BOOK OF ABSTRACTS

52nd Gulf and Caribbean Fisheries Institute

Key West, Florida USA

1 November 1999 - 5 November 1999

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UNIVERSITY OF FLORIDA SEA GRANT COLLEGE PROGRAM

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Tentative Program for the 52nd GCFI Conference
November 1 - 5, 1999
Holiday Inn Beachside Key West, Florida USA

MONDAY- NOVEMBER 1, 1999

0840 - 1000 WELCOME ADDRESS - PLENARY SESSION

1000 - 1020 Break

1020 - 1800 DEMERSAL FISHERIES

1020 - 1040 Habitat Use and Movements of Groupers and Grunts in Virgin Islands National Park, St. John, US Virgin Islands - Jim Beets

1040 - 1100 Preliminary Results of the Reproductive Biology of the Black Grouper, *Mycteroperca bonaci*, from the Southern Gulf of Mexico - Renan, X. *et al.*

1100 - 1120 Biology of The Tiger Grouper, *Mycteroperca tigris*, (Pisces: Serranidae) in The Southwest Zone of Cuban The Shelf. Feeding Habits, Age And Growth - Garcia-Arteaga, J.P. *et al.*

1120 - 1140 Portrait of the Commercial Fishery of the Red Hind, *Epinephelus guttatus*, in Puerto Rico During 1992-1998 - D. Matos-Caraballo

1140 - 1200 Tag and Recapture Study of Red Hind and Coney at Three Spawning Aggregations Sites off the West Coast of Puerto Rico - Rosario- Jimenez, A. and M. Figueroia-Fernandez

1200 - 1220 Evaluación de la Pesquería Demersal de Media Altura del Oriente de Venezuela, Período 1981-1997 - Lárez, A y J. Mendoza

1220 - 1240 Species Composition, Abundance and Catch Rates of Fish Caught on the Formigas Bank, Jamaica - S. Grant

1240 - 1400 Lunch

1400 - 1420 Preliminary Results from a Continuing Study of Spawning and Fecundity of the Red Snapper (Lutjanidae: *Lutjanus campechanus*) from the Gulf of Mexico, 1998 - 1990 - Collins, L.A. *et al.*

1420 - 1440 Age Validation of Red Snapper, *Lutjanus campechanus*, and Red Drum, *Sciaenops ocellatus*, from the Northern Gulf of Mexico Using 210Po/226Ra Disequilibria in Otoliths - M.S. Baker *et al.*

1440 - 1500 Age Estimates from Annuli in Otoliths of Red Snapper, *Lutjanus campechanus*, from the Northern Gulf of Mexico - C. Wilson *et al.*

1500 - 1520 Discriminating Age-0 Red Snapper, *Lutjanus campechanus*, Nursery Areas in the Northern Gulf of Mexico using Otolith Microchemistry - Patterson, W.F. *et al.*

1520 - 1540 Growth and Reproductive Biology of Red Snapper (*Lutjanus campechanus*) East and West of the Mississippi River: Preliminary Data Testing the Single Unit Stock Hypothesis - Woods, M.K. and J.H. Cowan Jr.

1540 - 1600 Aspects of Reproduction, Age and Growth of the Lane Snapper, *Lutjanus synagris* (Linnaeus), 1785 in Jamaican Coastal Waters - K. Aiken

1600 - 1620 Break

1620 - 1640 Diferenciación Sexual e Inicio de la Madurez de la Cachicata Blanca, *Haemulon Plumieri* (Pisces: Haemulidae), en la Parguera, Puerto Rico - Mateo, J.G. and R. Appeldoorn

1640 - 1700 Feeding Ecology of Deep Reef Fishes in the Northeastern Gulf of Mexico - Weaver, D.C. and K.J. Sulak

1700 - 1720 Methods and Lessons Learnt in the Application of Ultrasonic Telemetry to Coral Reef Fish Movement Studies - Eristhee, N. *et al.*

1720 - 1740 Aspectos Ecológicos de la Sardina, *Sardinella aurita*, en la Plataforma Oriental Venezolana, Determinados a Partir de Prospecciones Acústicas - Cárdenas, J.J. Y A. Achury

1740 - 1800 The Life History of Southern Flounder, *Paralichthys lethostigma*, in Louisiana Waters - Fischer, A. and B.A. Thompson

TUESDAY - NOVEMBER 2, 1999

0815 - 1700 HACCP WORKSHOP - Atlantic Room

0800 - 1520 INVERTEBRATE FISHERIES

0800 - 0820 Assessment and Management of Queen Conch, *Strombus gigas*, Fisheries in the Bahamas - Ehrhardt, N. *et al.*

0820 - 0840 Growth of Queen Conch, *Strombus gigas*, on Coral Reefs in Yucatan, Mexico - Perez -Perez, M. and D. Aldana-Aranda

0840 - 0900 Distribution and Seasonality of Reproduction of the Queen Conch, *Strombus gigas*, on Coral Reefs in Yucatan, Mexico - Perez-Perez, M. and D. Aldana-Aranda

0900 - 0920 Distribution and Abundance of *Strombus gigas* Veligers at Chinchorro Bank, Quintana Roo, Mexico - Navarrete, A.

0920 - 0940 Preliminary Observation of Reproductive Failure in Nearshore Queen Conch in the Florida Keys - McCarthy, K. *et al.*

0940 - 1000 Determinacion Electroforetica del Perfil Proteico del Caracol Rosado, *Strombus gigas*, en el Caribe Mexicano. - Cetina J. and L. Rodriguez-Gil

1000 - 1020 Break

1020 - 1040 On the Assessment and Management of the Spiny Lobster, *Panulirus argus*, Fisheries in the Bahamas - Ehrhardt, N.M. and V. Deleveaux

1040 - 1100 A Comparative Analysis of Regional Spiny Lobster, *Panulirus argus*, Abundance Dynamics: Are There Common Sources? - Ehrhardt, N.

1100 - 1120 Overview of the Spiny Lobster, *Panulirus argus*, Commercial Fishery in Puerto Rico During 1992-98 - Matos-Caraballo, D.

1120 - 1140 Reproduction of the Spiny Lobster, *Panulirus argus*, in St. Lucian Waters - Joseph, W. and M.O. Haughton

1140 - 1200 Preliminary Results from an Experimental Trap Fishery for the Spotted Spiny Lobster, *Panulirus guttatus*, in Bermuda - Luckhurst, B.

1200 - 1220 Pesca de Langosta (*Panulirus argus*) y Lambí O Caracol Rosado (*Strombus gigas*) en dos Areas Marinas Protegidas del Caribe: Parque Nacional Jaragua (República Dominicana) y la Reserva de la Biosfera Banco Chinchorro (México) - Reveles, B. *et al.*

1220 - 1320 Lunch

1320 - 1340 Assessment of the Functional Effects of a Harvest Refuge on Spiny Lobster and Queen Conch Populations at Glover's Reef, Belize - Acosta, C.A.

1340 - 1400 Trends in Catch, Effort and CPUE of the Demersal Shrimp Fishery of Guyana for the Period 1981-1997 - Shepherd, D.

1400 - 1420 An Examination of Brown Shrimp (*Farfantepenaeus aztecus*) Recruitment in Southern Louisiana, USA - Haas, H. *et al.*

1420 - 1440 Variables Ambientales Como Factores Importantes de la Distribución y Abundancia de la Fase Juvenil del Camarón Blanco (*Litopenaeus setiferus*) en la Laguna de Términos, Sur del Golfo de México - Ramos-Miranda, J. *et al.*

1440 - 1500 Calamares, Pesquería Potencial de la Plataforma Continental de Yucatan? - Solis-Ramirez, M.J. *et al.*

1500 - 1520 Break

1520 - 1820 SOCIO-ECONOMICS OF FISHERIES MANAGEMENT

1520 - 1540 Logical Framework Analysis as a tool for Management of a Tropical Fishery - Murray, P. *et al.*

1540 - 1600 Cultural Issues, Constraints and Consequences in Evaluating the Economics of a Barbadian Fishery - Carter , S.

1600 - 1620 Evolution of the Fisheries Fleet in Barbados: Causes and Implications - Willoughby, S. and R. Cecil

1620 - 1640 Towards Pan-Caribbean Management of Fisheries: Establishing a Regional Mechanism for Sustainable Fisheries in the Caribbean - Haughton, M.O.

1640 - 1700 A Fisherman's Dilemma and Fisheries Management - Kinch, A.

1700 - 1720 Organising Fisherfolk in Barbados Without Completing a Clean Round - McConney, P.

1720 - 1740 Bioeconomic Analysis of Effort Reductions in the Florida Spiny Lobster Trap Fishery - Milon, J.W. *et al.*

1740 - 1800 The Application and Influence of Share Systems Within the Grenada Fisheries Industry - Finlay, J. and J. Rennie

1800 - 1820 The Changing Face of Fisheries in the Economies of OECS Member States - Wilson, J. D. K. and P. A. Murray

1900 - 2100 TRADE SHOW RECEPTION

WEDNESDAY - NOVEMBER 3, 1999

0800 - 0840 GCFI BUSINESS MEETING

0840 - 1220 ADVANCES IN CARIBBEAN AQUACULTURE

0840 - 0900 The Caribbean Aquaculture Association: Past, Present and Future Direction - Lellis, W. *et al.*

0900 - 0920 Overview of Temperatures Used in Larviculture of *Strombus* spp - Aldana-Aranda, D.

0920 - 0940 The Manufacture of Aquaculture Feeds and Their Impacts on the Aquaculture Industry in St. Lucia, W.I. - Felix, M.L.

0940 - 1000The Aquaculture Industry in Venezuela: Current Status and Perspectives - Cabrera, T. *et al.*

1000 - 1020 Break

1020 - 1040 Mass Production of Fat Snook, *Centropomus parallelus* (Poey), Juveniles in Brazil - Alvarez-Lajonchere, L. *et al.*

1040 - 1100 Use of Light-attracted Zooplankton for Rearing Post-settlement Coral Reef Fish - Watson, M. *et al.*

1100 - 1120 The Status of Queen Conch Culture in the Caribbean and Florida - Davis-Hodgkins, M. and R. A. Glazer

1120 - 1140 Design and Implementation of a Marine Finfish Commercial Hatchery in The Florida Keys, with Report on First Production Trials of Mutton Snapper, *Lutjanus analis* - L. Eldridge *et al.*

1140 - 1200 Mitochondrial Control Region of Striped Mullet, *Mugil cephalus*: A Tool to Restore Marine Fisheries Resources - Garber, N.M. *et al.*

1200 - 1220 Hormonal Spawning of the Common Snook, *Centropomus undecimalis* - Grier, H.J. *et al.*

1220 - 1300 Lunch

1300 - 1730 FIELD TRIP TO WESTERN SAMBO ECOLOGICAL RESERVE

1830 - 2000 CARIBBEAN AQUACULTURE ASSOCIATION BUSINESS MEETING

THURSDAY - NOVEMBER 4, 1999

0800 - 1020 RECREATIONAL FISHERIES

0800 - 0820 Modeling the Effects of Regulatory Changes on Recreational Fishing Effort in the Gulf of Mexico - Fedler, A.J. and W. Haider

0820 - 0840 Aspects of the Atlantic Greater Amberjack, *Seriola dumerili*, Recreational Fisheries - Cummings, N.J. and D.B. McClellan

0840 - 0900 Recreational Scuba Diving Activity in the US Caribbean - Garcia-Moliner, G. *et al.*

0900 - 0920 A Longitudinal Perspective on the Social and Economic Characteristics of the U.S. Gulf of Mexico Charter and Party Boat Industry - Ditton, R.B. *et al.*

0920 - 0940 Assessment of the Recreational Fisheries of Florida Bay and Adjacent Waters from 1985-1998 - Schmidt, T.W. and G.A. Delgado

0940 - 1000 Comparison of Fatty Acid Composition in Different Tissues of the Spottail Pinfish During and Post-Spawning , Clavijo, I.E. *et al.*

1000 - 1020 Results of a Reef Fish Abdominal Deflating (Venting) Study in Florida - Burns, K. *et al.*

1020 - 1040 Break

1040 - 1240 PELAGIC FISHERIES

1040 - 1100 Monitoring Large Pelagic Fishes in the Caribbean Sea and the Western Central Atlantic by an Integrated Monitoring Program from Venezuela - Arocha, F. and L. Marcano

1100 - 1120 Enhancing the Contrast and Visibility of Presumed Annual Growth Marks on Sagittal Otoliths from Wahoo, *Acanthocybium solandri*, from the Northern Gulf of Mexico and Bimini, Bahamas - Franks, J.S. *et al.*

1120 - 1140 Aspects of the Reproductive Biology of Tripletail, *Lobotes surinamensis*, in the Northern Gulf of Mexico - Brown-Peterson, N. J. and J. S. Franks

1140 - 1200 Spontaneous Spawning of Cobia, *Rachycentron canadum*, Induced by Human Chorionic Gonadotropin (Hcg), with Comments on Fertilization, Hatching and Larval Development - Franks, J.S. *et al.*

1200 - 1220 The Atlantic Greater Amberjack, *Seriola dumerili*, Stock Status Through 1998 - Cummings, N.J. and D.B. McClellan

1220 - 1240 Characterization of the Mitochondrial DNA Control Region of the Wahoo, *Acanthocybium solandri*, from the Northcentral Gulf of Mexico and Bimini, Bahamas - Garber, A.F. *et al.*

1240 - 1340 Lunch

1340 - 1720 HABITAT ASSESSMENT

1340 - 1400 Habitat Mapping of Benthic Habitats Using Side Scan Sonar - Appeldoorn, R.S. *et al.*

1400 - 1420 Spatial Patterns of Reef Habitat and Linkage to Fish Populations on Andros Island, Bahamas - Kramer, P. *et al.*

1420 - 1440 Gulf and Caribbean Activities of NOS's Biogeography Program: Coupling Species Distributions and Habitat - Christensen, J.D. *et al.*

1440 - 1500 Temporal Change of a Coral Reef Community in the South Mexican Caribbean - Garza-Perez, J.R.

1500 - 1520 Seasonal Distribution of Gobiids in Waters Adjacent to Estuarine Marsh-edge Habitats: Assessing the Effects of Habitat Alteration - Hendon, J.R. *et al.*

1520 - 1540 Break

1540 - 1600 A Low Salinity Rock Jetty Habitat as a Nursery Area for Presettlement Larval and Juvenile Reef Fish - Hernandez, F.J. *et al.*

1600 - 1620 Essential Fish Habitat: Incorporating Habitat Assessment into Federal Fishery Management - Hill, R.

1620 - 1640 Identifying and Mapping Essential Fish Habitat for Brown Shrimp, *Farfantepenaeus aztecus,* in Galveston Bay, Texas - Minello, T.J. *et al.*

1640 - 1700 Effects of Refuge Size and Complexity on Recruitment and Fish Assemblage Formation on Small Artificial Reefs - Sherman, R.L. *et al.*

1700 - 1720 Mangrove Habitat as Nursery Grounds for Recreationally Important Fish Species – Great Pond, St. Croix, U.S. Virgin Islands - Tobias, W.J.

1800 - 1930 POSTER SESSION - RECEPTION

Diel Variations in the Fish and Decapod Crustacean Fauna of Exposed and Protected Seagrass Habitats on the Caribbean Coast of Guatemala - Arrivillaga, A. and D.M. Baltz

Monitoring of the Abundance and Population Biology of Exploited Reef Fishes in South Florida - Barbieri, L. and J. Colvocoresses

Tendencies, Patterns, and Allocations in the 1998 Spiny Lobster Special Sport Season - Bertelson, R. and W. Sharp

Preliminary Comparison of Age Estimates from Dorsal Spines and Otoliths in a Reef Fish - Borden, S.H. and I.E. Clavijo

Monitoring Spiny Lobsters in Florida Keys National Marine Sanctuary: A Third Year Progress Report. - Cox, C. and J. Hunt

The Coral Reef Fishes of Broward County, Florida, Species and Abundance: A Work in Progress - Ettinger, B.D, *et al.*

Reef Fish Assemblage Structure Affected by Small-scale Spatial Variations of Artificial Patch Reefs: Preliminary Results - Jordan, L.K.B. *et al.*

Toxicity and Sublethal Effects of Ethylene Glycol to Juvenile Florida Pompano (*Trachinotus carolinus*) - Kay, M.E. *et al.*

The Importance of Zooplankton in the Diets of Fish Associated with Mid-shelf Petroleum Platforms – Keenan, S.F. *et al.*

Dynamics of Low-profile, Inshore Artificial Reefs in Mississippi Coastal Waters - Warren, J.R. *et al.*

Efficacy of Two and Three Chamber Light Traps for Presettlement Fishes and Zooplankton from Mangrove and Coral Reef Habitats at Key Largo, Florida - Lindquist, D.G. *et al.*

The Role of Nearshore Habitats as Nursery Grounds for Juvenile Fishes on the Northeast Coast of St. Croix, USVI - Mateo, I. and W.J. Tobias

Sexual Development of Hogfish, *Lachnolaimus maximus*, an Exploited Wrasse in Florida - Johnson, M. *et al.*

A Bioenergetics Approach for Estimating Prey Demand by Red Snapper (*Lutjanus campechanus*) on Alabama Artificial Reefs - McCawley, J.R. *et al.*

Halfbeak, *Hemiramphus* spp., Fishing and Spawning Grounds in South Florida - McBride, R.

Vibrio vulnificus Responses to Cold Shock - Nguyen, K.L. *et al.*

Elemental Signatures of Red Drum (*Sciaenops ocellatus)* Otoliths from the Gulf of Mexico and Western Atlantic Ocean - Patterson, H.M. *et al.*

Seasonal Colonization of Artificial Low Profile Reefs in Mississippi Coastal Waters: Invertebrates - Perry, H. *et al.*

Habitat Use by Early Life-history Stages of Fishes and Crustaceans along a Changing Estuarine Landscape: Differences Between Natural and Altered Shoreline Sites - Peterson, M.S. *et al.*

Characterization and Partial Purification of Trypsin from Digestive Tissues of the Queen Snapper, *Etelis oculatus*: Considerations For Use as an Environmental Indicator - Quiñones, B. and J. Uscian

Alarming Overexploitation of the Caribbean Spiny Lobster Stock in Martinique : Ecological Point of View and Recommendations - Riclet, E.

Build It, but Will They Come? Preliminary Findings of Refuge Limitation Bottlenecking in Juvenile *Menippe adina* in the Mississippi Sound - Shervette, V. *et al.*

Size and Age of Juvenile Gag (*Mycteroperca microlepis*) at Egress from Estuary to Offshore Hardbottom in North Carolina - Rutten, O.

Reef Fish Demographics on Artificial Reefs: the Influence of Reef Design and Location - Strelcheck, A.J. and J.H. Cowan Jr.

Ingress of Postlarval Snappers (Principally *Lutjanus griseus*) into the Newport River Estuary, North Carolina - Tzeng, M.W. *et al.*

Growth and Reproductive Biology of Red Snapper (*Lutjanus campechanus*) East and West of the Mississippi River: Preliminary Data Testing the Single Unit Stock Hypothesis - Woods, M.K. and J.H. Cowan, Jr.

2000 - 2200 GALA RECEPTION AT AUDUBON HOUSE

FRIDAY, NOVEMBER 5, 1999

0800 - 1020 ANTHROPOGENIC IMPACTS OF COASTAL HABITATS

0800 - 0820 Spills And Groundings: Addressing Anthropogenic Insults Through Natural Resource Damage Assessment and Restoration - Iliff, J

0820 - 0840 Threats to Coastal Zone Management in the Small Island of the Commonwealth of Dominica, West Indies - Austrie, A.C. and R. D. Sebastian

0840 - 0900 Use of Decision Support Procedures to Evaluate Nine Beach Management Policy Alternatives in Southeast Florida - Lindeman, K. *et al.*

0900 - 0920 Relocated Sea Turtle Nests in Open-Beach Hatcheries: Lessons in Hatchery Design and Implementation from Broward County, Florida, USA - Wyneken, J.

0920 - 0940 Selecting Biodegradable Fasteners and Testing the Effects of Escape Panels on Catch Rate of Fish - Selliah, N. *et al.*

0940 - 1000 Potential Conflicts Between Deepwater Fishing and Oil and Gas Operations in the Gulf of Mexico - Snyder, D.B. *et al.*

1000 - 1020 Break

1020 - 1220 ARE FLORIDA FISHERIES DEPENDENT ON CARIBBEAN RECRUITMENT?

1020 - 1040 The Origin of Florida Fish and Fisheries - Gilmore, R.G. Jr.

1040 - 1100 Some Features of Fish Community Structure on Reef Habitats of The Greater Caribbean and Its Relation with Fishery Productivity - Claro, R. and J.P. Garcia-Arteaga

1100 - 1120 Transport of Pelagic Fish Larvae in the Intra-Americas Sea: The Caribbean-Florida Connection - Frias-Torres, S. and R.G. Gilmore, Jr.

1120 - 1140 Larval Biology and Transport Scenarios for Lutjanids and Haemulids of the Dry Tortugas and Southwest Cuba: Implications for Zoogeography and Fishery Reserves - Lindeman, K. *et al.*

1140 - 1200 Variations in Feeding Environment Influence Dispersal Patterns for Veligers of *Strombus gigas* - Davis-Hodgkins, M.

1200 - 1220 Spatial and Temporal Distribution of Queen Conch Larvae in the Offshore Waters of the Florida Keys - Hawtof, D. *et al.*

1220 - 1320 Lunch

1320 - 1640 MARINE FISHERIES RESERVES

1320 - 1340 Involving and Resolving Fisher's Issues in the Redesign of a Marine Reserve - Sinckler, T.A. *et al.*

1340 - 1400 "Do No Harm" Versus "Stop the Bleeding" in the Establishment of Marine Reserves for Fisheries Management - Appeldoorn, R.S.

1400 - 1420 Integrating Fish Fauna and Habitat Assessments: The First Step in Developing Marine Fishery Reserve Design Criteria - Recksiek, C.W. *et al.*

1420 - 1440 An Analysis of REEF Fish Survey Data from Marine Protected Areas - Pattengill-Semmens, C.V.

1440 - 1500 Assessment of the Reef Fish Community, Habitat, and Potential for Larval Dispersal from the Proposed Tortugas South Ecological Reserve - Dahlgren, C.P.

1500 - 1520 Break

1520 - 1540 Benthic Mapping from Fish and Habitat Transect Data Using GIS Technology - Appeldoorn, R.S. *et al.*

1540 - 1600 Sperm Limitation in Exploited Spiny Lobster Populations and Marine Reserves? - Butler, M. and A. MacDiarmid

1600 - 1620 Movement Patterns of Red Snapper (*Lutjanus campechanus*), Greater Amberjack (*Seriola dumerili*), and Gray Triggerfish (*Balistes capriscus*) in the Northern Gulf of Mexico and the Utility of Marine Reserves as Management Tools - Ingram, G.W., Jr. and W. F. Patterson, III

1620 - 1640 Connectivity and Replenishment of Reef Fish Populations - Cowen, R.K. *et al.*

Assessment of the Functional Effects of a Harvest Refuge on Spiny Lobster and Queen Conch Populations at Glover's Reef, Belize

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Marine harvest refuges hold great potential for protecting, sustaining, and possibly increasing fishery resources. Since 1996, I have monitored the abundance and distribution, population size structure, habitat use, reproductive seasonality, and movement dynamics of Caribbean spiny lobsters *Panulirus argus* and queen conch *Strombus gigas* at the Glover's Reef Marine Reserve, Belize. Fishery regulations currently provide minimal protection for both species. Reproductive activity in lobsters occurred during most of the year, substantially longer than the closed fishing season. In conch, shell length was a poor indicator of sexual maturity, resulting in a large proportion of subadults and juveniles being taken in the fishery. Habitat use patterns accounted for the distribution of size classes of lobsters and conch in the atoll. Abundances of lobsters and conch were similar in both the General Use Zone (fishing by permit) and the Conservation Zone (fishing prohibited), and density fluctuated with the fishing season in both areas. Despite the substantial area (130 km^2) closed to fishing, lobster and conch populations have not responded to protection over three years. Expected refuge effects may be precluded by inconsistent enforcement, fragmentation of habitat by zonal boundaries, and the dynamics associated with migration across boundaries.

Aspects of Reproduction, Age and Growth of the Lane Snapper, *Lutjanus synagris*, (Linnaeus), 1785 in Jamaican Coastal Waters

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The lane snapper, *Lutjanus synagris (Linnaeus),*1758 is the most important commercial species taken by the large and growing tangle and trammel net fishery on the south shelf of Jamaica. Samples taken from the commercial net fishery between February, 1996 and June, 1999 showed a size range from 150 - 430- mm FL with a mean of 232.1 mm FL (± 52.4) (N= 1,094), both sexes combined. Most fishes in the samples were encountered already gutted. Mean sizes for male and female fishes were 219.5 (± 3.72, N=99) and 220.0 mm FL (± 9.82, N=227), respectively. Weight ranged from 75-1.100 g. Mean size at maturity was 268 mm FL (± 0.27) and 221 mm FL (± 1.85) in males and females respectively. Sex ratio (F:M) was 2.6:1.0 from 150-310 mm FL, and above that 100% female. There was prolonged spawning with a maximum in July for both sexes. Sagital otoliths were examined whole and by thin (300 micrometers) section and showed a series of opaque and hyaline bands. Whole otolith analysis produced a maximum age of six years, but sections showed a possible maximum age of between 16 and 17 years. Marginal increment analysis showed that one opaque zone was laid down in July and one hyaline in March annually. Otolith studies showed that the relationship between otolith weight and fork length may be described by the regression equation $Y = 0.0403X - 1.543$ (n= 0.9407) for males and $Y = 0.0405 - 1.1716$ (n = 0.9711) for females. The high correlation values suggests that the otolith weight changes with fork length may be used to estimate growth. L_∞ for females and males differs, with females achieving 460 mm FL, but males only 310 mm FL, ELEFAN produced growth parameters K = 0.19 - yr. L_∞ + 460 mm FL, and t_0 - 0.001 (females).

Overview of Temperatures Used in Larviculture of *Strombus* spp.

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Strombus gigas, S. costatus, S. pugilis, S. raninus, S. gallus and *S. alatus* are of commercial importance in the Caribbean. Economically, *S. gigas* is the most important and consequently the most widely studied. In this overview we analyzed the effects of temperatures on the development, shell growth stage of conch veligers, metamorphosis rate, settlement rate and survival rate. Temperature has long been suggested as an important factor regulating the developmental rate, length of pelagic life, and mortality of larvae from benthic marine invertebrate organisms. It is known that the rate of early cleavage, within certain limits, is related directly to water temperature. The purpose of this paper is to describe the effects of temperature (24-32 °C) on the veligers development until metamorphosis. So, metamorphosis is attained within 14 days at 29°C or 60 days at 27 °C, Why ?

Mass Production of Fat Snook *Centropomus parallelus* Poey Juveniles in Brazil

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A larval, weaning and nursery pilot-scale trial with fat snook *Centropomus parallelus* Poey, was conducted at Florianópolis, Brazil. Fertilised eggs (96%) from a captive broodstock induced to spawn with 50 µg/kg LHRHa were stocked in two 4,000l cylindrical fibreglass tanks at a mean density of 19.2 eggs.l^{-1}. *Nannochloropsis oculata* was introduced together with the eggs and maintained daily at a mean density of 0.5 - 1.0 x 10^6 cells/ml up to day 31 post-hatch (d31ph). Larvae were fed rotifers *Brachionus rotundiformis* from d2ph to d36ph (30 - 40 rotifers/ml) enriched with an oil emulsion and *Artemia* meta-nauplii from d22ph to d60ph (mean 2.9 meta-nauplii./ml) enriched with Selcoâ. Weaning started at d45ph with an artificial dry diet NRGâ with 50% protein, supplied together with concentrated and enriched *Artemia* meta-nauplii. Hatching averaged 89.8%. No critical period was faced during the whole larval rearing period. During the 43 days of weaning and nursery, less than 1% mortality was detected. Specific growth rate of total weight was 13.0 and mean daily growth in total length and total weight were 0.65 mm.day^{-1} and 24.0 mg/day during the whole rearing trial respectively. Mean total length and total weight of juveniles were 57.6 ± 0.1 mm and 2.11 ± 0.12 g, respectively at d88ph, and the length-weight relationship was $W = 8.29931 \times 10^{-5} TL^{3.049607}$ ($r = 0.9986$). Food conversion rate during nursery was 1.17, with a growth depensation in total length of 1.3%. Condition factor at harvest was 1.104. A total of 35,000 juveniles were harvested, overall survival was 25.5% with mean final density of 4.4 fish/l and biomass of 6.9 kg/m^3. The present trial proved the feasibility of the mass production technology developed and other possible improvement toward a stable commercial scale cultivation of fat snook *C .parallelus* are discussed.

"Do No Harm" Versus "Stop the Bleeding" in the Establishment of Marine Reserves for Fisheries Management

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It has been argued that, in an analogy to medical science, the first rule of fishery management is "Do no harm". That is, when treating human patients, doctors should not act to worsen the patient's condition. Application of this analogy to fisheries management suggests that management should not take actions that knowingly will result in permanent resource and economic decline. Based on this analogy, it was recently argued that the establishment of marine reserves could be deleterious if placed in "sink" areas, as opposed to "source" areas. The implication is that management must await further scientific studies. However, this argument is flawed on several accounts. First, management cannot wait indefinitely for scientific proof. Management must consider the weight of scientific opinion and be flexible in response to increasing knowledge. A more appropriate medical analogy here is "Stop the bleeding", that is, stabilize the situation. Many fishery resources are in severe decline and actions are needed in the short term. Second, it is unlikely that scientific studies will *ever* be able to identify source and sink areas on the scale needed for multispecies fishery management. Third, there is now substantial empirical evidence that marine reserves create source areas by increasing spawning stock. Fourth, and perhaps most fundamental, the argument fails to understand the nature and importance of marine reserve networks. Marine reserves serve multiple management objectives in addition to enhancing spawning stock (e.g., provide control areas and buffers against management failure, maintain system integrity, diversify benefits). The principles of reserve replication and network design specifically serve to counter unknowns in siting reserves relative to source and sink areas, while further accounting for the obvious fact that species will differ in this regard. Following basic guidelines, marine reserves can be established now, for the betterment of resource managers and users.

Habitat Mapping of Benthic Habitats Using Side Scan Sonar

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Detailed but large-scale habitat mapping is necessary if fisheries researchers are to investigate habitat – species distributions on spatial scales relevant to fisheries management and marine conservation, and identify essential fish habitats and the qualities that underlie their importance. The latter will include both the immediate structural qualities of a given area and the linkages among surrounding habitats. Knowledge of the underlying structure of habitat function should allow simple rules to be developed for the future identification and protection of critical habitats. Despite over 40 years of concentrated academic investigation in the area of La Parguera, Puerto Rico, including geological mapping, there is no comprehensive habitat map suitable for large-scale biological studies. Developing such a map is now feasible using remote sensing and geographical information systems (GIS). We are using side scan sonar (SSS) to develop a habitat map extending from the shore line to the edge of the insular platform and covering over 20 nM^2. SSS is advantageous over air-borne remote sensing in its greater depth coverage and greater resolution. The SSS, associated navigation equipment (computer, software, GPS) and electric winch are mounted on a 22-ft vessel. We use a 300 kHz SSS towed over 100-m wide paths to collect bottom images. To create

larger-scale views, geo-referenced mosaics are created from individual images using GIS technology. To date we have identified broad areas of habitat and located unknown patch reefs in otherwise soft-sediment areas. One disappointment is the inability to detect metal-framed fish traps. Although SSS technology is valuable, it's success requires proper logistical set-up, plus expertise in computers and electronics.

Benthic Mapping from Fish and Habitat Transect Data Using GIS Technology

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The mapping of benthic habitats and corresponding fish fauna is essential for understanding the role of habitat in controlling the spatial distribution of fish abundance, diversity and production. Any approach to mapping must first standardize habitat definitions and classification, as well as a data collection methodology. Visual transects are a standard tool for quantifying fish abundance and habitat characteristics. Yet, for purposes of mapping and analysis these data must be scaled up to their relative areas. We report on a methodology using stratified sampling and Geographic Information System (GIS) technology to convert transect data into larger-scale habitat maps, illustrating the procedure with data from La Parguera, Puerto Rico. Sampling strata are determined using two criteria. The first is Lindeman's cross-shelf habitat (CSH) classification system adapted to the local insular shelf; the main determinants are position in the cross-shelf direction and depth. The second criteria is based on a visual inspection of the array of different habitat mosaics (100's m^2) present within any CSH stratum (e.g., grassbed, sand/algae plain, gorgonian/coral field). Representative transects, replicated where possible, are placed in the different mosaics, and associated fish and habitats are quantified. Areas within each mosaic stratum can be determined using a variety of approaches such as field mapping with Global Positioning System (GPS) coordinates, or remote sensing using areal photography or side-scan sonar. Use of GIS allows transect data to be overlain on the mosaic and CSH strata and facilitates further analyses such as calculation of total abundances and estimation of both fish and habitat diversity.

Monitoring Large Pelagic Fishes in the Caribbean Sea and the Western Central Atlantic by an Integrated Monitoring Program from Venezuela

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Monitoring of large pelagic fishes in the Caribbean Sea and adjacent waters from Venezuelan ports started in 1987 with the support of the International Commission for the Conservation of Atlantic Tunas (ICCAT) Enhanced Research Program for Billfish (ERPB). The purpose of the ERPB was to aid in determining the status of the billfish stocks in the western Atlantic Ocean. In the early years of the ERPB in Venezuela (1987 – 1990), effort was

concentrated on port sampling and monitoring recreational fisheries targeting billfish; at-sea-observer covered trips on commercial longlines were limited to an average of 3 trips/year, comprising on average 30 sets/year. In 1991, ICCAT's ERPB sponsored a pelagic longline observer program in Venezuela on vessels targeting tuna and swordfish, and on artisanal longliners targeting billfish. Efforts were made to increase port sampling by monitoring key localities where billfish and swordfish were being landed by artisanal fishers. The program trains scientific observers to record detailed information concerning gear characteristics, position and time the gear is set and hauled, status and action of the specimens caught (alive or dead, kept, discarded or tagged), length and weight measurements, and sex identification of specimens. In addition, observers collect biological samples to support research studies directed to answer questions about the species life history (age, growth, reproduction, etc.). Interaction of sea turtles, marine mammals and sea birds is also recorded. Since 1991, the observed covered trips showed a steady increase, from 16 covered trips (99 sets) in 1991 to leveling around 35 trips/year since 1993 (320 – 488 sets). After seven years, the overall program has provided information on shifts in fishing strategy (use of live bait and elimination of target species trips). The biological data provided information on the reproductive strategy of swordfish in the western central Atlantic, information on stock distribution and reproductive biology of dolphinfish, and movement direction of billfish from and to Venezuelan waters.

Diel Variations in the Fish and Decapod Crustacean Fauna of Exposed and Protected Seagrass Habitats on the Caribbean Coast of Guatemala

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Diel variations in the density of fishes and decapod crustaceans inhabiting seagrass (*Thalassia testudinum*) meadows in Bahia La Graciosa, on the Caribbean coast of Guatemala, were described for exposed (beach) and protected (bay) habitat types. Seagrass occurs over protected-muddy substrates in the bay, while around the bay's mouth, a more exposed shoreline with sandy substrates also supports seagrass meadows. Using a cylindrical drop sampler, we collected quantitative faunal samples at varying levels of seagrass cover (0 to 100%). Physico-chemical variables and seagrass structural characteristics were recorded for a total of 71 samples, including sixteen night samples, seven and nine in beach and bay, respectively. A MANOVA test of the ten most common fish and crustacean species indicated significant diel-by-habitat type interactions ($P<0.014$). Comparison of cell means revealed that among the fishes, hardhead silverside was the only species that showed a significant ($P<0.001$) diel effect, with beach-night sample density significantly higher than day. Among the crustaceans, three species showed significant diel differences in density ($P<0.008$). Southern pink shrimp and night shrimp (*Ambidexter symetricus*) densities in beach-night samples were significantly higher than day samples, and knot-finger mud crab density in bay was significantly higher during the night. Although no crustacean species were collected exclusively at night, three fish species were, including the redfin needlefish, the spaghetti eel, and the plainfin midshipman. An analysis of similarities (ANOSIM) of the fish and crustacean species abundance indicated no significant differences in community structure between day and night samples ($P<0.52$), but we found a significant effect of habitat type ($P<0.0005$). A one-way test of fish community structure indicated significant differences only when comparing beach-day and bay-day samples ($P<0.0005$) and beach-day vs. bay-night samples ($P<0.001$). For crustaceans, significant differences in community structure were found when comparing beach-day and bay-day samples ($P<0.007$) and beach-night and bay-night samples ($P<0.002$).

Threats to Coastal Zone Management in the Small Island of the Commonwealth of Dominica, West Indies

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Coastline in the Commonwealth of Dominica face the threats of degradation, the islands most vulnerable being along the Central West, South West and North West of the Island. Natural occurrences such as high seas, hurricanes and storms mining activities; hotel/tourism development as well as fishing and farming activities contribute to the demise of coastal zones. In addition, server landslides and flooding in 1997-98 affected miles of coastlines along the Central West Coasts.

Coastal Zone Management is new to the Commonwealth of Dominica. This paper seeks to propose strategies which should be implemented to deal with the degradation of coast lines. An integrated approach is suggested; combining on going monitoring of coastal zones; training for sustainable coastal tourism and fishing with Government and the Private Sector; establishment of partnerships between the public, private and academic sectors and environmental education program.

Age Validation of Red Snapper, Lutjanus campechanus, and Red Drum, Sciaenops ocellatus, from the Northern Gulf of Mexico Using 210Po/226Ra Disequilibria in Otoliths

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Radiometric analysis of naturally occurring 226Ra and its daughters within otoliths was used to independently validate age estimates derived from sectioned otoliths of red snapper and red drum from the Gulf of Mexico. Ages of most long-lived marine fish species are often estimated by counting presumed annual growth zones in the largest of their otoliths, the sagittae. Red snapper and red drum are two such species from the Gulf of Mexico which are currently under intense state and federal management, partially due to reported high longevity estimates. Otolith section age estimates of red snapper and red drum have been partially validated through most of their life histories, with maximum reported ages of 59 and 40 years, respectively. Despite the poor counting statistics and the high backgrounds incurred with the technique used in this study, radiometric age estimates closely approximated otolith section ages for both red snapper and red drum, thus validating the continued use of otolith sections as the most accurate way to estimate ages for these species.

Monitoring of the Abundance and Population Biology of Exploited Reef Fishes in South Florida

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Over the past two years the Florida Marine Research Institute has been developing a long-term, comprehensive program to provide management agencies with critical information regarding the population status and life history parameters of fishery resource species of the Florida Reef Tract. In this program, we will make population assessments of fishery species using both fishery-dependent and fishery-independent sampling strategies, and will conduct directed life history studies of species for which there are currently insufficient data for stock assessment and fisheries management.

Fishery-dependent efforts have thus far included collection of catch and effort data and biological samples from the headboat and private recreational fisheries along the southeast coast of Florida for analysis of age, growth and reproduction. Initial focus has been on 4 species of snappers: gray snapper (*Lutjanus griseus*), mutton snapper (*Lutjanus analis*), yellowtail snapper (*Ocyurus chrysurus*), and lane snapper (*Lutjanus synagris*), and biological samples for these species are now being collected in the Florida Keys region as well. Studies on other important species of the reef fish snapper-grouper complex will be initiated as current studies are completed.

Fishery-independent efforts have concentrated on the development of regular large-scale scientific field surveys of reef fish populations. A length-based visual survey based on a stratified-random design is being conducted monthly in the Florida Keys reef system. In this survey, a combination of transect and point count methods are utilized to enumerate snappers, grouper, grunts, and other families of exploited reef fishes and to assign them to length intervals. A concurrent monthly trawl survey, aimed at assessing the recruitment of early juveniles of these species into grassbed areas in the central Keys, is underway as well.

Habitat Use and Movements of Groupers and Grunts in Virgin Islands National Park, St. John, US Virgin Islands

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Groupers and grunts were tagged with spaghetti and sonic tags to determine their movements among habitats in two bays on the south side of St. John, US Virgin Islands. Both target species, red hind (*Epinephelus guttatus*) and blue-striped grunt (*Haemulon sciurus*) demonstrated high site fidelity. Sonically-tagged fishes remained in the bays for up to two months or until the battery failed. Groupers remained on the same reef and had small home ranges. Grunts moved among reefs and spent extensive time in adjacent seagrass habitat. Tagged fishes were frequently recaptured in the same portions of the seagrass bed, which suggests established noctural feeding sites.

Tendencies, Patterns, and Allocations in the 1998 Spiny Lobster Special Sport Season

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A special two-day recreational only spiny lobster season is held in Florida prior to the beginning of the regular commercial and recreational season. The presence of this special season has generated much discussion and controversy, defenders and opponents, especially in the Florida Keys where the majority of the fishers congregate. In 1998, the Florida Marine Research Institute revised their mail survey questionnaire to better understand the dynamics of various user groups and details of the harvest in the Florida Keys. The new survey has allowed us to analyze patterns of travel and to identify spatial and usage strategies between locals and travelers. For example, those who travel into the Florida Keys to fish have to decide where along the 160 km highway to end their journey. We have found that the length of the journey to the Keys is proportional to the distance they travel into the Keys. We will also present harvest estimates, and participation rates, then discuss these parameters at both a state-wide and Florida Keys scale.

Preliminary Comparison of Age Estimates from Dorsal Spines and Otoliths in a Reef Fish

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Determining age using dorsal spines has become relatively common in pelagic fishes such as the sailfish and bluefin tuna, but this method has not been widely used in reef fishes with the exception of triggerfishes. Dorsal spines are easier to collect and process than other hard parts (scales, otoliths and other bones). In addition, as with the use of scales, sacrificing the fish being studied may not be necessary. In larger fish vascularization may diminish early growth increments, and therefore statistical replacement may be necessary. Few studies have attempted to compare the ageing estimates obtained from dorsal spines with those obtained from otoliths. Many adult reef fish ageing studies use sagittae as the primary ageing structure. It may be beneficial in some cases to use dorsal spines if they were found to be as reliable as otoliths, which can be difficult and time consuming to extract and process for interpretation. In this study, the reef fish *Calamus nodosus* (Sparidae) was used to test the hypothesis that age estimates obtained from interpretation of the macrostructure of the 3rd dorsal spine is not statistically different from that obtained from the macrostructure of the sagitta. Verification of the annular periodicity of ageing structure increments will be made using marginal increment analysis. This method reveals when annuli are formed by measuring the distance from the last ring to the edge and plotting all age groups combined by month. At least three replicate analyses of each structure will be performed to increase the precision of the age estimated.

Aspects of the Reproductive Biology of Tripletail, *Lobotes surinamensis*, in the Northern Gulf of Mexico

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Tripletail, *Lobotes surinamensis*, is a large pelagic fish that is becoming increasingly popular with recreational anglers throughout the Gulf of Mexico. There is, however, little information on the biology of this species and virtually nothing is known regarding the reproduction of tripletail. We examined tripletail captured from the northern Gulf of Mexico in the spring and summer between July 1994 and August 1998 to determine size at sexual maturity and reproductive patterns. No sexually immature male tripletail were captured during the course of the study. The size at 50% sexual maturity for female tripletail is 500 mm TL, corresponding to an estimated age of one year. Mean monthly female gonadosomatic index (GSI) values were elevated throughout the summer, highest in July and near resting levels by September. Male GSI values were elevated from May through July. Histological analysis of gonadal tissue from 57 male tripletail showed the majority of males captured from May through September were running ripe. However, spermatogenesis was reduced in the testis from July through September. Histological analysis of gonadal tissue from 90 females provides evidence that tripletail are a multiple spawning species. Females were found in the late developing ovarian maturation stage from June through August; regressed and spent females were captured from July through September. A high percentage of females captured during May and June were in the immature and early developing ovarian maturation stages. Females with oocytes undergoing final oocyte maturation (FOM) were found June through August, with the highest percentage in July. Thus, tripletail appear to have a three month spawning season in the northern Gulf of Mexico, with July the peak spawning time. Preliminary estimates of spawning frequency, based on the percentage of females undergoing FOM in July, suggest that female tripletail are capable of spawning once every six days.

Results of a Reef Fish Abdominal Deflating (Venting) Study in Florida

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Reef fish commonly have ruptured swimbladders caused by the internal change of atmospheric pressure when the fish is brought to the surface by fishermen. As many of these fish are legally undersized, they are thrown back only to float on the surface and become prey to birds and predatory fish. A method of "venting" the fish with a hollow tool (similar to a needle) was developed which released the air from the fish cavities, allowing the fish to return to the reef. However, the question remained: "do the fish survive the venting process?" The abdominal deflating study looked at gag grouper, *Mycteroperca microlepis*, red grouper, *Epinephelus morio*, and red snapper, *Lutjanus campechanus*, to determine the efficacy of venting in enhancing their survival and to test the hypothesis that venting enhances the survival in some species but not in others. Tag returns for red and gag grouper demonstrate that as water depth increases, venting provides a slight edge and increases survival. Beneficial effects were not apparent for red snapper.

Sperm Limitation in Exploited Spiny Lobster Populations and Marine Reserves

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Changes in the population structure of marine species subject to fishing can have significant effects on mating dynamics and reproductive success. For spiny lobsters, the reproductive output of females increases exponentially with female size, so a shift toward smaller females in exploited populations reduces the aggregate fecundity of the population. Less clear, however, is the effect of reduced male lobster size on reproductive dynamics, especially since male size is disproportionately reduced by fishing relative to female size. To examine this issue, we conducted a comparative study of two species of spiny lobster, the Caribbean spiny *Panulirus argus* in Florida and the southern red rock lobster *Jasus edwardsii* in New Zealand. To examine the potential effects of reduced male size on mating patterns, we conducted field observations of both species in marine reserves and fished areas. In the laboratory, we conducted experiments to determine the effect of male size on mate choice and reproductive success. Our results provide strong evidence that the availability of sperm can limit the reproductive success of spiny lobsters subject to heavy exploitation.

The Aquaculture Industry in Venezuela: Current Status and Perspectives

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Only a few species are currently produced on a commercial scale in Venezuela, despite much research conducted with numerous marine and freshwater mollusks, crustaceans and fishes during the last four decades. In 1997 most seafood production came from ocean capture fisheries (93% of total production), with freshwater fisheries contributing 6%; aquaculture supplied only 1% of the seafood production in 1997. The main aquaculture species produced include penaeid shrimp (55% of aquaculture total), tilapia (21%), cachama (18%), trout (5%) and others including seaweeds accounting for less than 1%. Aquaculture activities in Venezuela began in 1937 with farming of rainbow trout. There are approximately 35 trout farms in the Andes Region of Venezuela; most of them - including the largest ones - are in Merida State. Most culture is done in concrete raceways, and installed capacity for farmed trout production is 1000-1200 mt. Production has been increasing steadily in the last four years, but current production is only about 500 mt per year, due to three main problems: insufficient supply of good quality eggs/larvae, inadequate and inefficient marketing. Shrimp culture is a relatively new activity in Venezuela since commercial production only began in the late 1980's. Venezuela apparently remains the only country in the western Hemisphere not affected by Taura Syndrome, possibly due to strict restrictions on live shrimp imports. Currently there are eight farms: three along the eastern mainland coast (Aquamarina de la Costa, Siembras Marinas, and Aquacam), and one (Aquatec) on the Island of Coche; and four farms along the western coast (Ricoa Agromarina, InterAqua, Bio-Industrias and AcuiZuliana). Other projects are under study or development. Total pond area is

about 1,200 ha, with an average production of 1,600-1,800 kg/ha/cycle, with 2.3-2.5 cycles per year. Harvests of 2,400-3,000 kg/ha are not uncommon at some farms. Two species are currently cultured: *Litopenaeus vannamei* and *L. stylirostris*, with the former accounting for over 90% of the production. Semi-intensive methods are used, with no aeration and with stocking densities of 15-25 PL/m^2. Reported survival rates are routinely above 70% and mean size at harvest typically range from 14-23 g. Most farms work at salinities that range annually between 15-36 ppt; one farm has salinities between 0-5 ppt and another has salinities over 38 ppt. There are five hatcheries producing PLs, working under closed cycle/maturation, some doing eye ablation while others do not.

Tilapia culture began in 1992, and there are around 215 tilapia farms producing mostly red hybrids for the local markets (1994 production estimated at 1000 mt). Cachama production has cultured for many years, with about 72 farms producing approx. 618 mt in 1994. Other species cultured and discussed include mussels, agarophyte seaweeds, freshwater prawns, ornamental fishes and others. Venezuela has excellent environmental and logistic characteristics for the successful development of commercial-scale aquaculture production of several valuable species. This is a critical review of current status of aquaculture operations for several species, and the legal framework and official initiatives and incentives. The near term requirements and perspectives for sustainable industry expansion and diversification are also critically reviewed and discussed, and recommendations are presented.

Aspectos Ecológicos de la Sardina (*Sardinella aurita*) en la Plataforma Oriental Venezolana, Determinados a Partir de Prospecciones Acústicas

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Con la finalidad de estimar la abundancia y distribución del recurso sardina (*Sardinella aurita*), se hizo una serie de ocho cruceros de prospección acústica en la zona nor-oriental del Caribe venezolano entre septiembre de 1995 y marzo de 1998, a su vez se obtuvieron las imágenes de satélite correspondientes a temperatura superficial en la zona durante las fechas de los cruceros, lo cual ha permitido comparar la distribución de temperaturas con la de biomasa de peces resultante. La serie revela estabilidad con relación a la distribución horizontal de la biomasa: altas concentraciones principalmente al sur de Margarita, entre esta isla y la de Coche, al norte de la península de Araya y en las zonas costeras entre el Morro de Puerto Santo (63.8° W) y el Cabo de Mala Pascua (63.2° W). A pesar de que esta distribución permanece con bastante constancia en el tiempo, es posible advertir desplazamientos de la biomasa, sobre todo en la dirección norte-sur, conservando siempre los mismos límites con respecto a la longitud. Ocasionalmente se ha observado un foco de alta densidad al norte de la isla de Margarita, sin embargo esta estructura no es permanente, y se presume que está ligada a la aparición de una pequeña surgencia en las costas de Juangriego. En cuanto a los resultados cuantitativos, se observa una fuerte consistencia en los valores de biomasa total obtenida, sin embargo, durante la cuarta y quinta campañas se obtuvieron estimaciones inferiores a las demás, con valores situados fuera del rango establecido por el coeficiente de variación promedio de la serie (15%). La rápida recuperación de los valores a cifras "normales" en las campañas posteriores, hace presumir que más que una disminución real del tamaño del stock, pudieron haberse producido migraciones masivas y temporales dentro y fuera del área preferencial de distribución, conservando el patrón general pero con bajos valores para los índices de abundancia. También se ha logrado establecer cierta coincidencia entre la distribución espacial de *S. aurita* y las temperaturas más bajas observadas para cada época. La constatación objetiva de esto, requiere del levantamiento de un modelo de relación entre la temperatura del agua y la distribución espacial de la biomasa. Finalmente, la serie evidencia un gradiente en la talla promedio individual de *S. aurita* en sentido creciente sur – norte.

Cultural Issues, Constraints and Consequences in Evaluating the Economics of a Barbadian Fishery

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Very little financial and economic research has been done on the Barbados fishing industry, particularly at the level of the fishing enterprise. Research of this nature faces many challenges. This paper focuses on the challenges encountered in determining the profitability of the Barbadian day boat fisheries enterprise during the 1996-1997 fishing season. These challenges included dealing with the culture of fishing in Barbados, the nature of institutional arrangements and relations in the fishery, and coping with the limited organizational resources. Consequently, several factors constrained data collection such as difficult access to dayboat owners and absent or inadequate systems of record keeping by dayboat owners and governmental agencies. These factors impacted in turn on data analyses. The peculiarities of the dayboat enterprise influence applicable accounting practices and analyses. A phased program to encourage dayboat owners to establish and maintain proper record keeping systems is recommended.

Gulf and Caribbean Activities of NOS's Biogeography Program: Coupling Species Distributions and Habitat

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NOS's Biogeography Program scientists conduct research in cooperation with Federal, State, and academic partners to analyze, interpret, and subsequently define the interrelationships between species distributions and the composite of physical and hydrological habitat(s) available to an organism. This work has been formulated to provide a suite of assessment tools and products that support living resources management. The Program's work to define these complex relationships is addressed through a continuum of approaches which differ in data content, complexity, and analytical structure. The purpose of this paper is to provide an overview on the Gulf and Caribbean activities of the Biogeography Program. Studies range from region-wide species distribution maps in marine and estuarine environments to site-specific ecological models. The projects include: 1) the Estuarine Living Marine Resources (ELMR) program; 2) Habitat suitability modeling (HSM) in Florida estuaries, 3) data to support the Gulf and Caribbean Fisheries Management Councils Essential Fish Habitat delineations, 4) spatial analysis of the Reef Environmental Education Foundation (REEF) diver fish census data and associated habitats. Emphasis is placed on the ELMR and HSM projects. The ELMR program provides species distribution maps, data, and life history information for 44 fishes and invertebrates found in 33 Gulf estuaries. The HSM research efforts have resulted in the development of spatially-explicit habitat selection models for economically and ecologically important species found in Gulf estuaries and Caribbean reef communities. Models were designed to accomplish a variety of objectives, including: 1) estimate probable species distribution patterns, 2) isolate optimal from sub-optimal habitat, and 3) simulate potential population-level responses resulting from altered environmental conditions. Program results are distributed in the form of publications, web-served digital data, and custom geographical information system (GIS) interfaces.

Some Features of Fish Community Structure on Reef Habitats of The Greater Caribbean and Its Relation with Fishery Productivity

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Reef fish community structure in different zones of the Cuban Archipelago were studied using visual censuses. Similar surveys were done on slope reefs from Martinique, Guadeloupe and Key West, Florida. Strip transects, 100 m length and 6 m width were made by two divers (3 m each at both sides of a previously extended line). All censuses where done by the same two observers.

There were greater differences in community structure (species composition, species richness, density and biomass) within Cuban reef habitats than among geographical zones in the same reef habitat. Fish species composition in slope reefs was quite similar between the four countries, but there were important differences in the proportion of each species. Fish density was higher in Martinique, due to a great abundance of *Chromis multilineatus*, but fish biomass was two orders of magnitude higher in Cuba and Florida. Fish diversity was also higher in the last two sites. The presence of herbivores and predators in Guadeloupe and Martinique was very low and the presence of algae on the reefs is higher on these reefs in comparison with the others. Larger fishes, such as snappers, groupers, and jacks were scarce in the Lesser Antilles, but common in Cuba and Florida. Absence of larger fishes was apparently a result of the over exploitation of the ecosystem in Lesser Antilles. Even when fisheries productivity per unit area was higher in the Lesser Antilles (Martinique, Guadeloupe, Sta. Lucia, Jamaica and other islands), it was based on small size and low quality fishes. Fish catch/trap/day in Cuba was 30-40 times higher than in Martinique and Jamaica, but a high proportion of the catch was considered not suitable for consumption in Cuba.

Comparison of Fatty Acid Composition in Different Tissues of the Spottail Pinfish During and Postspawning

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Analysis of fatty acids can provide an idea of the health and nutritive value of a fish for human consumption. However, studies addressing changes in composition of fatty acids in different tissues with respect to biological activities such as spawning are lacking. The spottail pinfish, *Diplodus holbrooki* (Sparidae), was selected as a model to test the hypothesis that fatty acids do not differ in composition among tissues during and postspawning. Our preliminary studies of this fish showed that the composition of certain fatty acids in muscle tissue changes seasonally, but it is not clear if this is due to reproductive activity or dietary changes. During spawning as gonads mature, fat content in muscle tissue may decrease as energy is allocated to spawning. In addition, certain fatty acids are needed for different biological functions. For example, arachidonic acid is a preferred precursor to prostaglandins which play a role in reproduction. We now plan to examine the fatty acid composition in gonad and liver compared to muscle in order to determine if fatty acids differ among different tissues in reproductively active and inactive fish. Initially, we will analyze these tissue fatty acids only in female spottail pinfish collected during the spawning season with mature ovaries and compare them with females possessing recently spent ovaries.

Preliminary results from a continuing study of spawning and fecundity in the red snapper (Lutjanidae: *Lutjanus campechanus*) from the Gulf of Mexico, 1998-1999

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In response to an emergency situation declared by the NMFS Southeast Science and Fisheries Center in early 1998, we analyzed red snapper (Lutjanidae: *Lutjanus campechanus*) gonads and otoliths from Texas, Louisiana, Mississippi, Alabama and west Florida (TX, LA, MS, AL and FL, respectively) along the coast of the U.S. Gulf of Mexico. Our main objective related to reproduction was to provide age-specific estimates of fecundity (batch fecundity and frequency of spawning) for large red snapper in order to enhance stock assessment of this species. We previously provided estimates of fecundity from northeastern Gulf of Mexico red snapper, which don't usually reach as great a size as those from the north-central and northwestern coasts of the Gulf of Mexico. Most samples came from headboat samplers stationed from South Padre Island, TX, to St. Petersburg, FL, beginning in late June or early July 1998 and ending in late August to October 1999. Red snapper were non-randomly selected to provide adequate sample numbers of large fish (500 - ~900 mm total length, TL). Sex ratio for all 1517 fish sampled was 1:1. The spawning season off TX and LA seemed to begin and end in the same months as in the northeastern Gulf: April-May and September-October, respectively. The presence of hydrated oocytes in ovaries of some large females (615-885 mm TL) indicated that spawning began in April 1999 off TX and LA. A few females had hydrated oocytes in October 1998 to signal the end of the spawning season in all areas. Batch fecundity for 1998 was estimated from 59 fish ranging from 359 to 901 mm TL. Greatest batch fecundity was 3.4 million for a 851 mm TL, 11 year-old LA fish. Spawning frequency estimates by age (for those ages or age ranges with n=36 or more females sampled) were about 50% greater for age 6-35 females than for age 3,4 or 5 females.

Connectivity and Replenishment of Reef Fish Populations

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Population connectivity is an important requirement for marine reserves to function as spawning refugia. But what are the appropriate scales for connectivity of different areas? If taken purely in terms of defining a population, then different areas need only to exchange very few individuals to maintain a genetically homogeneous population. However, if a protected area is intended to support 'downstream' populations on ecological time scales, then exchange needs to occur at higher orders of magnitude. Previous examples of connectivity have in reality only indicated the potential for exchange thus supporting the findings that local populations exchange sufficient number of individuals on evolutionary time scales to maintain a homogenous genetic stock. We present a model that not only incorporates typical advective and diffusive properties of larval transport by the ambient flow field, but also propagule production rates and mortality rates, to determine if and over what area sufficient numbers of larvae can be transported to numerically sustain downstream populations. We provide evidence of likely bio/physical mechanisms that may enhance local retention of larvae, thereby minimizing downstream transport. Our preliminary findings suggest the need to rethink the placement of reserves for the purpose of seeding downstream areas and outline future research efforts to quantify the rates of exchange.

Monitoring Spiny Lobsters in Florida Keys National Marine Sanctuary: A Third Year Progress Report.

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We have been monitoring abundance and size of spiny lobsters, *Panulirus argus*, in the Florida Keys National Marine Sanctuary during closed and open fishing seasons since 1997. Sampling sites comprise marine reserves (established in 1997) and 15 corresponding reference areas where fishing is permitted. Thirteen of the reserves are small (82 ha) Sanctuary Protection Areas (SPAs) or Research Reserves, one is a large (515 ha) SPA and one is a 3,000 ha Ecological Reserve (ER). There were significantly more legal-sized lobsters (76 mm CL) in reserves than in reference areas during the first two years. Third year data are still being collected. In 1997, abundance of lobsters declined in both reserves and reference areas during the open fishing season. This decrease in abundance was not observed in SPAs during the 1998 open season following the passage of Hurricane Georges. Legal-sized lobsters in SPAs and the ER have always been somewhat larger than those in reference areas, but the size differential increased from about 1 mm CL to about 3 mm CL between 1997 and 1998. Analysis of 1999 data is ongoing and monitoring will continue through September 2001.

Aspects of the Atlantic Greater Amberjack, *Seriola dumerili*, Recreational Fisheries

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Historical recreational Atlantic greater amberjack, *Seriola dumerili*, fisheries are described in detail. Estimates of the total catch in number and weight are given and the relationship between catch and observed nominal recreational fishing effort discussed. Trends in the primary recreational fisheries; headboat, charterboat, and private boat are given in regards to abundance trends and annual size and age composition. Patterns of exploitation are discussed in relation to inter-annual variation between fisheries and across years and seasons . Current trends in catch and observed sizes of fish landed in the charterboat fishery are contrasted with those from the Atlantic greater amberjack fisheries conducted during the 1950s.

The Atlantic Greater Amberjack, *Seriola dumerili*, Stock Status Through 1998

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The stock status of the Atlantic greater amberjack, *Seriola dumerili* through 1997 is discussed. A comprehensive history of the exploitation is presented covering the commercial fisheries since 1961, headboat anglers since 1981, and the recreational charterboat and private angler amberjack fishermen since 1981. Estimates of mortality from discards of fish below the minimum size limits, implemented in 1992 are presented. Estimates of

the total catch at length and catch per unit of effort abundance trends developed from samples that existed since the middle 1980's were used in addition to the catch time series to investigate the current stock status using Virtual Population Analysis (VPA) techniques. The sensitivity of the VPA results to changes in the input natural mortality parameter and the age of full selectivity are considered.

Assessment of the Reef Fish Community, Habitat, and Potential for Larval Dispersal from the Proposed Tortugas South Ecological Reserve

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The Florida Keys National Marine Sanctuary is engaged in a process that will create one or more marine reserves in the Dry Tortugas region. Recommendations for the Tortugas Ecological Reserve call for the creation of two reserves: Tortugas North, encompassing the northern parts of Dry Tortugas National Park, Tortugas Bank, and adjacent areas; and Tortugas South, encompassing Riley's Hump and deepwater areas to the south. These areas are expected to be important because they are located upstream of the Florida Keys and include some areas of high coral cover and fish spawning areas, yet little is known about the reef fish community, habitat characteristics, and larval dispersal from these areas, particularly the proposed Tortugas South reserve. We conducted extensive surveys within the Tortugas South area to characterize the reef fish community and habitat composition of the area. Several censuses were focused on areas identified as spawning aggregation sites for mutton snapper, *Lutjanus analis*, during a late May-early June full moon, a time of expected spawning activity. We then used satellite imagery, drogue vials and satellite tracked drifter buoys released at expected spawning sites, to examine potential larval dispersal pathways. Results suggest that, although coral cover is not particularly high within the proposed reserve, reef fish diversity is high and includes species that are rare elsewhere in the Florida Keys. Although no spawning was observed, we found some snapper species in relatively high concentrations, and collected several females with ripe eggs. Larvae spawned on Riley's Hump at this time may have settled between the upper Florida Keys and Biscayne Bay, possibly even as far north as Fort Lauderdale. The information we collected is essential to understanding the potential importance of the proposed protected area for conserving biodiversity, building spawning stock biomass, and supporting fisheries throughout the Florida Keys via larval replenishment.

Variations in Feeding Environment Influence Dispersal Patterns for Veligers of *Strombus gigas*

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Planktotrophic veligers of *Strombus gigas* disperse in the oligotrophic waters of the Caribbean region. In the Bahamas, two adjacent oligotrophic water sources differed in their nutritional composition. Veligers were food-limited and did not achieve metamorphic competence in offshore Exuma Sound water. Whereas, food conditions in the shallow waters of the Great Bahama Bank were favorable for high growth rates. Time to metamorphic competence and size at competence was influenced by variable food conditions and the amount of time veligers fed in different feeding environments. Feed history will determine larval dispersal patterns and supply to settlement sites on a local and regional scale.

The Status of Queen Conch Culture in the Caribbean and Florida

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The culture of the queen conch (*Strombus gigas*) has been proposed as a commercially viable venture, however, to date, only one production facility is in operation. We present the current biological and economic requirements needed to culture queen conch on a commercial-scale. Reseeding efforts and recommendations are reviewed. Market potentials for juvenile conch: (1) the aquarium trade, (2) the escargot market, and (3) the reseeding market are discussed. These markets along with diversified income from eco-tourism provide the revenue required for a successful conch aquaculture venture.

A Longitudinal Perspective on the Social and Economic Characteristics of the U.S. Gulf of Mexico Charter and Party Boat Industry

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Three hundred and four charter boat operators were randomly selected and interviewed in the five-state U.S. Gulf of Mexico study area (this includes the Florida Keys); this constituted 23% of the estimated population (1,286) of charter boats in the region. Interviews were also completed with operators of 43 of the 91 party boats (47%) in the same region. Personal interviews were completed between March and September 1998. Interviews lasted from 30- 60 minutes and covered a range of topics including: demographics, previous experience, community tenure; boat description and recreational fishing products offered; species dependence; financial operations and economic impact; and their opinions on problems facing the industry and fisheries management in the U.S. Gulf of Mexico. This study sought to replicate two previous studies conducted in 1987 by Ditton *et al.* (1989) and Holland and Milon (1989). The paper provides a longitudinal perspective on the charter and party boat industry in the U.S. Gulf of Mexico with regard to increases or decreases in the number of boats; number of passenger trips taken; average horsepower, boat length, and maximum capacity; and boat-trip base fees in standardized U.S. Dollars. Discussion will focus on understanding the resultant trends, charter and party boat definitional problems, methodological challenges, and usefulness of the data in support of fisheries management.

Assessment and Management of Queen Conch, *Strombus gigas*, Fisheries in the Bahamas

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Throughout history, the queen conch has been an important part of the diet of the Bahamian people. At present, the species sustains a fishery with high economic value that continuously attracts entry of new participants to the fishery. The fishery lands approximately 1.5 million pounds of edible conch meat per year with a significant fraction (over 60% and up to 90%) of the landings conformed by juvenile, hence immature conch. The fishery has a conspicuous increase in fishing activities during the summer months when the spiny lobster fishery is closed. This increase in seasonal exploitation coincides with queen conch spawning season, which, on the long range may jeopardize the reproductive potential of the resource.

The species is characterized by growth rates that significantly slow down after the onset of maturity, and growth is fundamentally determined by their local habitat conditions. Furthermore, queen conch stock assessment is marred by the fact that the species cannot be aged and stock assessment data are not readily applicable to common length-based stock assessment models. This is as a result of conspicuous changes in the axis of growth observed after the queen conch reaches maturity. In this paper we provide stock assessment results indicating that the status of exploitation of queen conch resources in the Bahamas are reaching levels that should be carefully monitored and controlled. We offer plausible fishery management strategies that can contribute to the long-range sustainability of this important fishery.

On the Assessment and Management of the Spiny Lobster, *Panulirus argus*, Fisheries in the Bahamas.

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Spiny lobsters sustain the most economically important fishery in the Bahamas with annual revenues exceeding $60 million. In recent years some significant changes in the character of the fishery have been observed. The historically common diving and trapping practices have substantially been replaced by the use of gathering structures or "condominiums". Adoption of these structures has resulted in greater fishing intensity in shallower areas, hence impacting more significantly the smaller (younger) individuals that commonly inhabit these areas. In this paper we present an assessment of the status of exploitation of the spiny lobster in the Bahamas, and we evaluate the optimum minimum size that has been adopted by the fishery. Based on current fishery trends, we review historic fishery management strategies adopted for the fishery and we discuss fishery management strategies to enhance the sustainability of the fishery.

A Comparative Analysis of Regional Spiny Lobster, *Panulirus argus*, Abundance Dynamics: Are There Common Sources?

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Comparative analysis of annual abundance of cohorts in the spiny lobster fisheries of Brazil and Florida is used to explore for potential upstream linkages between the two stocks. The analyses are further expanded to include comparisons of dynamic yield changes observed under different levels of fishing effort in the fisheries of Brazil, Central America and Florida. The results show trends with high correlations among regions that suggest similar population processes among regions – an indication of possible linkages among regions. An important strong coupling of yield and recruitment abundance to regional ENSO driven environmental conditions is also observed in these fisheries. The comparative analysis lays down the basis for further research that may be needed to elucidate the importance of up-stream stocks in fisheries management.

Design And Implementation of a Marine Finfish Commercial Hatchery in The Florida Keys, With Report on First Production Trials of Mutton Snapper, *Lutjanus Analis*

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Grassy Key Aquatic Center, Inc. (GKAC) and the University of Miami combined efforts to refine aquaculture technology of mutton snapper *(Lutjanus analis)* and other marine fish species. A state-of-the-art hatchery was designed to produce 500,000 fingerlings per year in 4 production cycles. The production target is 250,000 mutton snapper fingerlings within the first 2 years of operation. Salt water pumped from a 15 m well flows through degas towers and biofilters before entering a 20 ton reservoir, from where it is directed through the main filtration station, consisting of bag vessels with 100 µm polypropylene filter bags, 5 µm PVC cartridge filters and UV filters. Saltwater used in the phytoplankton, zooplankton and larval rearing areas is run through additional cartridge filters (1µm) and UV sterilization. Effluent water is treated using a rotating biological contactor before being discharged in a sedimentation pond. The maturation section consists of four round 7 m diameter x 2m high fiberglass tanks with photoperiod and temperature control. Each tank is an independent recirculating system fitted with pump, bag filter, sump, cartridge filter, biolfilter, protein skimmer, fluorescent light and a titanium core heat exchanger. The total volume of the larval rearing area is 30 ton, with twelve 1.5-3 m diameter cylinder-conical fiberglass tanks (1-5 ton), with stocking capacity of over 2 million larvae @ 75/l. The fingerlings area consists of fourteen 20 ton 5 m diameter circular fiberglass tanks, which can hold 300,000 fingerlings stocked at 1/l. These tanks are also used as "mesocosms" for semi-intensive larval husbandry of mutton snapper and other marine fish larvae. The microalgae laboratory produces *Isochrysis galbana* (C-Iso), a strain originally isolated from Turks and Caicos, and *Nannochloropsis ocullata*. The indoors microalgae lab delivers 4,200 liters of C-Iso at 3-5 million cells/ml per week. Mass culture of microalgae is also conducted outdoors using 20 ton tanks. The secondary productivity section is producing 300-600 million rotifers (*Brachionus plicatilis*) per day at 300/ml. To complement larval feeding, the lab is regularly inducing blooms of wild zooplankton, especially copepods of the genus Acartia. Artemia are decapsulated and hatched in 500 l cylinder-conical "cones" and the metanauplii and sub-adult are routinely enriched.

The first experimental trial of mutton snapper, conducted to test methodology and systems as well as to train new staff and graduate students, has yielded approximately 15,000 fully weaned fingerlings. Currently, growout trials are being conducted with the juveniles to evaluate their aquaculture performance in terms of growth, survival and food conversion rates, and to determine the economical feasibility of the operation. Mutton snapper fingerlings produced at GKAC will be raised to market size in offshore cages in the Gulf of Mexico and/or the Caribbean. The operation is scaling up from the R&D to the commercial level of feasibility.

Methods and Lessons Learnt in the Application of Ultrasonic Telemetry to Coral Reef Fish Movement Studies

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Increasing use is being made of ultrasonic telemetry to track the movement of fishes. Improvements in technology of acoustic telemetry has resulted in the reduction in size of both receivers and transmitters. Consequently, the number of fish species and the size range of individuals capable of carrying an acoustic transmitter have increased. Determination of suitable transmitter placement (internal versus external) was carried out using dummy tags made of PVC plastic, linseed oil putty and epoxy. Implantation of transmitters into the body cavity of fishes proved more successful than external attachment to the dorsal musculature for small reef fish (25-30 cm FL, < 5 cm body depth). Various methods of capture including the use of nets, a suction gun, traps and baited hook and line were attempted. The most successful method was species-specific. We give a detailed account of the methodology used to capture and implant Lotek CRAFT-11 acoustic transmitters in two species of Caribbean reef fish (*Cephalopholis cruentata* and *Kyphosus sectatrix*). 'Z' shaped Antillean traps baited with stale bread was found to be the most successful method to capture *K. sectatrix*, while baited hook and line was best for *C. cruentata*. Induction time to clove oil anaesthetic varied according to individuals, but was not correlated to either fork-length or weight in either of the two species. Super glue was found to be effective in closing the incision wound, with full healing in as little as 5 days. The use of coded transmitters operating on the same frequency allowed for tracking of many individuals simultaneously. This was particularly useful for examination of schooling behavior. However, close proximity of several transmitters greatly reduced the ability of the receiver to decipher individual transmitter codes.

The Coral Reef Fishes of Broward County, Florida, Species and Abundance: A Work in Progress

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Effective fisheries management requires, at minimum, knowledge of the extent of the resource; a baseline. Without such knowledge it is difficult to determine either the need for new management strategies or the effectiveness of existing policy. Despite the fact that recreational fishing and diving represent substantial income to Broward County, FL, there have been no previous attempts to make an in-depth survey of the local marine fishes. Therefore, we initiated such a survey, concentrating currently on the coral reef fishes.

The inshore environment of Broward County, FL, consists of three coral reef/hard bottom reef tracts, separated by sand substrate, running parallel to the coast in sequentially deeper water. Fishes were censussed at western,

eastern and central sites on each of the three reef tracts at quarter nautical mile intervals, along a five-mile section of coastline (site depths: inshore reef 3-10 m; middle 8-21 m; offshore 15-30 m). Using the Bohnsack and Bannerot point count method, divers recorded: fish species, individuals per species, size, and general habitat of a 15-m diameter cylinder. Each site was buoyed, with a tight buoy line, and its position recorded by DGPS after the census. During a 10-month period (August 1998-May 1999) 180 sites were censussed.

We recorded 16,855 fish in 132 species. There were significantly ($p<0.05$) more species at the offshore and middle reef sites than inshore (means: 17, 16 > 13), and more fish on the middle reef sites (mean: 119) than inshore (72), but not offshore (88).

Modeling the Effects of Regulatory Changes on Recreational Fishing Effort in the Gulf of Mexico

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Strategic choice modeling is increasingly being used by resource managers to understand the potential effects of their decisions on user groups. This paper reports the results of a strategic choice experiment involving the Gulf of Mexico red snapper, gag grouper and king mackerel recreational fisheries. The strategic choice model employed in this study used a fractional factorial design to generate hypothetical profiles of fishing experiences described by bag, size and season limits, distance traveled on water, and expectations of catch size and number on the allocation of fishing days. Recreational anglers were asked to allocate ten days among three fishing trip alternatives (one each for red snapper, gag grouper and king mackerel), an alternative to fish for different species, and an alternative to engage in a non-fishing activity. Analysis was conducted with a multinomial logit model, in which the aggregated allocation of fishing days to each alternative served as the independent variable. Part-worth utilities were estimated for each level of each variable and selected interactions. Based on these estimates, an interactive decision support system was developed to allow managers to easily evaluate the potential effects of alternative regulatory actions. Results of the study and the application of strategic choice modeling to Gulf of Mexico fisheries management are discussed.

The Manufacture of Aquaculture Feeds and their Impacts on the Aquaculture Industry in St. Lucia, W. I.

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Aquaculture crops in St. Lucia, most specifically the freshwater shrimp, have recently experienced significant competition from imported marine products from capture fisheries. In response, the Department of Fisheries of the Ministry of Agriculture, Forestry, Fisheries, and the Environment, in an effort to enhance the marketability of the aquaculture products, investigated the feasibility of reducing feed costs and improving feed quality and availability to farmers. This was done through the production of feeds using agricultural by-products. Five diets were developed, all with 30% protein levels, all costing significantly less than the price of imported feeds, and all having shelf-lives in excess of eight weeks. Production and field testing commenced in May and June 1999 respectively. Preliminary observations have indicated improvements in farmer involvement in the industry, faster growth rates and

increasedcrop production. The development of these locally manufactured feeds has also impacted positively on agricultural diversification efforts island wide.

The Application and Influence of Share Systems Within the Grenada Fisheries Industry

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Distinct share systems characterize each scale of fishing operation in the Grenada Fishing Industry, and share systems have always been used for equitable allocation of proceeds of catch. In spite of notable transformations taking place in recent years due to commercialization and accommoditization, remuneration continues to be done on a "job at catch per unit effort" basis. This paper presents a study conducted during the 1980s which examined financial performance of motorized fishing vessels and highlighting how an application of share systems by fishers might have limited or promoted fleet performance. The transformation in offshore fleet operations which came as a result of a popularization of fishing with longline palangre, from the late 1980's through 1990's, is compared so as to demonstrate how share systems evolve with technology and improved land based support systems.

The Life History of Southern Flounder *Paralichthys lethostigma* In Louisiana Waters

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The objectives of this study were to describe the age, growth, and reproductive biology of the southern flounder, *Paralichthys lethostigma,* in Louisiana waters. A variety of sample sources were included to demonstrate how the southern flounder's life cycle is dependent on both the estuarine and offshore waters during the various stages of its life cycle. Females exhibited greater maximum total lengths than males: 764 mm and 414 mm, respectively. Ages were estimated through examination of transverse sections of sagittal otoliths. Annuli were validated to form yearly in the winter months. Maximum age among females was 8 while that among males was of 4 years. Resultant Von Bertallanfy growth equations were shown to be significantly different between males and females. Males displayed a faster growth rate than females, but had a much smaller L.

Sex ratios indicate that males begin to migrate offshore as early as October in preparation for the spawning season. Female offshore migration takes place in November and December. Histological evidence and gonadosomatic indices indicate that southern flounder spawn in December and January in offshore waters. Females were found to reach fifty-percent maturity at 229 mm and all females were mature above 509 mm. Southern flounder are batch spawners as indicated by the presence in the ovaries of multiple stages of oocytes throughout the spawning season. Mean batch fecundity was estimated for 1991 and 1993 as 62,000 and 44,000 ova per batch. Spawning frequency was estimated using the post-ovulatory follicle method as 3.6 days and 6.4 days. The time-calibrated method provided estimates of 2.3 days and 3.1 days. Both males and females begin to move back into the estuaries during February as the spawning season comes to an end.

Enhancing the Contrast and Visibility of Presumed Annual Growth Marks on Sagittal Otoliths from Wahoo, *Acanthocybium solandri*, from the Northern Gulf of Mexico and Bimini, Bahamas

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Wahoo, *Acanthocybium solandri*, is an oceanic, pelagic fish that occurs worldwide in most tropical and subtropical seas. In the western Atlantic Ocean wahoo occur from New Jersey to Columbia, including Bermuda, the Bahamas, the Caribbean Sea, and the Gulf of Mexico. Although wahoo support recreational and commercial fisheries throughout the Western Central Atlantic, adequate life history data, including estimated size-at-age, for stock assessments are lacking. Sagittal otoliths from wahoo (57 males; 935-1,390 mm FL and 110 females; 875-1,803 mm FL) caught in the recreational fishery from the northern Gulf of Mexico during May-September 1997-98 and at Bimini, Bahamas in November 1997-98 were examined to determine their potential use for age estimation. Whole sagittae and transverse thin-sections of sagittae viewed under transmitted and reflected light at 25-40x magnification generally revealed a series of ridges, depressions, and faint opaque markings on the posterior portion of the distal surface of whole otoliths and vague markings on thin-sections. In an attempt to improve upon inadequate conventional methods and enhance the contrast and visibility of presumed growth zones on whole and thin-sectioned sagittae, experimental studies included: application of histological stains (1%, Toluidine Blue, Eosine Y, Neutral Red, and Analine Blue), etching with 5% EDTA followed by application of histological stains (1%), etching and staining with mixtures of 1% acetic acid and 1% histological stains, and digestion/etching with proteinase K buffer (PKb). Etching and staining exposure times varied, and most techniques did not effectively delineate growth zones. However, a 2-hr application of acidified Neutral Red (1%) to whole and thin-sectioned sagittae provided the best results and demonstrated enhanced contrast between presumed growth zones on some otoliths, particularly those from larger fish. Counts of enhanced opaque bands on some sagittae compared favorably with estimated ages previously reported by the authors for the same specimens using thin-sectioned dorsal fin spines.

Spontaneous Spawning of Cobia, *Rachycentron canadum*, Induced by Human Chorionic Gonadotropin (Hcg), with Comments on Fertilization, Hatching and Larval Development

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Two mature female cobia, *Rachycentron canadum*, injected with a single dose of human chorionic gonadotrophin (HCG) at 275 IU/ kg of body weight, and one non-injected ripe male spawned spontaneously in captivity. Oocytes aspirated from each female prior to injection were in the final oocyte maturation (FOM) stage and averaged 625 μ in diameter. Both females spontaneously spawned ~ 44 h post-injection; spawned oocytes ranged 1.1 - 1.3 μ in diameter. Fertilized eggs hatched ~26 h later. Estimates for number of eggs spawned (both females combined) and hatched were 3.2 million and 320,000, respectively. Aspects of embryogenesis and larval growth/development were observed. Critical survival period for larvae was day 3 at which time termination of yolk sac absorption occurred and first feeding commenced. Enriched rotifers, wild zooplankton, and artificial food were offered larvae during larval rearing treatments. Larvae contained in a black tank and fed a high density diet of enriched rotifers exhibited highest survival and were reared through day 13 post-hatch. The study documents the simultaneous, spontaneous spawning of wild-caught male and female *R. canadum* from the Gulf of Mexico, and

provides comments on fertilization, hatching and larval development. Results of the study confirm that *R. canadum* exhibits potential as an aquaculture species.

Transport of Pelagic Fish Larvae in the Intra-Americas Sea: The Caribbean-Florida Connection

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The Intra-Americas Sea includes the Gulf of Mexico, Caribbean Sea, Bahamas, Southeast US Coast and Guayanas. East Trade Winds drive part of the Equatorial Current through the Caribbean Sea (Caribbean Current). The water enters the Gulf of Mexico through the Yucatan Channel and exits through the Straits of Florida (Loop Current). At that point, the warm current follows the edge of the continental shelf of the Southeast US Coast (Gulf Stream). Eddies form both in the Gulf of Mexico and Caribbean basins with different frequency and intensity. Pelagic fish larvae and juveniles have limited capacity to overcome currents, therefore mesoscale dispersal dominates their ecology. The aim of this paper is to integrate both the oceanographic environment and the pelagic larvae dispersal of the Opossum Pipefish population from East Florida. The Opossum Pipefish (*Mycrophis brachyurus* lineatus) is a tropical anadromous syngnathid. Adults live in freshwater tributaries in specific emergent vegetative habitats but juveniles are found in pelagic environments associated with Sargassum. The subspecies lineatus is limited to the Tropical Western Atlantic. The oceanography of the Intra-Americas Sea is determined by CTD casts and satellite images of Sea Surface Temperature (AVHRR sensor) and Chlorophyll concentration (SeaWIFS sensor. Several oceanographic features that contribute to the dispersal of pelagic fish larvae are identified: 1) net current transport from the Caribbean and Loop Currents, 2) entrapment and drift to areas outside the current path due to eddy formation, 3) reach of continental shelf areas in current-shelf interactions (warm-core ring streamers). Possible pathways for the larval recruitment of the Opossum Pipefish population from East Florida are discussed: 1) recruitment by export from Caribbean and Southwestern Gulf of Mexico populations, 2) autorecruitment via entrapment in the continental shelf or by entering the North Atlantic Gyre into the Sargasso Sea and back to the Florida East Coast.

Characterization of the mitochondrial DNA control region of the wahoo, *Acanthocybium solandri*, from the northcentral Gulf of Mexico and Bimini, Bahamas

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Little information is available on the biology and life history of the wahoo, *Acanthocybium solandri*, and no information exists on the molecular genetics of this pelagic, circumglobally distributed species. Wahoo rank among the most coveted of fish sought by offshore recreational anglers in many parts of the world and are the basis of important commercial fisheries. Our preliminary research consisted of a molecular characterization of the mtDNA control region, including structure and sequence of the flanking tRNA genes. Whole DNA was isolated from wahoo tissue samples from the northcentral Gulf of Mexico and Bimini, Bahamas. Universal primers produced a fragment of approximately 1830 base pairs (bp) containing the tRNA's for proline (pro), threonine (thr), and phenylalanine (phe) and the entire control region of one fish from each site. The fragments were gel purified for direct sequencing, and species specific primers were identified in the tRNA's immediately flanking the control region and used in subsequent amplifications. The control region of the ten wahoo (five from northcentral Gulf of Mexico and five from Bimini, Bahamas) ranged in size from 886 bp to 892 bp. One termination activation sequence (TAS II), three

conserved sequence blocks (putative CSB I, CSB II, CSB III), five repeats, and two inverted repeats were identified. The 5' end of the control region contained the greatest sequence variability with approximately 100 variable bases and 3 indels within the first 332 base pairs. Two central conserved regions were present, and the 3' sequence adjacent to the tRNA-phe contained two variable sites and two indels over a 165 bp region. Multiple restriction sites for HinfI, RsaI, and SspI were identified that could be used to distinguish each fish as a unique haplotype by RFLP analysis. Results provide a characterization of the wahoo mtDNA control region for possible use in future investigations.

Mitochondrial Control Region of Striped Mullet *Mugil cephalus*: A Tool to Restore Marine Fisheries Resources

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Mitochondrial DNA (mtDNA) has been frequently used as a molecular marker in fisheries assessment and has potential applications in marine fisheries resources stock enhancement. In some species of fish, sequence data from the mtDNA control region exhibits enough intraspecific variability that the likelihood of two unrelated individuals being identical is very low to nil. Efforts to restore the depleted natural stocks of the striped mullet, *Mugil cephalus*, through the release of cultured fish have been undertaken in the Pacific. In such enhancement programs the use of molecular markers, particularly during the initial pilot-scale releases, is a reliable method to estimate contributions of cultured fish to wild stocks. The purpose of this study was to describe the molecular organization of the mtDNA control region in *M. cephalus* as a prerequisite for the eventual development of a genetic tag to support stock enhancement activities. We sequenced, identified, and characterized the flanking tRNAs (proline, threonine, and phenylalanine) of nine *M. cephalus*. Subsequently the entire control region of 101 *M. cephalus* collected in the U.S. South Atlantic Ocean/Gulf of Mexico Basins plus 20 individuals from the Pacific Basin were sequenced to delineate conserved sequence blocks, direct and indirect repeats, and the nucleotide compositions by population. Each of the 121 individuals exhibited unique haplotypes, indicating a high level of polymorphism. Due to the high level of polymorphism displayed in the *M. cephalus* control region, a larger sample size may be necessary to detect subdivisions within ocean basins. Further study of the control region may establish genetic tags to monitor the success/survival rate of released fish, distinguish released hatchery-reared fish from wild conspecifics, and identify maternal contributions of broodstock to offspring in stock enhancement activities in the Gulf of Mexico and Caribbean.

Biology of the Tiger Grouper, *Mycteroperca tigris*, (Pisces: Serranidae) in the Southwest Zone of the Cuban Shelf: Feeding Habits, Age and Growth

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Main aspects of feeding and growth of the tiger grouper, *Mycteroperca tigris*, in the southwest zone of the Cuban shelf are presented. Specimens were collected with speargun on the slope reef habitat. *M. tigris* is an opportunistic piscivore, whose diet may change in relation to the local ichthyofauna. Fishes of the families Haemulidae, Scaridae, Labridae, Acanthuridae and Sparidae were dominant in the gut contents. The otoliths were the best structure for age and growth estimation in this species. Parameters for the theoretical growth equation (Von Bertalanffy) were $L_\infty = 75.8$ cm; $K = 0.115$ and $t_0 = -1{,}875$.

Recreational Scuba Diving Activity in the US Caribbean

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SCUBA diving activity has been increasing in the US Caribbean without any statistics on the number of people involved as users of the marine resources. SCUBA diving schools, stores and centers were identified from the phone book, the tourism guides and the diving magazines. A telephone survey, conducted by the Caribbean Fishery Management Council during 1998 - 1999, aimed at (1) identifying these centers to establish a database; (2) gathering information on the (a) number of divers using the resource; (b) areas visited; (c) number of visits per area; and (d) activities carried out by the divers at these sites.

Preliminary results indicate that there are over 100 diving operations in the area. Of these, most are involved in taking divers sightseeing. All levels of expertise are reported, but the beginner and intermediate divers predominate. Diving activities take place at depths between 30 to 60 ft (USVI) and 30-100 ft (PR) over coral reef areas. The preliminary results of the survey show that, on average, there are 2 dive trips per day, 5 days per week, which include 9 divers per trip. As a first approximation, there could potentially be over 300,000 divers per year in the US Caribbean.

There were over 90 named diving locations which were reported as visited over 10 times per week. Further analysis of the data will include the number of areas frequented by divers (chartered activities) and the number of dives to each specific reef or wreck. This information, along with descriptions of changes in the species diversity and condition of the reef, could help in determining the effect of divers on reefs.

Temporal Change of a Coral Reef Community in the South Mexican Caribbean

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The south of the state of Quintana Roo in Mexico is one of the best preserved places along the Mesoamerican Reef, yet is one of the next zones to be developed as a tourist resort, namely: "Mayan Coast". Mahahual is a strategic place for its proximity with Sian Ka'an Biosphere Reserve, Chetumal, the capital city of the state and the tourist zone of Belize. This location has one of the best developed reefs in this area and its biological richness and diversity makes it a perfect place to monitor and assess the change in the coral communities due to natural and anthropogenic pressures of fisheries and tourism. The health of the fore reef coral community was assessed by the Aronson & Swanson Video transect Method for the years of 1998 and 1999 and later again in 1999 when a massive bleaching event was detected. The change of the coral community from year to year and the consequences of the bleaching event will be stated in this study as well. The importance of assessing the health of the coral reef communities, relies on the topographic complexity of the coral reef, which is one of the most important factors for recruitment and settlement for important fishing species as groupers, snappers, conch, lobsters, among others. This study is part of a complex research program to characterize the reefs of the South Mexican Caribbean and assessing their health, which is of critical importance for the knowledge of the resources and their correct management. It will also provide a baseline for future monitoring efforts and environmental impact assessments.

The Origin of Florida Fish and Fisheries

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Today the Florida peninsula provides habitat for one of the most complex and rich ichthyofaunas in the western Atlantic principally due to its geomorphology and transitional climate associated with regional oceanographic currents. The majority of these fish species are tropical, having migrated to the Florida peninsula only recently, during the Holocene submergence of the Florida platform. These tropical invaders now form a heterogeneous group that often numerically dominate Florida fish communities, particularly those dependent on tropical habitats and ecosystems. Many of these tropical species form the basis for major recreational and commercial fisheries. Most fishery species life histories require estuarine, coastal or shelf edge spawning often with passive/active movement of pelagic eggs and larvae into oceanic waters. Entrainment within oceanic currents allows larval transport for considerable distances downstream and, consequently, loss of larvae from Florida waters, conversely, larval recruitment from Caribbean Provincial waters.

The differential distribution of suitable habitats and hydrological/climatic environments around the Florida peninsula creates differential faunal associations with the Caribbean Province, consequently, successful fishery larval recruitment from Caribbean. The Floridian marine and coastal environment can be divided into at least five broad geographical regions which support largely warm temperate, eurythermic tropical and stenothermic tropical faunas, which can in turn be subdivided into at least 12 biogeographic faunal tracks which reveal the evolutionary history of the Florida fish fauna and its relationship with the Caribbean Sea. The differential association of the Florida fishery species with the Caribbean Sea has major implications on regional and local fishery management.

Species Composition, Abundance and Catch Rates of Fish Caught on the Formigas Bank, Jamaica

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Fishers, who fish on the Formigas Bank, approached the Fisheries Division, regarding the status of the fishable resource on the Bank. Their main concern was the reduction in catch, and suggested that as a management strategy the Division should close the Bank for at least one year. The Division with assistance from CARICOM Fisheries Resource Assessment and Management program embarked on a data collection programme to gather information on species composition, abundance and catch rates by gear type. The results were compared with data from Alice Shoal, Morant Bank and Discovery Bay. There were significant differences in the catch rates and species composition and abundance by gear type. Although, the overall catch rate by gear type is lower than at other areas, complete closure of the area might not be necessary, however, the Division needs to continuously monitor the area.

Hormone Spawning of Common Snook, *Centropomus undecimalis*

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The common snook, *Centropomus undecimalis*, is one of Florida's premier, inshore sport fish and the subject of an ongoing stock enhancement program. In the development of hatchery techniques for spawning this species, both human chorionic gonadotropin (HCG) and mammalian gonadotropin-releasing hormone (GnRH) were investigated. All female common snook that were captured during the spawning season were candidates for induced ovulation and strip spawning of the eggs at the time of ovulation. The optimal injection dose of HCG was found to be 500 IU/kilo. Fish could be captured and injected at any time from morning until 1530 hours. Ovulation began the following evening, approximately 28 hours later. Most fish ovulated between 1700 and 2400 h. GnRH was administered in a time-release pellet at an estimated release rate of 10 µgm/kilo/day. The time to ovulation closely followed that of HCG. Using either hormone, viable eggs were produced. Methods were developed to stage oocytes during final maturation using biopsies.

An Examination of Brown Shrimp (*Farfantepenaeus aztecus*) Recruitment in Southern Louisiana, USA

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Penaeid shrimp landings in the Gulf of Mexico display substantial interannual variability. We used regression and simulation modeling to better understand the sources of this interannual variation in shrimp recruitment. The regression model utilized biological and environmental data to predict Louisiana's inshore commercial landings. We examined 28 years of postlarval, juvenile, and adult abundance estimates from the Louisiana Department of Wildlife and Fisheries and the National Marine Fisheries Service. Postlarval data were collected from four major tidal passes in Barataria Bay, LA. Statewide estimates of juvenile abundance were obtained from six and sixteen foot otter-trawl surveys. The pounds landed for the inshore and offshore commercial catch in Louisiana were converted to numbers of shrimp, so that the number of early stage shrimp entering the estuary could be directly compared to those entering the fishery. The environmental parameters used in the regression equation included air temperature, water temperature, salinity, river discharge, and acres of suitable habitat. Preliminary results of the regression analysis indicate that there is only a weak relationship between postlarval abundance and subsequent recruitment. The absence of a clear spawner-recruit relationship may indicate that growth, mortality, and habitat factors within the estuary are a significant source of recruitment variability. In an effort to examine the importance of the latter factor to survival, a simulation model was used to track individual shrimp in a spatial grid of vegetated and open water cells from settlement to emigration. Habitat-dependent growth and mortality were recorded for each tidal cycle. Initial model simulations indicate the important role of edge habitat in affecting shrimp survival from settlement to emigration. Both the regression and simulation models are ongoing efforts and are undergoing refinement.

Towards Pan-Caribbean Management of Fisheries: Establishing a Regional Mechanism for Sustainable Fisheries in the Caribbean

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A great challenge facing the countries of the Caribbean is the development and management of the living aquatic resources of the region in a responsible and sustainable manner, to improve the quality of life of the thousands of persons who depend upon the fishery resources for their well-being and livelihood. The fish stocks of economic importance in the region either straddle or migrate across the national maritime boundary of several Caribbean states and require cooperation among the countries for sustainable development and management. Most Caribbean states, as a consequence of their small size and fragile, developing economies, have limited human, financial and institutional resources to devote to sustainable fisheries. Since 1996 several Caribbean countries have been working through the CFRAMP project to define and establish a permanent regional fisheries mechanism (RFM) to facilitate management of shared stocks and continue to provide technical advisory support for sustainable development of the fisheries resources of the region. This paper provides an overview of the development of the RFM to date and discusses the possible scope, mandate, functions, structure and composition of the proposed RFM.

Spatial and Temporal Distribution of Queen Conch Larvae in the Offshore Waters of the Florida Keys

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The queen conch once constituted a significant recreational fishery in south Florida. However, the population declined until a moratorium was declared on all harvest in 1986. Since then, the adult population has increased in some locations while, in others, it has remained depressed. We tested the hypothesis that these patterns may be attributable to larval availability by conducting plankton tows at four locations in the Florida Keys: the western, lower Keys; the eastern, lower Keys; the middle Keys, and the upper Keys. Transects were conducted over known conch populations and one km further offshore. The results are compared with abundance estimates of adult conch associated with these locations. We also discuss the possible origin of larval recruits.

Seasonal Distribution of Gobiids in Waters Adjacent to Estuarine Marsh-edge Habitats: Assessing the Effects of Habitat Alteration.

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In order to assess the effects of habitat alteration on local fish populations, collections were taken by beam plankton trawl (BPL) in waters adjacent to marsh-edge habitats of the Mississippi Gulf Coast. Monthly samples were taken over two years along natural marsh-edge, natural beach-edge, and altered marsh-edge habitats in Biloxi Bay and Davis Bayou, Mississippi. Altered habitats consisted of bulkheads and cobble stone rubble. Gobies were the most abundant fishes found in these habitats, with *Gobiosoma bosc*, *Gobiosoma robustum*, *Microgobius gulosus*, *Microgobius thalassinus*, *Gobionellus boleosoma*, *Gobionellus shufeldti*, and *Evorthodus lyricus* being collected during the study. *Gobiosoma bosc* constituted the bulk of both gobies (98.2%) and fishes in general (47.0%) collected, and postflexion larvae (95.1%) was the dominant life-history stage taken, occurring from spring to early winter. Juveniles and adults were collected sporadically throughout the year. Relative abundance of all gobies was highest along natural marsh-edge habitats (75.1%), followed by natural beach-edge (19.5%), and then altered marsh-edge (5.4%), and *G. bosc* larvae were significantly less abundant in waters along altered habitats than in those along natural marsh-edge in the first year of sampling (Mann-Whitney test; $p = 0.011$). The lower abundance along altered areas suggests these resident taxa are susceptible to declining habitat quality and perhaps quantity. Because gobiids are abundantly distributed throughout the Gulf and Caribbean, can tolerate wide fluctuations in environmental parameters, and inhabit a wide array of habitats, it is likely that similar habitat alteration may be equally if not more detrimental for less-tolerant fish species, many of which are of commercial and recreational importance.

A Low Salinity Rock Jetty Habitat as a Nursery Area for Presettlement Larval and Juvenile Reef Fish

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Previous studies have indicated that oil and gas platforms in the northcentral Gulf of Mexico provide habitat for economically important reef fish. Determining the dynamics of the cross-shelf supply of larvae and postlarvae and recruitment of juvenile reef fish to these artificial reef sites is currently an active area of research. Many presettlement larvae and juvenile reef fish appear to consistently invade shallow coastal or even estuarine habitats and utilize these habitats as nursery areas. The purpose of this study was to determine the composition and abundance of fish larvae and juveniles inhabiting a low salinity rock jetty environment, with particular emphasis on reef fish taxa. Quatrefoil light-traps and a bow-mounted push plankton trawl were used to collect fish along a pair of stone rubble jetties at Belle Pass, Louisiana during new and full moon periods from April through August 1997.

Light-traps and the push trawl collected 17,949 and 111,854 fish, respectively. Clupeiforms (engraulids and clupeids) comprised over 95% and 70% of the total light-trap and push trawl catch, respectively. Other typical coastal pelagic and demersal taxa, such as atherinids, bothids, carangids, ophichthids, sciaenids, and synodontids were also abundant. Reef fish taxa, although not as abundant, were also collected and included blenniids, gobiids, ephippids, lutjanids, and sparids. More reef (or structure-dependent) fishes were collected with the push trawl than with light-traps. There was a significant difference in both light-trap catch per unit effort and push trawl density between new and full moon sampling periods. Preliminary results indicate that the jetty may be an important refuge area for presettlement reef fish.

Essential Fish Habitat: Incorporating Habitat Assessment into Federal Fishery Management

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In October of 1996, Congress unanimously passed the Sustainable Fisheries Act (Public Law 104-297), re-authorizing and amending the Magnuson-Stevens Fishery Conservation and Management Act (16 U.S.C. § 1801 *et seq.*). New requirements call for better conservation of fishery resources and habitats and provide additional tools for federal fishery managers in the form of the essential fish habitat (EFH) mandates. To assist the councils in meeting the new requirements, NMFS issued EFH regulations designed to be flexible enough to apply to 100s of managed fish and crustacean species ranging from spiny lobster to swordfish managed under 39 different fishery management plans. Examples from the Gulf and Caribbean Councils and NMFS Highly Migratory Species Division (managing Atlantic Tunas, Swordfish and Sharks) are used to display the diversity of approaches. Theoretical goals for future direction of the program are discussed.

Spills And Groundings: Addressing Anthropogenic Insults Through Natural Resource Damage Assessment and Restoration

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Hazardous material spills (including oil) and vessel groundings, including the ensuing salvage efforts are examined in the context of natural resource damage assessment as acute anthropogenic activities resulting in both long and short term impacts to marine and freshwater fisheries and their habitats in particular. Two case studies and their restoration approaches are presented. The grounding of the M/V FORTUNA REEFER on the reefs of Mona Island, Puerto Rico resulted in approximately 7 acres of coral injury. The grounding resulted in a discreet impact zone, but the salvage effort increased the injury to many times the size of the grounding area. Emergency restoration efforts at the site entailed the use of stainless steel wire and nails to reattach detached and broken colonies of *Acropora palmata*. A restoration status report is provided. A phosphate industry spill of approximately 50-56 million gallons of process water containing phosphoric acid (pH 2) resulted in the instantaneous kill of over 1.3 million freshwater and marine fish in the Alafia River and Tampa Bay. The fish injury, including both the direct kill and the lost future somatic growth, was estimated at 64,892 kilograms of biomass lost. In addition, the spill injured approximately 377 acres of freshwater wetlands and contributed to nutrient loading in Tampa Bay. Emergent estuarine habitat and reef creation is planned to compensate for the fish injuries and restoration of freshwater riverine habitat is planned to compensate for freshwater vegetation injuries and to restore surface water impacts.

Movement Patterns of Red Snapper (*Lutjanus campechanus*), Greater Amberjack (*Seriola dumerili*), and Gray Triggerfish (*Balistes capriscus*) in the Northern Gulf of Mexico and the Utility of Marine Reserves as Management Tools

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In the Gulf of Mexico, reef fishes represent important commercial and recreational resources, and recently many concerns have arisen over the future of several reef fish species. These concerns arise from declining landings and spawning stock biomass (SSB) estimates, which are below threshold values in some cases. The Reef Fish Fishery Management Plan was implemented in November 1985 to rebuild declining reef fish stocks, including greater amberjack (GAJ), red snapper (RS), and gray triggerfish (GTF).

Based on tagging studies conducted in the northern Gulf of Mexico, the movement of these three species and the utility of marine reserves as management tools were analyzed. Of the 2,932 RS and 206 GTF tagged off the Alabama coast (1995-1997), 427 and 42 have been recaptured, with 195 (46 %) and 28 (67 %) being recaptured at the site of release, respectively. The greatest effect on magnitude of RS and GTF movement was that of tropical cyclones; the magnitude of movement of fish not at liberty during tropical cyclones were significantly less than those at liberty during storms. Of 564 GAJ tagged in an artificial reef permit area off Pensacola, Florida (1991-1995), 178 were recaptured with 173 (97 %) recaptured in the release area.

We reason that reef species exhibiting high site fidelity may profit from the shelter of a no-take marine reserve, which may lead to an increase in SSB. Since each of these species have pelagic larvae, which may be transported throughout the Gulf by oceanic currents, an increase in SSB in a reserve may increase the production and export of propagules. Also, tropical cyclones may facilitate the export of adult biomass from a no-take marine reserve, therefore restocking surrounding areas. However, due to interspecific differences in site fidelity, the relative effectiveness of marine reserves should be evaluated on a species specific basis.

Sexual Development of Hogfish, *Lachnolaimus maximus*, an Exploited Wrasse in Florida

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Hogfish are the largest and most valuable wrasse species in Florida's waters. Recreational and commercial fishers combined caught an annual average of 400,000 pounds of hogfish during the last 12 years. Declining landings and catch rates, together with rapidly increasing prices per pound, suggest that problems may persist for hogfish populations despite fishery regulations enacted in 1994. Hogfish are hermaphroditic (protogynous) and there is concern that the minimum size limit of 12 inches may be too small to allow females to change to males in heavily fished areas. We are currently reviewing data from the Florida Marine Fisheries Information System, the Marine Recreational Fishery Statistics Survey, and special collections of hogfish. Fish were collected with spears, trawls, and traps. Otoliths were removed for age determination and gonads were fixed for characterization of reproductive biology. Here, we present our methods of reproductive staging through the use of histological preparations. We also

present preliminary results on the associations between morphometric and pigmentation characters and reproductive development, and we compare the sizes at first maturity and sexual transformation of fish collected in the northeastern Gulf of Mexico with those of fish from the Florida Keys.

Reef Fish Assemblage Structure Affected by Small-scale Spatial Variations of Artificial Patch Reefs: Preliminary Results

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Concrete reef modules (~1m^3) were deployed to examine how reef fish assemblages are affected by varying the distance between artificial patch reefs. The modules were deployed on sand bottom at 8 m depth off Ft. Lauderdale, Florida, USA. Modules were positioned at the apices of one of four differently sized equilateral triangles (0.33 m, 5 m, 15 m, and 25 m sides). Each of the triangles was represented by two replicates. A monthly visual census of fishes (*i.e.*, species, abundance, and sizes [TL]) was performed by SCUBA divers. In order to examine how the amount of available substrate/refugia affects fish abundance, two additional configurations, also with two replicates, were deployed: a solitary module and two modules side by side. Statistical analysis of 12 months of fish abundance data has revealed statistically significant differences among treatments. The 0.33 m triangular treatment demonstrated significantly higher fish abundance and number of species when compared to the 5m, 15 m, and 25 m treatments. Fish abundance and number of species were positively correlated with increasing the number of modules. These findings offer potentially valuable information for future deployments of artificial substrata.

Reproduction of the Spiny Lobster, *Panulirus argus*, in St. Lucian Waters

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The rapid growth in tourism in St. Lucia over the past two decades has led to a steady increase in the demand for, and consumption of spiny lobster, putting increasing pressure on local stocks. In order to improve the management and sustainable development of the lobster fishery, in 1996, the Government of St. Lucia in collaboration with CFRAMP launched a two year study to obtain information on the reproductive seasonality of *P. argus* in St. Lucian waters. The specific purpose of the study was to collect information on the size frequency distribution in relation to the onset of maturity and peak spawning periods to determine whether adjustments are needed in the current minimum size restriction and closed season. The preliminary results and recommendations of the study are presented in this report.

Toxicity and Sublethal Effects of Ethylene Glycol to Juvenile Florida Pompano (*Trachinotus carolinus*)

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Deepwater oil production in the Gulf of Mexico has increased dramatically in recent years, creating a need for the assessment of new environmental impacts associated with deepwater activity. Ethylene glycol, which is often used as a chemical additive in the petroleum industry, may not be immediately lethal to fishes in surrounding waters,

but may affect the way a fish interacts with its environment through reduced growth, reproduction, and survival. Exposure to sublethal concentrations may temporarily reduce an individual's ability to capture prey and avoid predators. At all life history stages, Florida pompano, *Trachinotus carolinus*, are common in the Gulf where production or transport pipelines occur. Therefore, this species is potentially at risk of exposure to ethylene glycol leakage. Static, non-renewal, 24-hour toxicity tests were conducted to determine the LC50 for juvenile pompano at 25°C and 30 ppt salinity. Range-finding tests were conducted using concentrations ranging from .001 to 10%. Probit analysis determined that the LC50 is 5.63% (95%C.I., 5.22 to 6.08). Histological analysis of gill filaments showed obvious damage at the highest concentration. Behavioral observations during the LC50 experiments showed that a 1% solution was the lowest concentration at which the fish displayed slightly lethargic behavior at 24 hours, while a 1.77% solution produced highly disoriented behavior and, in some fish, an inability to swim at 24 hours. A 1.25% solution was selected as a suitable sublethal concentration to be used in a series of pre- and post-exposure swimming trials that are now underway. Using Blazka-type respirometers, changes in critical swimming performance and respiration rates will be evaluated following exposure to sublethal concentrations.

The Importance of Zooplankton in the Diets of Fish Associated with Mid-shelf Petroleum Platforms

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Offshore petroleum platforms comprise the majority of hard-bottom habitat in the northwestern Gulf of Mexico shelf region. While large numbers of fish are associated with these structures, the source of energy for these fish assemblages remains poorly understood. Recent data suggest that zooplankton are an important component of the diets of medium-sized predatory species such as blue runner *Caranx crysos*. Hyperiid amphipods, decapods and stomatopod larvae were major components of the diets of fish at a mid-shelf platform located west of the Mississippi River between May and July, 1996. Size frequency data and electivity indicies suggest that these zooplankton are actively selected for by blue runner. Gut fullness levels indicate a bimodal feeding pattern for blue runner with peak feeding occurring mid-day and early evening.

Comparative data from another mid-shelf platform located east of the Mississippi River collected June and July 1999 support the hypothesis that zooplankton are important in the diets of *C.crysos* and possibly in other species including little tunny *Euthynnus alletteratus* and amberjack *Seriola dumerili*.

A Fisherman's Dilemma and Fisheries Management

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As a fisher you are most interested in catching plenty fish and making more money each trip. But suddenly realization hits you. You are not catching as much fish as before. You are not making enough money. Why? Fisheries management information is not reaching fishers as it should, and what little they get they do not pay any attention to. This is cause for concern and there is no simple solution. Fishermen and fisheries managers often work in different worlds and do not communicate as they should. This causes mistrust and disrespect for the knowledge of both sides. What is needed is more collaboration in fisheries science and management between resource users, scientists and managers to emphasize sharing information and discoveries. This paper describes some of the problems encountered in this area, and possible solutions for consideration.

Spatial Patterns of Reef Habitat and Linkage to Fish Populations on Andros Island, Bahamas

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Large-scale assessments of coral reefs can reveal spatial patterns of community structure and disturbance that may be missed in smaller-scale studies. To characterize the spatial variability and linkage of reef habitat and fish populations along the 150 km Andros Reef Complex, we applied the Atlantic and Gulf Rapid Reef Assessment (AGRRA) method to 28 shallow (3 m) barrier and 33 intermediate-depth (10 m) fore reef sites. Fish assemblages were dominated by herbivorous acanthurids and scarids with low to moderate numbers of serranids and lutjanids observed. Herbivore abundance was related to differences in coral structural complexity, macroalgal biomass, and depth. We examined spatial variation in several parameters by conducting a hierarchical analysis at three different scales (1 km, 10 km and 100km). For benthic parameters (coral size, mortality, macroalgal abundance), the highest degree of variation occurred at the smallest spatial scales, with small but significant variation occurring at larger spatial scales. Fish populations (abundance and size) were strongly influenced by benthic community structure (coral size and abundance), but not coral condition (old and recent coral mortality, incidence of disease/bleaching). Significant differences were seen at larger spatial scales (100 km) in the abundance of commercially significant species (snappers and groupers) that do not seem to be related to differences in benthic parameters. These differences may reflect either the effects of fishing pressure and/or differences in larval supply. We summarize our results by demonstrating how integrating assessments of benthic habitats and fish resources can be used to improve spatially explicit habitat models and predictive management strategies.

Halfbeak, *Hemiramphus* spp., fishing and spawning grounds in south Florida

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We observed changes in the fishing patterns of halfbeak fishers in south Florida and are evaluating how these changes may affect the halfbeak fishery and the target species of that fishery: ballyhoo (*Hemiramphus brasiliensis*) and balao (*H. balao*). A specific question from managing agencies and the industry itself was how much the fishing grounds and spawning grounds overlapped. Data available prior to the present study pertained mostly to ballyhoo and were not spatially explicit, so new collections were necessary. Using both fishery-dependent and fishery-independent collections, we monitored fishing effort, catch, and halfbeak reproduction from November 1995 to February 1999.

Both species mix above the coral reef tract, but ballyhoo are also distributed widely inshore of the reef tract. The reproductive biology of halfbeaks is similar to other Atheriniformes but is quite different from other coral reef fishes. Females have group-synchronous oocyte development, a common marine fish trait, but batch fecundities are relatively low (500-2000 eggs) and hydrated oocytes are relatively large (about 2.5 mm diameter). At least some females appear capable of spawning daily for several months (March-August), so annual fecundity may be quite high. Neither species is well represented in regional ichthyoplankton surveys, so to determine spawning areas, we mapped the distribution of females whose oocytes were in the final stages of maturation. Our data show that both

species spawn throughout the Atlantic Ocean fishing grounds. Florida Bay is also identified as an important spawning area for ballyhoo, but not balao.

Evaluación de la Pesquería Demersal de Media Altura del Oriente de Venezuela, Período 1981-1997

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En este trabajo se hace una evaluación, por medio de modelos de dinámica de biomasa, de los principales recursos explotados por la pesquería demersal de media altura que opera en el Oriente de Venezuela, durante el período 1981-1997. Las especies más importantes están representadas por el mero fraile *Epinephelus flavolimbatus* y el pargo colorado *Lutjanus purpureus*. El mero fraile es la especie objetivo de la pesquería palangrera de fondo, mientras que el pargo colorado es la especie objetivo de las embarcaciones que operan con cordel. Los datos de captura y esfuerzo por arte de pesca provienen de los datos de las bitácoras de pesca y del control de los desembarques en los puertos más importantes de la región. Las capturas del pargo colorado han oscilado entre 350 toneladas y 2.000 toneladas, mientras que en el caso del mero fraile las capturas totales de esta flota han variado entre 670 toneladas y 2.400 toneladas. En ambas especies los índices de abundancia han mostrado una tendencia a la disminución a lo largo de la serie de tiempo, con una ligera tendencia al incremento en años recientes. De mantenerse el esfuerzo de pesca de los distintos artes a niveles similares a los observados en los últimos años, cabe esperar una recuperación importante del nivel de capturas de ambas especies. En lo que respecta al pargo colorado la Captura Máxima Sostenible (CMS) se estimó en 840 toneladas con un esfuerzo correspondiente de 80.000 cordeles por días de pesca. La CMS del mero fraile se estimó en 1.450 toneladas y el esfuerzo correspondiente en 10.300.000 anzuelos.

Assessment of the Artisanal Medium Range Demersal Fishery of Eastern Venezuela, Period 1981-1997

A biomass dynamic model is used to assess main resources exploited by the artisanal medium range fishery off eastern Venezuela during the period 1991-1997. The most important species are yellowedge grouper, *Epinephelus flavolimbatus*, and red snapper, *Lutjanus purpureus*. The yellowedge grouper is the target species of longliners and red snapper is the target species of hook and line boats. Catch and effort data by fishing gear have been gathered through log-books and landing controls in main ports of the region. During the study period, red snapper landings have varied between 350 and 2,000 MT, while yellowedge grouper landings have been between 670 and 2,400 MT. For both species, CPUEs have shown a decreasing trend during most of the time series with a slight increment in recent years following fishing effort reductions. Results indicate that if fishing effort is maintained at present levels, a substantial increase in catches may be expected. Red snapper MSY was estimated at 840 MT with a corresponding effort of 80,000 lines times days fishing, and yellowedge grouper MSY was estimated at 1,450 MT with a corresponding fishing effort of 10,300,000 hooks.

Seasonal Colonization of Artificial Low Profile Reefs in Mississippi Coastal Waters: Vertebrates

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The popularity of low profile reefs as fishing banks prompted the State of Mississippi to develop new artificial reefs and to augment existing oyster shell reefs. The creation of artificial fishing reefs from concrete rubble, crushed limestone, and oyster shells in Mississippi coastal waters provided an opportunity to obtain information on the colonization and utilization of these different substrates by benthic fauna. In this study, vertebrate colonization was compared between two substrate types, crushed limestone gravel and oyster shell. Colonization was determined by placing trays containing the reef material on an existing shell/gravel reef approximately 300 yards from shore in central Mississippi Sound. Every three months the trays were returned to the laboratory and all organisms were removed and identified to the lowest taxonomic level. Fish were measured to the nearest 0.1 mm TL and weighed to the nearest 0.01 g. Fish colonizing the reefs included members of the following families: Gobiidae (*Gobiosoma bosc*), Blenniidae (*Hysoblennius ionthas*), Gobiesocidae (*Gobiesox strumosus*), Ophichthidae (*Myrophis punctatus*), and Batrachoididae (*Opsanus beta*). The structural complexity of the reef appears to control population size structure and density. Differences in species composition and size may be related to the availability and size of "niches" provided by the oyster shell and limestone gravel. Although species composition between the two substrates was similar, significantly larger animals colonized the oyster shell than the crushed limestone gravel. Oyster shells provided fewer, but much larger niches than those found in crushed limestone gravel.

The Caribbean Aquaculture Association: Past, Present and Future Direction

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The Caribbean Aquaculture Association (CAA) was established at the University of Puerto Rico in 1983. CAA's missions are to: a) foster common interests in Caribbean aquaculture; b) develop communication and cooperation among Caribbean aquaculturists; c) help coordinate aquaculture research efforts in the Caribbean, and d) encourage practical application of research techniques to aquaculture. The CAA is an Associate Member of the World Aquaculture Society (WAS), and has co-sponsored WAS annual meetings in Puerto Rico (1990), Orlando (1992), New Orleans (1994), and San Diego (1995). The Association is currently headquartered at Harbor Branch Oceanographic Institution in Fort Pierce, Florida USA and conducts its annual business meeting at the Gulf and Caribbean Fisheries Institute (GCFI) conference. At present, there are approximately 120 active CAA members representing 23 countries worldwide. CAA members receive a biannual newsletter on regional aquaculture, quarterly copies of the WAS magazine "World Aquaculture," and discounts for both WAS and European Aquaculture Society (EAS) meetings and publications. Future efforts will center on improving communication among members through a CAA web page, instituting a CAA listserve, and increasing membership among under-represented countries in the Caribbean region.

Larval Biology and Transport Scenarios for Lutjanids and Haemulids of the Dry Tortugas and Southwest Cuba: Implications for Zoogeography and Fishery Reserves

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At least three categories of biotic variables may have a primary influence on larval transport patterns: the locations and timing of spawning, planktonic larval durations (PLDs), and larval behaviors. In the Dry Tortugas area and southwest Cuba, over 25 spawning aggregation sites for 8 snapper species have been tentatively identified. Based on otolith increment counts of settlers or increment transitions associated with settlement, mean planktonic larval durations (PLDs) ranged from 31-42 d post-fertilization in 6 snapper species (*Lutjanus* and *Ocyurus*) and from 13-20 d in 6 grunt species (*Haemulon* and *Anisotremus*). Larval behaviors that foster retention may influence transport more than PLDs and indirect behavioral information from ichthyoplankton sampling, larval morphologies, and patterns of metamorphosis is available. Snapper larvae occur offshore while grunt larvae are rare in offshore or inshore surface waters despite often being gregarious "settlers" on nearby benthic habitats. Grunt larvae may associate with the middle or lower water column in a saltatory manner, characterized by near-bottom associations as early as the flexion-stage. Gyres associated with the Dry Tortugas, the southwest FL shelf, and the Pourtales platform, can be present during spawning seasons. Off southwest Cuba, an area of extensive reefs and spawning activity, a variety of cyclonic and anticyclonic features have been identified by satellite-tracked drifters. In both regions, these features can have residence times exceeding known PLDs, suggesting that within-subsystem retention may be high. Based on PLDs and behavioral information, grunt populations may be less subject to advection than snappers. Coupled abiotic and biotic examinations of this and alternative hypotheses of taxa-specific variations in larval transport will be discussed. Preliminary comparisons suggest that inter-regional zoogeographic patterns of several species are influenced, in part, by larval transport. The hypothesis of at least partial self-replenishment is becoming increasingly valid in several areas often assumed to primarily export spawning products.

Use of Decision Support Procedures to Evaluate Nine Beach Management Policy Alternatives in Southeast Florida

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The combined use of decision support systems and risk assessment procedures may aid evaluations of competing policy alternatives in coastal habitat management. Using the analytic hierarchy procedure and a framework of stressor and effect relationships, intuitive models to identify optimal policy combinations were developed to assess effects of differing beach management alternatives upon representative coastal fishes of southeast Florida. Based on a 87-yr database, at least 47 beach widening projects in the last 39 yr have discharged approximately 48,000,000 yd^3

of mid-shelf sediments within an intertidal/subtidal corridor of approximately 500 ft x 110 mi. At least 80,000,000 yd^3 of additional sediments are planned for discharge within the same corridor over the next 48 yr. At least 30 acres of nearshore reefs and 35 acres of seagrass beds have been buried since 1970 (data on reef impacts at many sites are unavailable). Over 515 species of invertebrates and fishes are now known from nearshore reefs affected by these projects. Despite dozens of monitoring reports, journal publications or detailed information on effects and optimal mitigation options are absent. Ideally, permitting protocols would include requirements for journal-quality monitoring of particular projects, a functional equivalent of the performance bonds required of the engineering firms that execute these projects. Decision support analyses of the ichthyofaunal effects of nine policy alternatives using a ratings model identified sand transfer plants (STPs) as the most preferred technology among sedimentary deposition alternatives. Offshore dredging and inshore filling (restoration/renourishment) and nearshore berms ranked as the least favorable alternatives. The assumption that large dredge-and-fill projects in southeast Florida are environmentally benign may be premature. Combinations of several alternatives in addition to dredging (particularly, increased use of STPs) may be technically and politically feasible for enhanced environmental management of Florida's beach systems.

Efficacy of Two and Three Chamber Light Traps for Presettlement Fishes and Zooplankton from Mangrove and Coral Reef Habitats at Key Largo, Florida

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Light-traps have been used in ichthyo- and invertebrate zooplankton studies to sample the larval and juvenile stages of fishes and invertebrates that are often inadequately sampled with conventional nets. Light-traps can be used in shallow areas where the use of towed nets is difficult, such as in mangroves and over coral reefs. Our purpose was to field test and compare the efficacy of two- and three-chamber light traps in these two habitats. Three-chamber traps significantly out-performed two-chamber traps in both the mangroves and over the reef, collecting 7 and 9.5 times the number of fish larvae per hour, respectively. The three-chamber traps also sampled a greater diversity and abundance of invertebrate zooplankton.

Preliminary Results from an Experimental Trap Fishery for the Spotted Spiny Lobster, *Panulirus guttatus*, at Bermuda

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A two year experimental trap fishery commenced in April 1998 to assess the feasibility of re-establishing a commercial fishery for this species following the fish pot ban of 1990. This species was caught historically in fish pots and commercial landings are presented for the period 1975-98 although no measures of directed effort are available. The experimental fishery is testing two trap types, a commercially manufactured plastic crustacean trap (Fathoms Plus) and a wire mesh trap produced by the Division of Fisheries. A small number of commercial fishermen were provided with equal numbers of the two trap types to fish commercially with the provisio that detailed information on trap catches was provided. In addition, biological sampling was conducted by the authors to collect data on size structure, sex ratio and reproductive condition. A total of 11,119 spotted spiny lobsters were caught in the first year with over 60% taken in the plastic traps. The catch per unit effort (CPUE) values were 1.70 and 1.39 for the Fathoms Plus and wire traps, respectively. In addition, the fish by-catch in the Fathom Plus traps were less than 20% of the level in the wire traps. There was marked seasonality in the catch rates with the highest

catches recorded from July to November. The biological sampling revealed a male-biased sex ratio in the trap samples of approximately 10:1, and the mean size of males was larger than females. The presence of ovigerous females in the catches indicated that the productive period was from May to September with a probable peak in June.

Diferenciación Sexual e Inicio de la Madurez de la Cachicata Blanca, *Haemulon plumieri* (Pisces: Haemulidae) en la Parguera, Puerto Rico

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La cachicata blanca, *Haemulon plumieri* representa una especie dominante y un componente importante en la pesquería deportiva y comercial de aguas del Caribe. Por ser uno de los peces de mayor preferencia gastron≤mica dentro de su familia y debido a las artes de pesca empleadas en su captura, se encuentra en riesgo de sobrepesca. Los estudios reproductivos necesarios para el manejo de la especie como recurso en explotaci≤n son escazos y generalmente dirigidos hacia individuos adultos. Con el fin de caracterizar las etapas tempranas del desarrollo reproductivo y determinar la talla en la cual se inicia la diferenciaci≤n y la madurez sexual en *H. plumieri,* se realiz≤ un estudio en arrecifes de La Parguera de febrero a mayo de 1997. Se anotaron detalles individuales de comportamiento, talla, ubicacion dentro o fuera de la costa y se le asign≤ el estadio gonßdico correspondiente. Se encontr≤ que la talla mφnima de diferenciaci≤n sexual fue de 72 milimetros (mm) de longitud horquilla (LH) en las hembras y de 86mmL H en los machos, mientras que la madurez sexual se inicia a 91 y 86mmLH para hembras y machos, respectivamente. El 50% de machos maduran a partir de los 80mmLH, y las hembras desde 120mmLH. Estos valores son menores que los reportados anteriormente para la misma especie. Se discuten estos resultados con los reportados por otros autores para H. plumieri en el Caribe.

Sexual Differentiation and First Maturation of the White Grunt, *Haemulon plumieri* (Pisces: Haemulidae) in La Parguera, Puerto Rico

The white grunt, *Haemulon plumieri* represents a dominant species and an important component of the sport and commercial fishery on the Caribbean waters. Because it is one of the fishes with greater gastronomic preferences in its family and due to the improper fishing gear employed to catch it, this species is in risk of being overfished. The reproductive studies needed for the management of the species are scarce and generally directed to adult individuals. With the purpose to characterize the early stages of reproductive development also to determine the length at differentiation and first maturation in *H.* plumieri, one study was done in the reefs of La Parguera from February to May of 1997. Individual details of behavior, length, and inshore-offshore distribution were annotated and the corresponding gonadic stage was assigned. The minimal length found at sexual differentiation was 72 millimeters (mm) of fork length (FL) in the females and at 86mmFL in the males, while sexual maturity starts at 91mm for females and 86 mm for males. 50 percent (%) of the females were mature at 120mmFL and at 80mmFL for the males. These values are less than the previous values reported for this species. Our results were discussed with the other works made for *H. plumieri in* the Caribbean.

The Role of Nearshore Habitats as Nursery Grounds for Juvenile Fishes on the Northeast Coast of St. Croix, USVI.

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Three protected backreef embayments on St. Croix's northeast coast, were sampled quantitatively to determine species composition and juvenile fish abundance from October 1998 to September 1999. The study sites consisted of Yellowcliff Bay, Teague Bay and Cottongarden Bay. Juvenile reef fish assemblages were monitored using three complementary sampling methods: a visual strip transect census, fish traps and beach seine. Comparing juvenile fish communities from distinct habitats (patch reef, seagrass, rubble, algal plains, and sand) within the three embayments identified significant differences in species richness and abundance of juveniles. Patch Reef habitats had more species diversity than any other habitat. Most juvenile fish observed among the sites were scarids, labrids and haemulids. The Slippery Dick *Halichoeres bivittatus* and the Bucktooth Parrotfish *Sparisoma radians* and the Spotted Goatfish *Pseudupuneus maculatus* were among the most abundant species. Preference of nearshore habitats by economically important juvenile reef fishes, suggests a serious concern for habitat conservation.

Overview of the Spiny Lobster *Panulirus argus* Commercial Fishery in Puerto Rico During 1992-98

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Puerto Rico=s fishery has shown symptoms of overfishing for the last fifteen years. The spiny lobster, *Panulirus argus*, is the most important shellfish in this fishery. Since 1985, *P. argus* has been protected by fishing regulations. The minimum legal size for this species is 89mm (3.50 inches) carapace length (CL). This measure is related with the minimum size of sexual maturity. Landings data indicated that 1.6 millions pounds were caught in Puerto Rico during 1992-98. Traps caught 51% of the *P. argus* landings and divers caught 41% during the same period. To evaluate the resource=s status it is necessary to obtain size frequency data. From 1992-98 approximately 5,300 *P. argus* caught by commercial fishermen in Puerto Rico were measured CL by personnel of the Fisheries Research Laboratory of the Puerto Rico Department of Natural and Environmental Resources.

The landings, catch per unit effort(CPUE) , and length frequency distribution data during 1992-98 will be analyzed to evaluate the status of P. argus.

Portrait of the Commercial Fishery of the Red Hind *Epinephelus guttatus* in Puerto Rico During 1992-1998

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Puerto Rico=s fishery has shown symptoms of overfishing for the last fifteen years. Grouper represented 4% of the total catch reported in Puerto Rico. The red hind, *Epinephelus guttatus*, is the grouper most reported in the landings of the commercial fishery and also is a very important component of the first class fish. *E. guttatus* is a protogynous hermaphrodite and forms spawning aggregations. This event occurs around the full moon of

December, January and February. The spawning aggregation sites are well known by commercial fishermen, leading to a high exploitation of *E. guttatus*. This activity affected negatively the reproduction of this species.

Since 1995, some *E. guttatus* spawning aggregation sites off the west coast of Puerto Rico were closed to all fishing activity. This paper will analyze the landings data, catch per unit effort (CPUE) data, and length frequency distribution data during 1992-1998 to asses the status of *E. guttatus*.

Preliminary Observations of Reproductive Failure in Nearshore Queen Conch in the Florida Keys

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In the Florida Keys, adult queen conch occur nearshore in shallow water and offshore adjacent to the reef tract. Although anecdotal reports indicate that conch reproduced nearshore as recently as the mid-1980s, we have not observed reproduction during extensive nearshore population surveys conducted over a 12year period. Reproduction is commonly observed in offshore populations, however. We compared differences in the reproductive viability and in the mating and spawning frequency of conch at two nearshore and two offshore sites. Reciprocal transplants of adult conch were made in March, 1999 between pairs of nearshore and offshore sites, resulting in each site having both nearshore and offshore conch. Histological examination of individuals collected prior totransplanting indicated that all offshore animals exhibited active gametogenesis. No oogenesis was observed in nearshore females and few nearshore males exhibited normal spermatogenesis. Gonadal tissue occupied 20%or less of the available volume in nearshore conch compared to 50-80% of the available volume in offshore conch. Three months after transplant, nearshore conch were observed reproducing at offshore sites and offshore conch also reproduced after transplant to nearshore sites. Mating by nearshore animals was observed only twice at nearshore sites and nearshore females remaining at nearshore sites were never observed spawning. These preliminary results suggest that some component of the nearshore environment disrupts reproduction in conch; that reproductive failure requires chronic exposure in the nearshore habitat of more than three months; and that removal of nearshore animals tos uitable offshore habitat can increase reproductive viability of those transplanted adult conch.

A Bioenergetics Approach for Estimating Prey Demand by Red Snapper (*Lutjanus campechanus*) on Alabama Artificial Reefs

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Red snapper is a highly exploited finfish in the Gulf of Mexico. Following a near collapse, stocks began to recover in the 1990s; this recovery has been attributed in part to an increase in habitat in the form of artificial reefs. However, some scientists question whether artificial reefs produce fish or attract fish. In other words, do artificial reefs produce new biomass thereby increasing production or do they merely aggregate fish from surrounding areas? Bioenergetics can help to resolve the production versus attraction debate. Bioenergetics describes the energy flow through an organism or groups of organisms, and provides the framework necessary for relating feeding and growth rates to environmental conditions. By combining bioenergetics models with *in situ* estimates of red snapper diet, growth rate and abundance on artificial reefs, population consumption rate can be estimated. Estimates of prey demand will be equated with estimates of prey availability to determine if reefs can support high snapper biomass. In this presentation I will discuss the size-specific diet of red snapper and preliminary data estimates of the bioenergetics budget for red snapper. Diet analysis to date suggests that snapper feed mostly on crustaceans and fish.

Organising Fisherfolk in Barbados Without Completing a Clean Round

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In equestrian terms a clean round describes the completion of a prescribed course of jumps without time faults or jumping faults. In Barbados a prescribed course was set for the organisation of fisherfolk into formal groups such as associations or co-operatives. This was through a Fisherfolk Organisation Development Project that has been reported upon at previous meetings of the Gulf and Caribbean Fisheries Institute. The course was prescribed and bounded in time by the project work plan. From inception, most of the obstacles were spotted in the distance and prepared for, but some proved deceptive and difficult to overcome. Likewise the timing was calculated, but with each obstacle the course proved longer. We did not complete a clean round. This paper reviews the Fisherfolk Organisation Development Project that was implemented between June 1997 and July 1999 in Barbados. Features of the project and its results are analysed in relation to a framework of factors derived from the literature on co-management and institutional analysis. Some alternative approaches and future options for extending the work of the project into a long-term programme are explored.

Bioeconomic Analysis of Effort Reductions in the Florida Spiny Lobster Trap Fishery

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This paper reports the results of an integrated biological and economic analysis of the Florida spiny lobster (*Panulirus argus)* fishery. Using surplus production models combined with economic production cost models, the analysis is used to evaluate levels of fishing effort (traps) that are compatible with alternative management objectives for the fishery. The analysis indicates that the current effort of approximately 600,000 traps that has resulted from mandated trap reductions under the Florida Spiny Lobster Trap Certificate Program (TCP) are not consistent with efficient effort levels for the fishery. While the TCP has reduced trap effort in the fishery by nearly one-third since 1992, further trap reductions would be necessary to achieve economic efficiency. But, these reductions may have significant structural and distributional effects within the harvesting sector. The opportunity to transfer ownership of certificates under the TCP has resulted in some consolidation of fishing effort and the use of a trap "buyout" program is discussed as one possible mechanism to reduce fishing effort. Yet, the analysis suggests that the Florida Marine Fisheries Commission faces some difficult decisions about the desired long-term level of effort in the fishery and the most appropriate regulatory tools to achieve this effort level.

Identifying and Mapping Essential Fish Habitat for Brown Shrimp, *Farfantepenaeus aztecus*, in Galveston Bay, Texas

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A first step in identifying Essential Fish Habitat (EFH) for fishery species is to identify density patterns in relation to habitat characteristics. Brown shrimp *Farfantepenaeus aztecus* inhabit estuaries of the Gulf of Mexico during a critical period of their life cycle, and juveniles are present in estuarine habitats from spring through fall. We analyzed a large density database of quantitative enclosure samples (3,864 drop samples taken over a 16 year period)taken in Galveston Bay, Texas to isolate patterns of habitat selection for young brown shrimp. Observed distributional patterns were then extrapolated to ther est of the bay system using a geographical information system (GIS) to provide a spatial mosaic of potential EFH.

Habitat types included *Spartina alterniflora* marsh edge, submerged aquatic vegetation, and shallow non-vegetated bottom, and the analysis was further partitioned along seasonal temperature and salinity gradients. A model was developed to predict brown shrimp densities in relation to these habitat characteristics using multiple regression techniques. Model results were then applied to habitat geographies in the GIS. The identification of marsh edge as a highly-utilized habitat type in contrast to inner marsh (marsh surfaces located > 5 m from open water) presents problems in this type of analysis. Available geographic coverages for habitats cannot distinguish among these habitat types. We are currently developing an approach that combines digital imagery with National Wetland Inventory coverages in an attempt to map marsh edge habitat.

Logical Framework Analysis as a Tool for Management of a Tropical Fishery

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With the current state of exploitation, and economic importance, of the marine fishery resources of the eastern Caribbean, it may be timely to consider the development of a new approach to management of fishery resources. It has been suggested that there should be a reorientation of fisheries science toward the management of small stocks such as those prevalent in developing countries, most of which are tropical. The perception that management and management planning cannot begin until the stocks have been assessed is a view which has proven detrimental to fishery management in developing countires. OECS States have followed a management sequence of: preliminary fishery assessment; policy establishment; management strategy formulation; fishery assessment, including stock assessment; and finally implementation. This sequence focuses more on individual stocks or species groups than on the fishery as a whole. In this paper we consider the utilization of the Logical Framework Analysis approach for management of the shallow shelf and reef fishery of the island of Angulla in the British West Indies. Based on the stated goals and objectives of fishery management in that territory, we derive a Logical Framework model; and

suggest that this approach could provide for a comprehensive and holistic view for fisheries management in the Caribbean region.

Distribution and Abundance of *Strombus gigas* Veligers at Chinchorro Bank Quintana Roo, Mexico

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To determine the distribution and abundance of *S. gigas* veligers, duplicate plankton samples were collected bimonthly from August 1997 to July of 1998 in six sites at Chinchorro Bank. Plankton tows were realized with a conical net 0.5 m diameter and 202 µm mesh opening. 58.52% of veligers were found in rainy season, 35.46% in cold season and only 6.02% were collected in dry season. Higher abundance occurred at stations Penelope, Centro Key and Centro West Key. 89.08% of veligers corresponded to stage I, 3.76% to stage II, 0.25% to stage III, 6.52% to stage IV, and only 0.38% were competent, and suggest that Chinchorro Bank is an important source of veligers. Larval density varied from 0.00093 veligers.$10m^{-3}$ at Lobos key in May to 7.42 veligers.$10m^{-3}$ at Penelope in August. Larvae abundance was related with juvenile "zero-phase" abundance in the bottom.

Vibrio vulnificus Responses to Cold Shock

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Vibrio vulnificus is a common pathogenic bacterium in estuarine waters of temperate and tropical climates. This bacterium, found in oysters and other shellfish, can cause fatal primary septicemia and severe wound infections to individuals with certain underlying conditions. When *V. vulnificus* is stressed by cold temperature it rapidly undergoes morphological changes where rod shape cells become coccoid-like shape and osmotically sensitive. Bacterial death rapidly follows. Since *V. vulnificus* is able to enter the blood stream from the guts of individuals who suffer from preexisting illnesses, we have theorized that this bacterium is able to penetrate animal membranes in order to survive during stress condition such as cold temperature. We speculated that V.vulnificus is able to enter host tissue by sloughing off the cell wall to facilitate movement across membranes. Experiments conducted on twelve different clinical isolates of *V. vulnificus* showed a much more rapid die-off (3-4 times faster than standard ATCC strain) when the cultures were subjected to cold shock. These clinical isolates readily lose cell walls when cold shocked, further suggesting that loss of the wall facilitates cell survival by enabling entrance into host tissue. We conducted experiments using a dual growth chamber that was partitioned by a polycarbonate membrane filter of either 0.2 or 0.4mm pore size. Observations showed that cold shocked cultures passed through the 0.2mmpore size filter membrane more readily than the room temperature cultures. So far our experiments have demonstrated that V. vulnificus can easily penetrate membranes after cold shock as a result of sloughing off its cell wall, thus enhancing survival and enabling wintering over.

An Analysis of REEF Fish Survey Data from Marine Protected Areas

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The REEF/TNC Fish Survey Project is a volunteer fish monitoring program that was developed by the Reef Environmental Education Foundation (REEF) with support from The Nature Conservancy (TNC). REEF volunteers collect fish distribution and relative abundance data for the Project using a standardized visual method. These data are uploaded to a database that is housed on REEF's Website (http://www.reef.org). To date, the REEF database contains over 16,000 surveys from approximately 1,400 sites in the tropical western Atlantic region. The standardized census method provides a consistency in data collection applied over a wide geographic range. Such a database represents a valuable tool for marine resource managers. REEF data are currently being used to assist in the evaluation of the efficacy of harvest restrictions in the Florida Keys National Marine Sanctuary (FKNMS). Preliminary analyses on fisheries-targeted species within the FKNMS zones and other Caribbean marine protected areas (MPAs) will be presented.

Discriminating age-0 Red Snapper, *Lutjanus campechanus*, from the Northern Gulf of Mexico

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Natural biogeochemical tags of age-0 red snapper, Lutjanus campechanus, nursery areas in the northern Gulf of Mexico were determined based on sagittal otolith microchemistry. In 1995, 1996, and 1997, age-0 red snapper were collected from historically important nursery areas off Alabama, Mississippi, Louisiana, and Texas. Otolith microchemistry of these fish was determined by inductively coupled plasma-atomic emission spectrometry (1995) and by inductively coupled plasma-mass spectrometry (1996, 1997). Multivariate statistical techniques (MANOVA, discriminant function analysis (DFA), and canonical discriminant function analysis) were employed to determine the microchemical tags of different nursery areas. In 1995, age-0 fish were correctly classified to nursery area based on DFA results with accuracies greater than 90%, while 1996 age-0 fish were correctly classified with accuracies greater than 85%; statistical analyses are as yet incomplete for the 1997 age-0 fish. Future research will focus on determining the otolith core microchemistry of adult red snapper from offshore reefs in the northern Gulf of Mexico, and determining the nursery areas from which they recruited based on the microchemical tags developed from age-0 red snapper otoliths.

Elemental Signatures of Red Drum (*Sciaenops ocellatus*) Otoliths from the Gulf of Mexico and Western Atlantic Ocean

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The red drum (*Sciaenops ocellatus*) is an important estuarine-dependent species that supports recreational fisheries in the Gulf of Mexico and western Atlantic. In the mid-1980s, concerns about overfishing of red drum resulted in recreational catch limits and a ban on commercial fishing in Florida. Recent studies offshore of Tampa Bay, FL, suggest that at least in that area the species is recovering. However, the exact stock structure of red drum in the entire Gulf of Mexico remains unclear, despite its importance in management practices. Although genetic studies have shown that there are weakly differentiated populations in the Gulf of Mexico and a separate population in the Atlantic, for the purposes of fisheries management a single stock is considered to reside in the Gulf. However, as is the case in any genetic study that is unable to distinguish among sample locations, it is impossible to determine if connectivity is ecologically significant as well because only a small amount of genetic exchange is required to maintain homogeneity between stocks. Otolith chemistry has recently proven to be a useful natural tag for examining the stock structure of fishes because it can reflect the elemental composition of the water in which the fish resides. Juvenile red drum otoliths from Texas, South Carolina, and Georgia and from several sites in Florida, including Tampa Bay, Cedar Key, and Indian River, were analyzed using solution-based ICP-MS. Five elements (Mg, Mn, Zn, Sr, and Ba) were routinely detected above background levels. Discriminant function analysis indicated significant differences in the otolith chemistry of the red drum collected at different sites (Wilk's Lambda = 15.80, P=0.0001). A cross-validation procedure was able to correctly classify otoliths from the Florida sites with an accuracy of up to 95%. Although the origins of the otoliths from the other sites were not so clearly identifiable, this research demonstrates the potential of using otolith chemistry to delineate the stock structure of red drum throughout their range.

Growth of Queen Conch, *Strombus gigas*, on Coral Reefs in Yucatan, Mexico
Resultados Preliminares de Crecimiento de *Strombus gigas* en el Arrecife Alacranes Yucatan, Mexico

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El crecimiento de *Strombus gigas* se estudis en el Arrecife Alacranes Yucatan, Mexico, mediante el metodo de marcado recaptura de individuos localizados mediante el buceo libre. Los sitios de muestreo fueron seleccionados tomando como base el estudio "Estimacisn preliminar de la densidad y talla del caracol rosado, *Strombus gigas* (Linni, 1756) en el Arrecife Alacranes, Yucatan Mexico", en el que se obtuvo una densidad media de organismos por

metro cuadrado de 0.006 individuos/m2. De dicho trabajo se tomaron los sitios donde se encontrs por lo menos un individuo. Los caracoles fueron marcados con trozo de cinta plastica de color naranja de tres cm de longitud por 5 mm de ancho, numeradas con un dymo y sujetas a la espira con cinturones de plastico de 24 cm. El marcado se realizs de marzo a diciembre de 1998 en ocho campaqas de trabajo y de enero a agosto de 1999 en siete campaqas, en un total de 109 sitios de muestreo. Se marcaron 775 individuos, 334 juveniles y 441 adultos. El marcado de los 775 individuos se realizs en todos los meses de muestreo. Los sitios de marcado fueron: 66 en la zona norte de la laguna arrecifal entre los 22: 30.

Distribution and Seasonality of Reproduction of the Queen Conch, *Strombus gigas*, on Coral Reefs in Yucatan, Mexico
Areas y Pocas de Reproduccion de *Strombus gigas* en el Arrecife Alacranes Yucatan, Mexico

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De enero a agosto de 1999 se estudiaron las areas y las ipocas de reproduccisn de Strombus gigas en el Arrecife alacranes Yucatan Mixico. Se definieron tres sitios principales de reproduccisn: al norte en las coordenadas 22: 34La reproduccion inicis en el oeste, en el mes de febrero, observandose un apareamiento, dos hembras desovando y la presencia de tres masas de huevo. En el norte y el sur no se observaron individuos. En junio, en el oeste se observaron 75 individuos, ocho apareamientos y cinco masas de huevo. En este mes, para la zona norte se registraron 22 individuos, una hembra desovando y cinco masas de huevo. En el sur no se observaron individuos. En agosto se registran 68 individuos, ocho apareamientos, tres hembras desovando y cuatro masas de huevo. Para este mes en el norte se registraron cinco individuos, una hembra desovando y una masa de huevos. Para el sur no se registraron individuos.

El tipo de fondo que se registrs fue de fondos arenosos con restos de coral para el norte, fondos duros con pedaceria de coral para el oeste y camas de arena rodeadas de pastos de Thalassia testudinum para el sur. La profundidades promedio a la que se encontraron los sitios de muestreo fueron de dos metros para el norte, cuatro metros para el oeste y 0.6 m para el sur. Las temperaturas promedio registradas fueron de 23: C para el mes de febrero en los tres sitios de muestreo, 30: C en junio y 31: C en agosto. Los resultados indican que el desove en el Arrecife Alacranes inicia en el mes de febrero en el oeste y continua hasta el mes de agosto al norte del arrecife. Se continuara el estudio hasta diciembre de 1999 para definir el ciclo anual de reproduccion.

Seasonal Colonization of Artificial Low Profile Reefs in Mississippi Coastal Waters: Invertebrates

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Artificial reefs serve as fish attractants and may increase production of some species by increasing habitat. In an effort to enhance already established recreational fisheries and to increase numbers of and access to less common

structure-associated fishes, Mississippi began building new low profile artificial reefs and augmenting existing ones. Over twenty inshore low profile oyster shell reefs were developed prior to 1995. Subsequent reef development has utilized limestone gravel in conjunction with oyster shell or limestone alone. The creation of limestone gravel and/or oyster shell reefs provided an opportunity to obtain information on the colonization of these different substrates by benthic invertebrates and on fish populations associated with these reefs. Colonization studies were conducted using trays of artificial substrate placed on a gravel/oyster shell reef located approximately 300 yards offshore in central Mississippi Sound. Trays contained crushed limestone gravel or oyster shells. Trays were removed every three months and all organisms were removed. Invertebrates were identified to the lowest taxonomic level, measured to the nearest 0.1 mm and weighed to the nearest 0.001 g. Dominant invertebrate taxa included representatives of the following groups: Xanthidae (*Menippe adina, Eurypanopeus depressus, Panopeus simpsoni*), Porcellanidae (*Petrolisthes armatus*), Alpheidae (*Alpheus angulatus, A. heterochaelis*), Palaemonidae (*Palaemonetes vulgaris*), Amphipoda, Polychaeta (*Neanthes succinea*), Bivalvia (*Ischadium recurvum*), and Gastropoda (*Stramonita haemastoma*). Data were obtained on species composition and seasonality by substrate type and on the relationship between substrate and species composition and size.

Habitat Use by Early Life-history Stages of Fishes and Crustaceans along a Changing Estuarine Landscape: Differences Between Natural and Altered Shoreline Sites

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The recent population explosion along the Gulf Coast of Mississippi has accelerated the development rate of waterfront property. In an effort to assess potential effects of this development we compared use of pristine and altered marsh edge by early life-history stages of fish and crustaceans. Monthly beam trawls were taken at 13 sites along shoreline habitats characterized by *Juncus/Spartina* marsh, natural beach, and areas altered by bulkheads and rubble. A total of 52,068 fish (n = 48 taxa) and 288,715 crustaceans (n = 24 taxa) were collected during a two year study. The most abundant fish groups included gobiids, sciaenids, clupeids, and engraulids. Crustaceans, excluding the copepods, were numerically dominated by mysids, both caridean and penaeid shrimps, and crabs (*Callinectes* spp.). Demersal residents were dominated by *Gobiosoma bosc* and *Palaemonetes* sp. whereas clupeiformes, sciaenids and penaeid shrimps were dominant among the nektonic and demersal transient species. These taxa were least abundant along stretches of shoreline altered with bulkheads or rubble, and were generally most abundant in marsh-edge habitats fringed with *Juncus/Spartina* grasses. These data support the hypothesis that marsh-edge habitat is critical to various life history stages of ecologically- and commercially-important species, illustrate the influence of altering natural marsh-edge habitat on resident and transient nekton, and provide quantitative data for resource managers in the continued efforts to preserve the complex estuarine marsh landscape.

Characterization and Partial Purification of Trypsin from Digestive Tissues of the Queen Snapper, *Etelis oculatus*: Considerations For Use as an Environmental Indicator

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Trypsin was partially purified and characterized from pyloric caeca and intestinal tissues of the queen snapper, *Etelis oculatus*. Highest enzyme activity was recovered in the 65% ammonium sulfate fraction. The enzyme was further characterized with respect to the effects of enzyme concentration, pH, inhibitor, temperature, and time. Its approximate molecular weight was also determined. Findings from this investigation are compared to the trypsin activity we earlier detected in the red hind grouper, *Epinephelus guttatus*. The results are also considered with respect to their potential utility as an environmental indicator.

Variables Ambientales Como Factores Importantes de la Distribución y Abundancia de la Fase Juvenil del Camarón Blanco (*Litopenaeus setiferus*) en la Laguna de Términos, Sur del Golfo de México

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El camarón es un recurso de importancia comercial que genera una gran cantidad de divisas a México. En el Golfo de México se cuenta con aproximadamente 772 embarcaciones que pescan camarón en todo el litoral hasta las 60 brazas de profundidad. Entre las especies capturadas se encuentra el camarón blanco (*Litopenaeus setiferus*), especie altamente cotizada por las grandes tallas que alcanza (22 cm LT). Esta especie es uno de los principales recursos pesqueros de camarón de las costas de Campeche, su captura no solo se realiza en alta mar sino en la costa y aguas interiores como la Laguna de Términos. Debido a la alta productividad de esta laguna y al ciclo de vida de la especie, en esta laguna se encuentran los juveniles, que permanecen hasta alcanzar la edad suficiente y migran al mar para madurar y reproducirse. Los factores que determinan la abundancia y distribución del camarón en la Laguna de Términos son abordados en el presente trabajo (octubre de 1997 y marzo de 1999), haciendo énfasis en su abundancia, densidad y variables ambientales asociadas a la fase juvenil de esta especie. También se realizan comparaciones de estas variables con estudios realizados en los años 70's y 80's para la especie la laguna de Términos. Los resultados indican que las variables ambientales que determinan la distribución y la abundancia de camarón son la salinidad y el oxígeno disuelto, presentándose valores medios de O_2 a 5.21 mg/l y salinidad media de 33.93 ‰ con tallas de 8.36 cm LT 1998, y valores medios de O_2 de 5.7mg/l, salinidad media de 26.17 ‰ con tallas medias de 7.09 cm LT durante la temporada de lluvias. Por otra parte las determinaciones de abundancia, mostraron que en los años setenta, la abundancia era menor con las mayores número de individuos en la zona este de la Laguna comparados con en número de individuos encontrados en el presente trabajo, en 1980 se reportaron altas densidades en noviembre con 1.1 ind/m2. En el presente estudio las densidades máximas se encontraron en julio con 0.253 ind/m2.

Environmental Variables as Important Factors in the Distribution and Abundance of the Juvenile Phase of the White Shrimp (*Litopenaeus setiferus*) in the Terminos Lagoon, Southern of the Gulf Of Mexico

The shrimp is a resource of commercial importance that generates a whole slew of currencies to Mexico. In the Gulf of Mexico is counted on approximately 772 vessels that fish shrimp in all the coastal until 60 depth fathoms. Between the captured species is found the white shrimp (*Litopenaeus setiferus*), species highly quoted by the large heights that reaches (22 cm LT). This species is one of the principal shrimp resources of the coasts of Campeche, its catches not alone fishing is accomplished in high sea but in the coast and interior waters as the Terminos Lagoon. Due to the high productivity of this lagoon and to the life cycle of the species, in this lagoon are found the juveniles, that stay until reaching the sufficient age and move to sea for the reproduction. The factors that determine the abundance and distribution of the shrimp in the Terminos Lagoon are approached in the present work (October of 1997 and March of 1999), making emphasis in its abundance, density and environmental variables associated with the juvenile phase of this species. Also they are accomplished comparisons of these variables with studies accomplished in the years 70's and 80's for the same species and in the Terminos Lagoon. The results indicate that the environmental variables that determine the distribution and the abundance of shrimp are the salinity and the dissolved oxygen, being presented values means of O_2 to 5.21 mg/l and salinity mean of 33.93 ‰ with heights of 8.36 cm LT for 1998, and values means of O_2 of 5.7mg/l, salinity mean of 26.17 ‰ with hosiery heights of 7.09 cm LT during the rains season. On the other hand the determination of abundance, showed that in the years seventy, the abundance was smaller with the greater number of individuals in the zone this of the Lagoon compared with in number of individuals found in the present work, in 1980 were reported high densities in November with 1.1 ind/m^2. In the present study the maximum densities were found in July with 0.253 ind/m^2.

Integrating Fish Fauna and Habitat Assessments: The First Step in Developing Marine Fishery Reserve Design Criteria

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We report experience using underwater transects in assessing *dominant* fish faunas, i.e., those of apparent trophic and fishery significance, after mapping transect substrates. Our objective is to classify the various habitats of nearshore coral reef ecosystems with respect to their relative significance in harboring life history stages of dominant fish species. This process will facilitate designing marine fishery reserves where habitats essential for long term fishery production and ecosystem conservation are represented and, if possible, replicated. Our framework is Lindeman's 'Cross Shelf Habitat' matrix, where each species is relegated to a single matrix whose elements describe the substrate where the species occurs. For a given species, as we have applied the matrix idea, this enables one to focus upon a matrix element and quantitatively describe the size distribution within one *habitat category*, a standardized substrate classification, and at one *cross shelf stratum*, a physical positioning approximately along a gradient from inshore to offshore. We use habitat category maps of transects to compute areas which are used to estimate fish densities for different lengths. Visual identifications and length estimates are used to generate length distributions within transect habitat categories. Standardizing habitat categories and cross shelf strata are challenging problems; accurately quantifying and identifying young fishes are difficult. But the framework offers a standardized descriptive language and clear data structure. The approach will likely yield a practical set of habitat selection criteria in designing viable marine fishery reserves.

Preliminary Results of the Reproductive Biology of the Black Grouper, *Mycteroperca bonaci* from the Southern Gulf of Mexico

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The Black Grouper, Mycteroperca bonaci, locally known as "Negrillo", is one of the 17 grouper species found at the Campeche Bank. Its importance relies on being after the Epinephelus morio, the largest catching volume specie and a very important source of food for the state of the state of Yucatan, Mexico. In spite of this fact, the Black Grouper has not been well studied and little is known about its biology not only in this particular zone but throughout all its distribution area. This paper shows some results on sex determination, sexual maturation and sexuality of M. bonci. After 3 years of sampling in the Campeche Bank a gonadic histological analysis was done. It included more than 800 samples of individuals between 50 to 130 cm Fl approximately. Sex determination shows 605 females, 205 males and 5 individuals in sexual inversion. Considering the sexual classes and seasonal variation in mean of GSI , a gonadal activity was found to be from December to March, with a spawning period clearly identified in January and February. It can be concluded as well, that M. bonaci is an hermaphrodite protogynous specie.

Pesca de Langosta (*Panulirus argus*) y Lambí O Caracol Rosado (*Strombus gigas*) en dos Areas Marinas Protegidas del Caribe: Parque Nacional Jaragua (República Dominicana) y la Reserva de la Biosfera Banco Chinchorro (México)

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El Parque Nacional Jaragua (PNJ) y la Reserva de la Biosfera Banco Chinchorro (RBBCH) se encuentran ubicadas en el Caribe. Antes de ser decretadas como áreas marinas protegidas ambas han sido utilizadas como sitios de pesca por más de 30 años, siendo sus principales pesquerías la langosta y el caracol rosado o lambí. Considerando diversos parámetros socioeconómicos y biológicos se realizó un análisis para determinar cuales son los aspectos que deben tomarse en cuenta para lograr el incremento de la protección y el uso sustentable real de estos dos recursos naturales. En el PNJ se encontró que la langosta ocupa el primer lugar en explotación, mientras que en la RBBCH se presenta el caso inverso. Independientemente de los artes de pesca utilizados ambas especies presentan sobre pesca en las dos areas, observándose una disminución drástica en las capturas anuales. El número de pescadores, su nivel de educación, las artes de pesca utilizados y la pesca ilegal son causas que han contribuido al deterioro de los recursos. No se respeta cabalmente la legislación actual y en ambos casos se requiere de estudios más detallados, enfocados principalmente a la identificación de áreas de reclutamiento. Los aspectos mencionados, junto con la creciente demanda del sector turístico por ambas especies, la falta de actividades socioeconómicas alternativas para los pescadores y la inmigración de pescadores de otras zonas son los principales factores externos que mayor presión ejercen sobre estos recursos.Consideramos que incidir directamente en los aspectos antes mencionados así como establecer zonas cerradas a la pesca que contengan poblaciones de juveniles y adultos además de áreas de reclutamiento es la única alternativa para lograr la conservación de ambas especies.

Lobster (*Panulirus argus*) and Queen Conch (*Strombus gigas*) in Two Marine Protected Areas in the Caribbean: Jaragua Marine National Park (Dominican Republic) and Banco Chinchorro Biosphere Reserve (México)

The Jaragua National Park (PNJ) and the Banco Chinchorro Biosphere Reserve (RBBCH) are located in the Caribbean. Before they were decreted as marine protected areas both have been utilized as fishery areas for more than 30 years. Their main fisheries are lobster and queen conch. Focousing on different socioeconomic and biologic aspects, an analisis was made in order to determine wich are the actions that should be executed to improve real protection and sustainable use of this natural resources.We found that lobster is the main fishery in PNJ, as queen conch is in Banco Chinchorro. Independently of fishing devices both species are overfishing in both areas, and a decrement was observed in anual catches. The number of fishermen, their educational level, fishing devices used and ilegal fishing had contributed to damage these natural resources. In both cases more studies are required to identify the recuitment areas. All of these aspects, including the higer turistic demand of these fisheries, lost of economic opportunities for fishermen and fishermen imigration from other areas, represent a real pressure over these natural resources.We consider that to work directly upon the aspects mentioned, as well as to establish zones that contain populations of juvenile and adult besides areas of recruitment is the only alternative to achieve the conservation of both species.

Alarming Overexploitation of the Caribbean Spiny Lobster Stock in Martinique : Ecological Point of View and Recommendations

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The Caribbean spiny lobster (*Panulirus argus*) is the most valuable marine species along the entire intertropical area of the western Atlantic. *Panulirus argus* represents 54 % of the world catch of Palinuridae, about 39,700 tons. From 1996 to 1998, I managed an ecological monitoring program and conducted grow-out experiments on spiny lobsters in Martinique, to evaluate the state of the stock and the potential enhancement in the West French Indies. Postlarval supply, as measured on surface collectors, is moderate and continuous throughout the year, and throughout the shallow water habitats. However, juveniles are rare in the wild and can not be concentrated or protected by artificial habitats. Three non-exclusive marine reserves exist in Guadeloupe, but there are none in Martinique, nor is there any biological monitoring of neritic populations, or of shallow water nurseries. In fact, the decline of *P. argus* stock seems to be inexorable. In absence of any enforcement of fishery regulations (established since 1970), the artisanal fishery is largely unregulated and now impacts juveniles as much as adult spiny lobsters. All significant local markets are provided by imports of live (St-Vincent, Grenadines) and frozen (Cuba) *P. argus*. Given the dire status of the wild population near Martinique, the potential for future juvenile culture is theoretically good but still limited by the availability of an adequate and inexpensive lobster food. There is much that can be accomplished in further applied research studies, but I must strongly recommend that local elected representatives work for respect of pragmatic regulations and the education of younger generations on the environmental problems facing Martinique and Guadeloupe.

Tag and Recapture Study of Red Hind and Coney at Three Spawning Aggregations Sites off the West Coast of Puerto Rico

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A pilot study of mark-recapture for red hind (*Epinephelus guttatus*) and coney (*Cephalopholis fulva*) was started at three closed spawning aggregations off the West Coast of Puerto Rico. It is expected that the closed season and area will provide for the population to recover from the heavy fishing pressure to which it is submitted. Also it will provide a better understanding of the movement behavior during the spawning aggregation period of the red hinds thru other research methods, such as tag and release. A study of this type provide information in the ability of the species to identify their spawning site (homing), and the distribution of the species. Luckhurst (personal communication) has shown that red hinds have the ability of homing and identify particular spawning sites.

A total of 351 red hinds and 547 coneys were tagged and released. At the beginning of the study (first two months) the animals were released, approximately 5 km from the area of capture. Thirty-two (32) recapture of red hinds have been recorded, representing 9.12% of total tagged individuals. A few red hinds have been recaptured more than once, for instance one individual has been caught three (3) times at the site of first capture. To maximize the probability of recapturing coneys a single site (Abrir La Sierra) was selected to capture and release the last 193 individuals. Thus, far no coney has been recaptured.

Size and Age of Juvenile Gag (*Mycteroperca microlepis*) At Egress from Estuary to Offshore Hardbottom In North Carolina

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Otolith microstructure of juvenile gag, *Mycteroperca microlepis*, collected during egress from New River Inlet, North Carolina, was examined to determine fertilization date, ingress date, ingress age, estuarine duration, and age at egress. Gag (mean total length=202.5mm; mean weight=120.6g) were collected using channel nets in the fall of 1997. Examination of lapilli showed that fertilization (spawning) occurred from 21 February to 19 May (mean date of 16 April) and larvae entered the inlet from 10 April to 29 June (mean date of 30 May) at a mean age of 43.8 days $\pm$ 4.4. Gag utilized the estuary for 77.7 to 163.7 days (mean = 114.2 $\pm$ 14.4) before emigrating to offshore reefs between the ages of 123.0 to 214.7 days (mean=158.0 $\pm$ 16.1). Data show that gag arriving in the estuary later in the ingress period leave the estuary at a younger age. While no correlation was found between catch per unit effort and temperature or salinity, standardized catches and salinity measurements suggest that increases in the number of gag at egress seem to occur with decreases in salinity associated with cold fronts. Examination of otolith microstructure is an effective means of determining many aspects of juvenile gag early life history events.

Selecting Biodegradable Fasteners and Testing the Effects of Escape Panels on Catch Rates of Fish Traps

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The 1998 Fisheries Regulations in Barbados require that all fish traps be fitted with a biodegradable escape panel and carry an identification marker. The first part of the study tests various biodegradable escape panel fasteners to find the pane that will open in no less than three weeks and no more than six weeks. Fasteners were made of materials which were low cost and readily available, and included: cane lily, coconut bark, caulking, no. 6 cotton, cane trash, paper ribbon, and hemp twine. The second part of this study compares the catch rates of conventional fish traps with identical traps fitted with escape panels and identification markers. This was done with the assistance of three commercial trap fishers over a 5-month period (January - May 1999), each fishing a different reef habitat using an equal number of conventional traps and new regulation traps fished side by side. The numbers, sizes, and species of fish taken were recorded for all trap hauls.

Trends in Catch, Effort and CPUE of the Demersal Shrimp Fishery of Guyana for the Period 1981-1997

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Trends in catch, effort and CPUE of the demersal penaeid shrimp fishery of Guyana for the period 1981-1997 are presented in this report. Data used in this study were obtained from plant and vessel production summaries and on-site data collection. A generally declining trend in the combined penaeid shrimp catches and the associated effort has been observed for the period studied, with the average annual production being around 2800 mt of tails for the

period 1980-1985 and 2000 mt for the period 1986-1990. In more recent years (1990-1997), production has ranged between 1500 and 1900 mt per annum. This trend indicates the possibility of significant changes in the temporal abundance of the shrimp species available to the fleets.

Effects of Refuge Size and Complexity on Recruitment and Fish Assemblage Effects of Refuge Size and Complexity on Recruitment and Fish Assemblage Formation on Small Artificial Reefs

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There have been a number of coral reef and artificial reef studies correlating refuge size and complexity with associated fish assemblages. Results of some of these studies have been contradictory indicating possible site dependent differences. We decided to assess the role of refuge size and complexity in fish recruitment and the formation of associated fish assemblages, using artificial reef modules, at two different depths off Fort Lauderdale, Fl. The reef modules (Swiss Cheese reefs) were constructed of $1m^3$ of poured concrete with 12 tunnels running through the block, six tunnels in each direction perpendicular to each other. Twenty replicates were constructed of each of three different refuge configurations, 12 large tunnels (square opening, 15 cm per side), 12 small tunnels (7.5 cm per side) or six large and six small tunnels. Ten replicates of each reef design were deployed at each depth (7m and 20m) on sandy substrate. Significant differences were found for recruits (fishes 0-5 cm TL), total fishes, species, and biomass between refuge configurations as well as depths. Additionally, this study was designed, in part, to replicate work done previously by others, in the Caribbean, examining the effects of refuge size on fish assemblage formation. Differences in assemblage structure were found between the two studies. This may be due, in part, to differences in local fish species composition and population structure.

Build It, but Will They Come? Preliminary Findings of Refuge Limitation Bottlenecking in Juvenile *Menippe adina* in the Mississippi Sound

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Many marine organisms are restricted to habitats which provide essential refuge. *Menippe adina*, the western Gulf stone crab, depends on patchy hard substrata in the otherwise soft-bottomed Mississippi Sound for individual and population survival. *Menippe adina* supports small, developing fisheries in Louisiana and Texas, and occurs as an incidental catch in the blue crab fishery in Mississippi and Alabama. Stone crab zoeae, megalopae, and small juveniles (10-24 mm carapace width) are relatively abundant in Mississippi Sound and the species does not appear to be recruitment limited. Larger juveniles are less common and their numbers may be related to quantity and quality of suitable habitat. There is strong evidence that refuge limitation exerts control on both population size structure and density of stone crabs. The establishment of low profile reefs in the Mississippi Sound has provided an opportunity for preliminary investigations of refuge limitation in local stone crab populations. Preliminary results indicate that suitable habitat is lacking for juvenile stone crabs and competition for available habitat may be acute between stone crabs and other xanthids (*Eurypanopeus depressus*, *Panopeus simpsoni*) as well as the toadfish, *Opsanus beta*.

Involving and Resolving Fishers' Issues In the Redesign of a Marine Reserve

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With the establishment of the Barbados Marine Reserve (BMR) in the early 80's , inshore fishers were restricted from operating within two (2) kilometer stretch of coastline on Barbados' west coast. This prompted claims of social displacement and inequity by the fishermen given the perceived bias towards tourism development along the island's "Gold Coast". At present, a government project is evaluating the feasibility of expanding and redesigning the BMR in the context of balancing social, economic, and ecological interests. This paper focuses on the issues and constraints encountered in involving fishers from five (5) fishing communities into the planning process. Available literature, structure and informal surveys, participant observation, field trips, workshops, and a series of roundtable meetings were the main tools used in the fishers' outreach exercise. Issues affecting the level of participation of the fishers included the perceived stake of the different communities, the presence of fisherfolk organizations, the scheduling of meetings, disenchantment with the existing BMR, disenchantment with public consultations, as well as limited project resources (time, financial, and human). Lessons learnt included the need to consider all relevant stakeholders from project conceptualization to project completion, and the need to provide adequate resources for public consultation purposes.

Potential Conflicts Between Deepwater Fishing and Oil and Gas Operations in the Gulf of Mexico

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The fishing and offshore energy industries have coexisted and developed amicably for many years in shelf waters of the northern Gulf of Mexico. Recently, the offshore energy industry in the Gulf has shifted its interest beyond the shelf into deep waters (>200 m). This is evidenced by over 3,000 active leases and about 50 development/production facilities in water depths greater than 200 m. Existing and future structures represent new and evolving technology which could interact with existing deepwater fishing practices. All phases of the deepwater offshore energy industry - geophysical surveys, exploratory drilling, development/production, and abandonment - could conflict with current deepwater fishing practices. In the northern Gulf of Mexico, these practices include trapping for golden crab, trawling for royal red shrimp, bottom longlining for groupers and tilefishes, and surface longlining for sharks and tunas. Of these gear types, the pelagic longline presents the greatest possibility for interactions or space-use conflicts. Our analysis of potential conflicts includes experience from domestic and international waters of the Gulf.

Calamares, Pesquería Potencial de la Plataforma Continental de Yucatan?

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Con base en los rendimientos en número de cajas de 10 kg por clase en tallas y en número de ejemplares de 10 cruceros de pesca experimental de calamar (*Loligo (=Doryteuthis) plei*) con poteras japonesas y máquinas semiautomáticas y manuales operadas a bordo de dos embarcaciones de bandera coreana en aguas mexicanas del Golfo de México, nueve de ellos en la plataforma continental yucateca, así como en la medición de la longitud del manto (cm) de 7123 ejemplares y del peso (g) de 7009 para determinación de las frecuencias correspondientes, coordenadas geográficas y número de lances por crucero; parámetros tales como poteras por línea y número de líneas, temperatura superficial del agua, fase lunar, estado del mar y dirección del viento , se estima que casi 60 toneladas capturadas evidencian la existencia del recurso, y también permiten recomendar impulsar un nuevo ciclo de cruceros con embarcaciones industriales yucatecas adaptadas a fin de abatir costos de operación.

Con base en 5879 cajas de 10 kg c/u de calamar (*Loligo (=Doryteuthis) plei* y Sepioteutthis sepioidea) capturado en aguas de la plataforma continental yucateca a bordo de 10 cruceros de pesca experimental con poteras, máquinas semiautomáticas y manuales a bordo de dos embarcaciones de bandera coreana, con un total de 313 lances; medición de la longitud del manto de 7123 ejemplares (cm) y del peso (g) de 7009 para determinación de las frecuencias correspondientes; coordenadas geográficas, número de lances por crucero; poteras por línea y número de líneas, temperatura superficial del agua, fase lunar, estado del mar y dirección del viento; se estima que casi 60 toneladas capturadas evidencian la existencia del recurso, y también permiten recomendar impulsar un nuevo ciclo de cruceros con embarcaciones industriales yucatecas adaptadas, a fin de abatir costos y hacer redituable la operación.

The Potential for a Squid Fishery on the Continental Shelf of the Yucatan?

With base in the yields in number of boxes of 10 kg for class in sizes and in number of copies of 10 cruises of experimental fishing of squid (Loligo (=Doryteuthis) plei) with Japanese poteras and semiautomatic machines and manuals operated on board two crafts of Korean flag in Mexican waters of the Gulf of Mexico, nine of them in the platform continental yucateca, as well as in the mensuration of the longitude of the mantel (cm) of 7,123 copies and of the weight (g) of 7009 for determination of the geographical corresponding, coordinated frequencies and number of you rush for cruise; such parameters as poteras for line and number of lines, superficial temperature of the water, lunar phase, state of the sea and address of the wind, are considered that almost 60 captured tons evidence the existence of the resource, and they also allow to recommend to impel a new cycle of cruises with crafts industrial yucatecas adapted in order to knock down operation costs.

Assessment of the Recreational Fisheries of Florida Bay and Adjacent Waters from 1985-1998

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A stock assessment based on recreational catch and CPUE from 1985-1998 was conducted on four of the most popular gamefish in Florida Bay (Everglades National Park): snook (*Centropomus undecimalis*), gray snapper (*Lutjanus griseus*), spotted seatrout (*Cynoscion nebulosus*), and red drum (*Scianops ocellatus*). The responses of catch and CPUE to fishing effort and environmental factors (rainfall, water level, and salinity) were determined.

Snook catch rates have shown a cyclical trend every four years. The peaks may reflect recruitment of juveniles

that were released in prior years because of size restrictions. Recruitment may also be enhanced by increased rainfall/runoff as there was a weak correlation between water levels recorded three years before and CPUE from 1985-1998. Although, no statistical significance was found, this trend suggests that periods of low salinity lead to increases in abundance.

During the 1990's, gray snapper CPUE and estimated total harvest have dropped as low or lower than anytime during the previous record and may be due to regulations imposed on the fishery in 1988 and 1990. A positive relationship was found between CPUE and mean annual salinities found in northern Florida Bay, suggesting that periods of high salinity may lead to increases in abundance. Mean annual rainfall and water levels were significantly inversely related to CPUE during the same year suggesting that low rainfall and water levels lead to increases in abundance.

Sport harvest rates for spotted seatrout have been holding steady since 1990; however, catch rates have increased recently. The lack of increase in harvest associated with the increase in catch may be due to size restrictions and to the increase in catch-and-release practices. A significant negative correlation was found between CPUE and annual water levels from the previous year. The increased rainfall/water levels may improve the recruitment of larvae and juveniles.

Red drum CPUE has been stable since 1989 when present bag limits were imposed No statistically significant relationships were found between CPUE and any of the environmental variables.

For each species, annual estimated total catch was highly correlated with the estimated total effort. This suggests that current catches do not greatly impact Florida Bay stocks and that additional increases are possible.

Reef Fish Demographics on Artificial Reefs: the Influence of Reef Design and Location

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In the past 40 years approximately 20,000 artificial reefs have been deployed within 3,100 km2 of artificial reef permit zones along coastal Alabama. The deployment of these reefs has led to increased fishing opportunities for both recreational and commercial fishermen. Undoubtedly, artificial reef construction has provided increased fish habitat. However, it is debated whether artificial reefs have helped to increase regional fishery production or served to increase fishing pressure by attracting fish from other habitats. To address the production versus attraction question, we deployed 7 replicated reefs of 2 designs within the Hugh Swingle General Permit Area in 20-30 m depth. These reefs were deployed without consideration of the location and abundance of nearby natural and artificial reefs. Since October 1998, we have assessed reef fish demographics on our experimental reefs by utilizing several methodologies, which include catch-per-unit-effort, diver surveys, tag-recapture techniques, and video camera. Preliminary results reveal high variability in reef fish abundance and size structure due to reef location, reef design, and sampling methodology. In addition, we assume high rates of turnover are occurring on our experimental reefs based on tag recaptures. Less than 9% of tagged reef fishes have been recaptured, and only 31 of 737 tagged reef fishes have been recaptured at their original tagging site. To explain the observed variability in reef fish demographics among experimental reefs we will be mapping the distribution and abundance of artificial reefs surrounding our experimental reefs. We believe the proximity and abundance of artificial reefs surrounding our experimental reefs will contribute to the observed variability in reef fish demographics on our experimental reefs.

Determinacion Electroforetica del Perfil Proteico del Caracol Rosado *Strombus gigas* en el Caribe Mexicano

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En la naturaleza prácticamente todas las especies de animales y vegetales existen como un mayor o menor número de poblaciones completa o parcialmente aisladas , propiciando con ello la aparición , ya sea de subespecies o subpoblaciones.

En el ámbito marino las poblaciones pueden ser definidas desde una perspectiva biológica, la cual implica algún nivel de aislamiento reproductivo o desde el punto de vista pesquero al cual concierne una descripción práctica de un grupo de individuos explotados en una unidad especifica. La caracterización de la estructura genética poblacional es de vital importancia para especies de interés comercial y ecológica ya que esta sobre todo nos indica la heterogeneidad o homogeneidad de las poblaciones sobre grandes regiones geográficas. En México, el caracol marino *Strombus gigas* se encuentra en la Península de Yucatán y específicamente en las costa de Yucatán y Quintana Roo. La pesquería de este organismo en estas zonas representa una de las principales actividades económicas y estando expuesto a una sobreexplotación se ha tenido que su captura ha decaído drásticamente propiciando dificultades diversas entre las que destaca de sobre manera el desconocimiento real de sus niveles de captura y de ello de manejo, determinándose medidas de veda en todas las zonas de captura en la Península de Yucatán. Sin embargo este manejo se ha venido efectuando sin un sustento científico, lo que ha dado lugar a subestimar el recurso y no poder sustentar adecuadamente las medidas de manejo implementadas.

En este trabajo se determinó por el sistema PAGE en SDS el perfil proteico total de muestras de músculo de caracoles rosados obtenidos en tres sitios de las costas de quintana Roo, Isla Mujeres en la zona norte, Banco Chinchorro en la zona sur y Punta Allen en la zona centro del estado, apoyándonos en un programa de análisis de imágenes desarrollado por estudiantes del Instituto Tecnológico de Mérida y estableciéndose una diferencia en cuanto al número de proteínas obtenidas en cada sitio para los organismos muestreados y de ello la posible diferenciación geográfica de los organismos en el caribe mexicano en cuanto a su perfil proteico.

Mangrove Habitat as Nursery Grounds for Recreationally Important Fish Species – Great Pond, St. Croix, U.S. Virgin Islands

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Mangrove habitat in the U.S. Virgin Islands consists primarily of fringe vegetation along lagoons and oceanic bays. This habitat has been severely impacted and reduced by coastal and upland development since 1960. The importance of fringe red mangrove (*Rhizophora mangle*) habitat as nursery grounds for recreationally important fish species was assessed in Great Pond, a 0.5 km square mangrove-lined, tidal pond on the south coast of St. Croix. Fish species composition and abundance were quantitatively sampled monthly in four areas of mangrove prop-root and pond habitat over a two-year period, using standardized rectangular fish traps and seine netting.

A total of 1,403 fish were caught in traps in Great Pond, representing 18 species and 12 families. The family Lutjanidae had the highest abundance (46.4%), followed by the families Gerridae (36.9%) and Carrangidae (10.0%). *L. apodus*, *G. cinereus*, *E. jonesi*, *C. latus* and *L. griseus* were the five most abundant species caught in order of abundance in the four trap areas. Mean number of species and individuals caught per trap and overall abundance of the five most common species showed significant differences by area relative to mangrove cover. A total of 1,433

individuals, representing 17 species and 13 families, were caught in seine net samples. The family Gerreidae had the highest abundance (92.1%). Permit (*Trachinotus falcatus*), snook (*Centropomus undecimalis*) and bonefish (*Albula vulpes*) were present in trap and net samples but in low abundance. Length-frequency distributions of the most abundant species caught in trap and net samples verify the importance of mangrove habitat for juvenile fish species.

Ingress of Postlarval Snappers (Principally *Lutjanus griseus*) into the Newport River Estuary, North Carolina

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An understanding of the process of estuarine ingress of larval fishes is important for understanding the variations in abundance of adults. Along the southeastern U.S. coast, summer-spawning, estuarine dependent species have not been as well studied as winter-spawning species. Ingressing postlarval snappers were sampled with a fixed neuston net from a bridge over a channel in the Newport River Estuary in 1993 and 1998. Lutjanus griseus was the most abundant species found, at densities as high as 11 per cubic meter. Other species collected include *L. analis*, *L. synagris*, and *L. apodus*. Snappers ranged in standard length from 11 to 20 mm. In both years, ingress of snappers occurred between July and October, with a strong peak in September in 1993. A lunar pattern was found; snappers ingress primarily during new moon and secondarily during full moon. Interestingly, snappers which ingress into the estuary are rare as adults in offshore waters of North Carolina. Larvae may be transported to North Carolina estuaries from the south by Gulf Stream processes. Whether these fish survive to join adult populations is unclear. Age and growth studies are currently underway for *Lutjanus griseus*. A pilot study is also in progress to assess the ability of the juvenile snappers to survive egress in North Carolina.

Dynamics of Low-profile, Inshore Artificial Reefs in Mississippi Coastal Waters

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The popularity of low-profile reefs as fishing banks and the need to increase the potential for harvestable food from the ocean has prompted many coastal states to begin artificial reef programs. The territorial waters of Mississippi contain several open Gulf artificial reef sites and inshore, artificial, low profile reefs within the Mississippi Sound. Past studies have provided valuable information on the success of the offshore reefs and their attraction and possible support of recreationally important species. Little documented data is available about inshore, low profile reefs relative to their productivity and ability to attract fish. Mississippi has established over twenty inshore low profile reefs using oyster shell, crushed limestone, and concrete rubble. The increased number of artificial fishing reefs in Mississippi's coastal waters over the last five years has provided an immediate need in obtaining information on the association of fish populations with these reefs and their subsequent use by the fishing public. An assessment and monitoring program for four of these reefs was implemented in 1998 using entanglement gear, a 16 ft. lined otter trawl, and custom fish traps. Intercept creel surveys were also initiated to obtain usage data by the fishing public. Substrate samples from oyster and limestone were also taken to provide information on seasonality and colonization of benthic fauna on these reefs. These data may provide information on the trophic

relationships between attracted finfishes and a particular substrate. The attraction of finfishes by the artificial reef varied significantly by the geographic location, substrate composition, various abiotic factors, and a variety of anthropogenic factors. *Cynoscion arenarius*, *Scomberomorus maculatus*, and *Micropogonias undulatus* were the most numerous, in decreasing abundance, recreationally important species observed from the sampled reefs. The number of these species were more numerous on the reef site when compared to adjacent off reef sites.

Use of light-attracted zooplankton for rearing post-settlement coral reef fish

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Settlement stage *Lutjanus synagris* and *Ocyurus chrysurus* were caught in light traps set off fore reefs in the British Virgin Islands and raised in floating mesh cages tethered in water 1-2m deep. Lights were designed to attract plankton into the cages and provide live natural food for the fish. Plankton taxonomic composition around lights was compared with samples taken in nets in adjacent open water and also with gut contents of cage cultured fish. Fish length, weight and mortality and total cage biomass were followed over the first few weeks of life and compared to results from a field trial assessing natural mortality and growth. If cage culture reduces the exceptionally high early post-settlement mortality typical of reef fish this technique may be useful to help speed recovery of over-exploited stocks within no-take marine reserves. Cages could also be used to rear settlement stage ornamental species until they are large enough to survive on artificial food. Light traps and cage culture in combination could replace destructive fishing practices on reefs exploited for the aquarium trade.

Feeding Ecology of Deep Reef Fishes in the Northeastern Gulf of Mexico

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Feeding ecology and food web structure of fishes was examined in the deep reef community along the Mississippi-Alabama outer continental shelf. Fish communities on high-profile topographic features are numerically dominated by rough tongue bass, *Pronotogramus martinicensis*, and red barbier, *Hemanthias vivanus*. Stomach content analysis reveals that calanoid copepods, mollusk larvae and pelagic tunicates dominate the diet of both species, and these fishes in turn serve as prey for large reef predators. Seasonal shifts in the diet of planktivores were also evident. Fish eggs and fish larvae constitute a greater portion of stomach contents in Feb/March samples, and indicate trophic links to pelagic, soft-bottom, and possibly nearshore primary production (via spawning aggregations of large, migrating species). Dietary shifts in predatory fishes reveals that pelagic plankton and planktivorous reef fishes form the primary trophic pathways throughout the year for common fishes in the deep reef community.

Evolution of the Fisheries Fleet in Barbados: Causes and Implications

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The Bajan fisheries fleet has undergone a steady evolution from sail boats to modern fishing vessels, during the half century spanning the end of the colonial era to the present. This paper chronicles the major changes that changed the nature and appearance of the fleet, periodically. There is an emphasis on uncovering the causes of the changes, originating in public policy and in decision-making by individual entrepreneurs. The social and economic implications of the major changes are equally examined. The current fleet is an admixture of vessels representing the various evolutionary phases of the development of the fleet, parts are tantamount to functioning museum pieces, while others are ultra-modern. The heterogeneity of the fleet has serious implications for development planning. The evolution of the fleet demonstrates the inherent capacity of Bajans to pursue their own destinies. However, exterior forces have played, and continue to play, a role in the evolution of vessels and techniques. Currently, areal geopolitics are a significant factor in the viability of the most recent and modern vessels in operation. The complexity of the local and regional human aspects of fisheries evolution are stressed.

Age Estimates from Annuli in Otoliths of Red Snapper, *Lutjanus campechanus,* from the Northern Gulf of Mexico

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The red snapper *Lutjanus campechanus* is currently under stringent federal management in the Gulf of Mexico (GOM) off the southeastern United States due to apparent overfishing of many populations. Management strategies employed to promote recovery of the species are dependent upon knowledge of various demographic variables such as the ages of individuals, the distribution of these ages (cohort strength) within the population, and maximum longevity. Thus a reliable and accurate aging methodology for red snapper is of paramount importance. Annuli on otoliths have been used to age many species of fishes, including red snapper. However, the utility of this methodology for aging red snapper has been questioned by those who dispute both the apparent longevity (over 50 yr) of red snapper and the position of the first annulus within the otolith.

We counted annuli and assessed edge condition in sagittal otoliths of 3,791 red snapper collected from the northern GOM off Louisiana during the periods 1989 to 1992 and 1995 to 1998. Opaque annuli were validated by marginal increment analysis to form once per year from December through June. Among the otoliths examined, estimated ages ranged from 0.5 to 52.6 yr for individuals from 104 mm to 1,039 mm total length and from 0.017 kg to 22.793 kg total weight. The great heterogeneity in red snapper age at a given total length or total weight limits the use of morphometric variables as predictors of age.

The changing face of Fisheries in the Economics of OECS Member States

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Fisheries continue to play an important and sometimes underrated part in the economics of OECS Member States, providing both full-time, part-time and seasonal employment, contributing significantly both to domestic food security and national GDP. Offshore resources and large pelagics are felt to have the best potential for increased exploitation and present an identifiable path for technical and economic diversification. At national levels there are indications of fishers becoming both more professional and more committed. The sub-regional fisheries sector is now managing to attract private investment from persons who, with few traditional links with fishing , are bringing a new level of professionalism to it. There has, in recent years, been a significant investment in fisheries infrastructure in the OECS sub-region, contributing to a transformation process in some member State fisheries. In some areas moves have been made to manage existing resources, but the existing technologies are inadequate to take up the challenge of resource management and the exploitation of new resources. Additionally, national policy statements and objectives for fisheries need to be further developed and clarified to assist the implementation of national fisheries strategies.

Growth and Reproductive Biology of Red Snapper (*Lutjanus campechanus*) East and West of the Mississippi River: Preliminary Data Testing the Single Unit Stock Hypothesis

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Red snapper is an important fishery resource in the Gulf of Mexico that has been intensively managed since 1990. Management plans have been based on the assumption that this species belongs to a single panmicitc population or unit stock. To test the unit stock hypothesis and answer questions about regional variability, a detailed three year investigation of red snapper from West Florida to Texas will employ otolith microchemistry, genetics, age and growth, and reproductive biology. The preliminary data presented here will compare size-specific reproductive biology of red snapper in the Northern Gulf of Mexico east and west of the Mississippi River. Reproductive biology will be assessed according to ovary and oocyte examinations and gonadosomatic index (GSI) comparisons. Regional differences in reproductive biology, if they exist, will provide insight to the population structure of red snapper and perhaps lead to improved conservation and management plans for this important resource.

Relocated Sea Turtle Nests in Open-beach Hatcheries: Lessons in Hatcherydesign and Implementation from Broward County, Florida, USA

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Conservation efforts to enhance sea turtle stocks include nest relocation to increase the numbers of hatchlings reaching the water. Several forms of nest relocation are used around the world. Because beaches of Broward County, Florida, USA have been extensively developed, 75-80% of the nests deposited are threatened by erosion and human impacts. As a result, many nests are relocated to open-beach hatcheries on relatively dark shores where they incubate and hatch unattended. Hatcheries can increase nest densities to abnormal levels. The study described herein was designed to assess the success of self-releasing hatcheries and determine what factors might increase the effectiveness of this conservation tool. The production of hatchlings at hatcheries and at natural nest sites was monitored, as was hatchling survival during their first 15 minutes in the water. Several conclusions were drawn from these studies. (1) Predation pressures on hatchling sea turtles are greater in front of open-beach hatcheries than in front of non-hatchery sites. (2) The location of a hatchery is significant in predicting aquatic predation. Positioning hatcheries adjacent to nearshore reef structures and inlets can increase risks. Sites normally less attractive to fish, may remain unattractive even when used as a hatchery if the nest density is kept low, ~1 nest/2m/season. (3) When hatcheries are required, the best nest relocation beaches should include characteristics such as easy access, darkness, adequate width and elevation, and low fish densities near the site. In the event that these characteristics are absent, nest relocation could actually imperil hatchlings rather than protect them.

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