



# AQUACULTURE CRSP 22<sup>ND</sup> ANNUAL TECHNICAL REPORT

DEVELOPMENT OF AQUACULTURE TECHNIQUES FOR THE INDIGENOUS SPECIES OF SOUTHERN MEXICO,  
*CENTROPOMUS UNDECIMALIS*: SEX DETERMINATION AND DIFFERENTIATION AND EFFECTS OF TEMPERATURE

*Eleventh Work Plan, Indigenous Species Development Research 3 (11ISDR3)  
Final Report*

Wilfrido M. Contreras-Sánchez, Ulises Hernández-Vidal, Arlette Hernández-Franyutti, Gabriel Márquez-Couturier,  
and Guadalupe Morales Lara  
Laboratorio de Acuicultura  
División Académica de Ciencias Biológicas  
Universidad Juárez Autónoma de Tabasco  
Villahermosa, Tabasco, México

Reynaldo Patiño  
USGS Texas Cooperative Fish and Wildlife Research Unit  
Texas Tech University  
Lubbock, Texas

Kevin Pope  
Department of Range, Wildlife & Fisheries Management  
Texas Tech University  
Lubbock, Texas

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## ABSTRACT

Species of “robalo,” or snook, are an important indigenous food fish in southern Mexico. Overfishing has resulted in diminishing catch volumes of the common snook (*Centropomus undecimalis*). This has led to concerns for the health of the regional fisheries and to calls for improved management practices. An important step in reducing pressure on native populations, while ensuring a reliable food source, would be incorporation of the species into aquaculture systems. An understanding of the reproductive biology of a fish species is necessary in order to begin an aquaculture program, yet little is known regarding these processes in snook. As an important first step, we conducted a workshop on the biology and culture of snook, which brought together specialists from North and Central America and the Caribbean. The workshop was conducted for four days at the División Académica de Ciencias Biológicas, Universidad Juárez Autónoma de Tabasco in Villahermosa, Mexico, and was attended by 51 people from 23 institutions. The workshop covered general snook biology, people’s experiences with the culture of snook, and culminated with a visit to a grow-out farm in Tabasco. Knowledge gained from this workshop will aid us during our next phase of research, which will examine the timing and morphological pattern of gonadal sex differentiation in common snook and also determine the effect of early treatment with low or high water temperature or sex steroids on sex ratios and growth rate.

## INTRODUCTION

Species of “robalo,” or snook, are among the most important indigenous fish species along the Mexican coastline of the Gulf of Mexico. Among the species of snook, the robalo blanco, or common snook (*Centropomus undecimalis*) are caught in relatively greater numbers and enjoy a high market value (Anonymous, 2002). During the last few years, the average annual catch for common snook has been approximately 5,000 tons in Mexico, and 900 tons for the state of Tabasco (Anonymous, 2002). However, there is an overall national trend for

diminishing catch volumes despite occasional and short-lived local increases, a situation that has led to concerns for the health of the regional snook fisheries and to calls for improved management practices (Anonymous, 2002). The natural range of common snook extends from North Carolina to Brazil (Muller et al., 2001), and therefore the status of natural snook populations is also of international concern. In places such as Florida, common snook were until recently considered a “species of special concern,” for which commercial harvest was banned, and strict management regulations are currently in place for its recreational fisheries (Anonymous, 2001).

Knowledge of the reproductive biology of common snook is limited. Histological observations of the gonads of fish collected from the field are consistent with the concept that common snook are protandric hermaphrodites. Namely, they appear to first develop as males and thereafter reverse into females. In Florida, all fish younger than 1-2 years (depending on site of collection) seem to be males, an even sex ratio is observed at 5-7 years, and most fish older than 12-15 years seem to be females (Taylor et al. 2000). Interestingly, the available data (Taylor et al., 2000) also indicates that within the same age class, females are larger than males. This size differential is particularly pronounced in younger fish, 1-2 years old, where the fork length of females is 60-70 percent longer than that of males (Tables 2 and 3 in Taylor et al., 2000). The spawning season for common snook runs from spring through early fall, depending on the geographical location, during which they spawn multiple times (Peters et al., 1998; Taylor et al., 1998). Although it is sometimes assumed that sex reversal in common snook occurs after their first spawning (Muller et al., 2001), there is histological evidence suggesting that males may retain their gender through consecutive spawning seasons (Grier and Taylor, 1998). Additional studies are clearly needed to obtain a better knowledge of the reproductive biology of common snook. Further, most studies of common snook reproduction have focused on Florida populations and research with populations in other geographical locations is necessary to determine the general applicability of the results obtained.

Techniques for aquaculture production of snook are at present not fully developed. Snook broodstock has been difficult to maintain in captivity and thus the few available hatchery-spawning programs have relied on wild-caught fish. Wild-caught broodstock are either immediately processed upon capture to obtain gametes for in vitro fertilization, or they are brought to the hatchery where they are promptly injected with hormones to induce spawning (Anonymous, 2001). Fingerlings for stocking purposes have been successfully produced using this technique.

The development of an aquaculture industry for common snook would benefit the Gulf Coast region of Mexico for various important reasons. It would be consistent with regional plans for the development of aquaculture as a source of income and of food fish. It would also be consistent with the common sense premise that the use of indigenous species for aquaculture has a much lower probability of causing ecological damage compared to exotics such as tilapias or carp. Finally, it would provide relief from the intense fishing pressure currently being exerted on wild snook populations. To accomplish this, we have initiated with a basic step: conducting a workshop on biology and

culture of snooks, bringing together the people that have worked with snooks the most in North and Central America and the Caribbean.

## METHODS AND MATERIALS

Training activities were undertaken at different levels. Graduate student Guadalupe Morales-Lara received hands-on training on histology at the aquaculture laboratory at UJAT. Guadalupe also traveled to Texas Tech University for a three-week training on histology and otolith reading.

In December 2003 Texas Tech University Principal Investigators Reynaldo Patiño and Kevin Pope and UJAT Co Principal Investigators initiated the planning of the first workshop on snook biology and culture to take place in Mexico. The idea was to invite researchers from the USA, Mexico, and the Caribbean that had research experience with snooks. The invited speakers were: Harry Grier, Ron Taylor and Mike Tringali (Florida Marine Research Institute, USA); John Tucker (Harbor Branch Oceanographic Institute, USA); Luis S. Alvarez-Lajonchere (Centro de Investigación en Alimentación y Desarrollo, Mexico); and Adolfo Sánchez (Instituto de Ciencias del Mar y Limnología; Mexico). Principal Investigators Reynaldo Patiño (Texas Cooperative Fish and Wildlife Research Unit, USA), Kevin Pope (Department of Range, Wildlife & Fisheries Management, USA), and Wilfrido M. Contreras-Sánchez (División Académica de Ciencias Biológicas, Mexico) were also included.

The workshop was advertised using a national aquaculture network and pamphlets were distributed among producers, researchers, NGO's, and extension agencies.

## RESULTS

The following program was elaborated based on a consensus with the speakers.

### Day 1 (27 April)

#### General Snook Biology

- Natural history of the common snook in Florida
- Endocrine control of reproduction in fishes
- Snook reproduction
- Ovarian follicle formation in snooks
- Early development of the common snook
- Habitat preferences
- Studies on Molecular biology of snooks
- Snook juvenile harvest for commercial use: a fisheries perspective

### Day 2 (28 April)

#### Snook Culture

- Scale economies for the production of juvenile common snooks
- Potential for the culture of snooks and strategies for its development
- Spawning induction in common snook
- Larval culture
- Disease control
- Feeds for snooks
- Natural sex reversal in fishes; hermaphroditism in snooks

### Day 3 (29 April)

#### Snook Culture Experiences

- Monitoring freed snooks in Central Florida
- Fisheries dynamics of the common snook in Florida
- Experiences on snook culture in Cuba
- Experiences on snook culture in Texas
- Experiences on snook culture in Mexico

### Day 4 (30 April)

#### Visit to Snook Grow-Out Farms in Tabasco

Fifty-one people from 23 institutions attended the workshop. On day one, Wilfrido Contreras explained the dynamics of the workshop. First speaker Ron Taylor described the natural history of the common snook in Florida, commenting on the importance of this species' fishery in Florida's Pacific coast and Gulf of Mexico. Reynaldo Patiño continued with a detailed explanation of the endocrine control of fish reproduction emphasizing on the principal stages at which maturation can be monitored for spawning induction. Ron Taylor gave his second speech on common snook reproduction in Florida, detailing spawning ground characteristics and habitat conditions, spawning temporality, and estimations of sex ratios. Harry Grier gave a speech on ovarian follicle formation in common snook; his detailed explanation of follicle stages and phases using light and electron microscopy provided valuable information regarding snook maturation at the structural level. Ron Taylor gave talks on early development and habitat preferences of common snook. He speculated that a major predator of juvenile snooks are adult organisms of the same species, since they both use the same feeding grounds. Mike Tringali talked about molecular studies of snook species, mentioning differences between them and highlighting the need of more studies on snook genetics. Kevin Pope closed the day with a talk on juvenile harvest for commercial use. Using a fisheries model, he explained potential trends in the populations if wild juveniles are caught for aquacultural purposes.

On day two, Luis S. Alvarez-Lajonchere started with a talk on scale economies for the production of juvenile common snooks, he showed trends on economics based

on a sports fishery. Luis S. Alvarez-Lajonchere also gave a speech on the potential for the culture of snooks and strategies for its development, he presented reasons why snooks have a great potential in aquaculture using his experiences in Brazil as an example. Harry Grier and Ron Taylor shared a talk on spawning induction of snooks several key steps were visited including tank size, hormonal stimuli and environmental conditions. John Tucker reviewed larval culture, disease episodes, and control and feeds for snooks. His expertise on Florida snook culture and the cost of fry production for supporting wild populations was very valuable to the meeting. His main concern regarding snook culture is cost of fry production due to difficulties with feeds at the larval stage. The final talk of this day was provided by Wilfrido Contreras, who spoke on the mechanisms of natural sex inversion and hermaphroditism on snooks. Wilfrido emphasized on UJAT's induced sex inversion projects with native species, including a project on snook feminization.

Day three was used to talk about experiences on snook culture in different countries. Ron Taylor spoke about the monitoring program in Central Florida and the status of the fisheries and trends. John Tucker commented on their efforts to reproduce common snook in Florida and difficulties posed by very high mortalities and high cost per larvae. Luis S. Alvarez-Lajonchere gave a detailed talk on snook potential for aquaculture and the difficulties that Brazil had when starting the snook project. Reynaldo Patiño and Kevin Pope mentioned that little work with snook has been conducted in Texas despite the relevance of the snook fisheries. This session was closed with Alfonso Sanchez, who reported on efforts in Campeche to reproduce common snook. He also mentioned how difficult it is to keep a few hundred fish alive and major constraints due to a lack of adequate facilities.

At the end of the workshop a closing session was organized, every speaker had five minutes to talk about present and future of snook culture. There were several topics were all speakers agreed: 1) the importance of workshops like this to share experiences about a single species; 2) more research is needed to support snook culture; 3) snooks have great potential for aquaculture and although spawning may not be a constraint, larval grow-out remain a major obstacle ("green water" systems may be the answer to live food production for larval grow-out); and 4) a snook research network should be created to keep this group communicating.

Day four was used for a field trip. All participants and speakers visited two places in Tabasco where snooks are used for grow-out. First we went to Ejido Unión in the municipality of Comalcalco. This group has been capturing juvenile snooks from the mangroves and grow them up in earthen ponds. They have had good

results, but they claim that the government is forcing them to stop the capture of wild juvenile snooks. This group captures other species of fish to feed the snooks (small cichlids, poecilids, small catfish). Juveniles are caught during the summer and stocked in ponds at a density of 1,000 fish per pond. Snooks are grown for about 17 months. There are six ponds with an average size of 5,000 m<sup>2</sup>. The second place visited was "Isla Rebeca" located in the coastal municipality of Paraiso. This group has one enclosure where they place juvenile snooks. Small fish enter the enclosure through the one-inch net these fish are eaten by the snooks and no extra food is needed in this system. The number of fish used varies. At the time of the visit they had only 12 adult fish. Three fish were captured with a seine net. One of them appeared to be a female and was anesthetized and Dr. Grier gave an explanation on techniques to extract oocytes for maturity checking. However, the sampled fish was not mature, and eggs were not sampled.

### DISCUSSION

This workshop brought together specialists with the most expertise on snook biology and culture in America and the Caribbean. The expectations for a near future development of a seed production unit are high and several people are willing to dedicate time to shorten the time to support snook aquaculture by conducting research on the topics needed. The main constraint to develop snook aquaculture is larval grow-out – a step that lasts only 30 days. A very enthusiastic group wants to build a network of researchers that work on snook biology and culture.

### ANTICIPATED BENEFITS

Fifty-one researchers, students, farmers, and extension agents have participated in the first workshop on snook biology and culture. They all agree that snooks have great potential to be incorporated in aquaculture. The level of the meeting produced a very enthusiastic

response, and people are committed to support research and networking for a better understanding of snooks.

### REGIONAL INTEGRATION

Six U.S. researchers, people from ten states of Mexico, one British, two Cubans and one Honduran individual who participated in this workshop represent an excellent example of regional integration. This group is committed to continue communicating to ensure the development of techniques for snook aquaculture.

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