

# Sustainable Cobia Culture and Fisheries



*Rachycentron canadum*

Research and Development Strategy for  
Sustainable Cobia Culture and Fisheries

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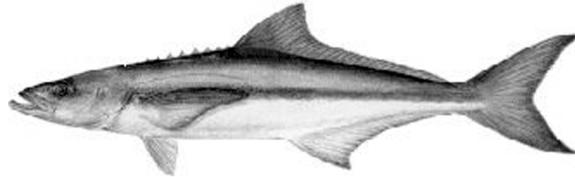
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# Sustainable Cobia Culture and Fisheries

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This document is the result of a summit on research, outreach and policy needs which can lead to the successful culture of cobia and possible enhancement of cobia stocks in the United States.

The summit convened in September 2000 in Biloxi, Mississippi.

The final manuscript and assignment of priorities were developed through consensus of the summit attendees.





## Executive Summary

Interest in the culture of cobia has grown substantially in the past five years as researchers have gained some familiarity with captive fish and begun to recognize this fish's rapid growth and adaptability to confinement. Researchers in several states have investigated a variety of aspects of cobia biology, population structure, seasonal distribution, etc., and the knowledge gained in such studies is providing the foundation upon which preliminary attempts at culturing this fish are based. An exhaustive literature search concerning cobia has been compiled (*Franks, J., unpublished*) and is providing background information for many of the studies that are under way or planned.

With access to both mature males and females, initial successes in spawning and rearing cobia to market-sized fish are nearing completion, but the techniques applied have not been adequately tested to demonstrate commercial feasibility. Methods for capturing and transporting mature wild broodstock have been developed and put into practice, and cobia are being maintained in captivity through the winter of 2001 for attempted spawning in the ensuing summer. If successful, the induced spawning of captive broodstock will alleviate pressure for capturing mature adults from wild stocks.

The capability to produce fingerling cobia leads almost immediately to considerations of grow-out systems and the optimal procedures for producing fish for human consumption or for stock

enhancement. Tests are currently under way in the Gulf of Mexico to determine the physical performance of an offshore cage structure that is being considered as the site for an initial test of cobia grow-out techniques.

### Research and Outreach Issues and Priorities

Representatives of academic institutions, private enterprise and the federal government identified and prioritized a series of issues that relate to enabling commercialization of cobia culture. The issues fall under five categories –

- ✓ Reproductive, hatchery and grow-out technology
- ✓ Environmental compatibility
- ✓ Economic feasibility and marketing
- ✓ Policy and regulation
- ✓ Technology transfer, outreach and education.

Within each category, priority actions are recommended in this report with the intention that the most immediate research and outreach activity concerning cobia culture will relate directly to these action items –

### Reproductive, hatchery and grow-out technology:

*#1. Define requirements for broodstock management and the reliable production of high quality eggs and sperm, as well as the resulting larvae.*

*#2. Identify the developmental, nutritional and environmental needs and tolerances of larvae.*

*#3. Improve disease diagnosis and prevention from the*

Cover photo:  
Sally Mills, Virginia Institute of Marine Science  
Cobia illustration: Diane Rome Peebles, from Fishing Lines,  
a Department of Environmental Protection publication



larvae to fingerling stages of development.

#4. Identify commercial-scale performance characteristics of cobia under various grow-out conditions.

### Environmental compatibility:

#1. Characterize and quantify waste streams from different types of grow-out facilities and develop waste management strategies.

#2. Characterize the genetic profiles of captive cobia broodstock, the resulting fingerlings and the wild stock.

#3. Determine water quality and salinity tolerances of cobia.

### Economic feasibility and marketing:

#1. Conduct basic economic feasibility studies that evaluate risk/return ratios and produce risk/return models for various types and stages of cobia culture programs.

#2. Evaluate technologies to meet identified demand.

### Policy and regulation:

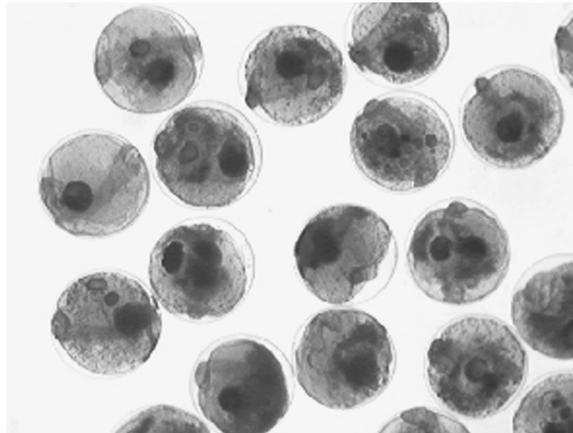
#1. Identify and compare existing legal and regulatory frameworks for cobia culture and stock enhancement programs in the United States.

#2. Identify locations in the United States and other countries where aquaculture is practiced in sustainable and environmentally sound ways and analyze the regulatory regimes that have made this possible.

### Outreach and education:

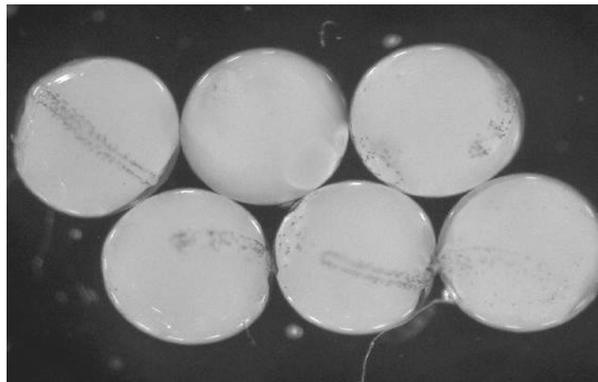
#1. Establish a cobia aquaculture technology transfer and demonstration program, identify research needs and open the door to additional investment and activity in the cobia culture industry.

Further discussion regarding each category and the priority actions is presented in the report.



Dr. John Olney, Sr. photo

Two microscopic views of cobia eggs.



Patrick Kilduff photo

# Introduction

## Workshop Purpose and Goal

This document is the result of a summit on research, outreach and policy needs concerning the successful culture of cobia (*Rachycentron canadum*) in the United States. The summit was held September 19-20, 2000, in Biloxi, Miss. The purposes of this workshop were:

- 1) to determine the current status of the technology for cobia culture;
- 2) to bring together all persons with an interest in cobia culture so that a dialogue could be focused on the issues and problems that need to be addressed before cobia culture can become commercially feasible; and
- 3) to develop a research and outreach plan that provides the rationale for developing projects in support of the overall goal of this strategy which is to build a sustainable and economical cobia culture industry in the United States.

This document resulted from the input, discussion and interaction of 23 participants with varying degrees of “cobia experience”, or interest in the culture of this fish, as presented in the Summit Attendees. It is important to note that attendees included researchers from Texas, Mississippi, Alabama, South Carolina, and Virginia, as well as private industry representatives from South Carolina and Florida. The National Office of Sea Grant, NOAA, provided the perspective of a federal agency.

## Problems and Potentials

Cobia are found worldwide in tropical and subtropical ocean and estuarine waters. In the U.S., cobia are primarily targeted by recreational fishermen, and the annual catch is estimated at about 2 million pounds. In the Gulf of Mexico, there appears to be some segregation of the sexes (i.e. males are more prevalent west of the Mississippi River), but males and females occur together in mid-Atlantic waters near and in the

Chesapeake Bay. Cobia may range over considerable distances during a given year, but the extent of stock mixing and resulting reproduction and stock dynamics are not well known.

Cobia have good consumer appeal – the meat is white and mild tasting – and on occasions when it does appear in market along the Gulf of Mexico the price is approximately \$4.00 U.S. per pound. Recreational fishermen frequently target cobia, and such sport fishing generates considerable economic activity for equipment, boat rentals, food, fuel, etc.

Scientists have developed a basic understanding of cobia life history, but aspects of larval and juvenile ecology are unknown. Initial attempts to culture this fish have achieved some success, but many aspects of nutrition, disease, behavior, grow-out and system management remain to be determined. This first attempt at a strategy for developing the technology to culture cobia is intended as a blueprint for addressing these questions so that commercial culture of cobia can become a reality. If this occurs, the resulting fish may be destined for either the market place or for release to enhance the wild stock.

## Current State of Knowledge and Research

An extensive literature search (*Franks, J. unpublished*) is the basis upon which current studies of cobia culture are being built. Studies of wild fish have shown that growth is rapid during the first two to three years; individuals up to 10 years old have been caught by fishery biologists. Males mature at an earlier age and smaller size than do the females, and running ripe males have been captured in all months; however, the spawning season appears to occur primarily from April through November, with more northerly occurring fish spawning mainly during mid-summer months.

In the Gulf of Mexico, males are more common than females west of the Mississippi River, while the reverse is found east of the river plume. Mature males are difficult to locate east of the Mississippi, but are relatively easy to locate west of the river. However, in the mid-Atlantic region, mature fish of both sexes can be captured, and initial indoor spawning attempts have taken advantage of this.

Past attempts to maintain cobia in captivity and recent efforts to hold wild-caught males and females for spawning in tanks have confirmed that these fish adapt readily to being enclosed and to being fed prepared diets.

During June, 2000, wild-caught mature males and females were induced to spawn in indoor tanks, and the resulting larvae were raised through to fingerling size using methods and feeds designed for other species. The surviving fish are being fed commercial feeds intended for other species, and the growth rate during just 6 months has been very impressive. The investigators anticipate having eight-pound fish within 12 months of culture.

With this initial successful spawning and rearing, researchers are now beginning to consider the many questions that must be answered before commercial culture of this fish can become economically feasible and whether or not stock enhancement could be reasonable.

## Purpose and Nature of this Strategy

Though scientists have some knowledge about cobia ecology and life history, culture systems and stock enhancement, a great deal is not known. This strategy identifies actions needed in research, policy and education to advance the development of sustainable cobia culture in the U.S.

At the present time, the National Sea Grant College Program is the primary federal or state funding source supporting cobia culture research. Other potential funding sources include Saltonstall-Kennedy Grants, the U.S. Department of Agriculture, the National Marine Fisheries Service, the Small Business Innovative Research

Program, and state departments of natural resources. Private enterprise interest in cobia is in its infancy, and the prospect of offshore cage culture or intensive indoor recirculating system culture of cobia seems likely to generate investment in the coming decade.

**T**his strategy provides an agenda for focused, integrated public and private investment in research, facility development and education to establish viable cobia aquaculture systems and, potentially, improve the condition of existing fisheries. To accomplish this, the strategy contains priority actions in five key areas:

- ✓ Reproductive, hatchery and grow-out technology development
- ✓ Environmental compatibility
- ✓ Economic feasibility and marketing
- ✓ Policy development and regulation
- ✓ Outreach and education.

In addition to these areas, two underlying principles run through this document and relate to how the strategy should be implemented.

### *Principle #1:*

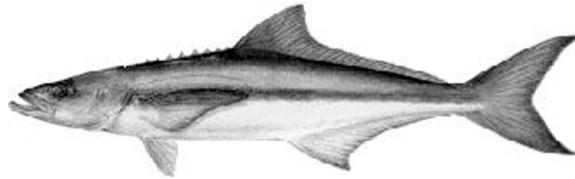
Strong partnerships of many kinds must be formed to achieve sustainable cobia culture operations and fisheries in the U.S. Research and technology transfer partnerships must be formed with other countries, especially in Asia, where cobia culture activity is more advanced than the U.S. Partnerships must be forged between researchers, policy makers and key interest groups to expedite development of responsible public policies, reasonable time frames and procedures for permitting. Researchers should collaborate with economists so data are collected in ways that will facilitate analysis of costs, benefits and economic feasibility. Public-private partnerships of all kinds will be needed to finance research and facilitate culture systems development and management.

### *Principle #2:*

Research, policy development and real world applications must be integrated from the outset.

For effective strategy implementation, it is crucial to advance all priority action areas simultaneously. It is not wise to wait until all questions are answered before moving forward nor to release young cobia into existing waters before potential impacts are better understood and appropriate policies and regulations are in place to protect the

public interest. Real world questions must drive research to improve the quality of public and private decisions and investments. Greater knowledge will make possible reducing risks and attracting more investment into building sustainable cobia culture operations and fisheries.



## Research and Outreach Needs and Priorities

### Reproductive, Hatchery and Grow-out Technology

The capacity to produce a large and dependable supply of cobia fingerlings at an affordable price is essential to establishing and maintaining sustainable cobia aquaculture operations in the U.S. In recent years, progress has been made in the ability to spawn captive fish, but production of large quantities of fry and fingerlings, and initial commercialization of this process is not yet a reality. Much research is needed to develop reliable spawning, hatching and rearing techniques so that fingerling production becomes reliable and subsequent methods for grow-out to market size can be developed.

#### Research Needs:

Key areas needing study to advance the knowledge of cobia spawning and development and to achieve consistent and reliable production of fry include:

- ✓ cobia reproductive physiology
- ✓ broodstock domestication
- ✓ nutritional and dietary requirements
- ✓ disease control in hatcheries.

To make advances in delivering cobia fingerlings on demand to grow-out facilities or stock enhancement programs, research is needed on:

- ✓ larval and juvenile feeding and nutrition requirements
- ✓ optimal culture system conditions
- ✓ disease diagnosis and control.

In addition to improving scientific understanding of the conditions that produce large, healthy and dependable crops of fingerlings, efforts directed at culture and stock enhancement will likely be different, depending on whether the goal is to produce fish that can thrive under captive conditions or in the wild without disturbing the natural balance of the habitat.

#### Priority Actions:

*#1. Define requirements for the reliable production of high quality broodstock, gametes and the resulting larvae.*

Establish broodstock husbandry practices that lead to consistently high fertilization rates, hatch percentage and survival rates through first feeding. Give priority to defining environmental

cues (photoperiod, temperature, salinity, etc.) responsible for egg maturation. Equally important is defining nutritional factors in broodstock diets that lead to consistency in egg viability and larval survival. Hormone implants may be required to reliably induce ovulation so that broodstock spawning becomes volitional.

*#2. Identify the developmental, nutritional and environmental needs and tolerances of larvae.*

For reliable production of healthy larvae, determine optimal rearing conditions. Ascertain nutritional requirements of each developmental stage with the goal of formulating feeds to partially replace live feed in larval diets. Delimit specific fatty acid requirements for each developmental stage.

*#3. Improve disease diagnosis and prevention from the larvae to fingerling stages of development.*

Determine causes of larval mortality – including bacterial, viral and nutritional factors – and develop corrective techniques. Develop disease diagnostic techniques that are rapid and reliable.

*#4. Identify commercial-scale performance characteristics of cobia under a variety of grow-out conditions.*

Define optimum and tolerance limits of salinity, temperature and stocking densities and investigate nutritional requirements. Once these have been established in laboratory conditions, investigate the growth, survival and feed conversion of cobia raised in tanks, ponds and offshore cages.

## Environmental Compatibility

It is essential that aquaculture production systems, including those for cobia, be developed to be sustainable and environmentally compatible. Waste materials must not degrade receiving waters, aesthetic considerations should be included in facility design and location, and the genetic structure of natural stocks must not be compromised.

### Research Needs:

Information is lacking on the types and

quantities of wastes produced from cobia culture hatcheries or grow-out facilities. If fish are destined for release as stock enhancements, the genetic structure of the released fish should not have the potential to negatively impact the genetic structure of the wild stock.

### Priority Actions:

*#1. Characterize and quantify waste streams from different types of grow-out facilities and develop waste management strategies.*

Generate information on suspended, settleable and dissolved solids levels; TAN, nitrite, nitrate and biochemical oxygen demand (BOD); and discharge volumes in commercial-scale versions of fingerling and food fish grow-out facilities. While initial design criteria and facility evaluation for permit purposes will likely be based upon data from existing culture operations for other species and locations, the emerging cobia culture industry will need its own waste management techniques so that permitting requirements can be met. In many cases, existing waste management methods will be relevant, and only technology transfer will be necessary.

*#2. Characterize the genetic profiles of captive cobia broodstock, the resulting fingerlings and the wild stock.*

Determine genetic diversity of the wild stock and compare it to cultured stock before release so that the potential for risk (i.e. negative impact on wild stock genetic diversity) can be evaluated. Substocks differing genetically are most vulnerable to genetic change, so genetic characterization must be done over the species' range.

## Economic Feasibility and Marketing

Due to expected increased fishing pressure on wild stocks, and increasing demand for cobia in the market place as the human population grows, wild cobia stocks cannot be counted on to meet demands at reasonable prices. The purpose of building a sustainable aquaculture sector is to increase the supply of cobia to the consumer and, through enhancement, provide additional harvest

opportunities for commercial and recreational fisheries. Success of farm-raised seafood products demonstrates consumer acceptance of cultured fish in this country. Part of any strategy to enhance availability of cobia must be a systematic analysis of market characteristics, demand/price variables and ways to achieve optimum combinations of these.

### Research Needs:

To understand and evaluate the market for cultured cobia, research should be undertaken on:

- ✓ the nature of the market for cultured and wild-caught cobia, including quality/market interactions and demand/price interactions
- ✓ husbandry techniques that produce the highest quality products
- ✓ effects of environmental conditions on product quality and value
- ✓ nutritional and other factors that produce quality differences between wild and cultured cobia
- ✓ the economic feasibility of different cobia production and enhancement systems that incorporate risk and uncertainty measures.

A clearer understanding of the levels of risk involved in different types and stages of aquaculture production and how these match up with potential returns to investors is needed. With regard to culture systems, the private sector will make the up-front investments to establish the industry. Private investors, venture capital groups and banks are reluctant to make investments in an industry with little or no track record and no risk/return research available. Under current conditions, the public sector will take the investment and risk in stock enhancement. Environmental impact concerns will garner much of the public attention related to stock enhancement, but rigorous economic cost benefit analysis should be part of any policy decisions regarding stocking as well. Desires for maintaining the economic viability of the harvest of wild cobia

should be balanced with careful scrutiny of the likely economic costs and benefits of stocking programs.

### Priority Actions:

*#1. Conduct basic economic feasibility studies that evaluate risk/return ratios and produce risk/return models for various types and stages of cobia culture programs.*

Determine potential risks and returns for cobia culture systems. Include various stages of culture from hatchery to grow-out. Factor the cost of waste disposal and/or minimization into production costs. Stock enhancement risk/return ratios must take into account potential costs and benefits, environmental impacts, interference with wild stocks, impacts of forage species and public policy. Economic feasibility can be estimated best by developing risk/return models for cobia culture operations and sustainable fisheries.

*#2. Evaluate technologies to meet identified market demand.*

The technology, aquaculture systems and husbandry practices for producing cobia to meet the identified requirements for the consumer market and/or enhancement programs should be evaluated to determine the most economically viable use of financial and natural resources. Consumer acceptance depends on type and quality of products, which research can identify. Market assessments will depend upon the market's basic underpinnings and size, versus the potential for production.

## Policy and Regulation

Aquaculture is still in the early stages of development in this country and lacks the policy and regulatory framework needed by entrepreneurs to plan and by the public to feel their concerns are addressed. Rules are highly variable among states and localities. When an aquaculturist seeks the federal, state or local approvals needed to site a new facility, it may be

the first time that locality or agency has had to review such a project. Lack of precedents and general concern about potential impacts lead to lengthy delays to obtain permits, which in turn place a heavy burden on fledgling enterprises.

Cobia stock enhancement programs could lead to an even more complex set of public policy and regulatory concerns. Our current state of knowledge does not allow us to say with any degree of certainty what the impacts of stock enhancement programs will be on receiving waters or what the implications of stocking are for the genetic diversity of the species, or to answer a host of other complex ecological questions. A systematic examination of these and related questions is needed to explore the advisability of stock enhancement.

### Research and Outreach Needs:

Research and outreach should advance understanding of the federal, state and local policy and regulatory frameworks that govern fish culture and stock enhancement activities, including cobia farming. Research is needed on the extent to which aquaculture has been addressed in local comprehensive plans and zoning ordinances, the number and types of state permits required, whether criteria exist for issuing permits, and the potential for one-stop permitting for aquaculture facilities. Regulators should identify the different types of facilities that require permits – hatcheries, recirculating systems, ponds, cages – and the issues to address for each. With stock enhancement programs, a variety of federal and state laws govern what can and cannot be released into public waters, and new policies and regulations should be developed if research suggests stock enhancement is a viable way to improve cobia fisheries.

In addition to the issues involved in siting facilities in particular communities, a number of policy or regulatory issues cross state lines. Interstate commerce rules will apply to transporting cobia at different stages of development across state lines. Ability to verify the health of stock and its genetic composition will

be important. With stock enhancement programs, it will be essential to address such issues as common property and competing uses in public waters. Other legal issues include water quality implications, water withdrawal and discharges, stocking outside a natural habitat, water use planning and zoning, and state versus local decision making. Many of these issues are not unique to cobia culture and stock enhancement, but they could pose substantial barriers to the emergence of cobia farming as a business enterprise.

### Priority Actions:

*#1. Identify and compare existing legal and regulatory frameworks for cobia culture and stock enhancement programs in the U.S.*

The National Research Council has identified the regulatory environment as one of the major reasons for aquaculture's limited growth in the U.S. Comparative state-by-state analyses of the current regulatory framework for aquaculture show that regulatory programs vary greatly. Until now, no specific state-by-state comparisons for fish culture operations and stock enhancement programs have been conducted. Such an analysis will provide state and local decision-makers with information on the institutional feasibility of siting and operating such culture and stock enhancement programs and will identify state where changes in regulatory frameworks are needed beforehand. Additionally, the inability to distinguish between wild and hatchery animals necessitates policies and management strategies that would treat both types as one stock.

*#2. Identify locations in the U.S. and other countries where aquaculture is practiced in sustainable and environmentally sound ways and analyze the regulatory regimes that have made this possible.*

The U.S. has no overarching regulatory framework for aquaculture, and laws and policies vary widely from state to state. However, a number of places in the U.S. and other countries have established sustainable aquaculture operations. An analysis of the regulatory frameworks under which these operations were

sited and permitted can provide models for establishing similar frameworks elsewhere, estimating the economic costs and benefits of the regulatory practices in different regions and suggesting how regulatory and policy-making institutions can be changed to maximize net benefits to society or at least minimize regulatory inefficiencies.

## Outreach and Education

In the U.S., decision makers, the business community and the general public lack knowledge about cobia aquaculture and stock enhancement issues and opportunities. Taiwan is establishing a sizable cobia culture industry, but the U.S. needs education and outreach initiatives to realize the potential of this industry.

### Outreach Needs:

It is important to reach out to state and local decision makers, potential entrepreneurs and the public to communicate what is known about cobia aquaculture and stocking, the status of the technology, the legitimate concerns and how to address them. A two-way dialogue can identify and address the questions and concerns of policy makers and the general public.

Additionally, more technical assistance, technology transfer and outreach to all parts of the cobia aquaculture industry will be needed. Research findings regarding the cobia production process should be passed along to enable culturists to produce the highest quality product at the most affordable price. Bankers and other members of the capital market should be educated about the real risks and potential gains of cobia culture. As with decision makers and the public, this educational process should work both ways, with culturists, financiers and others crucial to the development of a successful industry communicating their specific questions and concerns to the research community.

Forming partnerships with other countries actively involved in cobia culture and stock enhancement to exchange information and learn

from one another should receive more attention. It is important to reach out to environmental and other interest groups that have concerns about the impacts of intensive farming and about the ecological impacts of stock enhancement. The research, legal, technological, policy and environmental issues raised by intensive aquaculture and stocking programs can be addressed only with open and candid exchange among all parties.

### Priority Action:

*#1. Establish a cobia aquaculture demonstration program, identify research needs and open the door to additional investment and activity in the cobia culture industry.*

A cobia aquaculture demonstration program can serve as the principle means of transferring research findings to the public and private sectors. An integrated program, with demonstration facilities at a number of different sites, should be established to convey information on permitting processes, system design and maintenance, production scale, waste management, spawning techniques, and larval rearing and grow-out procedures. This program, through its various activities and sites, can in turn provide feedback on additional research needs as identified by the aquaculture industry, the regulatory community and others participating in the program.

## Literature Cited

Franks, J. 2000. Bibliography of scientific information on cobia, *Rachycentron canadum*. University of Southern Mississippi. Unpublished. 9 pp.

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# Cobia Culture Research and Development Planning Workshop

Isle of Capri Casino Resort, Biloxi, Mississippi, 19-20 September 2000

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## Day 1 (Sept 19)

**0830**

Welcoming Remarks - Jim Franks

Dr. Jay Grimes, Dean, Institute of Marine Sciences, University of Southern Mississippi

Introductions and Workshop Purpose - Bill Rickards and Barry Costa-Pierce

### **Cobia Research Updates**

John Olney (VIMS) - biological studies in Chesapeake Bay

Jim Franks (USM) - biological studies in Gulf of Mexico

Nancy Brown-Peterson (USM) - reproductive biology

John Ogle (USM) - capture, transport and holding

Mike Oesterling (VIMS) - capture, holding and spawning

Patrick Kilduff (VIMS) - larval rearing during 2000

Barry Costa-Pierce (MS/AL-SG) - offshore cage facility

Status of cobia production in Taiwan - Jesse Chappell (Southland Fisheries)

### **Lunch**

Research and outreach needs for cobia culture in U.S.

- facilitated session: Claire Dugger

Tour of USM Institute of Marine Sciences' Aquaculture Facility - John Ogle

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## Day 2 (Sept 20)

**0830**

Conclude facilitated session - finalize the outline for a plan of research and extension related to culturing cobia for food production or stock enhancement (C.Dugger)

### **Lunch**

Wrap-up session - Bill Rickards and Barry Costa-Pierce

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