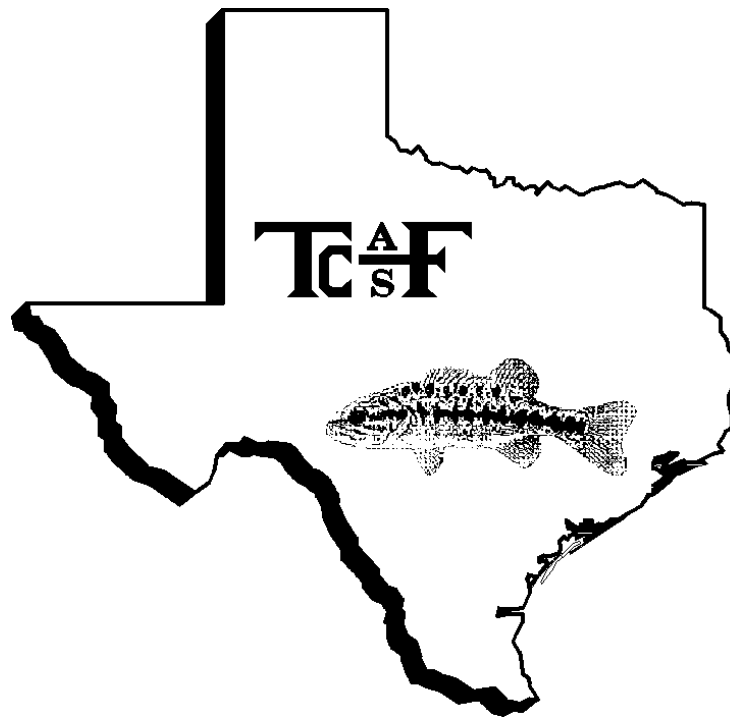


ANNUAL PROCEEDINGS
of the
TEXAS CHAPTER

AMERICAN FISHERIES SOCIETY



San Antonio, Texas
8 – 12 February 2006

Volume 28

TEXAS CHAPTER

AMERICAN FISHERIES SOCIETY

The Texas Chapter of the American Fisheries Society was organized in 1975. Its objectives are those of the parent Society – conservation, development and wise use of recreational and commercial fisheries, promotion of all branches of fisheries science and practice, and exchange and dissemination of knowledge about fishes, fisheries, and related subjects. A principal goal is to encourage the exchange of information among members of the Society residing within Texas. The Chapter holds at least one meeting annually at a time and place designated by the Executive Committee.

MEMBERSHIP

Persons interested in the Texas Chapter and its objectives are eligible for membership and should apply to:

Texas Chapter, American Fisheries Society
Secretary-Treasurer
Texas Parks and Wildlife Department
4200 Smith School Road
Austin, Texas 78744

Annual membership dues are \$12 for Active Members and \$5 for Student Members.

**ANNUAL PROCEEDINGS OF THE TEXAS CHAPTER
AMERICAN FISHERIES SOCIETY**

Annual Meeting
(Joint Meeting with the Southern Division of the AFS)
8-12 February 2006
San Antonio, Texas

2006-2007 Officers

Debbie Wade, President
Texas Parks and Wildlife Department

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Texas Parks and Wildlife Department

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2007

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PAST TEXAS CHAPTER PRESIDENTS AND MEETING LOCATIONS

Date	President	Location
1976		College Station
1976	Ed Bonn	Lake Brownwood
1977	Jim Davis	San Antonio
1978	Bill Rutledge	San Marcos
1979	Bobby Whiteside	College Station
1980	Richard Noble	Arlington
1981	Charles Inman	Austin
1982	Gary Valentine	Kerrville
1983	Don Steinbach	Lake Texohoma, OK
1984	Gary Matlock	Port Aransas
1985	Maury Ferguson	Junction
1986	Brian Murphy	San Marcos
1987	Joe Tomasso	Kerrville
1988	Dick Luebke	Abilene
1989	Mac McCune	San Antonio
1990	Bobby Farquhar	Lake Texohoma, OK
1991	Gene McCarty	Galveston
1992	Bill Provine	Kerrville
1993	Barbara Gregg	Port Aransas
1994	Loraine Fries	Lake Travis
1995	Pat Huston	College Station
1996	Mark Webb	Pottsboro
1998	Katherine Ramos	Athens
1999	John Prentice	Corpus Christi
2000	Paul Hammerschmidt	Bossier City, LA
2001	Charles Munger	San Marcos
2002	Gordon Linam	Junction
2003	Gene Wilde	Galveston
2004	Gary Garrett	College Station
2005	Fran Gelwick	Grapevine
2006	Dave Terre	San Antonio
2007	Debbie Wade	Lake Jackson

TEXAS CHAPTER AWARDS RECIPIENTS

- 1977 Fish Culture - Don Steinbach (TAMU)
Fisheries Management - Edward Bonn (TPWD)
Fisheries Administration - David Pritchard (TPWD)
Fisheries Research - John Prentice and Richard Clark (TPWD)
- 1978 Fish Culture - Pat Hutson (TPWD)
Fisheries Education - Clark Hubbs (UT)
Fisheries Research - Clark Hubbs (UT)
Special Recognition - Edward Lyles (USFWS)
- 1979 Fish Culture - Robert Stickney (TAMU)
Fisheries Education - Richard Noble (TAMU)
Fisheries Management - Gary Valentine (SCS)
Fisheries Research - Phil Durocher (TPWD)
Special Recognition - Charles Inman (TPWD)
- 1980 None
- 1981 Fish Culture - Billy White (TPWD)
Fisheries Education - Bobby Whiteside (TXSTATE)
Fisheries Management - Steve Smith (TUGC)
Fisheries Research - Al Green (TPWD)
Special Recognition - Jim Davis (TAMU)
- 1982 Fish Culture - Roger McCabe (TPWD)
Fisheries Research - Clell Guest (TPWD)
Special Recognition - Bob Hofstetter (TPWD)
- 1983 Special Recognition - Robert Kemp (TPWD)
- 1984 None
- 1985 Fisheries Education - Donald Wohlschlag (UTMSI)
Fisheries Research - Connie Arnold (UTMSI)
- 1986 Fisheries Management - Billy Higginbotham (TAES)
Fisheries Research - Robert Colura (TPWD)
- 1987 Fish Culture - Kerry Graves (USFWS)
Special Recognition - The Sportsmen's Club of Texas
Best Presentation - Kerry Graves (USFWS)
- 1988 Honorable Mention (culture) - Loraine Fries (TPWD)
Fisheries Research - Gary Garrett (TPWD)
Special Recognition - Kirk Strawn (TAMU)
Best Presentation - Joe Fries (USFWS)
Honorable Mention (presentation) - Catherine Dryden (TAMU)
- 1989 Fish Culture - Robert Vega (TPWD)
Fisheries Management - Joe Kraai (TPWD)
Fisheries Administration - Gary Matlock (TPWD)
Fisheries Research - Roy Kleinsasser and Gordon Linam (TPWD)
Honorable Mention (research) - Bob Edwards (UTPA)

- Best Presentation - Robert Smith (TAMU)
- 1990 Fish Culture - Glen Alexander and David Campbell (TPWD)
 Fisheries Management - Dave Terre (TPWD)
 Fisheries Administration - Gene McCarty (TPWD)
 Best Presentation - Joe Kraai (TPWD)
 Scholarships - Tommy Bates (TAMU:1989), Michael Brice (TTU)
- 1991 Fish Culture - Jake Isaac (TPWD)
 Fisheries Management - Mark Webb (TPWD)
 Fisheries Administration - Pat Hutson (TPWD)
 Fisheries Research - Ronnie Pitman (TPWD)
 Special Recognition - The Wetland Habitat Alliance of Texas
 Best Presentation - Mark Stacell (TPWD)
 Scholarships - Jim Tolan (TAMUCC), Michelle Badough (TXSTATE)
- 1992 Fish Culture - Camilo Chavez (TPWD)
 Fisheries Education - Brian Murphy (TAMU)
 Fisheries Management - Ken Sellers (TPWD)
 Fisheries Research - Bob Colura (TPWD)
 Special Recognition - Bobby Farquhar, Andy Sansom, and Rudy Rosen (TPWD)
 Best Presentation - Maurice Muoneke (TPWD)
- 1993 Fisheries Management - Bruce Hysmith (TPWD)
 Special Recognition - Joe Martin and Steve Gutreuter (TPWD)
 Best Presentation - Jay Rooker (UTMSI)
 Scholarships -Erica Schlickeisen (TXSTATE), Brian Blackwell and Nancy McFarlen (TAMU)
- 1994 Fish Culture - Ted Engelhardt (TPWD)
 Fisheries Management - Steve Magnelia (TPWD)
 Fisheries Administration - Dick Luebke (TPWD)
 Special Recognition - Bob Howells (TPWD)
 Best Presentation - Travis Kelsey (TXSTATE)
 Scholarships - Kathryn Cauble (TXSTATE), Howard Elder and Kim Jefferson (TAMU)
- 1995 Fish Culture - Robert Adami (TPWD)
 Fisheries Education - Bill Neill (TAMU)
 Fisheries Management - Spencer Dumont (TPWD)
 Fisheries Administration - Roger McCabe (TPWD)
 Fisheries Research - Maurice Muoneke (TPWD)
 Special Recognition - Tom Heffernan and Robin Reichers (TPWD) S. Ken Johnson (TAMU)
 Best Presentation (s) - Robert Weller (TTU), Robert D. Doyle (ACE)
 Scholarships - Jay Rooker (UTMSI), Robert Weller (TTU), Gil Rosenthal (UT), John Findiesen and Karen Quinonez (TXSTATE)
- 1996 Fisheries Education - Billy Higginbotham (TAMU)
 Fisheries Management - Gary Garrett (TPWD)
 Fisheries Administration - Gene McCarty (TPWD)
 Fisheries Research - Ivonne Blandon (TPWD)
 Special Recognition - Reeves County Water Improvement Board
 Best Presentation (s) - Craig Paukert (OSU), Gene Guilliland (ODWC)
 Scholarships - Chad Thomas (TXSTATE), Anna-Claire Fernandez (UTMSI), Kenneth Ostrand (TTU), Dawn Lee Johnson
 Technical Support - Jimmy Gonzales (TPWD)
 Honorable Mention (technical support) - Eric Young (TPWD)

- 1997/8 Fish Culture - Tom Dorzak (TPWD)
 Fisheries Education - Robert Ditton (TAMU)
 Special Recognition - Fred Janssen, Chris Cummings, Dan Lewis, Dan Strickland, and Gary Graham (TPWD), Jim Davis (TAMU)
 Best Presentation (s) - Timothy Bonner (TTU) and Gene Wilde (TTU)
 Scholarships - Tony Baker and Allison Anderson (TAMU), Patrick Rice (TAMU-Galveston), Laurie Dries (UT)
- 1999 Fisheries Administration - Lorraine Fries (TPWD)
 Special Recognition - Pat Hutson (TPWD, retired)
 Best Presentation (s) - Gene R. Wilde and Kenneth G. Ostrand (TTU)
 Scholarships - Scott Hollingsworth and William Granberry (TTU), Brian Bohnsack and Michael Morgan (TAMU)
- 2000 Fisheries Research - Gene R. Wilde (TTU)
 Best Presentation - J. Warren Schlechte, coauthors - Richard Luebke, and T.O. Smith (TPWD)
 Best Student Presentation - Scott Hollingsworth, coauthors - Kevin L. Pope and Gene R. Wilde (TTU)
 Special Recognition - Emily Harber, Joe L. Hernandez, Robert W. Wienecke, and John Moczygamba (TPWD), Joe N. Fries (USFWS)
 Scholarships - Mandy Cunningham and Calub Shavlik (TTU), Laurieanne Lancaster (SHSU)
- 2001 Fisheries Administration - Ken Kurzawski (TPWD)
 Fisheries Education - Kevin Pope (TTU)
 Fisheries Management - Brian Van Zee (TPWD)
 Fisheries Research - Reynaldo Patino (TTU)
 Fisheries Student - Timothy Bonner (TTU)
 Technical Support - David DeLeon (TPWD)
 Special Recognition - Rhandy Helton, Rosie Roegner, and Walter D. Dalquest (TPWD)
 Best Presentation – Jason Turner, coauthors – Jay Rooker and Graham Worthy (TAMUG), and Scott Holt (UTMSI)
 Scholarships, Undergraduate - Mandy Cunningham, and Cody Winfrey (TTU)
 Scholarship, Graduate - Abrey Arrington (TAMU), and Laurieanne Dent (SHSU)
- 2002 Fisheries Administration – Leroy Kleinsasser (TPWD)
 Fisheries Management – Gordon Linam (TPWD)
 Special Recognition – Raymond Mathews, Jr. (TWDB), Austin Bass Club of the Deaf
 Best Presentation – Jay Rooker, coauthors – Bert Geary, Richard Kraus, and David Secor (TAMUG)
 Best Student Presentation – J. P. Turner, coauthor – Jay Rooker (TAMUG)
 Best Poster Presentation – Michael Lowe, Gregory Stunz, and Thomas Minello (NMFS)
 Scholarships, Undergraduate – Felix Martinez, Jr. (TTU), Stuart Willis (TAMU)
 Scholarships, Graduate – Mathew Chumchal (TCU), Michael Morgan (TAMU)
- 2003 Fisheries Culture – Dennis Smith (TPWD)
 Fisheries Education – Gene Wilde (TTU)
 Fisheries Student – Christine Burgess (TAMU)
 Special Recognition – Larry McEachron (TPWD)
 Best Presentation – Gregory Stunz (TAMUCC), coauthors Thomas Minello and Phillip Levin (NMFS)
 Best Student Presentation – Monte Brown, coauthors Felix Martinez Jr., Kevin Pope, and Gene Wilde (TTU)
 Best Poster Presentation – Suraida Nanez-James (TAMUG) and Thomas Minello (NMFS)
- 2004 Fisheries Culture - Lisa Griggs (TPWD)
 Fisheries Education - Timothy Bonner (TXSTATE)
 Fisheries Research - Dave Buckmeier (TPWD)
 Fisheries Student - Casey Williams (TXSTATE)
 Special Recognition - Deborah Wade (TPWD)

Best Presentation - Richard Kraus and David Secor (TAMUG)
Best Student Presentation - Tracy Leavy, coauthor Timothy Bonner (TXSTATE)
Best Poster Presentation - Brian Scott and Gary Aron (TXSTATE)

- 2005 Fisheries Administration – Roger McCabe (TPWD)
Fisheries Management – Todd Driscoll (TPWD)
Fisheries Student – Bart Durham (TTU)
Special Recognition – Jimmie Green (TPWD) and Kirk Green
Special Recognition – The Patsy B. Hollandsworth Family Foundation
Best Presentation – Gregory Stunz (TAMUCC), and coauthors Jay Rooker (TAMUG), Joan Holt and Scott Holt (UT)
Best Student Presentation – Julie Hulbert, and coauthors Timothy Bonner and David Pendagrass (TXSTATE), and Joe Fries (National Fish Hatchery – San Marcos)
Best Poster Presentation – Michael Baird (TPWD)
Scholarships, Undergraduate – Brian Bartram (TAMUCC), John Putegnat (TAMU)
Scholarships, Graduate – Megan Fencil (UTMSI), Casey Williams (TXSTATE)
- 2006 Fisheries Education – Kevin Pope (TTU)
Fisheries Management – Dave Terre (TPWD)
Fisheries Research – Loraine Fries (TPWD)
Technical Support – Todd Robinson (TPWD)
Special Recognition – Bruce Hysmith (TPWD)
Special Recognition – Joan Glass (TPWD)
Best Presentation - Richard Kraus and David Secor (TAMUG)
Best Student Presentation - Tracy Leavy, coauthor Timothy Bonner (TXSTATE)
Best Poster Presentation - Brian Scott and Gary Aron (TXSTATE)
Scholarships, Undergraduate – Chris Arredondo (TAMUCC), Josh Perkin (TXSTATE)
Scholarships, Graduate – Bart Durham (TTU), Casey Williams (TXSTATE)

Abbreviations:

ACE - Army Corps of Engineers	TPWD - Texas Parks and Wildlife Department
NMFS - National Marine Fisheries Service	TTU - Texas Tech University
ODWC - Oklahoma Department of Wildlife Conservation	TUGC - Texas Utilities Generating Company
OSU - Oklahoma State University	TXSTATE - Texas State University-San Marcos
SCS - Soil Conservation Service	USFWS - US Fish and Wildlife Service
SHSU - Sam Houston State University	UT - University of Texas at Austin
TAES - Texas Agricultural Extension Service	UTMSI - University of Texas Marine Science Institute
TAMU - Texas A&M University	UTPA - University of Texas/Pan American
TAMUCC – Texas A&M University-Corpus Christi	

TECHNICAL SESSION ABSTRACTS

An Internet Survey of Private Pond Owners and Managers in Texas

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The primary emphasis of this survey was to determine what specific problems Texas private impoundment owners/managers confront, how widely these problems occur, and where owners/managers get their information on pond management. A secondary emphasis was to examine the potential utilization of the Internet to gather information and distribute outreach materials. A random sample of 2,999 private impoundment (i.e. no public waters) applicants for Triploid Grass Carp Permits from Texas Parks and Wildlife was utilized as the survey mailing list. A 49-question survey was developed and placed on a secure web site. Each questionnaire contained five sections: general pond characteristics, physical pond characteristics, aquatic vegetation, fish and other wildlife, and management goals. Two post-card mailings were made asking the recipients to go online to the web site and fill out the survey. The overall response rate was 21.3% (excluding non-deliverables and unusable submitted surveys). Summary statistics for each question were calculated and then compared to each other in order to gain a clearer picture of pond management practices employed by Texas impoundment owners/managers. The results indicated some initial discrepancies between management practices and preferences and common management recommendations. This was most dramatically illustrated in aquatic vegetation management and basic understanding of management principles.

Species Identification of Sciaenid Fish Eggs in Aransas Bay, Texas, by Molecular Species-Specific Markers

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Sciaenid fishes are an important resource for commercial and recreational fisheries, representing millions of dollars to the U.S. economy. Most sciaenid species are estuarine dependant, either through the larval stage or their entire life cycle. The development of a reliable technique to accurately discriminate sciaenids eggs by species would provide an important tool for the study of the spawning biology of sciaenid fishes in the Aransas Bay estuaries and its surrounding areas. Identification of preferred spawning areas as well as spawning seasonality is required for effective conservation and management of fisheries. Visual identification of eggs to species level is difficult due to overlap in size and/or pigmentation patterns of many sciaenid eggs. The objective of this project is to develop a reliable molecular method to identify sciaenid eggs to species level using molecular species-specific markers. Fragments of the mitochondrial genes cytochrome b (608 bp) and nicotinamide adenine dinucleotide dehydrogenase (NADH dehydrogenase; 900 bp) were sequenced in 11 sciaenid species caught in the Corpus Christi, Texas, bay system. Sequence comparison showed 85% and 65% identity, respectively. Due to higher heterogeneity, NADH dehydrogenase sequences were used to design species-specific polymerase chain reaction (PCR) primers. The multiplex-PCR identification assay is capable of accurately discriminating among sciaenid species based on the size of NADH dehydrogenase products. Effective discrimination of sciaenid eggs to species level by utilizing multiplex-PCR will allow us to accurately monitor spawning seasonality and spawning grounds preferences, information that is necessary to protect essential fish habitats.

Status of an Introgressed Guadalupe Bass Population in a Central Texas Stream

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Introductions of non-native smallmouth bass *Micropterus dolomieu* into central Texas streams resulted in introgressive hybridization with an endemic allopatric congener, the Guadalupe bass *Micropterus treculi*. In an attempt to reestablish a dominant Guadalupe bass population and to genetically swamp the smallmouth bass genome, a total of 80,000 hatchery-reared Guadalupe bass fingerlings was stocked in the Blanco River (Guadalupe River drainage, Texas) in 1994 and 1995. Objectives of this study were to examine the proportion and genetic influence of Guadalupe bass, smallmouth bass, and their hybrids 10 years following supplemental stockings of Guadalupe bass in the Blanco River by analyzing allele frequencies at fourteen unlinked microsatellite loci. Genetic analysis identified 40% of individuals as smallmouth bass, 51% as smallmouth bass x Guadalupe bass hybrids, and 9% as other *Micropterus* hybrids. Pure Guadalupe bass were not collected. Despite supplemental stockings, introgression continues in the Blanco River and has likely continued or spread in other areas. Our study documents the need for a current review of the genetic integrity of the Guadalupe bass throughout its range.

Trends in Texas Populations of Gulf Flounder *Paralichthys albigutta* following Management Measures Targeting Southern Flounder *P. lethostigma*

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Many species of flounder occur in the Gulf of Mexico, but Gulf *Paralichthys albigutta* and southern flounder *P. lethostigma* are the two species that have been recreationally or commercially harvested from Texas bays. Due to the decline in southern flounder abundance, the Texas Parks and Wildlife Department (TPWD) Commission implemented a number of management measures in an attempt to increase the population. These included, but were not limited to, increasing minimum size limits, reducing bag limits, and initiating bag limits for commercial harvest. Even though these measures were designed to reduce harvest and increase the abundance of southern flounder, they have also had an effect on Gulf flounder. Two additional measures recently adopted by the Commission that may have also positively affected flounder populations were requiring by-catch reduction devices during inshore shrimping operations and implementing the TPWD Shrimp License Buyback Program. Using TPWD's long-term fisheries-independent and -dependent databases, we assessed the status and trends of Gulf flounder compared to southern flounder. We also determined relationships between management efforts and juvenile recruitment and adult relative abundance of both species. Recommendations for future management of both species are discussed.

Seagrass Protection Initiative in the Redfish Bay State Scientific Area

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The Seagrass Conservation Plan for Texas published in 1999 contained specific recommendations for agency actions to protect seagrass habitat. Mechanical damage to seagrass was one particular concern listed in the plan. Redfish Bay State Scientific Area (12,955 hectares) was designated in June 2000 by the Texas Parks and Wildlife Commission (TPWC) for the purpose of protecting fragile shallow water seagrass beds. Redfish Bay is a shallow coastal embayment near Aransas Pass, Texas which contains the northernmost extensive seagrass beds in the western Gulf of Mexico. The Redfish Bay State Scientific Area designation had a five year review for sunset provision. Extensive damage to seagrass beds from boat propeller scarring had been documented. Initial protection efforts included three voluntary no-propeller zones as well as education and outreach programs. Voluntary measures appeared to be ineffective, and damage from "prop scarring" continued to occur. In June 2005 TPWC renewed the scientific area designation with the intent of pursuing additional measures of protection. In order to

evaluate the effectiveness of any potential new regulations a baseline transect study was conducted in August of 2005 which found 0.015 scars/m, SE=0.004. A regulation to further protect seagrasses will go into effect in May 2006, making it illegal to destroy seagrasses with boat propellers within the State Scientific Area.

Golden Alga Fish Kills in the Brazos River Basin

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Fish kills in the Brazos River Basin caused by toxins of golden alga *Prymnesium parvum* have been documented since 1988. The frequency, intensity and impacts of the blooms causing these fish kills have increased over the years. Presented is a review of impacts on the Brazos River Basin and three of its reservoirs, with bloom progressions, fish kill intensity, physical parameters and the chemical environment of these kills.

Testing if Knowing White Crappie Locations Can Improve Trap Net Sampling

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We utilized biotelemetry to observe adult white crappie *Pomoxis annularis* locations at Lyndon B. Johnson (LBJ) and Waco reservoirs in Texas over two, six-month periods (December 2000 – May 2001 and November 2001 – April 2002). We tested whether deploying trap nets at sites near known fish locations and at similar sites predicted to hold fish would result in increased trap-net catch per effort compared to randomly selected sites. Trap-net catch rates for the three deployment strategies were not significantly different in any month (November 2001 – April 2002) for LBJ or Waco reservoirs ($P > 0.083$ for all months). In our study, selecting sampling sites subjectively offered no significant benefit over selecting sites randomly. However, other findings suggested that water depth at the trap-net cod end and reservoir area can influence catch rates regardless of deployment strategy. In our study, trap nets set in deeper water (> 3 m) typically caught fewer fish at both reservoirs and nets set in the upstream third of Waco Reservoir generally caught greater numbers of adult crappies. We found that addressing large and small-scale habitat variables (i.e., linear distance from dam, water depth, bank slope, etc.) may be more important than actual fish locations when deciding on a trap-net deployment strategy.

Correlative Relationship of Brown Shrimp Catch to Nursery and Hypoxic Areas in the Northwestern Gulf of Mexico

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The Louisiana Department of Wildlife and Fisheries has spatially quantified salinity measurements for decades, with salinities above 10 ppt deemed favorable for juvenile brown shrimp. Scientists at Louisiana Universities Marine Consortium have quantified the hypoxic zone on the Louisiana shelf since the mid-1980s and have identified it as a negative factor in the production of brown shrimp. We performed stepwise linear regressions to determine the influence of nursery area and hypoxia area on shrimp catch. When modeling combined Texas and Louisiana total catch (both inshore and offshore), the hypoxia area was a significant factor, contributing to 26% of the variability in catch ($F=4.967, df=1, P=0.043$). Combined Texas and Louisiana offshore catch was also significantly affected by the hypoxia area ($F=4.765, df=1, P=0.047$). Louisiana nursery area was not a significant variable for Texas and Louisiana combined shrimp catch. However, Texas and Louisiana combined inshore catch was significantly influenced by nursery area size ($F=8.489, df=1, P=0.011$), but not by hypoxia area. For the Louisiana total brown shrimp catch (inshore and offshore), nursery area was a significant factor ($F=13.246, df=1, P=0.002$), but hypoxia area was not. For the Texas total brown shrimp catch (inshore and offshore), hypoxia area

was a significant factor ($F=6.229$, $df=1$, $P=0.026$), but nursery area size was not. Therefore, both nursery and hypoxia areas are significant factors in determining brown shrimp catch in the Northwestern Gulf of Mexico.

Swimming Performance of Five Warmwater Stream Fish Species

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Relative swimming ability of fish species may help explain their persistence or absence in flood-disturbed streams. I tested five common fish species from the Arkansas Ozarks (central stoneroller, cardinal shiner, orangethroat darter, green sunfish and longear sunfish) in artificial stream channels with smooth and complex substrates to examine critical swim speeds (CSS) and flood resistance behavior. Stonerollers and cardinal shiners had higher CSS than the other species in the smooth substrate treatment, and orangethroat darters outperformed the sunfish species. In the complex substrate treatment, stonerollers attained higher speeds than green sunfish, whereas all other species did not differ. Cardinal shiners and longear sunfish selected velocity patches that were slower than the flume average in the smooth substrate treatment at the highest swim speeds. Orangethroat darters and green sunfish selected slower patches in the complex substrate treatment at half speed. All other species in all other scenarios did not exhibit significant patch selection. These results suggest that the swimming ability of central stonerollers may give them an advantage over other species during high flows in low complexity substrates, whereas sunfish and darters appear better able to use high complexity substrates as velocity refugia during high flows.

The Growing National Threat of the Toxic Golden Alga *Prymnesium parvum* and How Texas Is Addressing It

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The toxic golden alga was first identified in the US from samples during a 1985 fish kill investigation on the Pecos River. World-wide, the alga has normally been associated with estuarine and marine waters. Since 2001, golden alga-induced fish kills have been expanding in Texas. It has now caused fish kills on five river systems in Texas (Rio Grande, Colorado, Brazos, Red, and Canadian rivers). It has been reported in 13 states (TX, NB, OK, NM, AZ, CO, WY, AR, AL, FL, GA, NC, and SC). It is a small alga with 2 flagella and a haptonema. Besides being motile, it exhibits mixotrophy by consuming algae, protists, and bacteria. It releases toxins including ichthyotoxins. An environmental trigger or condition seems to be needed to give it a competitive advantage over the normal algal community (e.g., change in temperature, salinity, etc.) and produce a bloom. Fish, mussels, clams, crayfish, and gilled amphibians are killed by the toxins but most aquatic insects and higher organisms do not appear to be directly impacted. Treatments have been developed for hatcheries and small ponds but are unsuitable for large waterbodies. Texas Parks and Wildlife Department has instituted a cooperative effort with universities,

state agencies, river authorities, and others to address this problem. Monitoring and event investigations have been initiated. Workshops with experts have been held to determine information needs and gaps. Research is being funded to address those needs. It is desired for management options to be developed for large waterbodies.

Does Early Life Exposure Impact Survival of Hatchery Red Drum?

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It has been demonstrated that hatchery-reared fish experience significantly higher rates of mortality compared to their wild counterparts. Many times this discrepancy can be linked back to the hatchery environment which is often void of many or all natural stimuli (e.g. prey types, predators, complex habitat). In this study, we evaluated how exposure to complex habitats (*Spartina* spp.) and predators (pinfish *Lagodon rhomboides*) during the early juvenile stage may influence the development of survival skills in hatchery red drum *Sciaenops ocellatus*. At the end of the exposure period, individuals were run through a series of high-speed video trials used to quantify differences in prey-capture performance and anti-predator response. Preliminary trials indicated that prey-capture performance was significantly different between the rearing groups. Information gathered from these trials can be used to gauge the effectiveness of red drum stocking initiatives and provide critical feedback to hatchery and fishery managers.

Texas Abandoned Crab Trap Removal Program

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Each February since 2002, the Texas Parks and Wildlife Department has conducted a volunteer-based abandoned crab trap removal program in Texas coastal waters. During these events, more than 12,700 volunteer man-hours were expended to remove a total of 18,008 abandoned crab traps. Most, 70%, were removed from the Galveston and San Antonio Bay systems (6,762 and 5,855 traps, respectively). Of the traps removed, 1,251 traps were examined to determine contents and condition. The examined traps contained 2,392 organisms representing 30 species. The most abundant species found were blue crab *Callinectes sapidus* and stone crab *Menippe adina* (62% and 19%, respectively). Sheepshead *Archosargus probatocephalus* was the most abundant vertebrate species, representing 7% of all organisms observed. The strong support for the program from volunteers, and the resource benefits of removing these unsightly and wasteful artifacts of the commercial crab fishery, justify continuation of the Texas Abandoned Crab Trap Removal Program well into the future.

The Arroyo Colorado Revisited: An Ecological Survey of the Arroyo Colorado, Texas, 2001-2003

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The lower Arroyo Colorado, flowing 40 km from the Port of Harlingen to the lower Laguna Madre in South Texas, is one of the few mesohaline systems associated with the lower Laguna Madre, and provides essential nursery habitat for many estuarine species. Bag seine and otter trawl samples and hydrological data were collected during 2001-2003 to characterize species composition, abundance, and seasonal distribution. Over 23,000 vertebrates and nearly 16,000 invertebrates in 120 species were collected. The dominant species collected was white shrimp *Litopenaeus setiferus* (25%), followed by gulf menhaden *Brevoortia patronus* (13%), spot *Leiostomus xanthurus* (10%), Atlantic croaker *Micropogonias undulatus* (7%), and pinfish *Lagodon rhomboides* (7%). Species distributions and multivariate analysis of assemblage composition showed few consistent longitudinal patterns. Seasonal changes in species richness and diversity were noted with the highest richness in

September through January and the lowest from June through August. Of particular interest was a change in species composition when compared to an earlier study completed along the same stretch of the Arroyo Colorado between 1966 and 1969. Analysis of hydrological data showed vertical and longitudinal stratification of the water column for temperature, dissolved oxygen, and salinity. Most notable was the seasonal lack of dissolved oxygen on the bottom along the length of the Arroyo Colorado above the 10 km point.

Impact of Tournaments on the Largemouth Bass Population at Sam Rayburn Reservoir

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Concerns regarding black bass *Micropterus* spp. tournament-related impacts have escalated during the last 40 years, due to increased tournament frequency. However, few studies have empirically estimated effects of tournaments on black bass populations. An estimated 52% of Sam Rayburn Reservoir anglers participate in tournaments and the annual number of events likely exceeds 300. In 2003, we tagged 6,021 largemouth bass *M. salmoides* to estimate the annual proportion of the population caught and harvested by tournament anglers. Tag returns were obtained via creel sampling to avoid non-reporting uncertainty, adjusted for recruitment and tag loss, and expanded to estimate total annual tagged fish catch and harvest. We conducted simulations to evaluate impacts of tournament mortality using rates of 10, 30, and 50% and compared those estimates to non-tournament harvest and catch-and-release mortality (simulated at 5, 10, and 15%) to assess specific contributions to annual angling mortality. From 3,447 angler interviews, creel clerks identified 40 tagged fish caught by anglers during the interview day (27 immediately released, 6 harvested by non-tournament anglers, and 7 harvested by tournament anglers). Total tag return estimates resulted in 1,620 fish immediately released (27% of population), 372 harvested by non-tournament anglers (6% of population), and 274 harvested by tournament anglers (5% of population). Tournament mortality and catch-and-release mortality each comprised a total of 1 to 6% of the population losses across all simulations. Tournament mortality comprised 6 to 28% of total angling mortality, whereas catch-and-release mortality contributed 10 to 31%. We conclude that tournament-related impacts on the largemouth bass population at Sam Rayburn Reservoir are low. Although we estimated no size-selective harvest from tournament anglers, size-selective tournament mortality could alter size structure by reducing large fish numbers.

When the Rio Grande Ceased to Flow: Effects of Rio Grande Mouth Closure on Estuarine-Dependent Species

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From February 2001 to November 2002, the Rio Grande ceased to flow to the Gulf of Mexico due to drought, noxious aquatic vegetation and international water management practices. This 21-month closure of the river mouth was interrupted by a 3-month period when its confluence with the Gulf of Mexico was temporarily re-established by a man made ditch. During the mouth closure, the former tidal (estuarine) portion of the river was sampled using bag seines and otter trawls to detect changes in relative abundance and species composition of aquatic organisms. Comparisons were made to data collected in the same area from 1992-97 when the river mouth was open. During the closure of the river mouth, striped mullet *Mugil cephalus*, gulf menhaden *Brevoortia patronus*, white shrimp *Litopenaeus setiferus*, and Atlantic croaker *Micropogonias undulatus* utilization decreased and estuarine habitat utilization by other organisms such as blue crab *Callinectes sapidus* and common snook *Centropomus undecimalis* was altered. Results of this study demonstrate impacts that occur with the loss of estuarine habitat due to low freshwater inflows.

Comparisons of Population Structure in Western Gulf of Mexico Species of Menhadens: a Genetic Perspective

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The North American species of the genus *Brevoortia* support large commercial fisheries on the Atlantic and Gulf coasts. Historically, the industry supported by these species has comprised as much as 40% of all commercial landings in the U.S., with the Gulf menhaden *B. patronus* supporting the largest single fishery by weight, in North America. Two species of menhaden are found in the western Gulf of Mexico; the Gulf menhaden, main target of the reduction fishery, and a congeneric Clupeid, the finescale menhaden *B. gunteri*, which makes up <1% of commercial landings. We examined the population structure of both species using genetic techniques. Specifically, we used mtDNA sequencing and microsatellite DNA markers to examine patterns of genetic variation of putative “stock” structure in both species, and to examine the possibility of hybridization between these species. Furthermore, we used the genetic variability within each species to estimate relative effective population sizes, and compared these estimates to anecdotal evidence of census size variation between species. Finally, we compared patterns of variation in western Gulf menhaden with similar patterns in two additional species of menhadens from the eastern Gulf and Atlantic, respectively. Genetic evidence supports the assertions that 1) Gulf menhaden compose a single large, interbreeding population in the Gulf of Mexico, 2) finescale menhaden exist in smaller and less variable populations, 3) pre- or post-mating boundaries exist which limit or preclude hybridization between the species and 4) similar patterns of genetic variation exist in menhadens from the eastern Gulf and Atlantic.

Evolution of Texas Parks and Wildlife Department’s Approach to Managing Spotted Seatrout *Cynoscion nebulosus* Populations Following Freeze Events

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Polar air masses which push deep into south Texas and cause mass mortality of marine organisms in Texas’ shallow bays have a long and destructive history that dates back to the early 1500’s. Prior to 1940, news accounts provide insight in to severity of freezes and their effect on fishery resources. From 1940 to the mid 1970s, state biologists documented the effects of freeze events on marine resources; however, information was generally limited to their effects on commercial landings. When the 1983 freeze occurred, Coastal Fisheries Division of Texas Parks and Wildlife Department had standardized monitoring programs in place to record trends in relative abundance and harvest of marine resources. With these programs and the adoption of a standardized approach to estimate the number of animals killed during freeze events, Coastal Fisheries was able to assess freeze mortality, recommend regulatory changes, and chronicle the recovery of fish populations. These measures were used to expedite the recovery of the spotted seatrout population following the 1983 and 1989 freeze-induced mortalities. In contrast to these reactive measures which were aimed towards assisting recovery of impacted populations, new regulations adopted after the Christmas 2004 cold front are intended to reduce fishing mortality prior to and during freeze events. This marked the beginning of an ongoing proactive approach to reduce impacts of cold weather events on Texas marine resources.

Spatiotemporal Variation in Fish Assemblage Structure Based on Functional Groups and Species Composition

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Stream ecosystems across the world are dynamic and complex. Biogeographic and historical constraints cause many of these systems to be unique and create difficulty in predicting compositional changes in fish assemblages. However, each system appears to be comprised of similar functional groupings despite phylogenetic differences. Hence, the objectives of this study were (1) to compare assemblage structure of stream fishes from a taxonomic and functional perspective among rivers and seasons, and (2) to determine whether certain variables that structure taxonomic assemblages (e.g., temperature, current velocity, water depth, substrate, stream width) can be used to predict functional diversity. I surveyed fish assemblages from three tributaries of the Colorado River in Texas (Pedernales River, San Saba River, and South Llano River) across all four seasons, and from these data created functional and taxonomic data sets. Fish assemblages within each river were more similar to assemblages from the same river than assemblages from different rivers, regardless of season, from both taxonomic and functional perspectives. However, abiotic variables were better predictors for functional diversity than taxonomic diversity. These findings could be very useful for management agencies that are bestowed with the task of helping maintain freshwater ecosystems.

Combined Nitrogen and Phosphorus Fertilization for Controlling Golden Alga

Prymnesium parvum

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Prymnesium parvum has caused significant fish kills at Texas hatcheries since 2001. Copper sulfate and ammonium sulfate can control *P. parvum* but they provide short-term relief and have undesirable side effects. Copper sulfate can kill desirable algae and invertebrates, and ammonium sulfate can be toxic to fish. Because dominance of the phytoplankton community and toxin production by *P. parvum* appears to be nutrient-related, we evaluated two fertilization regimens of nitrogen (N) and phosphorus (P) for their efficacy in controlling *P. parvum* populations and toxin production. The experiment was conducted with three treatments (30P:300N and 60P:300N three times weekly and no fertilization) in limnocorrals at the Texas Parks and Wildlife Department's Dundee fish hatchery. In unfertilized treatments *P. parvum* cell densities and toxicity persisted throughout the 40 d experiment. In both fertilized treatments *P. parvum* cell densities and toxicity declined below detectable levels within two weeks and remained undetectable during the duration of the study.

Species Composition and Annual, Seasonal, and Spatial Variability of Fish and Macroinvertebrate Assemblages in the Texas Surf Zone

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The Texas Parks and Wildlife Department's Coastal Fisheries Division has monitored the relative abundance of marine organisms since 1975 using a standardized, fishery-independent sampling program. Long-term trend data based on these types of sampling programs are necessary to effectively manage marine resources.

From 1988 through 1995, beach seine and bag seine samples were collected from May through November from seven Gulf beach areas along the Texas coast as part of the marine resource monitoring program. The purpose of the surf zone monitoring project was to augment existing knowledge of the life histories of organisms using the surf zone, to develop a more comprehensive understanding of seasonal, annual, and spatial variation in Texas' surf-zone fish and macroinvertebrate assemblages, to determine if the abundance or distribution of these organisms are related to measured environmental variables, and to identify any management implications. Over eight years of sampling along Texas beaches, a total of 36,107 vertebrates and 4,941 invertebrates were collected in beach seines, and a total of 203,249 vertebrates and 28,876 invertebrates were collected in bag seines. The overall composition of the catch as well as annual, seasonal, and spatial variation in the abundance of organisms was examined, and management implications for selected species were explored.

Development of Bioenergetic Model for Zebrafish and Application in Toxicology Research

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Bioenergetic models are a potentially important tool in ecotoxicological studies by providing a null model to make comparisons of growth, consumption, and respiration. Zebrafish *Danio rerio* is a common fish species used in ecotoxicological studies, yet there has not been a model fit for zebrafish. Thus, we fit a bioenergetics model with observed consumption, growth, and respiration across a temperature range of 18-30° C. The model's fit was evaluated with a 60-d laboratory validation at 28° C. We applied the zebrafish model as a null model in a toxicological study of Hexahydro-1,3,5-trinitro-1,3,5-triazine, a cyclonitramine commonly known as RDX (royal demolition explosive). RDX is a high energetic compound used mainly for the production of munitions and has been reported in water bodies around the world but information on its toxicity to aquatic organisms is scarce. We observed diminished growth and survival for zebrafish at high concentrations (10 ppm). Contrary to a priori expectations, we found no difference ($P=0.75$) in specific respiration between control and RDX-exposed zebrafish at low concentrations of RDX (1 ppm).

Spatial Variation in Biochemical Condition and Growth of Newly Settled Southern Flounder

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Several flatfish species, including southern flounder, recruit to estuaries during early life; identifying habitats and sites which serve as nurseries is critical to conservation and management efforts. Here, biochemical condition and growth measurements were used to determine the quality of settlement sites used by southern flounder in the Galveston Bay estuary. Beam trawl collections were conducted in three major sections of the estuary (East Bay, West Bay, Galveston Bay), and three sites were sampled from each bay (3 bays x 3 sites = 9). Within each sampling site, replicate beam trawl collections were taken in three habitats: 1) marsh edge 2) intermediate zone (10-20m from marsh interface; ~1m depth) and 3) bay zone (typically >100m from marsh interface; depth > 1 m). Catch data indicated that newly settled southern flounder were present throughout the Galveston Bay Estuary, but densities were significantly greater in East Bay (0.0313m^{-2}) than West Bay (0.0034

m⁻²) and Galveston Bay (0.0071m⁻²). Habitat-specific variation in density was not found. Spatial variation in nutritional condition (RNA:DNA) and recent growth were negligible, suggesting that early life survival and recruitment success of southern flounder in the Galveston Bay Estuary may be favorable regardless of settlement site.

Efficacy of Marking Fingerling Palmetto Bass with Oxytetracycline in Hard Water

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An oxytetracycline (OTC) marking study was performed to determine an OTC concentration that would successfully mark palmetto bass (♂ white bass *Morone chrysops* x ♀ striped bass *M. saxatilis*) in hard hatchery water (500 mg CaCO₃/L). Juvenile palmetto bass immersed for 6 h in concentrations of 500 and 700 mg/L of OTC mixed with hard water from Dundee State Fish Hatchery were examined to determine if differences existed in marking mortality, mark intensity, and mark identification after 14 and 344 d. Sagittal otoliths were examined for the 14 d portion of the study and lapillus otoliths were examined for the 344 d portion. Examination of the lapilli for OTC marks after 344 d was chosen over sagittae because of the time saved in otolith preparation and ease of mark identification. No significant marking mortality was noted but identification of the OTC mark in sagittal otoliths 14 d post-immersion was poor for both OTC concentrations. The 700 mg/L OTC concentration yielded better results than the 500 mg/L treatment when examining lapilli for identifiable marks and mark intensity 344 d post-immersion. It is recommended that juvenile palmetto bass OTC marked in hard water (500 mg CaCO₃/L) be immersed in 700 mg/L of OTC for 6 h and that lapillus otoliths be used for OTC identification.

Effects of the Probiotic Liquid Live Micro-Organisms System on Sludge, Water Quality and Koi Carp Production in Hatchery Ponds

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Turbidity and sludge in hatchery ponds can adversely impact water quality and fish production. To reduce turbidity, hatchery managers use chemical coagulants, chopped hay, or cottonseed meal. However, the turbidity-causing substances removed from the water column sink to pond bottoms as sludge which at pond draining can severely pollute receiving water bodies. For hatcheries to operate within effluent discharge limits total suspended solids (TSS), total settleable solids, total ammonia nitrogen, pH and carbonaceous biochemical oxygen demand (CBOD) must be effectively managed. We tested the effects of the probiotic, Liquid Live Micro-Organisms System (LLMO), on sludge accumulation, selected water quality variables, and koi carp production in plastic-lined ponds for 148 d. The results revealed no significant differences in sludge accumulation, water quality variables (turbidity, Secchi disk transparency, CBOD, chlorophyll a, TSS, and pH) and koi carp production between ponds treated with the LLMO and untreated control ponds.

Experience as a Hutton Junior Fisheries Biologist

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The American Fisheries Society (AFS) Hutton Junior Fisheries Biology summer internship program offers an opportunity for high school students to acquire collegiate-level internship experience working with professional biologists. The San Antonio River Authority (SARA) was involved in the Hutton program in the summers of 2004 and 2005, with Michael Gonzales, SARA Environmental Services Department Manager, serving as mentor. I gained a wide range of experiences with fish and macroinvertebrate sampling, habitat and water

quality monitoring, and data collection associated with SARA monitoring programs and special projects within the San Antonio River drainage. In the summer of 2004, I assisted with a contracted project for the National Parks Service. Objective of this study was to determine occurrence and abundance of fishes within the San Antonio Missions National Historical Park. In the summer 2005, I was involved with monitoring activities associated with the State of Texas Clean Rivers Program. The application of scientific techniques provided me with useful knowledge about the fisheries profession. Perhaps one of the most beneficial aspects of the AFS Hutton Junior Fisheries Biology Program is the connections a student can develop with professional biologists and other members of the Texas Chapter AFS. Overall, I feel that this internship experience has prepared me for college and a career in fisheries.

Some Evidence for Anadromy in the Black Drum *Pogonias cromis* Populations in Baffin Bay, Texas

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The Laguna Madre of Texas is a large hypersaline lagoon, sustaining the largest stock of black drum *Pogonias cromis* in their range. In Baffin Bay, little is known of their life history characteristics. There, black drum are known to migrate several kilometers up creeks after heavy rain events. There is also some evidence suggesting bimodal spawning. The objectives were to determine black drum reproductive condition in creeks and determine the seasonal reproductive condition of black drum in the bay. In September 2003, eight females and two males were obtained from Los Olmos Creek after heavy rains and examined histologically. Water salinity was estimated at 0 ppt. Of fish collected from creeks, one male displayed diffuse spermatozoa, while females exhibited final and mid-maturation oocyte stages suggesting spawning activity in the creek. To determine reproductive seasonality, fish were collected monthly from commercial fishermen. Standard lengths, body weight, and gonad weight were recorded, and samples of the gonads were collected for histological examination. Black drum were collected from November 2004 to November 2005. Approximately 25 fish were collected from the bay each month. Bimodal spawning activity was observed peaking in spring, with a smaller peak in fall. The smaller peak coincides with the rainiest month in South Texas. Because even modest rainfall events would reduce the salinity in creeks more than in larger bodies of water, black drum might have adapted an anadromous strategy to place vulnerable eggs and larvae with limited osmoregulatory ability in a more favorable environment.

Recruitment, Spatial Distribution, and Fine-Scale Movement Patterns of Red Drum *Sciaenops ocellatus* through Major and Shallow Passes in Texas

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Information on geographical recruitment patterns of marine fish populations is critical to understanding their ecology. This is problematic for estuarine-dependent species because of large adult migrations and larval dispersal. For example, red drum *Sciaenops ocellatus* are an estuarine-dependent fish that use seagrasses as nursery habitat, and it is unknown how far recruitment occurs from the inlet. Packery Channel is a natural tidal inlet in Corpus Christi Bay that had been closed since the 1930s but was recently opened, creating a direct link for marine fishes and crustaceans that spawn in the Gulf of Mexico and use the estuary as nursery habitat. The purpose of this research is to determine the distance that red drum disperse from an inlet before settling into a

seagrass meadow and to examine the effects of a new inlet on red drum recruitment. We also assessed fine-scale movement patterns of newly settled wild and hatchery-reared red drum using mark and recapture techniques. Our results suggest that juvenile red drum have relatively large movement patterns within seagrass meadows. Although red drum have large movement patterns within a seagrass meadow they do not disperse far from the inlet before settling. The greatest densities of red drum were found near the inlet with significantly decreasing densities at farther distances. These results suggest that the opening of Packery Channel will increase recruitment in an area that previously exhibited low densities of red drum and that remote seagrass meadows surrounding Packery Channel may now become an important nursery area for this species.

Impacts of a New Tidal Inlet on Estuarine Nekton: The Opening of Packery Channel in Corpus Christi, Texas

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In the Gulf of Mexico the vast majority of commercially important species are estuarine-dependent with larvae migrating through tidal inlets where they use estuaries as “nursery” grounds. Access to high quality habitats in estuarine areas via tidal inlets is critical for reproduction, growth, survival, and sustainability of these populations. Packery Channel, a natural tidal inlet, had been closed since the 1930s due to sedimentation. The US Army Corps of Engineers recently dredged and permanently reopened this inlet to allow water exchange from the Gulf of Mexico into the Laguna Madre near Corpus Christi Bay, Texas. We established seven zones at varying distances from Packery Channel to assess the impact of this new inlet on estuarine nekton. Within each zone we selected two sampling sites in seagrass meadows dominated by *Halodule wrightii* and collected triplicate nekton samples (10 m²) twice per season using an epibenthic sled. Sampling took place one-year prior to the opening of Packery Channel and will continue one-year after. Using red drum (*Sciaenops ocellatus*) as a model species for fall recruitment, we found distinct differences in their densities post-channel opening. However, red drum densities were not as great as those found near natural inlets. Despite these differences in density patterns between natural and dredged inlets, these results suggest that Packery Channel may have important implications to fisheries along the Texas coast by allowing newly recruiting nekton access to the extensive seagrass meadows of the Laguna Madre.

A Synoptic Survey for Non-Indigenous Ichthyofauna in Selected Tidal Bayous of Galveston Bay

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A synoptic survey was conducted between April 2004 and February 2005 on three tidal bayous of Galveston Bay to assess the presence of non-indigenous species. Active and passive sampling gears were used to collect finfish species within these waterbodies on a quarterly basis. Six non-indigenous species were collected: snow plecos *Pterygoplichthys anisitsi* (n = 167), grass carp *Ctenopharyngodon idella* (n = 18), blue tilapia *Oreochromis aurea* (n = 16), Nile tilapia *O. niloticus* (n = 14), Rio Grande cichlid *Cichlasoma cyanoguttatum* (n = 13) and common goldfish *Carassius auratus* (n = 2). Plots of gonadosomatic indices (GSI) for female *P. anisitsi* showed elevated values, indicative of spawning activity, during the spring sampling period while spawning activity for male *P. anisitsi* was less discernable with GSI data appearing slightly bimodal, with peaks during the summer and winter. Genetic analysis suggests either the putative tilapia species were of hybrid origin or hybridization among the tilapia species is occurring whereas the lack of variation in grass carp suggests they are

from a single lineage, possibly resulting from either a single introduction event or multiple releases of the same stock.

Dynamic Surplus Production Models for Analyzing the Texas Commercial Blue Crab *Callinectes sapidus* Fishery

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The blue crab fishery is the third largest commercial saltwater fishery in Texas, accounting for approximately 10% of total annual landings and generating around 11.7 million dollars into local economies. Commercial landings have declined from a high of 11.7 million pounds reached in 1987 to a 35-year low of 4 million pounds in 2004; catch-per-fisherman dropped from 38,000 lbs/year to 18,000/year over the same period. Fishery-independent bay trawl data revealed similar declines in catch-per-hour and mean carapace width, signaling increasing levels of mortality. These data were analyzed using a dynamic surplus production model in an attempt to determine a more favorable harvest strategy with a view of increasing and sustaining future yields. Preliminary results suggest that an annual sustainable yield of 7-million pounds is possible if yields are capped and populations allowed to recuperate. Current and future management measures such as effort and license limitation are also discussed.

Dissimilarity of a Blanco River Reservoir Fish Assemblage from Other Riverine Sites

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Main stem dams impact fish assemblages upstream and downstream of the modified areas. In general, decreased flow and pooled areas cause a shift from fluvial specialists to lentic species and increased taxa richness because of habitat diversification and subsequent stocking of game and forage species within the newly constructed impoundment. The purpose of this study was to determine fish occurrence and habitat changes in the Blanco River (Guadalupe drainage) relative to flow alterations caused by multiple low-head dams constructed in the 1950s. Analysis of similarities was used to test for differences among impounded and non-impounded sites. Our results show that the reservoir assemblage is significantly different from non-impounded sites and is the most unique among main stem sites. Additionally, the reservoir is dominated by lentic species and has few endemic forms. In contrast, sites relatively near to and distant from impoundments did not differ. Although fish assemblage changes were related to low-head dams, the extent of impact was limited.

Theoretical Model for Prey Size of Largemouth Bass

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A linear relationship is generally observed between the length of largemouth bass, *Micropterus salmoides* (Lacepède), and the length of prey they can consume. However, one should instead expect an allometric relationship, in which the maximum size of prey increases relatively more rapidly than does the largemouth bass length. We have constructed a theoretical model based on: (1) this allometric relationship; (2) the speed with which largemouth bass capture prey; and (3) the escape ability of prey fish. This model predicts a linear relationship between length of largemouth bass and length of prey. We test the model using published data sets.

Can Barley Straw and the Probiotic Liquid Live Micro-Organism System Control *Prymnesium parvum* and Improve Water Quality for Fish Production?

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The ichthyotoxic microalga *Prymnesium parvum* has caused extensive fish kills in many parts of the world. Since 2001, *P. parvum* has been implicated in major fish kills in 13 U.S. states. Chemicals can control *P. parvum* in hatchery ponds and small impoundments. However, chemical treatments are not feasible for large reservoirs because they are expensive, effective for a few days and may cause adverse ecological impacts. Barley straw and the Liquid Live Micro-Organisms System (LLMO) are natural products demonstrated to exert relatively long-term control on algal populations with potential to improve water quality. They are inexpensive and nontoxic to aquatic organisms or humans. However, their effects on *P. parvum* are unknown. We investigated the effects of these two products on *P. parvum* density, toxin production, ichthyotoxicity, and water quality (total nitrogen, total phosphorus, pH, and chlorophyll *a*) in hatchery ponds for 140 d. Barley straw or LLMO had no significant effects on *P. parvum* density, toxin levels and ichthyotoxicity. Similarly, they had no significant impacts on water quality.

Managing Freshwater Inflows to Estuaries: an Application of the DermoWatch Program

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DermoWatch (www.dermowatch.org) is a web-based community for the monitoring and management of the lethal oyster parasite, *Perkinsus marinus* (= *Dermocystidium marinum*). Dermo disease is more prevalent in larger oysters (*Crassostrea virginica*) in warmer, saltier waters. Online services are provided to oyster growers, resource managers and scientists. Data displays include station information, water temperature and salinity, and percent infection and disease intensity of sub-market and market-sized oysters. Adult oysters are sessile indicators of mesohaline environments. They are constrained on the freshwater side of their range by reproductive and osmotic failure, and constrained on their seaward side by predation and parasitism. The parasite *P. marinus* is less tolerant of low salinity than are oysters, and host and parasite provide a good integrator of salinity conditions. Resource managers can thus use DermoWatch to better manage freshwater inflows into estuaries. Freshwater inflows might be adjusted to maintain low disease levels in the central part of the estuary. This prevents wholesale mortalities due to parasites (and predators), and insures that oysters are optimally abundant across the salinity gradient.

The Expansion of Giant Salvinia *Salvinia molesta* on Toledo Bend Reservoir, Texas

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Mild winters and high water levels throughout the spring and summer of 2004 resulted in a record expansion of giant salvinia *Salvinia molesta* throughout Toledo Bend Reservoir. By May of 2005, aerial surveys estimated 5,000 acres of giant salvinia reservoir-wide. Since its discovery on the reservoir in 1998, isolated

infestations have been held in check by aggressive herbicide treatments conducted by Texas Parks & Wildlife Department and the Louisiana Department of Wildlife and Fisheries. An extended drawdown of the reservoir by the Sabine River Authority in 2000 resulted in a marked reduction of infestations, but failed to eliminate the threat. The expansion of giant salvinia on Toledo Bend Reservoir in 2004 poses a serious threat to neighboring water bodies. Giant salvinia is easily transported overland to new locations by boat trailers and personal watercraft. Due to the plant's overwhelming rate of growth and magnitude of areas covered, herbicide treatments on Toledo Bend Reservoir proved ineffective in 2004. Large-scale introductions of a bio-control agent in the form of the giant salvinia weevil *Cyrtobagous salviniae* on the Texas portion of the reservoir began in July of 2004. It is hoped the establishment of the giant salvinia weevil will provide a long-term management tool for the control of giant salvinia in the future.

Oyster Reef as Essential Habitat for Finfishes and Invertebrates

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Biogenic reefs formed by dense aggregation of the eastern oyster *Crassostrea virginica* are a dominant feature in many estuarine systems along the Atlantic and Gulf of Mexico. Oyster reefs are complex in their structural nature and may provide critical habitat for several species of fishes and invertebrates, but few studies have quantitatively assessed the use of oyster reefs by fish species in the Gulf of Mexico. Limited assessment of nekton using this habitat type has primarily been due to inefficiency of conventional gear to adequately sample oyster reefs. We have developed an effective technique for quantitatively sampling oyster reefs using an enclosure sampling approach. During 2000 and 2001, oyster reef, marsh *Spartina alterniflora*, and nonvegetated bottom habitat types were sampled on a seasonal basis in Galveston Bay, Texas. We found higher densities of nekton using oyster reef and marsh than over nonvegetated bottom, and species composition varied considerably among habitat types and season. These results suggest that identifying and quantifying the habitat role of oyster reefs, particularly in relation to other habitat types, is critical to implementing effective management and protection measures for Essential Fish Habitat.

Marine Fisheries and Ecosystem-Based Management: Is the National Coastal Assessment the Link?

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For many years marine fishery scientists have been recommending a move toward a multi-species approach to fisheries management. More recently, there has been a call for an ecosystem-based approach to the management of fisheries and for the management of ecosystems in general. As we assess the current strategies used to manage natural resources, they appear, in general, to be either issue- or resource-oriented, with little cross-cutting coordination or collaboration. For the past six years, the National Coastal Assessment (NCA) has been collecting data and assessing the health of the nation's bays, estuaries and in some cases, continental shelf waters. This program collects water, sediment, benthos and fish data that allows for, in a limited way, cross-resource analysis and assessment. The NCA program is leading the way toward ecosystem-based monitoring and management of fisheries and other natural and human resources.

Distribution of Exotic Fish Species in the Clear Lake Watershed, Texas: Potential Mechanisms of Dispersal in Coastal Streams

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During September 2004 through October 2005, we conducted surveys in selected first- and second-order tributaries of the Clear Lake watershed in Galveston Bay, Texas. Fish community data were collected using backpack electroshocking gear and seines. In addition, limited trawling and gillnetting was conducted in one of the larger bayous. Results of these surveys and comparisons with past data suggest that regional natives such as the Rio Grande cichlid *Cichlasoma cyanoguttatum* have invaded and extended their range within the watershed, becoming dominant in some waterbodies. In addition, other exotic species including tilapia *Oreochromis niloticus* and suckermouth catfish *Pterygoplichthys* spp. were collected in Armand Bayou. Possible sources include introductions by tropical fish hobbyists and downstream invasion through low-salinity bay systems. The probability is high for widespread invasion of these species into other portions of southeastern Texas and Louisiana coastal streams, due to their tolerance to brackish water.

Mercury Concentrations in Fish from Caddo Lake, Texas

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We compared mercury concentrations in largemouth bass *Micropterus salmoides* to mercury concentrations in other game fish from Caddo Lake, Texas, and determined how habitat type, trophic position, growth rate, and genetics were related to mercury concentration in largemouth bass. Largemouth bass and freshwater drum *Aplodinotus grunniens* had the highest concentrations of mercury and white bass *Morone chrysops* and channel catfish *Ictalurus punctatus* had lower concentrations of mercury. Largemouth bass from different habitats exhibited different mercury total-length relationships with individuals from shallow, vegetation-dominated habitats having higher concentrations of mercury than individuals from open-lake habitats. The trophic position of largemouth bass (measured with ^{15}N) was not statistically different between the two habitat types. Growth rate of largemouth bass was higher in the open-lake habitats than the shallow, vegetation-dominated habitats. Largemouth bass did not exhibit significant population genetic substructure between the two habitats. Largemouth bass growth rates between the two habitats were not related to differential occurrence of Florida subspecies largemouth bass *M. s. floridanus*. We suggest that when a lake may be contaminated with mercury, game fish in the lake should be collected from multiple habitats when assigning fish consumption advisories.

Epibenthic Survey of Larval Black Drum Habitat in the Baffin Bay System

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The Laguna Madre of Texas and Mexico is the world's largest hypersaline lagoon system, and it sustains the largest stock of black drum *Pogonias cromis* in the world. Despite their recreational and commercial importance, relatively little is known of their life history characteristics, particularly in the Laguna Madre. Living in hypersaline waters, ion and water regulation must impose a great energetic demand on these fish particularly for egg and larval stages with limited regulatory abilities. These early stages will likely perish if not in the proper environment. The nursery habitat utilized by newly settled black drum larvae in the Laguna Madre has not been well described. An epibenthic plankton survey was conducted over a variety of substrates in the Laguna Salada and Cayo del Grullo areas of Baffin bay. A weighted sled, fitted with a 500 μ m mesh cone net, was used to collect triplicate plankton samples from seven different sites in the Baffin Bay system bimonthly, between May of 2004 and March of 2005. Grass, mud and sand substrates were targeted. These samples were analyzed to determine relative densities of black drum larvae over these different substrates throughout the sampling period, in an effort to identify the preferred nursery habitat of black drum in Laguna Madre.

Habitat Use Patterns of Newly-Settled Spotted Seatrout *Cynoscion nebulosus* in Three Texas Bays

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Estuaries are one of the most notably productive marine ecosystems, supporting diverse populations of flora and fauna. Numerous ecologically and economically important fish species use estuaries during some phase of their life cycle. Despite the recognition of the importance of estuarine habitat, there are considerable gaps in knowledge concerning the specific spatial patterns of habitat use within estuaries for many important fishery species including the spotted seatrout *Cynoscion nebulosus*. The purpose of this study was to examine the habitat use patterns of newly-settled spotted seatrout in three Texas Coastal Bend bays. Newly-settled trout were sampled using an epibenthic sled from three different habitat types: seagrass, non-vegetated bottom, and marsh edge. We found significantly higher densities of spotted seatrout in seagrass beds compared to other habitat types. Using experimental mesocosms, we conducted a series of habitat selection studies assessing selection for potential estuarine habitat types with hatchery-reared and wild-caught spotted seatrout. Both hatchery-reared and wild-caught mesocosm fish showed selection patterns for structured habitats (oyster reef, seagrass beds and marsh edge) over non-vegetated bottom, but selection among structured habitat types was not as significant. These results suggest that structured habitat types, particularly seagrasses, are important nursery habitat for juvenile spotted seatrout.

A Fine-Scale Study of Temporal and Spatial Variability in Habitat Use by Early Life Stages of Estuarine Fishes with a Focus on Red Drum *Sciaenops ocellatus*

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While a large amount of work has been done to determine how abundances of fish larvae vary between distinct habitat types, relatively little work has focused on variability in habitat usage within fairly homogenous areas at small spatial and temporal scales. Accurate estimation of abundance and distribution of fish in seagrass beds is needed to clarify the relationship between planktonic supply, settlement, and recruitment to juvenile populations of commercially and recreationally important species. Between 2 October and 20 November 2003, 18,731 larval and early juvenile fish representing 32 species were collected from a south Texas seagrass meadow. The community was numerically dominated by darter goby *Ctenogobius boleosoma* (43%), gulf pipefish *Syngnathus scovelli* (18%), red drum *Sciaenops ocellatus* (12%), and code goby *Gobiosoma robustum* (11%). ANOSIM analysis indicated significant variability in species similarity in both time and space. Samples that were collected near each other in time and space were more similar (Bray-Curtis) than sites that were spatially or temporally distant. To determine the degree to which similarities between sampling units were based on environmental variables, both biotic variables (seagrass blade length, blades per shoot, shoots per core) and abiotic variables (temperature, salinity, depth, dissolved oxygen) were considered in the BIO-ENV procedure. Seagrass blade length was the environmental variable that best explained sampling unit similarity, although the correlation was low. Seemingly homogenous habitats may support larval assemblages whose composition is considerably variable even at small temporal and spatial scales.

FISHERIES APPLICATIONS OF GIS ABSTRACTS

A Grid-Based Approach to Mapping Habitat in Texas Reservoirs

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In 2004, the Inland Fisheries Division of the Texas Parks and Wildlife Department began a process to update the aquatic vegetation and habitat survey methodology in its procedures manual. Procedures and analysis tools were needed that were fast, efficient, objective, repeatable, and utilized the power of geographic information systems (GIS). An application was developed as an ArcView 3.x extension that allowed staff to assign up to three habitat features or plant species to customized grids that were overlaid on reservoir outlines or images. Grids currently range from 63 square meters to 1 hectare in size, depending on the type of survey being conducted. Grids extend beyond reservoir shorelines at conservation pool to enable surveys to be conducted during high water levels. This system is designed to be flexible to accommodate a range of tools or conditions. At the reservoir, staff can collect data on paper maps, using global positioning systems (GPS), or assign values directly to grids while surveying in the boat. Data not directly assigned to a grid at the reservoir can easily be assigned on a desktop computer in the office. Grid-based data are stored in a relational database system for long-term change detection, but can also be dissolved to create polygons for mapping in the GIS. Time conducting the survey at the reservoir has remained essentially the same, but data processing and analysis time has been cut by up to 80 percent.

Using GIS for Reservoir Creel Surveys and Mapping

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To take advantage of recent and intensive training in geographic information systems (GIS), powerful desktop computers, and more accurate global positioning systems (GPS), I developed some practical fisheries management applications with creel survey data and reservoir mapping using GIS. Visual analysis of bank fishing locations, fishing preferences, and angler catch at one West Texas reservoir, Lake Kirby, provided new perspectives into where anglers concentrated their seasonal fishing effort, location of “hot spots” for given species, and even the location of at least one major crappie spawning area, along with the timing and duration of the spawn. Using the spatial capabilities of GIS data, we hope to bring to the City of Abilene visual information on locations of high-use areas at Lake Kirby and recommend potential sites for angler-use facilities and improvements. We will also use these data to inform less-experienced anglers and new anglers to Abilene about good sites to fish for given fish species. In addition, angler use data will be useful with our habitat enhancement plan in selecting sites for habitat improvement and fish attractors. Contour maps were developed for five older reservoirs that previously had no elevation data available. These reservoirs ranged in size from 21 acres to 740 acres. Maps were constructed using a Garmin 188 sounder and a spatial analyst extension in ArcView 3.3. These maps will be an excellent product that we can provide to our anglers as a means to improve their fishing success or satisfaction. In addition, we could use the data to improve sample site selections and layer it with habitat and/or fish data to develop more intensive management applications and sampling designs.

INSTREAM FLOWS ABSTRACTS

Aquifer-Dependent Fishes of Central and Western Texas

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We provide a review of the status of many of the important aquifer-dependent fishes found in Texas. These fishes occur both in the spring outlets that are directly dependent on aquifer levels to sustain their habitats and also in downstream rivers and streams that indirectly depend on ground water. Of paramount importance to these environments is their overall habitat stability, especially with respect to water chemistry and flows. Exploitation of limited resources, particularly groundwater pumping, has caused environmental degradation, extirpation and extinction of species and, ultimately, loss of habitat and ecosystems. Many of these fishes could serve well as biological indicators of the overall system integrity. The few remaining relatively intact faunas and unmodified localities need careful management if they are to be sustained.

Response of Oxbow-Lake Biota to Hydrologic Exchanges with the Brazos River Channel

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Fishes and aquatic habitat variables were sampled between June 2003 and September 2004 to obtain information on the ecological dynamics associated with river channel–oxbow lake connectivity in relation to instream flows. Standardized fish samples were collected from oxbow and channel habitats using seines and gillnets, with data analyzed separately as catch per unit effort. Statistical ordination techniques revealed a strong gradient of fish assemblage structure that contrasted oxbow samples from river channel samples. A secondary gradient contrasted oxbows with different physicochemical attributes and connection frequencies. In contrast to the river channel, oxbow lakes contained high densities of white crappie *Pomoxis annularis*, sunfishes *Lepomis* spp., and shads *Dorosoma* spp. A number of minnow species (e.g., *Hybognathus nuchalis*, *Macrhybopsis hyostoma*) appear to be fluvial specialists that were primarily collected from the river channel. For species common in oxbow lakes, density tended to decline following periods of peak flow, which indicates a net export of individuals from oxbows to the river channel during floods that connect these habitats. Consistent with this view were patterns of higher densities of these species in the river channel following periods of peak flow. Fluvial specialists appeared in oxbow lakes in low to moderate numbers during periods of peak flow, but these sub-populations generally did not persist more than a month or two. It is concluded that oxbow lakes of variable ages and geomorphological structures provide essential habitats that function to increase overall fish species diversity in the lower Brazos River.

ENSO Impacts Translated to the Watershed Scale: Estuarine Salinity Patterns along the Texas Gulf Coast 1982 to 2004

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The importance of the El Niño-Southern Oscillation (ENSO) on regional-scale climate variability is well recognized, although the communication of this atmospheric signal onto the watershed and ultimately into estuarine salinity structure at the bay-system level is less well known. The Texas coast, situated in a climatic gradient, is an ideal location to study ENSO influences on estuaries. The seven major estuaries found on the coast share similar physical properties, yet each one is maintained by a hydrologically isolated watershed. Inflow differences maintain estuaries spanning the range from positive, to neutral, to negative. Three monthly measures of ENSO indices (Niño 3.4 sea surface temperature anomaly, atmospheric Southern Oscillation sea level pressure anomaly, and Pacific Decadal Oscillation sea surface temperature anomaly) were related to estuarine-wide average salinity during the period 1982-2004. Power spectrum analysis revealed that most of the variation in salinity is related primarily to five fundamental cycles (10.67, 5.33, 3.55, 1.94, and 1.02 years), and these periodicities closely correspond with frequencies related to the ENSO measures. The 1.94 year cycle is postulated to be related to the frequency of the Atlantic Oscillation, an ‘ENSO-analog’ operating in the Atlantic basin. Cross-correlation analysis showed the ENSO signal is translated almost immediately into the estuaries receiving the largest amounts of riverine inflow, and the signal is propagated across the state’s climatic gradient over a calendar year. Despite having very different underlying salinity regimes, the seven estuaries of the Texas coast appear to be operating in near unison to the low frequency forcing signals of ENSO. Current water planning in Texas focuses much

attention on maintaining estuarine salinity conditions at a monthly, bi-monthly, or seasonal scale. At this temporal resolution, water planning efforts may not adequately address the important ENSO-driven periodicities governing coastal estuarine salinity patterns.

Ichthyoplankton Recruitment to the Delta Nursery Areas of Nueces Bay, Texas

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Numerous commercially and recreationally important finfish species are considered estuarine-dependent in their early-life-history stages, and as such, they must find suitable nursery habitats. For species that spawn in areas distant from nursery areas, planktonic larvae face a variety of factors that can influence their dispersal. The objectives of this study are to quantify the seasonal recruitment of larval and juvenile fish and shrimp to the nursery areas of Nueces Bay, Texas, and to compare their distributions in relation to the discharge location of the Nueces River. Sampling, conducted biweekly during the spring of 2004, resulted in the collection of 38,218 larval and juvenile fish representing > 25 species from 20 families. Community structure of the ichthyoplankton was determined by non-metric multidimensional scaling (MDS) and rank-based analysis of similarity (ANOSIM). An unusually large ‘freshet’, or flood event that effectively replaced the volume of the back-bay with freshwater, greatly influenced the water quality parameters recorded during this study. Despite this flooding event, taxa still appeared to be seeking out the back-bay portions of the estuary. Community structure spatial and temporal patterns showed a great degree of overlap among stations, especially stations directly impacted by the flood waters. The abundance and distribution of many taxa indicates that the back-bay and delta regions of Nueces Estuary are sought out as nursery habitats. While the freshet altered the abiotic character of the bay, it showed the current river discharge location does not appear to act as a recruitment barrier for taxa seeking nursery habitats.

Freshwater Inflow Needs of the Matagorda Bay System

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Matagorda Bay is the second largest estuary on the Texas Gulf Coast covering approximately 352 square miles. The abundant production of finfish and shellfish make this bay system an important ecological resource and an economically significant commercial and sports fishery. Many factors contribute to this high natural productivity, but the most significant is an ample source of fresh water. To determine the freshwater inflow required to maintain bay productivity, the Lower Colorado River Authority (LCRA) entered into cooperative studies with the Texas Parks and Wildlife Department (TPWD), Texas Water Development Board (TWDB) and the Texas Commission on Environmental Quality (TCEQ). Two levels of inflow need, Target and Critical, were estimated for the estuary. Target inflows represent the monthly and seasonal inflows that optimize biomass while maintaining certain salinity, population density and nutrient inflow conditions. LCRA applied an existing TPWD and TWDB methodology, involving the synthesis of three components, to estimate Target freshwater inflow needs. First, statistical relationships were developed between freshwater inflows and key indicators of estuarine conditions. Second, monthly and seasonal freshwater inflows were calculated to optimize bay productivity subject to specific constraints at key estuarine locations. Third, estuarine-wide salinity conditions were evaluated to ensure conditions remain within desired limits. Critical inflow needs were determined by finding the minimum annual inflow needed to keep salinity near the mouths of the Colorado and Lavaca Rivers at levels required to maintain viable habitat under low flow conditions.

Cycleptus elongatus Life History Studies on the Lower Colorado River, Texas, as Part of the LCRA/SAWS Water Project

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The lower Colorado River basin supports a diverse ecological community that relies heavily on the quality and quantity of water moving through the system. The LCRA-SAWS Water Project (LSWP) has the potential to alter the flow regime for the lower Colorado River. Therefore, the study team has initiated a series of studies specific to a State Threatened resident fish of the lower Colorado River (*Cycleptus elongatus* - blue sucker). The objective of these studies is to characterize the essential life history requirements (migration, spawning, and recruitment) of *Cycleptus elongatus* in the lower Colorado River, Texas. In the Fall 2004, 30 adult blue suckers were collected and implanted with radio tags. So far, there has been an excellent survival rate for these fish and they continue to move up and down the lower Colorado River providing the study team with data on migration, habitat preferences, and spawning locations. During the Spring 2005, over 70% of the movement was upstream with fish swimming over 170 river miles to reach suitable spawning locations. Post-spawning movement was predominantly downstream with a high percentage of tagged *C. elongatus* returning to the very riffle complex in which they were originally tagged. The purpose of this presentation is to provide the technical details of the tagging effort and subsequent migration, spawning, and habitat preference results to date for this large riverine species.

Colorado River Flow Relationships to Aquatic Habitat Study as Part of the LCRA/SAWS Water Project

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The lower Colorado River basin supports a diverse ecological community that relies heavily on the quality and quantity of water moving through the system. The wide range of variables and conditions associated with biological communities in the lower Colorado River presents complexity in understanding its ecological processes. The LCRA-SAWS Water Project (LSWP) has the potential to alter the flow regime for the lower Colorado River. Therefore, the study team has embarked on the development of a comprehensive ecologically based tool encompassing data from existing studies and field-gathered information that will provide prediction capabilities necessary to evaluate the effects of a full range of flows on ecological components of the lower Colorado River system. The objective of the study is to characterize the flow-habitat and flow-ecological relationships within the lower Colorado River and its riverine ecosystem from just downstream of Austin (i.e., Longhorn Dam) to Matagorda Bay to provide a means of assessing biological impacts/benefits of various flow regimes. The presentation will discuss the technical details associated with data collection activities and hydraulic and habitat model development to date.

Development and Effectiveness of the Biological Condition Gradient in a Warm-Water River with Implications to Instream Flow Assessments

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Biological Condition Gradient (BCG) is a conceptual model used within the Tiered Aquatic Life Use framework to describe biological responses related to anthropogenic stressors. The model can be used to predict the assemblage effect by an assortment of anthropogenic stressors (e.g., alterations to the hydrologic regime), but differs from other bioassessments by providing explicit goals for restoration efforts. Objectives of our study were to develop methodologies for constructing a BCG for a western gulf-slope river in Texas and to determine the effectiveness of the BCG in assessing fish assemblage changes related to anthropogenic stressors compared to that of more commonly used models such as EPA and regional Indices of Biotic Integrity. To construct the BCG, the Brazos River drainage was divided into smaller regions based on distributional assessment of the historical and current fish assemblage. Once subdivisions were established (i.e., lower Brazos River main stem), historical records of fish occurrence and abundance were compiled and analyzed to assess gradual faunal shifts related to anthropogenic stressors. Hydrologic alterations (i.e., impoundments and dewatering) are the primary anthropogenic stressor in the Brazos River and other western gulf slope drainages; therefore, predictions of the BCG can be used as a conceptual framework for instream flow recommendations.

A Template for Conducting Ecosystem-Based Instream Flow Studies

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Since the development of the first quantitative instream flow techniques in the 1970s and 1980s, much has been learned about ecological processes of rivers. Though much remains to be learned, many technical tools or methods have been developed to incorporate that understanding into developing and applying instream flow prescriptions. However, most studies to date have focused on only one or a few of the several elements that affect biological processes and ecosystem needs of rivers. In a recent project by the Instream Flow Council, a template for conducting instream flow studies and improving strategies for riverine management was developed. That construct draws on existing facts and knowledge to emphasize that effective instream flow management should integrate 5 riverine components (hydrology, geomorphology, biology, water quality and connectivity), public education and involvement, and legal/institutional elements.

Texas Instream Flow Program Reconnaissance Efforts

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Recognizing the competing interests of water for human uses and conserving rivers and streams, the Texas Legislature directed the three state water agencies in Senate Bill 2 to identify and conduct priority studies for determining flow conditions necessary for conserving rivers and streams. In response to that legislation, Texas Parks and Wildlife Department, Texas Commission on Environmental Quality, and Texas Water Development Board initiated the Texas Instream Flow Program (TIFP). In cooperation with river authorities, reconnaissance work has begun on three river basins: Brazos, Sabine, and San Antonio. The main objective of reconnaissance is to identify and organize the existing historical information on the hydrology, biology, geomorphology, and water quality of each study area. Data and information compatible with spatial analysis will be organized into a GIS-

based tool for use in study planning and design. Review and analysis of the collected information will provide a summary of the state of knowledge and identify areas that need further attention. This presentation will provide a brief overview of the TIFP, field efforts, and the GIS framework used for reconnaissance efforts.

RED SNAPPER FISHERIES ECOLOGY IN THE U. S. GULF OF MEXICO ABSTRACTS

Population Structure and Historical Demography of Red Snapper *Lutjanus campechanus* from the Northern Gulf of Mexico

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Allelic variation at 19 nuclear-encoded microsatellite loci and haplotype variation in a 590 bp protein-coding fragment of mtDNA was assayed among Gulf red snapper sampled from four cohorts at each of three offshore localities in the northern Gulf of Mexico. Significant heterogeneity in allele and genotype distributions among samples was detected at four microsatellites. Pairwise exact tests revealed that six of seven 'significant' comparisons involved temporal rather than spatial heterogeneity. For mtDNA, exact tests of genetic homogeneity among cohorts within localities and among localities were non-significant. Estimates of variance effective population size (microsatellites) ranged between ~1,000 and >75,000 and differed significantly among localities, with the sample from the northcentral Gulf having significantly greater effective size than localities in the northeastern and northwestern Gulf. Estimates of female effective size (based on mtDNA) also indicated substantially larger effective size in the northcentral Gulf. The differences in variance effective size could reflect differences in number of individuals successfully reproducing and/or differences in patterns and intensity of migration, and are consistent with the hypothesis, supported by life-history data, that different 'demographic stocks' of red snapper occur in the northern Gulf. Nested-clade analysis of mtDNA variants provided evidence of different temporal episodes of range expansion and isolation by distance. The spatial distribution of red snapper in the northern Gulf thus appears to have a complex history that likely reflects glacial advance/retreat, habitat availability, and hydrology. These factors may partially restrict gene flow among present-day red snapper in the northern Gulf and give rise to a metapopulation structure with variable connectivity. This type of population structure may be difficult to detect with commonly used, selectively neutral genetic markers.

Reductions and Changes in Shrimp Trawl Fishing Effort in the Gulf of Mexico

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Shrimp trawl fishing effort in the Gulf of Mexico has declined dramatically in recent years due to a combination of economic factors and natural catastrophes. In 1990, shrimp fishing effort was in excess of 220,000 nominal days fished. In 2004, effort was less than 160,000 nominal days fished. Total effort has not been estimated for 2005. However, those vessels which fished in 2005 averaged trawling 33 to 40% fewer days than were fished on average in 2004. In 2005, hurricanes and continuing economic deterioration contributed to further reductions in the fishing fleet. Fewer than 3,000 vessels have applied for permits to fish the Exclusive Economic Zone waters in the Gulf. Historical and recent data suggest that a fundamental change in the fishing pattern has

occurred in the Gulf shrimp fishery. However, this change has yet to be recognized in the effort estimation process. As a result, mid-shelf effort is systematically overestimated whereas nearshore and offshore effort is underestimated. These changes will significantly reduce red snapper bycatch because red snapper are most abundant in the mid-shelf area.

Red Snapper Bycatch in the Gulf of Mexico Shrimp Fishery: A Review

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Historically, the magnitude and age composition of juvenile red snapper bycatch in the Gulf of Mexico shrimp fishery has been a highly contentious issue. Past studies provided dissimilar estimates of both the magnitude and age composition of red snapper bycatch. A 2005 publication provides the most recent bycatch estimates and the new approach has resolved the contention regarding bycatch estimation. During 1999-2003, bycatch averaged ~22.1 million fish per year of which 28% were age-1 fish and 72% were age-0 fish. Bycatch has declined dramatically since 1990 when some 60 million juvenile red snapper were taken in shrimp trawls. In contrast, total red snapper bycatch levels in 2001, 2002, and 2003 were about 24, 22, and 9 million fish, respectively. Red snapper CPUE in the shrimp fishery is high between the 10- and 30-fathom depth contours and low inshore and offshore of this zone. Reductions in total effort and an ongoing shift in fishing effort from mid-shelf zones to inshore and offshore habitats should greatly reduce red snapper bycatch in future years.

Red Snapper *Lutjanus campechanus* Young-of-the-Year in the Texas Territorial Sea

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Between 1985 and 2004, Texas Parks & Wildlife conducted 18,482 trawls in the Texas Territorial Sea, extending from the beach out to 16.7 km (9 nm), and including statistical zones 17 – 21. Samples were selected using a stratified random sampling methodology and were collected monthly. Red snapper (*Lutjanus campechanus*) catches are discussed here. Mean total length (TL) was 91 mm (± 0.35 SE, $n = 5,799$), making all red snapper collected young-of-the-year. Coast-wide mean CPUE was 1.9 (± 0.10 SE), although catches were minimal along the northern Texas coast with only 14.8% of red snapper collected in statistical zones 17 through 19. Zones 20 and 21 dominated red snapper catches with 39.6% and 45.6% of total catch, respectively. Mean CPUE was higher during fall (4.9 ± 0.34 SE) than in any other season and higher in September (7.1 ± 0.69 SE) than in any other month. Although there was statistical significance in the linear relationship between CPUE and salinity, water temperature, and dissolved oxygen ($p < 0.0001$), little variation around the mean was explained ($r^2 < 0.01$). Annual variability in CPUE may be associated with changes in shrimping effort. Recent CPUE increases (2000 – 2004) may have resulted from shrimping effort reduction caused by economic factors such as increased fuel prices, decreased market prices, and competition from foreign imports, and/or regulatory management measures such as the nearshore seasonal shrimping closure off the southern Texas coast, and BRD requirements instituted in 1998, which reduced red snapper bycatch.

Analysis of the Relationship between Shrimp and Juvenile Red Snapper Distributions on Large Temporal and Spatial Scales

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Closed areas are often relatively short-term restrictions of specific gear types in specific sensitive areas used by fishery managers to reduce overfishing, to rebuild stocks, or to achieve other management goals. The use of closed areas to reduce red snapper bycatch in the Gulf of Mexico shrimp trawl fisheries has never been seriously investigated as a management tool because of the assumption that bycatch of red snapper is a random event that cannot be avoided by fishermen. We used GIS analysis of SEAMAP data to investigate whether there are locations where shrimp and juvenile red snapper overlap consistently in space and time, which would indicate the potential for closed areas to reduce red snapper bycatch. We also investigated areas with high abundances of shrimp and low abundances of red snapper to show areas where fishermen are likely to catch shrimp with less red snapper bycatch. Finally, we have tried to correlate the areas of highest and lowest overlap with environmental parameters such as temperature, dissolved oxygen, and sediment type to better predict under what conditions shrimp and juvenile red snapper might be expected to overlap.

Movements of Red Snapper Tagged off Texas

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Over the last three years, we have tagged over 6,000 red snapper *Lutjanus campechanus* off Texas. Fish under the sixteen inch (40.6 cm) recreational size limit were tagged from party boats and charter boats out of Port Isabel, Port Aransas, Freeport, and Galveston. Most fish were tagged off oil platforms, artificial reefs, and natural structures in water greater than 100 feet, and most were tagged from May through August. Only about 2% of tagged fish have been recaptured. Time at large of recaptured fish ranged from 2 to 564 days. Fish were recaptured by both recreational and commercial fishermen. Most fish were recaptured from the Port Aransas and Port Isabel areas. Most recaptured red snapper exhibited localized movements and many fish were recaptured at the same platform or structure where they were initially tagged.

Patterns of Habitat Use by Juvenile Red Snapper *Lutjanus campechanus* on Natural Banks in the Northwestern Gulf of Mexico

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Trawl surveys were conducted to measure patterns of habitat use by newly settled red snapper *Lutjanus campechanus* at three bathymetric highs, or banks, on the inner continental shelf of Texas. Digital side-scan sonar and multibeam bathymetric data were used to define inshore mud, shell-ridge, and offshore mud habitats for Freeport Rocks, Heald Bank, and Sabine Bank. Monthly surveys were conducted using an otter trawl from July-September of 2003 and 2004 during the settlement period for red snapper. Peak recruitment occurred July-August

on all three banks. Red snapper densities were significantly influenced by date, bank, and habitat. Freeport Rocks had markedly higher densities of red snapper than the other two banks; however, no habitat effect was detected. Conversely, densities of red snapper at Heald and Sabine Banks were affected by habitat, with densities on offshore mud habitat significantly higher than shell-ridge or inshore mud habitats. Otolith microstructure analysis was used to estimate age, hatch date distributions, and growth. In addition, recent growth (based on increment widths near the otolith margin) was used to assess the relative quality of settlement sites inhabited by red snapper.

TROPHY FISH MANAGEMENT ABSTRACTS

Factors Related to Angler Catch of Trophy Largemouth Bass in Texas Reservoirs

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We used angler catch reports of largemouth bass *Micropterus salmoides* from Texas Parks and Wildlife Department angler recognition programs to determine if catch occurrence of trophy fish (>5.9 kg) was greater in reservoirs stocked with fingerling Florida largemouth bass *M. s. floridanus* (FLMB) than in non-stocked reservoirs. We also compared trophy fish catch occurrence between reservoirs having the standard 356-mm minimum length harvest limit to reservoirs having a more restrictive length limit, and evaluated the relation of catch occurrence to reservoir age, surface area, shoreline development index (SDI), latitude, longitude, FLMB stocking frequency and density. Catch occurrence of trophy fish was significantly greater in FLMB-stocked reservoirs (29%) than in non-stocked reservoirs (4%). Probability of trophy largemouth bass catch occurrence in FLMB-stocked reservoirs increased with reservoir SDI, decreased with reservoir age, and was greater for reservoirs managed with special harvest regulations (high minimum length, protective slot, and no harvest restrictions) than for reservoirs managed with the statewide standard minimum size. Our study indicated that introduction of FLMB into Texas reservoirs yielded greater trophy largemouth bass potential and suggested that differences in trophy potential among FLMB-stocked reservoirs are likely more a function of differing reservoir habitat than differences in FLMB stocking frequency and density.

Managing the Texas Spotted Seatrout *Cynoscion nebulosus* Fishery for Larger Fish

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Texas began implementing coastwide regulations on the spotted seatrout *Cynoscion nebulosus* fishery in 1978. Between 1980 and 1990, regulatory measures were adopted to assist spotted seatrout populations recover from the combined effects of overfishing and three catastrophic cold-induced fish kills. These early management measures resulted in the spotted seatrout population being 50% greater than that observed in the early 1980's. In spite of the increase in spotted seatrout numbers, Texas Parks and Wildlife Department (TPWD) received numerous comments, between 1999 and 2001, concerning the apparent decrease in the abundance of larger spotted seatrout and increase in the number of undersized fish in the population. TPWD was presented the opportunity to improve the trophy component of the spotted seatrout fishery by fine-tuning existing regulations in response to a sociological component, rather than a biological need, of the fishery. The resulting regulations, adopted by the TPWD Commission in 2003, were a proactive approach to reduce spotted seatrout landings, increase the proportion of large fish in the population and distribute the harvest of large spotted seatrout among more anglers.

Using a Voluntary Survey to Improve Knowledge of Trophy Largemouth Bass Catches in Lake Fork Reservoir, Texas

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Lake Fork Reservoir is an established trophy largemouth bass *Micropterus salmoides* fishery and has been managed under a protective slot limit since 1989. The fact that Lake Fork has produced 34 of the 50 biggest largemouth bass in Texas draws anglers from a broad geographic area and the trophy fishery provides a significant source of revenue for the local economy. Despite intensive sampling using standard procedures, fisheries managers in Texas have very little information on catches of trophy bass. We sought to characterize the Lake Fork trophy bass fishery using voluntary reporting of trophy fish catches. Initiated in March 2003, this ongoing survey targets bass weighing >7 lbs and/or measuring >24 inches. Initially developed to provide recreational anglers with information on trophy bass catches, and to promote the bass fishery on Lake Fork, the trophy bass survey contains valuable information for managers. As of October 2005, we obtained information on over 4,900 trophy largemouth bass. We examined whether mean weight and body condition (W_T) varied as a function of year, season, moon phase, or time of day when the fish was caught. Preliminary analyses suggest mean weight and body condition of trophy bass caught during winter (December – February) were significantly higher than during all other seasons, while trophy bass mean weight and body condition during summer (June – August) were significantly lower than during all other seasons. Additionally, more trophy bass were caught per day during full moon periods than other moon phases, but this was only significant during fall months. The number of trophy bass reported during a sampling quarter was positively correlated with directed angler effort as estimated by access creel surveys; however, the number of trophy bass caught per hour of effort was higher during the winter than during other seasons. Using trophy bass survey data in conjunction with angler access creel surveys, we conclude that the slot limit on Lake Fork is effectively sustaining the trophy bass fishery.

ShareLunker Program

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The ShareLunker program (SL) is an angler recognition program which documents the catch of trophy largemouth bass (>5.9 kg) from Texas waters. The objective of the program is to encourage anglers to loan largemouth bass weighing at least 5.9 kg to Texas Parks and Wildlife for public relations/education purposes, research, and spawning. Since the program's inception in 1986 through April 2005, a total of 375 anglers have provided 391 fish to the program. The SL program has been instrumental in illustrating the importance of catch and release fishing in the development of trophy largemouth bass fisheries. Data from the program have been used to evaluate Florida largemouth bass stocking success, evaluate effects of restrictive harvest regulations, and to identify reservoir characteristics which produce trophy fisheries. Fish donated to the program have been incorporated into hatchery brood stock in a manner that maximizes effective population size of the brood stock. Additionally, genetic markers thought to be associated with quantitative traits (i.e., amplified fragment length polymorphisms) are being evaluated for their use in a selective breeding program.

Admixture and Ancestry of Trophy Bass

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Taxonomic identification at the population and individual level is made more difficult by introgressive hybridization and commonly requires invasive sampling techniques. In order to estimate the genetic composition and ancestry of valuable trophy bass without mortality we used microsatellite DNA variation to evaluate 37 trophy bass (defined here as ≥ 5.90 kg) donated to the Texas Parks and Wildlife Department (TPWD) between 2004 and

2005. Based on comparative analyses at eleven polymorphic loci, in five Florida largemouth bass *Micropterus salmoides floridanus* ($N = 175$) and eight northern largemouth bass *M. s. salmoides* ($N = 249$) populations, allele frequencies indicated that all trophy fish had a majority of Florida largemouth bass influence with ancestry genetically similar to populations sampled in western Florida. Twenty-four fish were direct descendents of Florida largemouth bass as either remnants or direct descendants from introductions, and thirteen were admixed with northern largemouth bass. All admixed individuals were later generation hybrids (non-F₁s) providing no evidence of heterosis or outbreeding depression with respect to size in select environments.

Relationship between Fishery Quality and Angler Catches of Trophy Fishes

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Biologists have used descriptive characteristics of trophy fishes (e.g., maximum size) to infer information about population dynamics. That is, biologists generally assume that population characteristics are related to the production of large, trophy fish. We tested this assumption by comparing angler catches of large fishes with population characteristics determined during routine monitoring of fish populations for bluegill (spring trapnets), largemouth bass (spring electrofishing) and walleye (fall gillnets). We hypothesized that numbers and maximum size of fishes captured by anglers (and reported in the Nebraska Mater Anglers database) would be: 1) positively related to population abundance (catch per unit effort [CPUE] multiplied by lake area) if trophy fish production is related to “number of tickets in the lottery,” 2) positively related to fish density (CPUE) and size structure (traditional stock density indices) if trophy fish production is related to “average” fish production, and 3) negatively related to fish density (CPUE) if production of trophy fish is related to density-dependent growth. We found, in general, positive correlations of angler catches of trophy fish with fish density and size structure, although responses varied among species. Trophy fish generally are inadequately sampled by standard fishery sampling gears; however, our data suggest that fishery quality, as measured with standard fishery sampling gears, does relate to angler catches of these large fishes.

Potential Use of North American Fishery Agency Record-Fish Lists in Identifying Patterns in Trophy Fish Occurrence

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We examined web pages for all 50 US state and 13 Canadian provincial fishery management agencies. Web pages for all 50 US states included lists of state record specimens; only three of 13 provincial web pages included such information. Among US state agencies, 49 agencies posted record lengths or weights of freshwater fishes and 21 posted records for saltwater fishes. Although capture information varied among states, most presented the date and location of capture. These records allow testing of a number of simple hypotheses of importance to trophy fish management (e.g., whether maximum size is related to latitude or growing season length). We will discuss these and other potential uses of web pages for study of trophy fishes.

The Science of Trophy Fish Management

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Creating and managing fisheries for trophy-sized fishes represents an emerging challenge for fishery managers. However, there is relatively little scientific information available on which to base management of these valuable fishery resources. In large part, this is due to the rarity of these large fishes. Consequently, standard sampling methods collect so few large individuals that geographic and temporal patterns in abundance are difficult to detect. Nonetheless, a review of the literature on trophy fishes revealed a number of geographic, bioenergetic, ecological and human dimensions related factors that affect the occurrence of trophy fishes. Unsurprisingly, within species, there is greater trophy potential at lower latitudes. Forage availability and quality influences production of trophy fishes, which may explain a general relationship between water body size and maximum fish size. Regulations, angling effort and mortality, and climatic events, including El Niño, also affect catches of trophy fishes. From these and other observations, we developed a general conceptual model for guidance of research and management of trophy fishes.

Symposium Wrap-Up: The Role of Science in Trophy Fish Management

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The presentations included within this symposium include case histories, descriptions and analyses of existing sources of information on occurrence and size of trophy fishes, and initial attempts to develop conceptual and mathematical models that might be useful in the study and management of trophy fishes. This paper will synthesize these presentations and offer comments on: (1) our current state of knowledge of trophy fish biology and management and (2) how this symposium advances this knowledge.

TROUT FISHERIES IN REGULATED RIVERS ABSTRACTS

Angler Attitudes and Opinions and Economic Impact of Trout Anglers on the Canyon Reservoir Tailrace

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The Canyon Reservoir tailrace is a 22.2-km portion of the Guadalupe River located below Canyon Reservoir in Comal County, Texas. The tailrace was first stocked with rainbow trout in 1966. It is one of the most popular winter trout fisheries in Texas and was listed in 2005 by Trout Unlimited as one of the United States' top 100 trout fishing destinations. While the tailrace has always supported a popular put-and-take winter (December to February) fishery, water temperatures from May through October were thought to exceed lethal levels (>25 C) for trout. Oversummer survival was confirmed in the early-1990s and in 1997 an 18-inch minimum length and one trout daily bag limit was implemented in 15.9-km stretch of the tailrace. Since the mid-1990s, angler utilization of the fishery has dramatically declined. An analysis of covariance model suggested that historical angler counts were related to the fishing regulation change, river flow (cfs), number of days post stocking, day of the week, access site and ambient air temperature. Anglers were also surveyed to measure economic impact of the fishery and gain a better understanding of angler attitudes and opinions towards tailrace fishing regulations and access.

Recommendations for increasing angler use included increasing the number of stockings, decreasing the interval between stockings, increasing the number of free access sites and more effectively promoting free lease access site availability.

URBAN FISHERIES ABSTRACTS

Texas Urban Fishing Programs

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Texas Parks and Wildlife has provided fishing opportunities to its urban constituents for many years but recent patterns of population growth have added impetus to provide high quality fishing opportunities “close to home” for the state’s 17 million urban residents. Texas’ urban fishing program is a multi-faceted “work-in-progress”, not a finished product. Some components have been around for many years; others are new. A statewide network of community fishing lakes, developed over the past decade, brings fishing opportunities to small cities and towns, as well as metropolitan centers. These lakes are stocked a few times each year with small, but harvestable channel catfish *Ictalurus punctatus* (rainbow trout *Oncorhynchus mykiss* in winter), similar to other southern states. A newer component is the “Texas Urban Fishing (TUF) Program”. This pilot program provides high quality, year-round fishing opportunities in major metropolitan areas and targets non-traditional users from local neighborhoods. The TUF program is designed to be self-supporting, easily expandable, and reliant upon effective city partnerships. Frequent stockings throughout the year will combine with angler education, tackle loaner programs and a coordinated marketing strategy to attract users. Originally based on evaluations and institutional wisdom from this and other state agencies, the program has evolved to be similar to the successful Arizona urban fishing program – and that program is the model for much of our current and future efforts. Critical to the success of Texas programs will be continued commitment from all levels of the agency, successful partnerships with communities, and continued research and evaluation.

POSTER SESSION ABSTRACTS

Biotic Diversity of Mid-Shelf Bank Communities in the Northwestern Gulf of Mexico

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Hard banks in the northwestern Gulf of Mexico support diverse fish and coral communities, and several of these banks have recently been designated as habitat areas of particular concern (HAPCs) by the Gulf of Mexico Fishery Management Council. Here, we present preliminary results from an ongoing study aimed at characterizing and monitoring benthic habitat and reef fish assemblages at one of these areas, Sonnier Bank. We conducted photographic surveys of the benthos on two primary peaks using SCUBA and determined the percent coverage of coral, sponge, and macroalgae with image analysis. We also surveyed ichthyofauna with SCUBA and ROV (remotely operated vehicle). Our assessment of benthic communities was similar to a previous characterization of the area as a *Millepora*-sponge community. The dominant coral species in our assessment was *Millepora alcicornis* with up to 70 percent coverage (per m²), while the dominant sponges were *Neofibularia nolitangere*, *Ircinia strobilina*, and *Agelas clathrodes* with up to 50, 15, and 12 percent coverage (per m³), respectively. Preliminary tallies from both SCUBA and ROV surveys revealed a total of 45 fish species at Sonnier Bank compared to at least 88 fish species reported previously. At depths where visual surveys were conducted (<31m), there were higher abundances of groupers, grunts and snappers in the intermediate range (24-28m). Additional video analysis should reveal more species and allow us to evaluate the efficacy of our ROV approach by quantifying associations between species richness and elapsed time.

Validation of Daily Growth Increment Formation in the Otoliths of Juvenile Brazos River Fishes

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Proper use of otoliths for age and growth determination requires that the periodicity of increment formation within the otolith be known. The most reliable method of age validation involves the use of known age fish. When known-age fish cannot be used, fish of unknown age can be either immersed in or injected with various chemicals which bind with calcium as the otolith grows; thereby creating a reference mark on the otolith that is detectable at a later date. Age is then validated by comparing the number of growth increments between the reference mark and the outside edge of the otolith with the amount of time that has elapsed since the chemical treatment. To assess the utility of age and growth data obtained from daily growth increments for Brazos River fishes, we conducted a chemical marking trial. Juvenile smalleye shiner, sharpnose shiner, plains minnow, and Red River pupfish were immersed in a 100mg/L solution of alizarin complexone for 24 hours. After immersion, fish were sampled at 5 day intervals for 30 days. Regression models indicated high correspondence between number of days post-treatment and number of growth increments between alizarin mark and the edge of the otolith for smalleye shiner ($r^2 = 0.98$), sharpnose shiner ($r^2 = 0.99$), and plains minnow ($r^2 = 0.97$), providing strong evidence that daily growth increments are indeed formed daily in these species. Unfortunately, ages for Red River pupfish could not be validated because clear alizarin marks were only detectable in 5 out of 56 otoliths.

Atlantic Croaker Maturation and Spawning in Texas Marine Waters

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Gonadal maturation of 725 Atlantic croaker *Micropogonias undulatus* was investigated from September 2002 to November 2003 during fall and spring seasons along the Texas coast. The specimens were composed of 20.14% males and 79.86% females; males ranged from 135 mm to 455 mm total length (TL) and females ranged from 130 mm to 437 mm TL. The majority (90 %) of Atlantic croaker females 2 years and older and 50% of age 1 females were reproductively mature in the fall, as indicated by elevated gonadosomatic indices (GSI). Comparisons made between bays showed some significant differences in total length and GSI averages of mature females.

Characterization of Exposure of a Tilapid *Oreochromis mossambicus* Residing in a Water Reclamation Facility

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Recent evidence indicates that pharmaceutical and personal care products (PPCPs) are pervasive in wastewater treatment processes. PPCPs have been identified as problematic in laboratory exposures at very low concentrations, as low as 0.1 ng/L. Toxicity studies incorporating whole-life histories of exposed organisms would greatly help determine any potential effects these chemicals may have on native fish. However, translation of laboratory studies to native populations has been largely unsuccessful. In this regard, the City of Denton's Pecan Creek Water Reclamation Plant introduced a population of Mozambique tilapia *Oreochromis mossambicus* in October 2003 to combat a burgeoning population of Lemna. Tilapia primarily reside in the clarifier and sand filter beds of the facility, in water consisting of 100% treated effluent. Introduced tilapia have not only efficiently

controlled Lemna growth, but are reproducing at prolific rates. My research is a comprehensive examination of possible consequences for tilapia exposed to this chemical “soup”, incorporating an investigation of biomarkers including cortisol and vitellogenin, production, growth, and reproductive effect. An initial demographic study involving visual sexing of fish revealed an aggregate female:male ratio (N=2,709) of 57.9:42.1, significantly different from expected, but not unlike ratios observed in tilapia reared in cooler (20°C) temperatures. As a warm water species, sexual differentiation in tilapia is influenced by temperature, with warmer water producing a preponderance of males, cooler water more females. Further research will prove beneficial in determining impact of wastewater effluent exposure to fish populations.

Movements of Blue Marlin in the Gulf of Mexico Recorded with PAT Tags

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Atlantic blue marlin *Makaira nigricans* populations are being exploited unsustainably and fishing mortality (primarily by pelagic long-liners) is approximately 4x the level required for MSY. Pelagic long-line fishing effort by the U.S. fleet is highest in the Gulf of Mexico; on average 3.5 million hooks were set per year between 1996 and 2003. Since 1999, by-catch of blue marlin in the Gulf of Mexico has been higher (N=2,759) than in all other parts of the north Atlantic combined (N=1,912). We deployed 21 pop-up archival transmitting (PAT) tags on blue marlin to understand how vertical and horizontal movements in the Gulf of Mexico influence susceptibility to pelagic long-line fishing. We observed that blue marlin tend to remain within the northern Gulf of Mexico for several months where long-line fishing effort has become concentrated in recent years. They primarily utilized the upper mixed layer (from the surface to the thermocline) of the water column, and the observed vertical movements suggested differential vulnerability to long-line fishing depending on the depth of the thermocline. In the western Gulf where shallow thermocline depths predominate, blue marlin spent most of their time at depths <60m, indicating that they would be especially susceptible to shallow long-line sets (i.e., long lines with a small number of gangions between floats). Conversely, blue marlin associated with the loop current in the eastern Gulf (where the thermocline is considerably deeper) spent more time in deeper habitats up to 200m, indicating vulnerability to both shallow and deep long-line hooks.

Feeding Habits of Juvenile Black Drum *Pogonias cromis* from South Texas Creeks

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Black drum *Pogonias cromis* are one of the most commercially and recreationally important finfish in Texas. They have an estuarine-dependent life cycle. Adults are found coastally and migrate into estuaries to spawn. Eggs, early larvae, and juveniles are found in bays. Larval and juvenile black drum from the Laguna Madre, a hypersaline lagoon, are commonly found in creeks. The objective of this study is to examine the food habits of juvenile Black Drum from these creeks. Black drum were caught from two creeks, San Fernando Creek and Escondido Creek. Juvenile black drum were obtained using a cast net, and then placed in 10 % formalin that fixed the fish and stopped further digestion. Standard length (SL) was taken for each fish. During dissection, the stomach and intestine were examined and contents were identified to lowest possible taxon. Ten fish were examined. The size of the fish examined ranged from 4.1 to 11.5 cm SL. Food items found were larval insects, gastropods, ostracods, amphipods, and isopods.

Ichthyofaunal Differences between Oyster Reef and Littoral Estuarine Habitats with Emphasis on Spotted Seatrout *Cynoscion nebulosus* Sexual Digeography

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The Texas Parks and Wildlife Department is investigating recent anecdotal information suggesting that male spotted seatrout prefer open-water oyster-reef habitats and that females prefer littoral habitats. Twenty oyster reef gill-net sets were added to TPWD's standard 40 shoreline sets in East Matagorda Bay during the 2005 sampling season. Preliminary analyses suggest differences in sex ratios and population structure of spotted seatrout between the habitats. Additionally, fish assemblages vary between the habitats.

Components of Fishing Mortality for Largemouth Bass at Sam Rayburn Reservoir with Implications for Alternative Length Limits

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The largemouth bass *Micropterus salmoides* fishery at Sam Rayburn Reservoir is managed with a 356-mm minimum length limit (MLL). In 2001, 47% of anglers favored more restrictive largemouth bass length limits, assuming a resulting increase of fish > 457 mm. In 2003, 6,021 largemouth bass > 315 mm were tagged to estimate annual fishing mortality and explore potential benefits of more restrictive length limits via population modeling. Due to popularity of tournament angling (52% of anglers participate and annual events exceed 300) and high voluntary release rate (42%) at Sam Rayburn Reservoir, our fishing mortality estimate included non-tournament harvest, tournament mortality, and catch-and-release mortality. Catch and harvest of tagged fish by tournament and non-tournament anglers was estimated via creel sampling to avoid non-reporting uncertainty, adjusted for recruitment and tag loss, and expanded to estimate total annual tagged fish catch and harvest. Tournament and catch-and-release mortality was simulated at rates of 10, 30, and 50% and 5, 10, and 15%, respectively. Population loss from non-tournament harvest was 6 - 14% and tournament and catch-and-release mortality simulations both resulted in losses of 1 - 6%. Our estimated range of total fishing mortality was 7 - 24%. Compared to the current 356-mm MLL, population modeling indicates 406-mm and 457-mm MLLs provide minimal increases of fish reaching 457 mm (1 - 4% and 3 - 11%, respectively). A more restrictive MLL would reduce tournament catch available for weigh-in and provide little benefit compared to the current regulation.

Field Guide to Freshwater Fishes of Texas

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This guide provides high resolution photographs, distinguishing characteristics, a synopsis of habitat and life history information, and range descriptions for freshwater fishes of Texas. The purpose is to aid in the identification of Texas fishes by students of ichthyology, fish enthusiasts, and anglers. In addition, this guide will also benefit biologists and resource managers in fish identification as a supplemental text to available dichotomous keys and other fish texts. Photographs were taken with a Nikon Coolpix 950 digital camera. Most photographs were taken within 24-48 hours of collecting each fish in an effort to capture natural color patterns. Color patterns differ between breeding and nonbreeding individuals and between males and females in some fishes; consequently, additional photographs were taken to display this variability in color patterns. For rare and

endangered species, photographs were taken of preserved specimens held in the Texas State University Ichthyology Teaching Collection.

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