOPESCA 2006). In Miami, which is the main fresh fish export market, prices go from

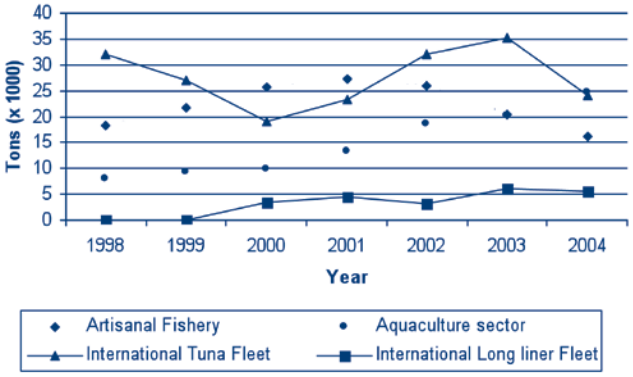

Fig. 1. Fish landings and aquaculture production (tons) along the Costa Rican coast, 1998 to 2004 (INCOPESCA 2006).

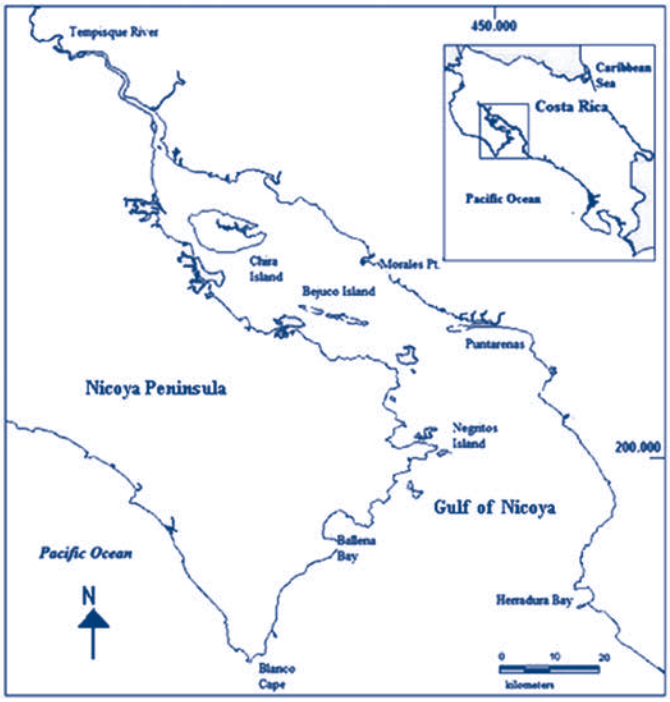

Fig. 2. Costa Rica and the Gulf of Nicoya.

US$4.00 to US$6.50/Kg. Exports by 2002 to the US were 521 t (Seafood Watch 2004).

Spotted Rose Snapper Aquaculture Feasibility Study

Research in Costa Rica on spotted rose snapper began in the 1980s by INCOPESCA, and the Universidad Nacional (UNA). By 2002, a marine larval production laboratory was opened at the Parque Marino del Pacífico (PMP), a coastal management agency in the Ministry of Environment (MINAET).

By 2003, PMP developed studies on the aquaculture sector that showed weak effectiveness of the public agencies, limited research and promotion, low enforcement, weak public policy and lack of interest from the private sector. An ecosystem-based-management (EBM) strategy was chosen and joint efforts were established among PMP, UNA, International Cooperation and Development Fund (ICDF) from Taiwan, INCOPESCA, MINAET and the Asociación de Pescadores de Isla Venado. The main objective was the establishment of local sustainable mariculture with artisanal fisheries focusing on spotted rose snapper.

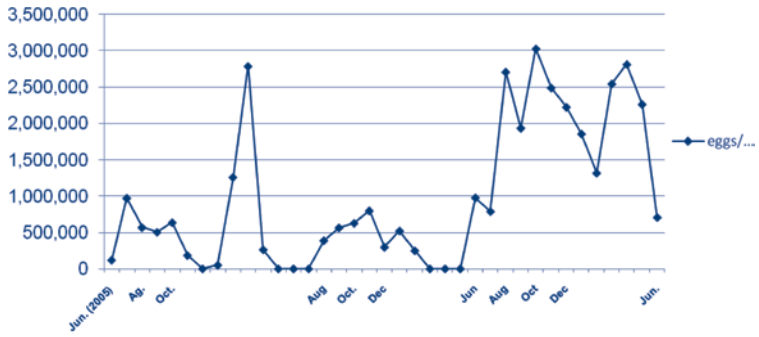

Fig. 3. Spontaneous spawning productions since June 2005 to June 2008.

Broodstock and Spawning

Wild spotted rose snappers (1-2 kg; 40-60 cm) to be used as broodstock were caught in the Gulf of Nicoya using long lines and maintained in 20 t fiberglass tanks. The fish were fed squid, shrimp and polichaetes (*Americonouphis reesei*). A second batch of broodstock was maintained as a backup.

Hormonal induction of spawning was attempted but the results were not acceptable. By 2004, with spontaneous spawning as the goal, environmental manipulations were applied in the broodstock holding facility. Noise was avoided as much as possible by moving tanks to indoors, light intensity was decreased, a recirculating system was applied and the seawater pumping and treatment system was improved. By 2005 spontaneous spawning became frequent and the quantity of eggs increased. The larval rearing process was begun under controlled conditions.

Three to four months was determined to be an adequate amount of time for adaptation of the broodstock. About 3,000,000 eggs were produced in 2005, 7,000,000 in 2006 and 15,000,000 in 2007 (Figure 3). December to February showed decreased production, probably because of low water temperature.

Eggs were collected using a surface drainage system; buoyant eggs were skimmed and transferred to the larval rearing area. Total numbers of eggs were determined volumetrically. Fertilized eggs were placed in rearing tanks (500 L), with light aeration and a low rate of seawater exchange (400 percent per day). Larvae hatched about 17 hours after fertilization. Aeration was removed and water exchange stopped at the time of hatching. When the larvae ascended to the surface, they were collected and moved to 6 m^3 larval tanks at density at about 33 larvae/L.

Larval Rearing

Larval rearing was difficult phase because of the small mouth (100 µm) of the spotted rose snapper. From 2005-2007 viable eggs were stocked in 6,000 L round fiberglass tanks, without any water exchange from day one to four. Hatched larvae were fed from day 2 post hatch with about 500 L per day of *Tetraselmis chui* (100-200 cells/mL) and renriched rotifers (5-20/mL) until day 20 post hatch.

The rotifer, *Brachionus plicatilis,* was unsuccessful and was substituted with *B. rotundiformis* (about 10-20/mL). Rotifers were grown at 32 ppt salinity in a batch culture system and fed with *Tetraselmys chui*. Rotifers and algae in the rearing tanks were monitored daily and replenished as necessary.

Enriched *Artemia* nauplii (1/mL) were added from day 15 to day 16 post hatch until day 30, and adult *Artemia* (2/mL) from day 25 to day 35 post hatch. Daily water exchange was 30 percent, from day 5 to day 25. The weaning phase was about eight days, day 30-32, depending water temperature, The *Artemia* supply was decreased gradually until day 42. A diet of shrimp and fish was added. Daily water exchange was 100 percent from day 25 to day 40. Fingerlings were move to 6,000 L round fiberglass tanks from day 38-40 to day 55-60. Daily water exchange was 150 percent from day 40 to day 50. After the weaning phase, juveniles were maintained from three to 10 days before being move to a fish farm. The average rate of survival was two percent. Daily records were kept on water temperature (average 28.6ºC), salinity (average 33.8 ppt), pH (average 8.1) and dissolved oxygen (average 6.5 mg/L).

By 2005, 10,000 juveniles were produced That was increased to 20,000 by 2006 and 70,000 by 2007 (Figure 4). The production was used at the pilot farm and by 2007, juveniles were also being released in the Gulf of Nicoya.

Pilot Sea Farm

Spotted rose snapper aquaculture areas along the Gulf of Nicoya were established based on biological, chemical and physical variables, waves, currents, wind protection, seafloor, beach distance, pollution, marine transport and information from INCOPESCA, UNA and Kapetsky *et al.* (1987). A community-based management approach was carried out for all the phases of the project including the pilot farm project. By 2005, a social survey and participatory processes were conducted in coastal communities of the Gulf of Nicoya. After six months a fisherman's association from Venado Island was chosen. Financial and technical support

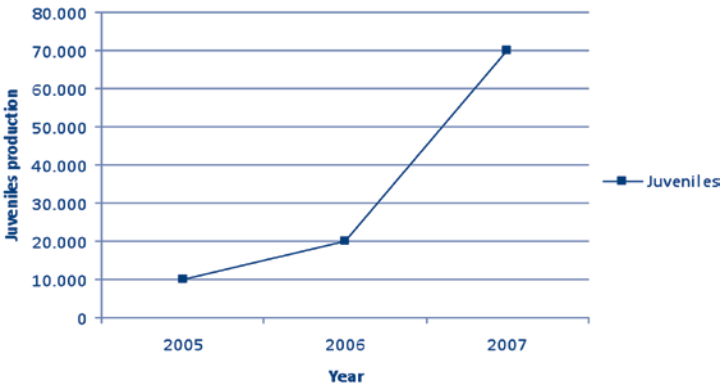

Fig. 4. Spotted Rose Snapper juveniles production.

Table 1. Fish artificial food composition (percent of diet) in diets 1 and 2.

Fish Food	Moisture	Ash	Protein	Lipid	Phosphorus	Calcium
1	11.314	8.680	42.5	5.191	1.33	1.54
2	6.927	12.363	43.9	13.168	2.34	3.29

Table 2. Spotted rose snapper sales during first 18 months.

	Kilos	N° of fish	Average Weight (Kg)	$/K	Income US$	Cost US$	Profit US$
Sale 1	800	2,000	0,40	3,87	3,095	2,166	928
Sale 2	900	2,571	0,35	3,50	3,150	2,205	945
Sale 3	800	2,286	0,35	3,50	2,800	1,960	840
Sale 4	1,120	3,200	0,35	3,50	3,920	2,744	1,176
Sale 5	700	2,000	0,35	4,20	2,940	2,058	882
Average	1,207	2,411	0,36	3,71	3,181	2,227	954
Total	4,320	12,057			15,905	11,133	4,771

was provided to the fishermen by IDCF, including the donation of pilot farm facilities. The PMP claimed three aquaculture areas. After day 45 post hatch, juveniles were moved to the co-management pilot sea farm.

Prepared feed evaluations were conducted by Corporación PIPASA using two cages (6x6x6 m, 108 m^3) containing 4,000 juveniles each. Two diets were tested at different times during the culture period (Table 1).

The first trials at the pilot farm produced mixed results. During the first 18 months, 12,057 spotted rose snapper (4,320 Kg) were sold from five partial harvests. Fish were sold to local markets at an average weight was 0.36 Kg for US$3.71/Kg for a total of US$4,771 in sales (Table 2).

Conclusions

Using a participatory process and management strategy, Parque Marino del Pacífico and the Universidad Nacional created a pilot laboratory juvenile production program. Lack of expertise and finance were avoided by joining efforts with other public agencies. Cooperation from ICDF helped support the critical phases, including the creation of a marine pilot farm that allowed larger production. Culture of rose spotted snapper is possible and can provide a sustainable alternative to other species from the tropical American Pacific countries for increased marine production. In the future, the focus of spotted rose snapper culture will be to increase links with the private sector and international agencies, to increase production at the laboratory level, growth at the farm level and spread low cost biotechnology from Mexico to Ecuador.

Notes

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