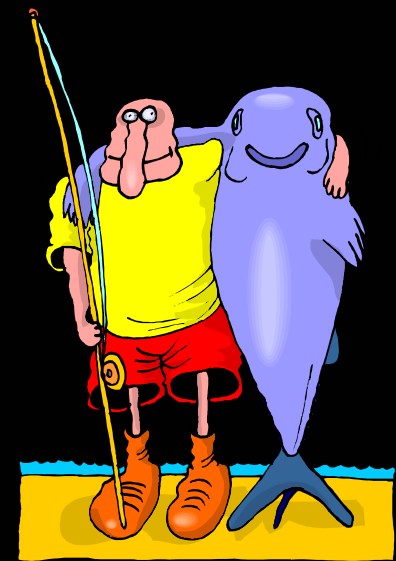


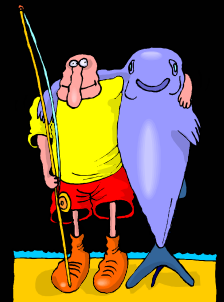
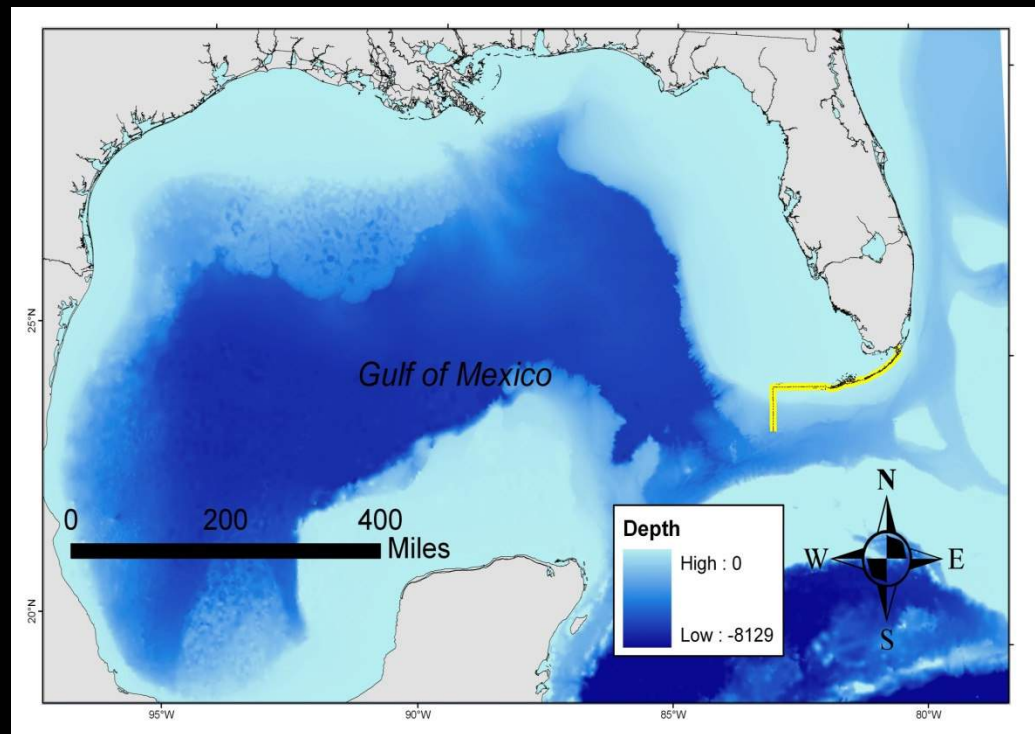
Barotrauma in Gulf of Mexico Reef Fish Fisheries

March 2011



9th Largest Water Body in the World
Bordered by the United States, Mexico,
Cuba and the Caribbean Sea

Area: 580,000 cubic miles of water
Average Depth: 5,299 ft



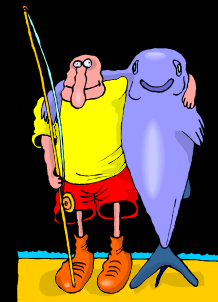
Recreational Reef Fish Fisheries

70 Species Managed 42 are Reef Fishes

Most Belong to the Grouper/Snapper Complex

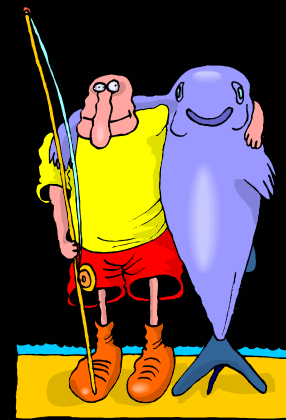
Highest Recreational Catch: red grouper, gag, black grouper, scamp, yellow edge, snowy grouper, Warsaw grouper,, red snapper, vermilion snapper, mutton snapper, gray snapper, and lane snapper

Other Species: greater amberjack, hogfish
blueline tilefish, gray triggerfish, and red drum



Reef Fish Species

Long Lived
Slow to Reproduce
Some Are Hermaphroditic
Some Form Spawning
Aggregations
Territorial



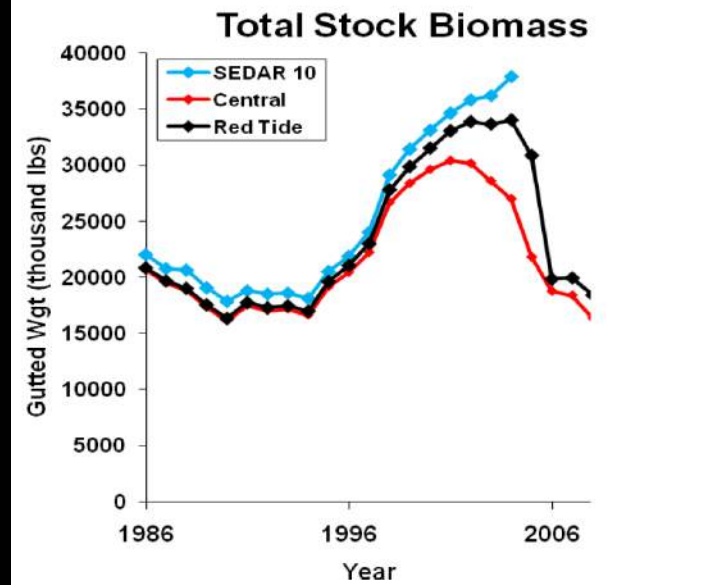
Gag Stock Abundance



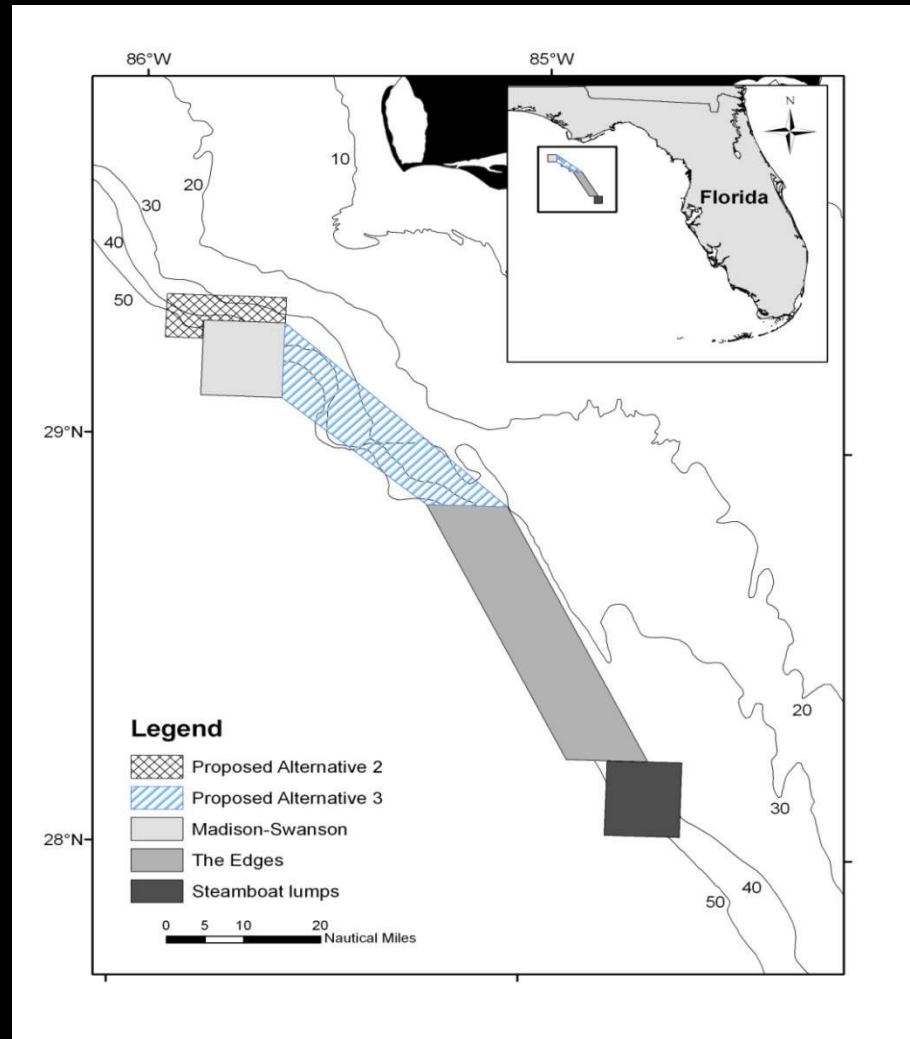
Classification: Overfished and Undergoing Overfishing

Subject to Barotrauma
High Hook Mortality

Figure 8.7. Total stock biomass estimates at start of year, before recruitment or mortality occur. Biomass units are thousand pounds, gutted weight.



Marine Protected Areas to Protect Gag Spawning Aggregations



Protected Species - Moratorium

Goliath Grouper



Red Drum



Nassau Grouper



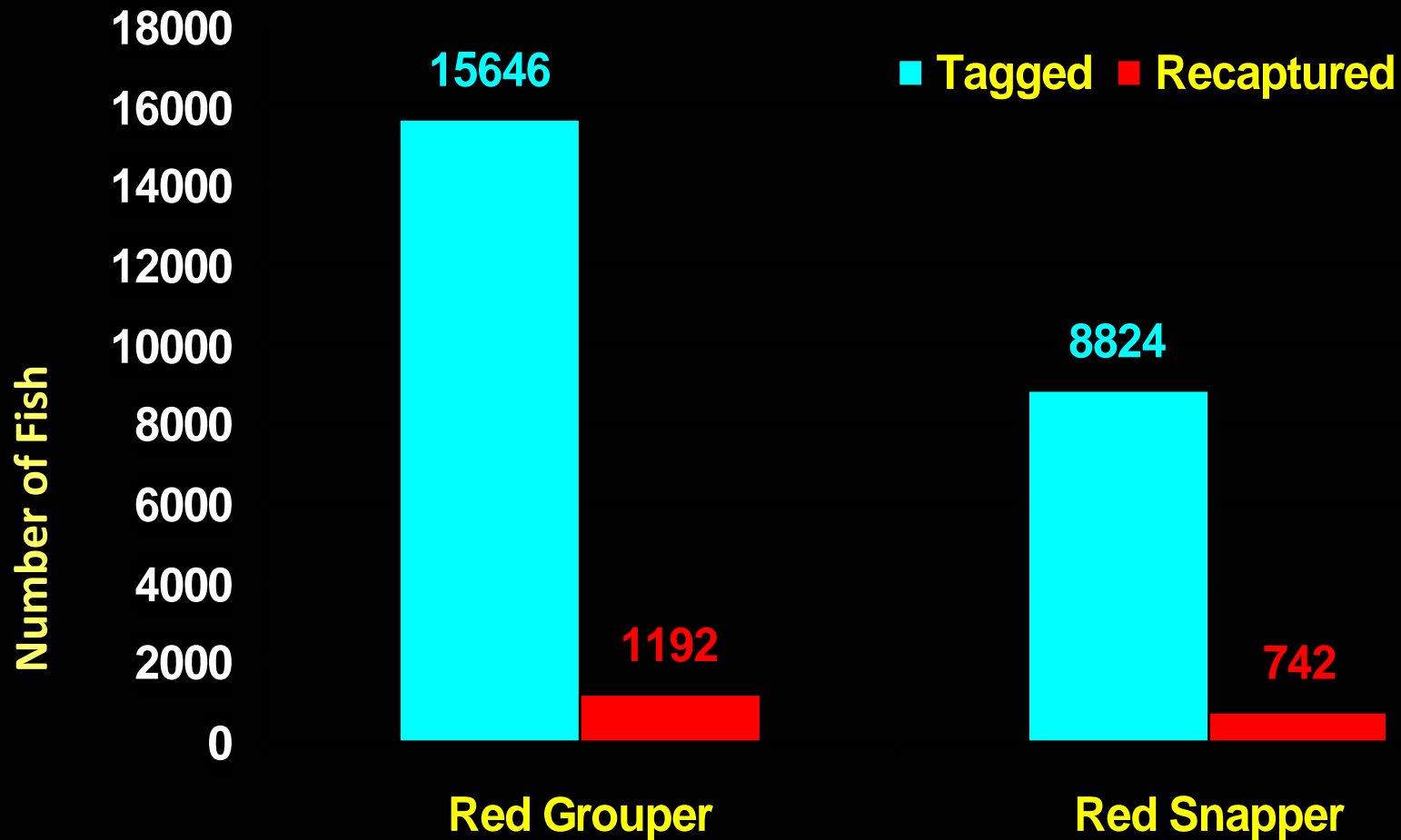
Nassau grouper Copyright 2006 by Emagine (Bahamas) Ltd. The webpage is at:

<http://www.breef.org/OurMarineResources/Grouper/Othergrouper-species/tabid/81/Default.aspx>

Marine Protected Areas



Number of Tagged and Recaptured Fish

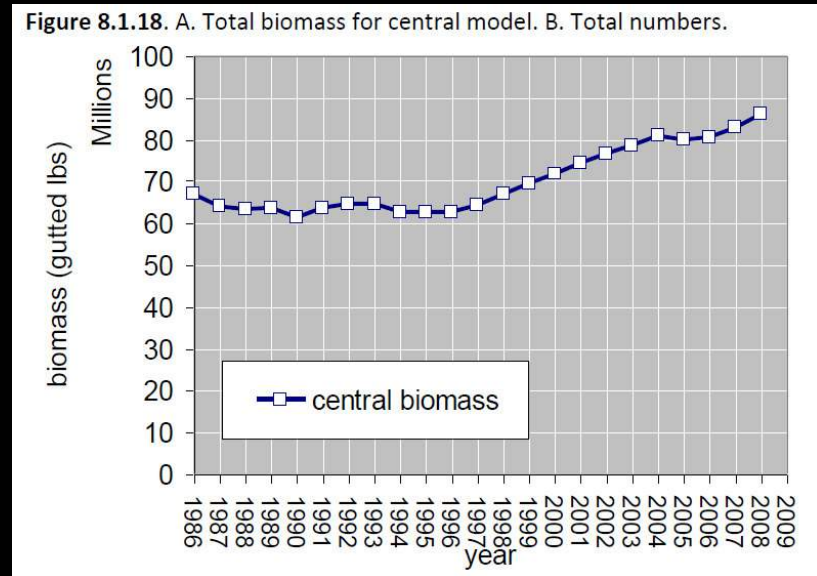


Red Grouper Stock Abundance

Classification: Not Overfished,
Not Undergoing Overfishing



Subject to Barotrauma
Low Hook Mortality



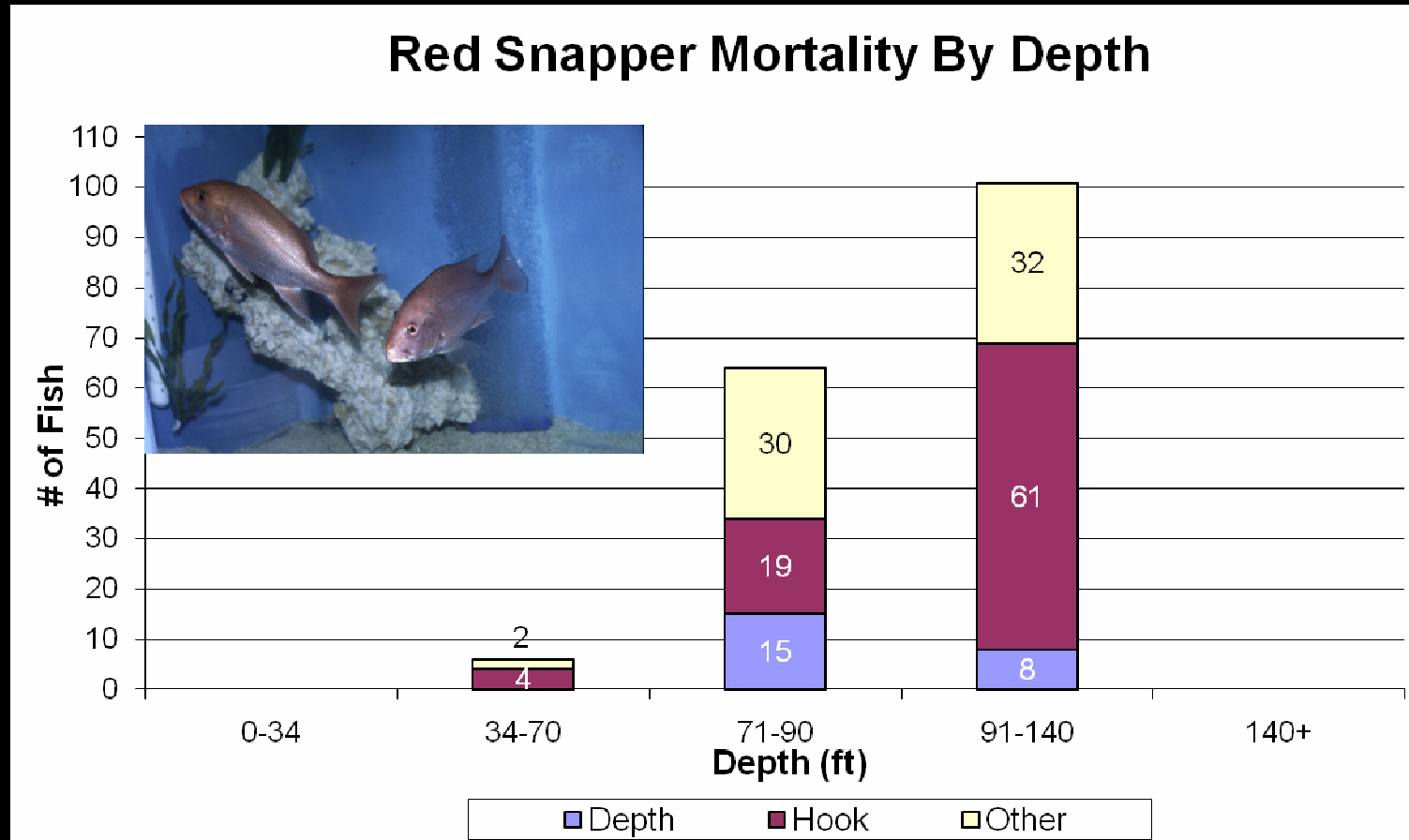
Red grouper SEDAR stock assessment



Red Grouper Caught From a Headboat

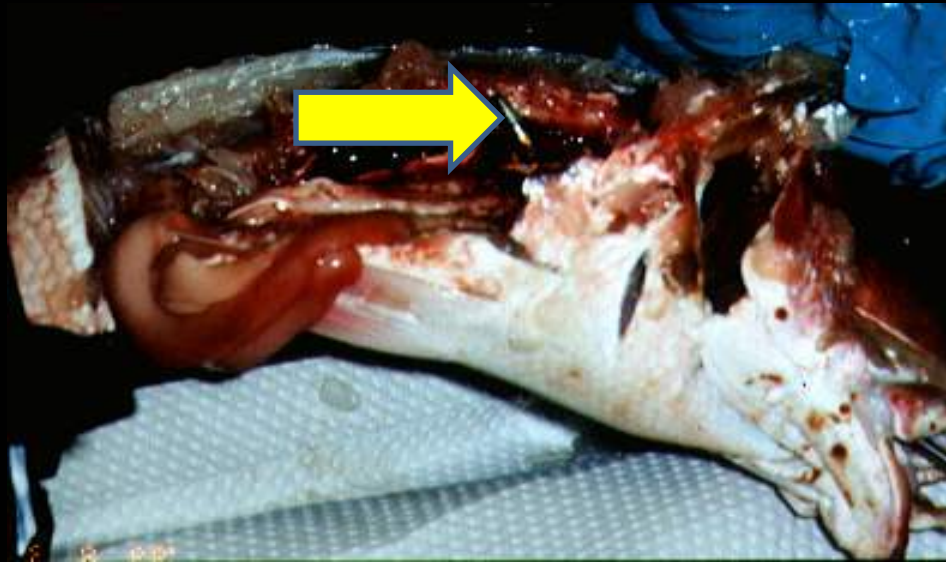


Mortality Effects Determined by Necropsy

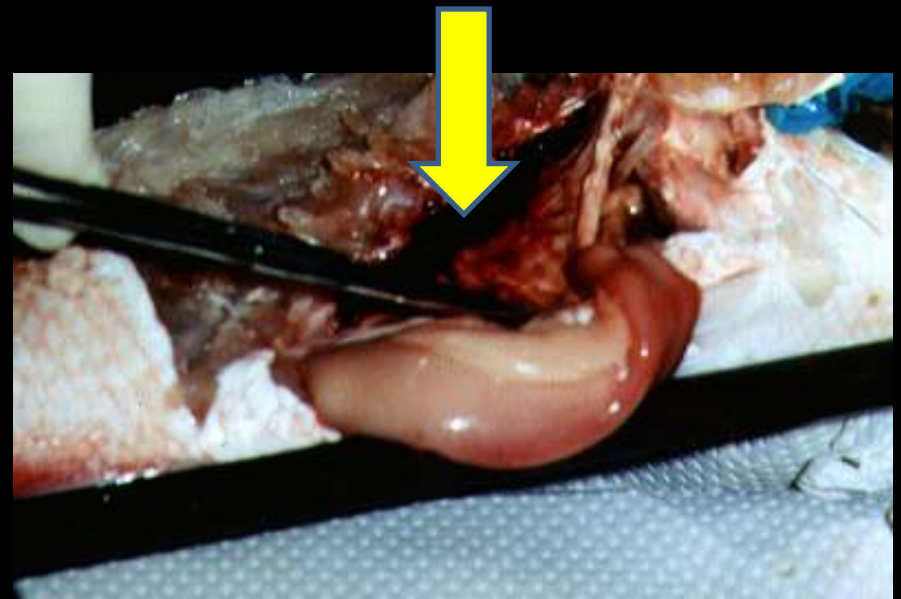


Acute and Latent Hook Mortality in Red Snapper

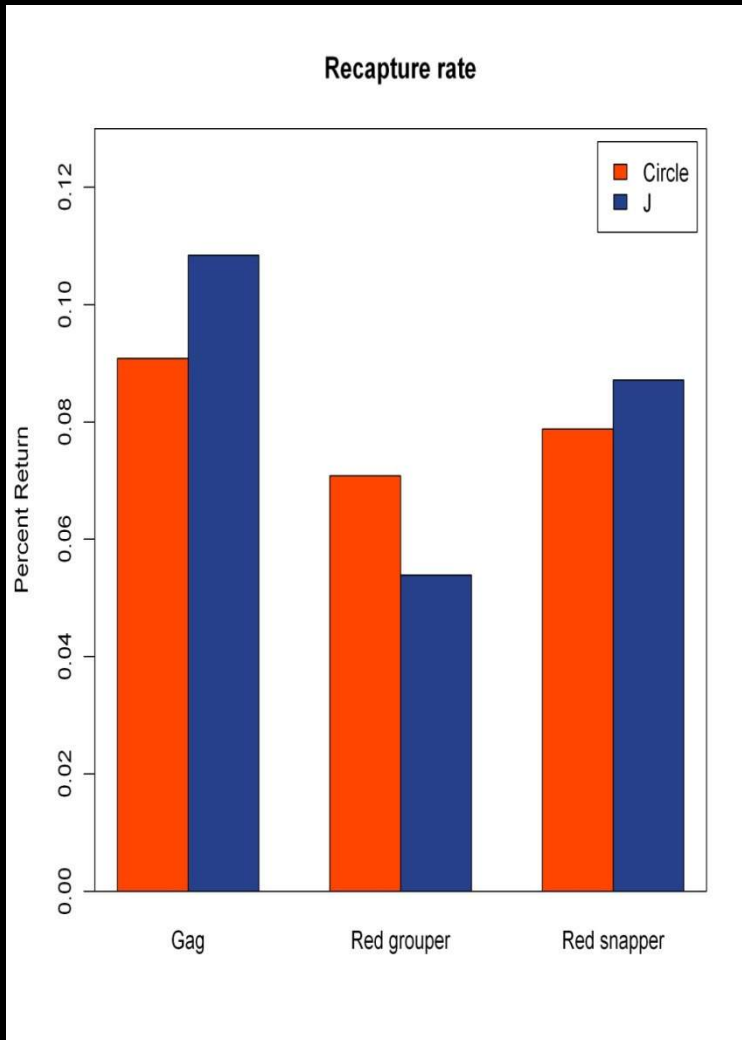
Acute



Latent



Recaptures from Circle vs J Hooks



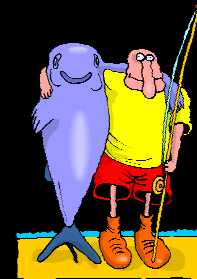
Species	Hook Type	Tagged (n)	Recaptured (n)	Recaptured %
Gag	Circle	1,024	93	9
	J	3,183	345	11
Red Grouper	Circle	2,160	153	7
	J	8,381	452	5
Red Snapper	Circle	3,630	286	8
	J	5,129	447	9



Predation

**Panama City: 2 trips: 6.9%
& 2.9 % confirmed**

**21.7 & 20% chased
downward: probable take**

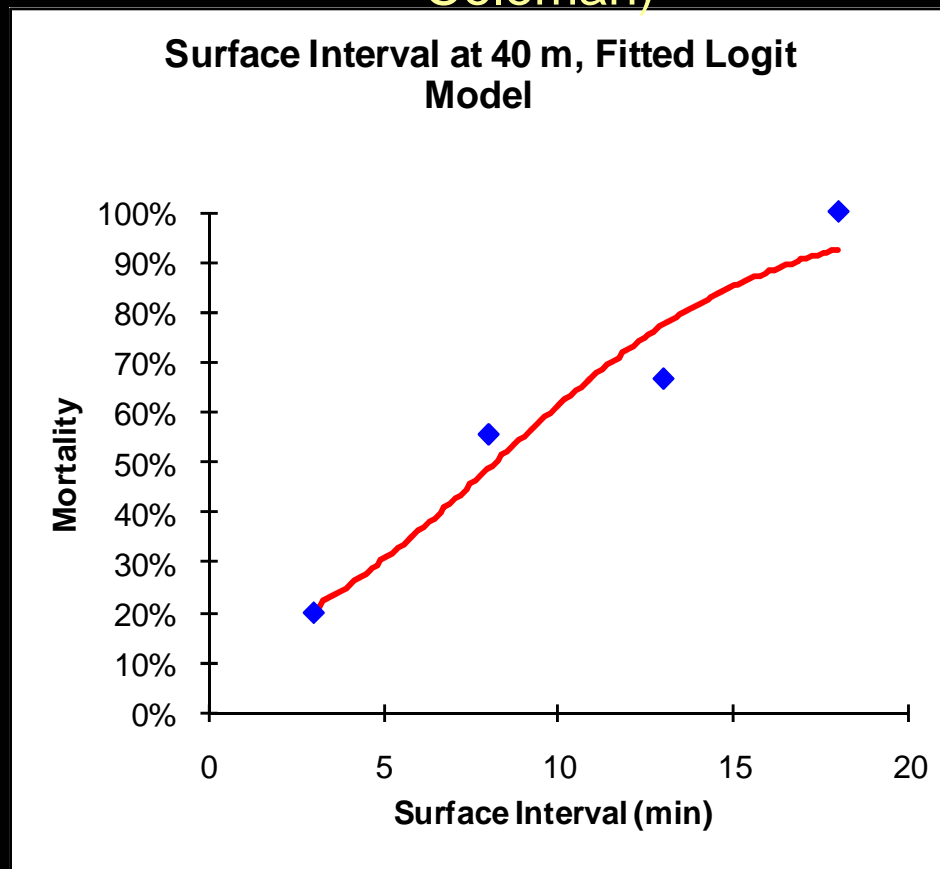


Venting

Seasonality
Thermal Shock
Surface Interval
Species
Differences
Pelagic vs Benthic
Improper Venting
Gear Differences



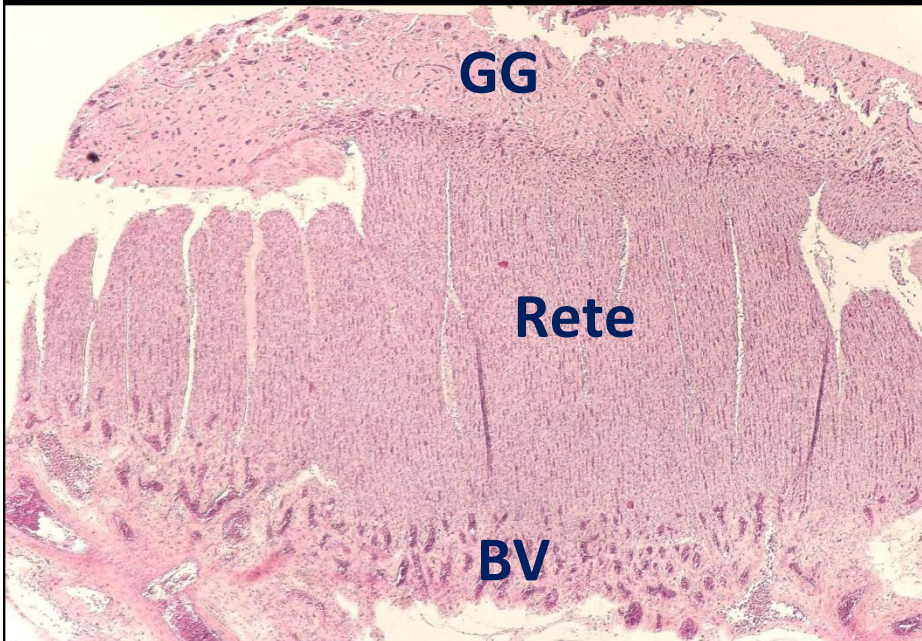
Relationship Between Surface Interval of Captured Red Grouper, Red Snapper, and Gag and Mortality at 40 m Capture Depth (Chris Koenig & Felicia Coleman)



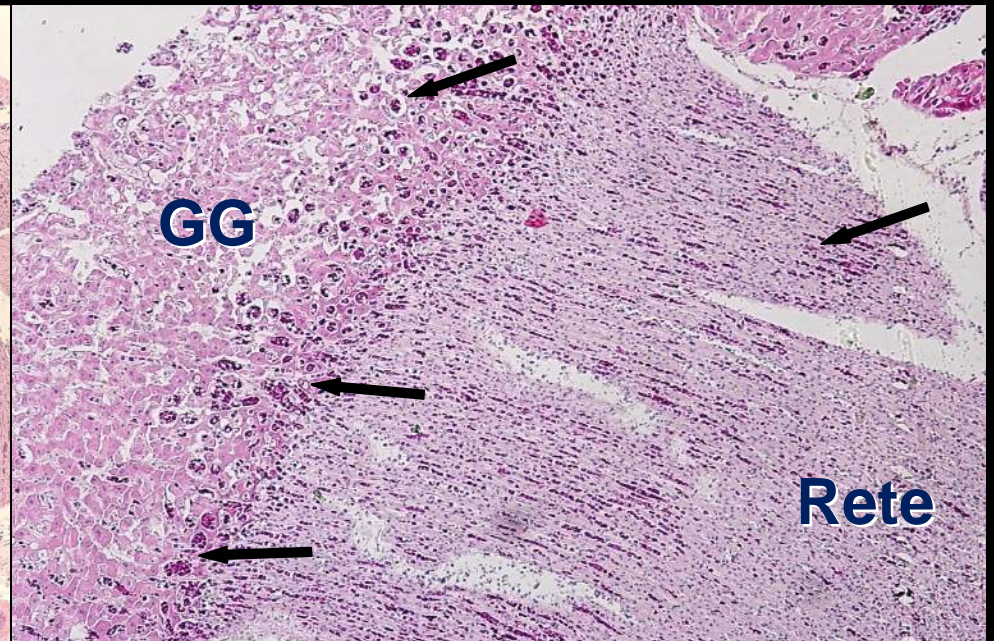
Swim Bladder Histology

- Angler caught fishes from headboats
- Measured hemorrhaging as a function of fish size

Red Grouper



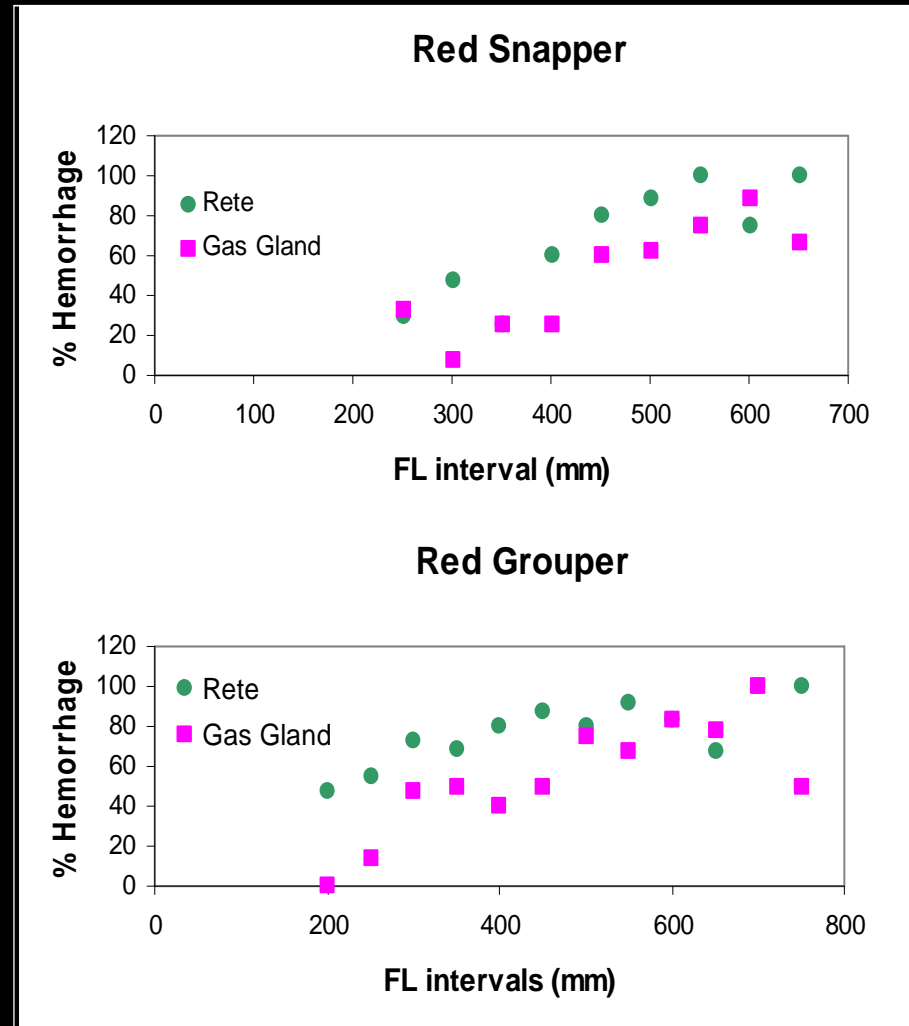
Red Snapper



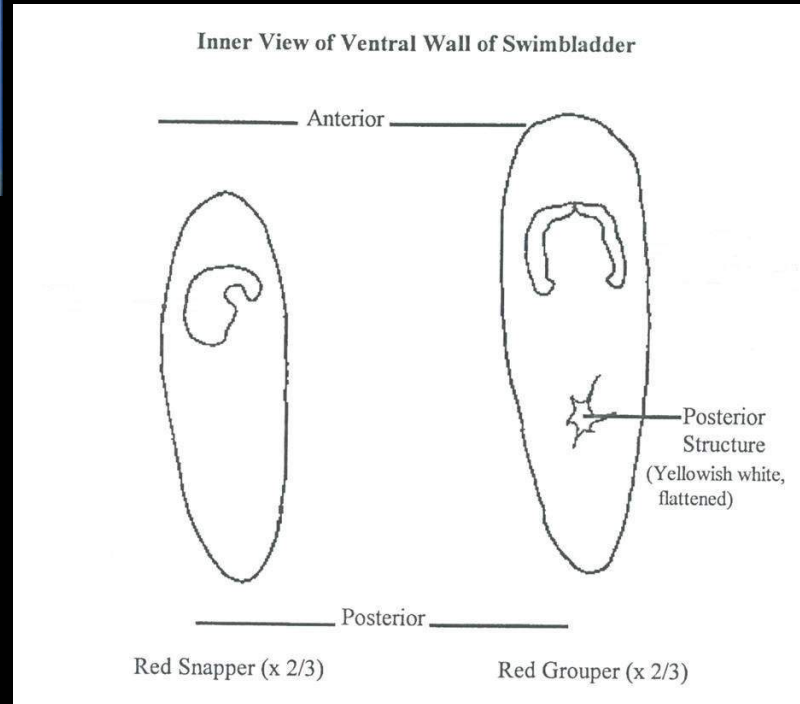
GG = Gas Gland, BV = Blood Vessel



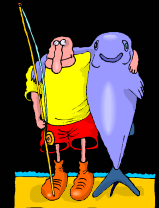
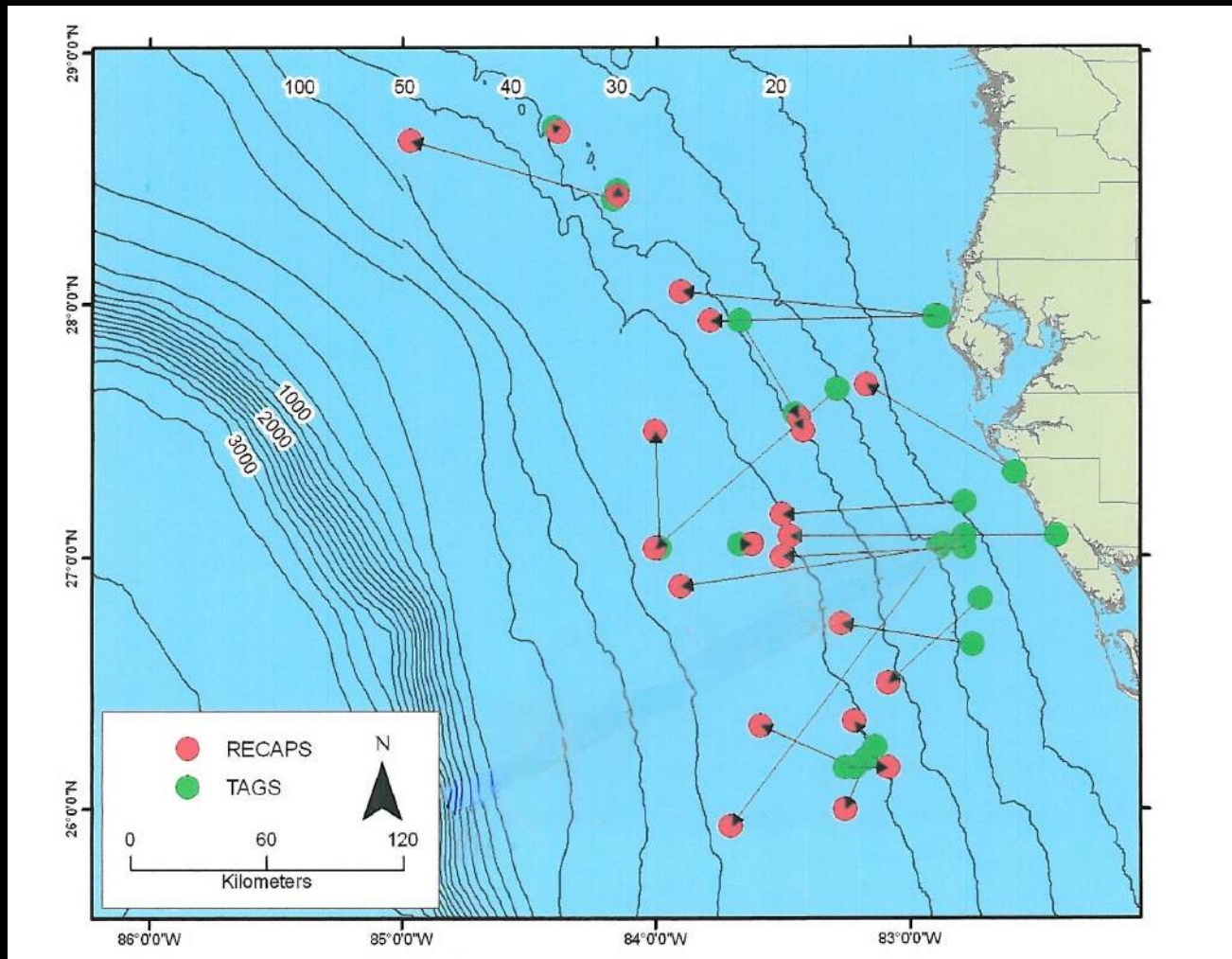
Differences in % Hemorrhaging by Species by Size



Differences in Swim Bladder Structure Between the Species



Red Grouper Offshore Ontogenetic Movement



Vermilion Snapper

Small pelagic species
Found offshore
Poor tag recapture rates
High Survival from
barotrauma for fish
captured up 62 m (200 ft)
when placed in tanks or
cages

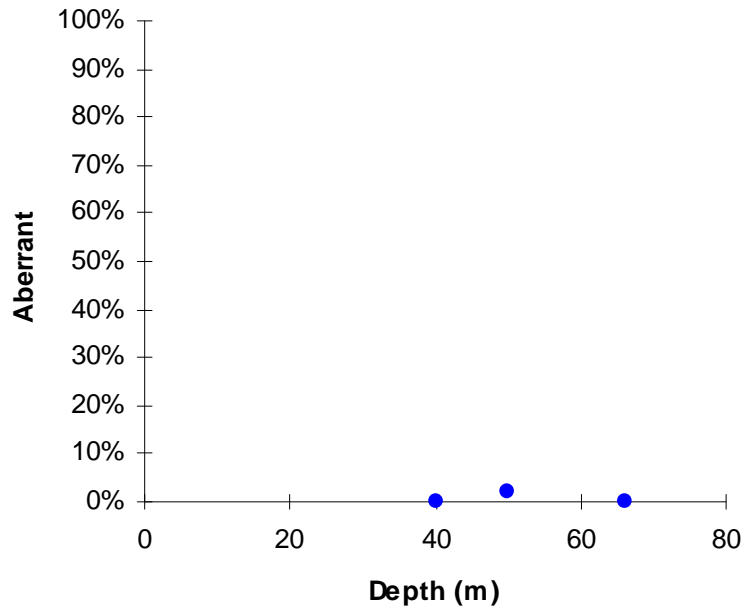


Rhomboplites aurorubens

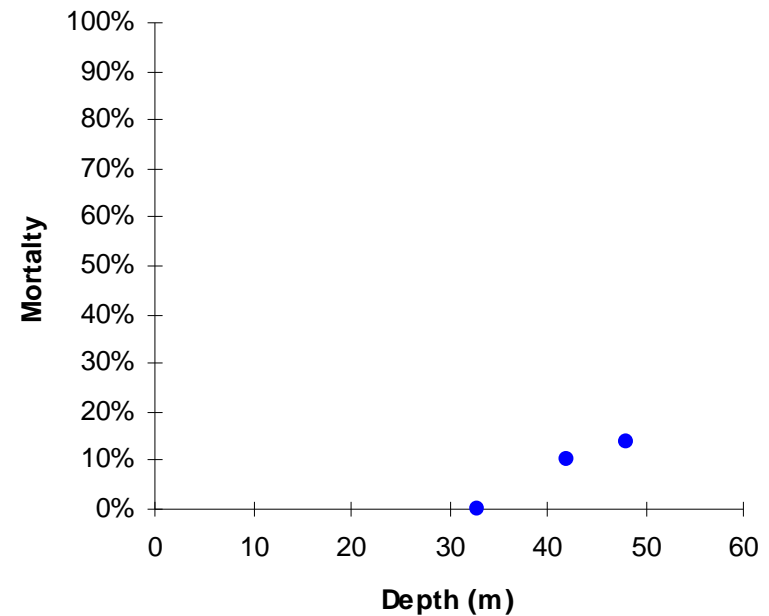


Chris Koenig's Cage Study Data

Vermilion Snapper Aberrations, N = 85



Vermilion Snapper Mortality, N = 94



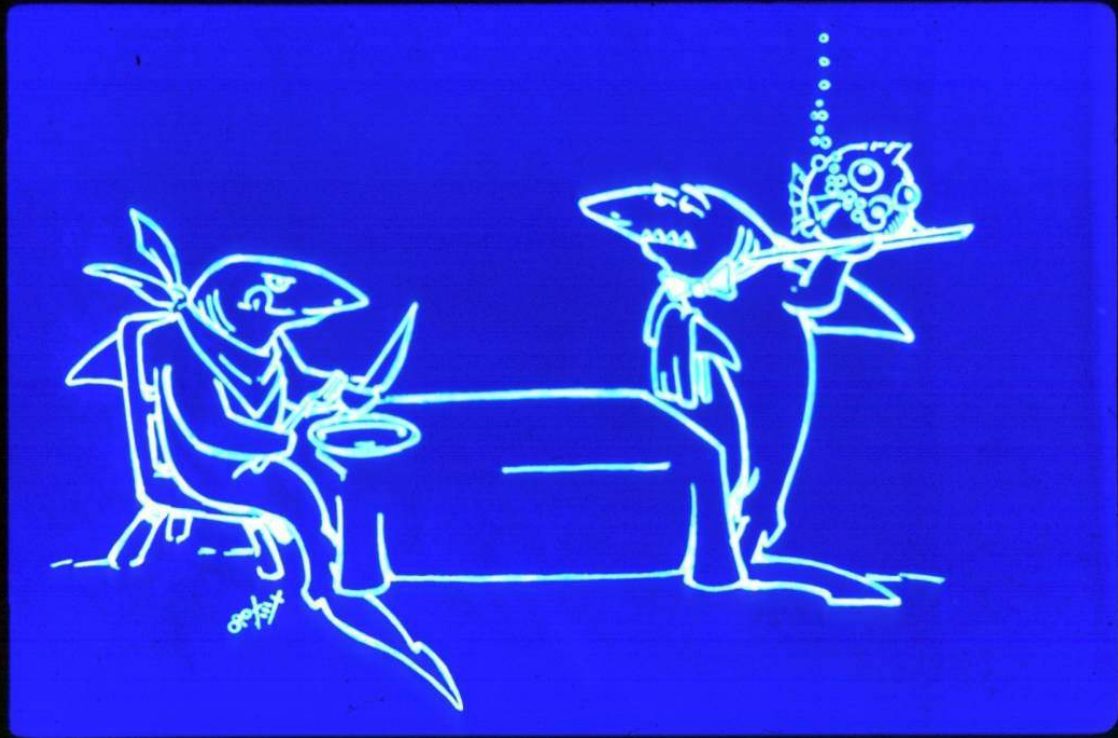
Depth Related Aberrations =
stomach or intestine prolapse, or
exophthalmia



Predation

Vermilion snapper kept safe in cages or in tanks following rapid decompression and swim bladder rupture healed sufficiently within 2-4 days to return to the water column.

At sea, they were subject to predation for 2-4 days until they were able to return to the water column



Vermilion Snapper at 62 m (200 ft)
Photo taken from an ROV camera



Gulf Council Outreach Program

FISH SURVIVAL GUIDELINES

Fishing laws are designed to maintain a desirable spawning stock size to ensure adequate future recruitment of juvenile fish. Compliance with fishing laws is essential for sustaining U.S. sport and commercial fisheries. When compliance means releasing a fish, follow these guidelines to improve its survival.

- Have a plan for releasing a fish before landing it. Because time is crucial in locating a released fish alive, work quickly and in concert with others on board for quick releases.
- Avoid using gaffs and landing nets if possible.
- Handle the fish as little as possible and try to keep the fish in the water.
- Handle the fish with wet hands, wet gloves or a pool towel to avoid removing the natural fish slime which is vital to avoid damaging the gills and eyes.
- Back hooks not being plan or on the leader as close to the trunk or saddle as yellow-striped fish, the leader will not be degraded in saltwater.
- Revive an exhausted fish in the water by pouring water over the fish's gills by using a gentle sack and keep supporting motion until the fish recovers.

Information in this document is based on the best available research regarding red fish venting as intended by a Florida Sea Grant Advisory Panel assembled to review this research. Although the authors realize the need for further study of the influence of venting on long term red fish survival, sufficient information exists to warrant this educational brochure providing guidelines to most anglers in successful release activities.

The research, conducted by scientists in the Fisheries Biology Program at the Center for Fisheries Enhancement, Marine Marine Laboratory, was supported by NOAA, Office of Sea Grant, Department of Commerce, under Grant Number NA46RG0078. The U.S. Government is authorized to produce and distribute reprints for governmental purposes not withstanding any copyright notice that may appear hereon.

For more information, contact your local Florida Sea Grant marine extension agent at:

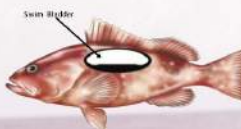
Sea Grant Florida
Science Serving Florida's Coast
Florida Sea Grant College Program
University of Florida, PO Box 110200
Gainesville, FL 32611-0409
www.flseagrant.org
(352) 392-1000

Venting

A Guide for
Releasing
Red Fish with
Pectoral
Swimbladders

THE PROBLEM

Many marine reef fish have a gas-filled organ called a swimbladder, which controls buoyancy and allows the fish to maintain a certain depth in the water column.



The gas in the swimbladder can over-expand when fish are brought quickly to the surface by hook and line. This can result in serious injury to the fish, and if released in this buoyant condition, the fish may float away and die from exposure to the elements or become an easy target for predators. This defeats the purpose of fishery management laws such as minimum size restrictions and daily bag limits.

SWIMBLADDER BIOLOGY

Many reef fish have a closed swimbladder, an internal organ filled with gases, mostly oxygen, carbon dioxide, and nitrogen. This organ is located in the peritoneal cavity attached to the fish's backbone beneath the dorsal fin.

Swimbladders can expand only so far before they burst. When the swimbladder bursts, the swimbladder gases escape into the fish's body cavity, where they can continue to expand. The pressure exerted by these gases is sufficient to push the stomach out the mouth and the intestines out of the anus.



Venting releases these gases from the body cavity, thus eliminating the pressure on the internal organs. If damage is not excessive, the organs will return in place on their own, once the gases are expelled. Venting also will allow the fish to overcome buoyancy problems and swim down to habitat depth, enhancing its immediate survival.

DETERMINING WHICH FISH TO VENT

Scientific studies have shown that species with large swimbladders such as red grouper, black sea bass, and gag derive immediate benefit from venting.

Your ability to judge which should be vented will improve with practice and experience. After reeling in a fish, closely observe its condition. If the fish is bloated and floats (is unable to control its buoyancy) or if the fish's stomach is distended out of the mouth, the fish should be vented. If the fish appears normal, not bloated, and is able to swim down to habitat depth on its own, venting is not necessary.

VENTING PROCEDURE

It is best to vent the fish as quickly as possible with a minimum of handling. If the fish's stomach is everted out of the fish's mouth, do not attempt to push it back into the fish's body. Expelling the swimbladder gases will allow the stomach to return to its normal position within a few hours.



Hold the fish gently but firmly on its side and insert the venting tool at a 45-degree angle approximately one to two inches back from the base of the pectoral fin. Only insert the tool deep enough to release the gases — do not skewer the fish. The sound of the escaping gas is audible and deflation is noticeable. If a fish is extremely bloated, use your free hand to exert gentle pressure on the fish's abdomen to aid deflation. The fish's everted stomach should not be punctured.

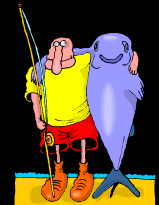
Return the fish to the water as soon as possible. If necessary, revive it by holding the fish with the head pointed downward and moving the fish back and forth to pass water over the gills until the fish is able to swim unassisted.

VENTING TOOLS



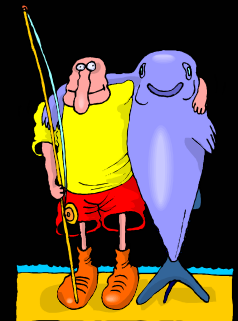
A venting tool can be any hollow, sharpened instrument that allows gases to escape. Ice picks and knives are not suitable because simply puncturing the fish is undesirable and can result in a mortal injury. The modified hypodermic needle pictured is an excellent choice for a fish venting tool. A hollow, sharpened stainless-steel dowel is mounted on a hollow wooden dowel also works.

Cannulas (16-gauge recommended) can be obtained from farm supply and feed stores. The tool should be cleaned between uses and kept in a safe and accessible place. Cleanse bleach (10 ppm) disinfectant. Be sure to cap or place a cork on the tip of the tool after use to prevent personal injury.

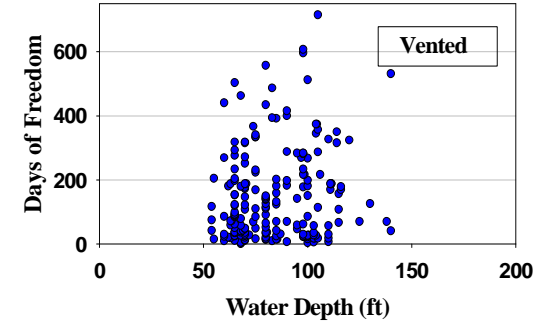
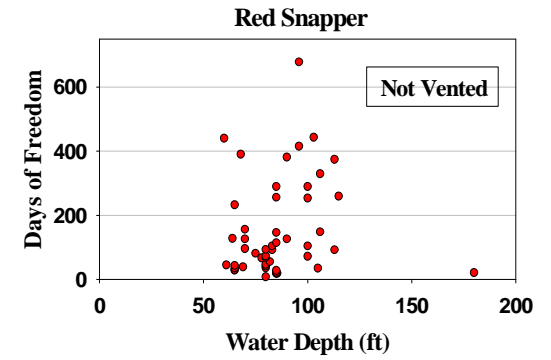
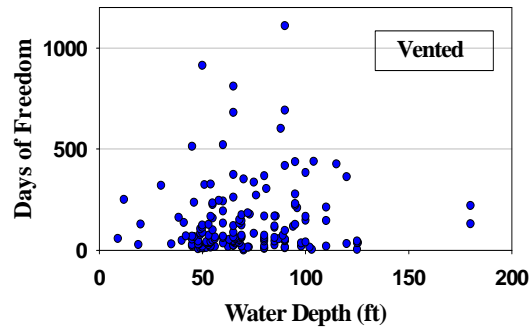
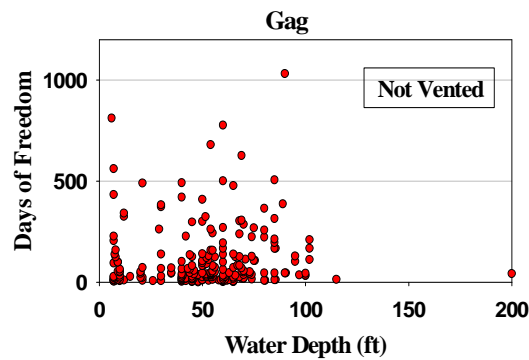
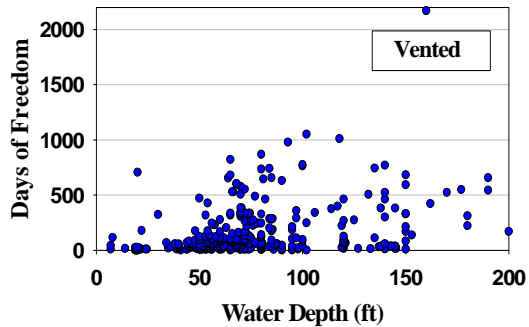
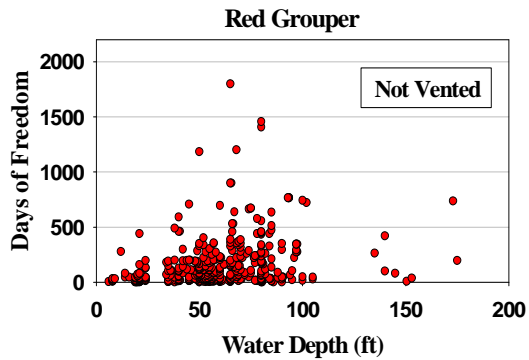


Control Group: Fish caught, tagged and vented in shallow water : less than or equal to 21 m (70 ft)

Species	No. Tagged & Vented	No. Recaps & Vented	% Recap	No. Tagged Not Vented	No. Recaps Not Vented	% Recap	G crit	<i>p</i> value
Red Grouper	322	27	8.4	192	17	8.9	3.8414	0.8671
Red Snapper	441	36	8.2	90	8	8.9	3.8414	0.8376



Comparison of DOF for Vented & Non-Vented Fish By Depth



Rapid Decompression Experiments

Fish compressed to depth
(21, 27, 43, 61 m; 4 replicates per
trial; two trials)

- After acclimation confirmed,
rapidly decompressed
- Fish removed, vented
- Sacrificed immediately, 2, 4, 7
days
- Characterized trauma and
healing



Hyperbaric Chambers: Variability of Mortality Between Species

	Depth (m)	21.3	27.4	42.7	61.0
Red Grouper N=8/depth	% By Depth	0	50	75	100
Red Snapper N=8/depth	% By Depth	0	0	40	45



Stepwise Decompression Experiment

- Acclimated fish to 42.7 m
- Lowered pressure until fish could not regulate buoyancy
- Allowed fish to acclimate and regain buoyancy
- Lowered pressure again
- Repeated until at 1 atmosphere

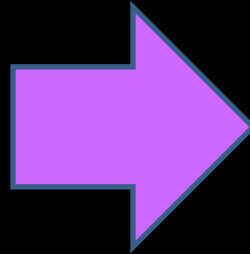
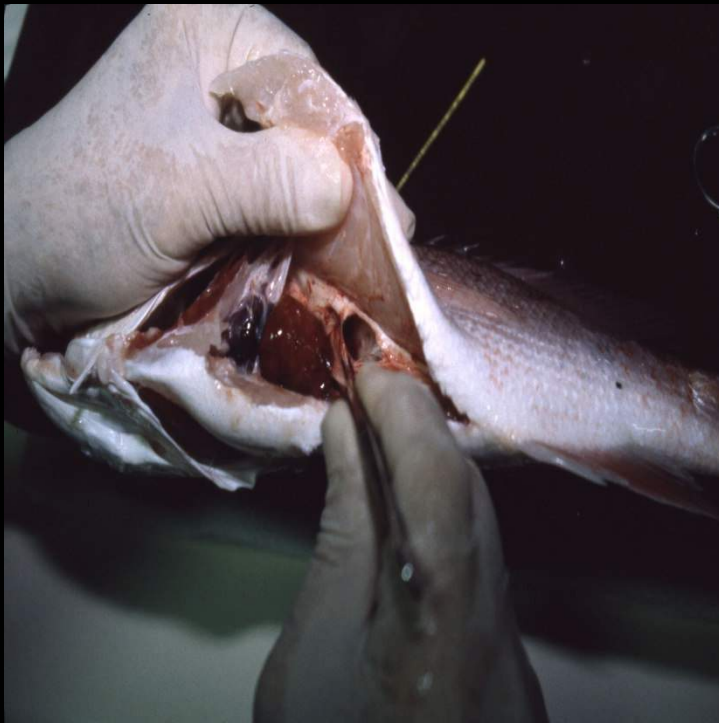


Incremental Step-wise Decompression Results from 42.7 m Simulations

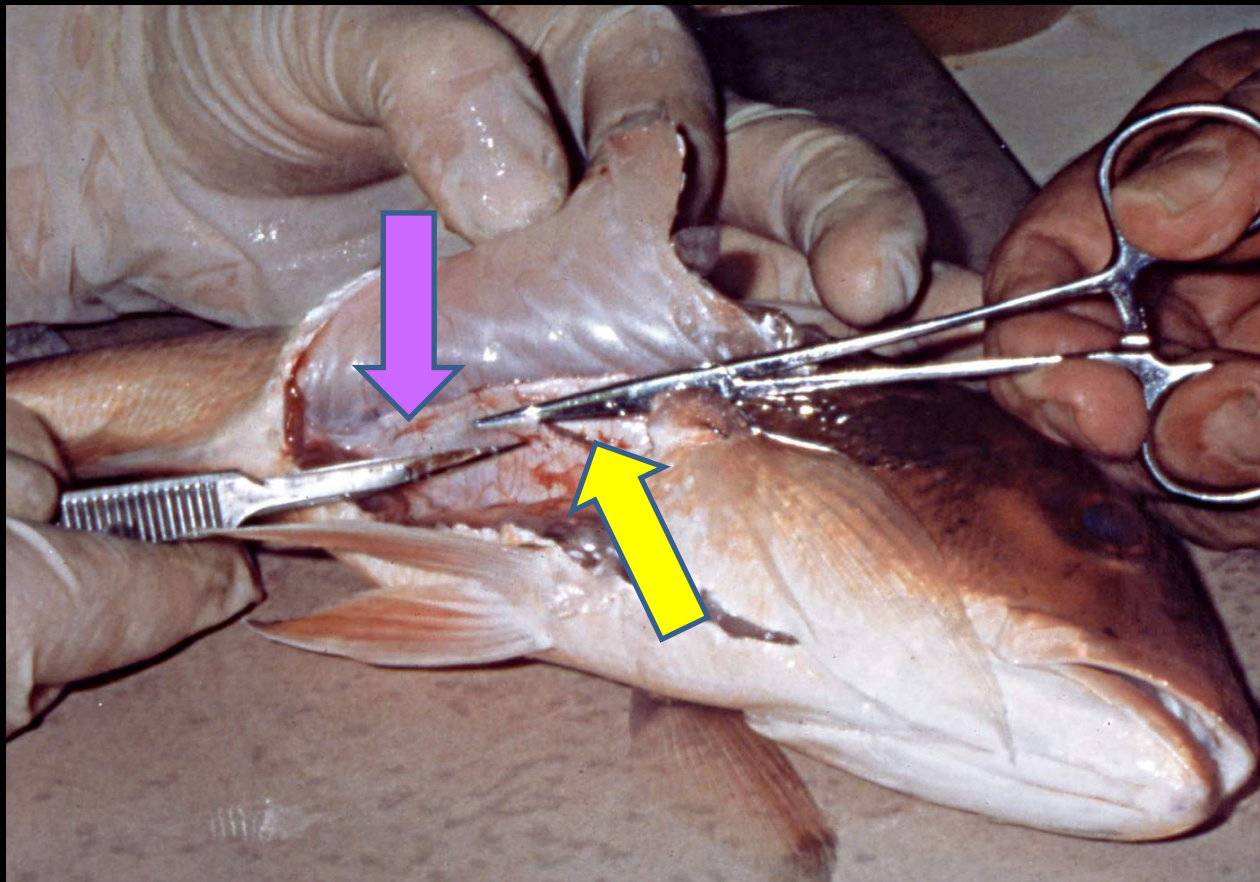
	Pressure Increments (<i>psi</i>)					Time (h)
Red Grouper (n=8/depth)	60	50	35	20	5	76.5
Red Snapper (n=8/depth)	63	40	25	15		104 .0



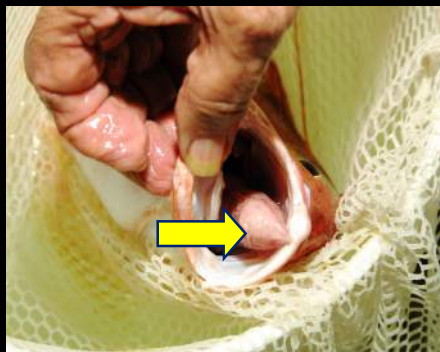
Difference in Trauma, Survival and Healing Dependent Upon Fish Sanitation



New (from Chamber yellow) and Healed (from Original Capture purple) Ruptures in Red Snapper at 21.3 m (70 ft)

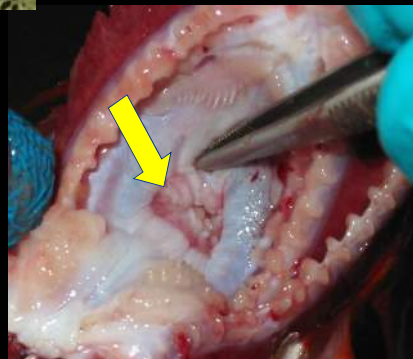


Post-experimental Fish Feeding



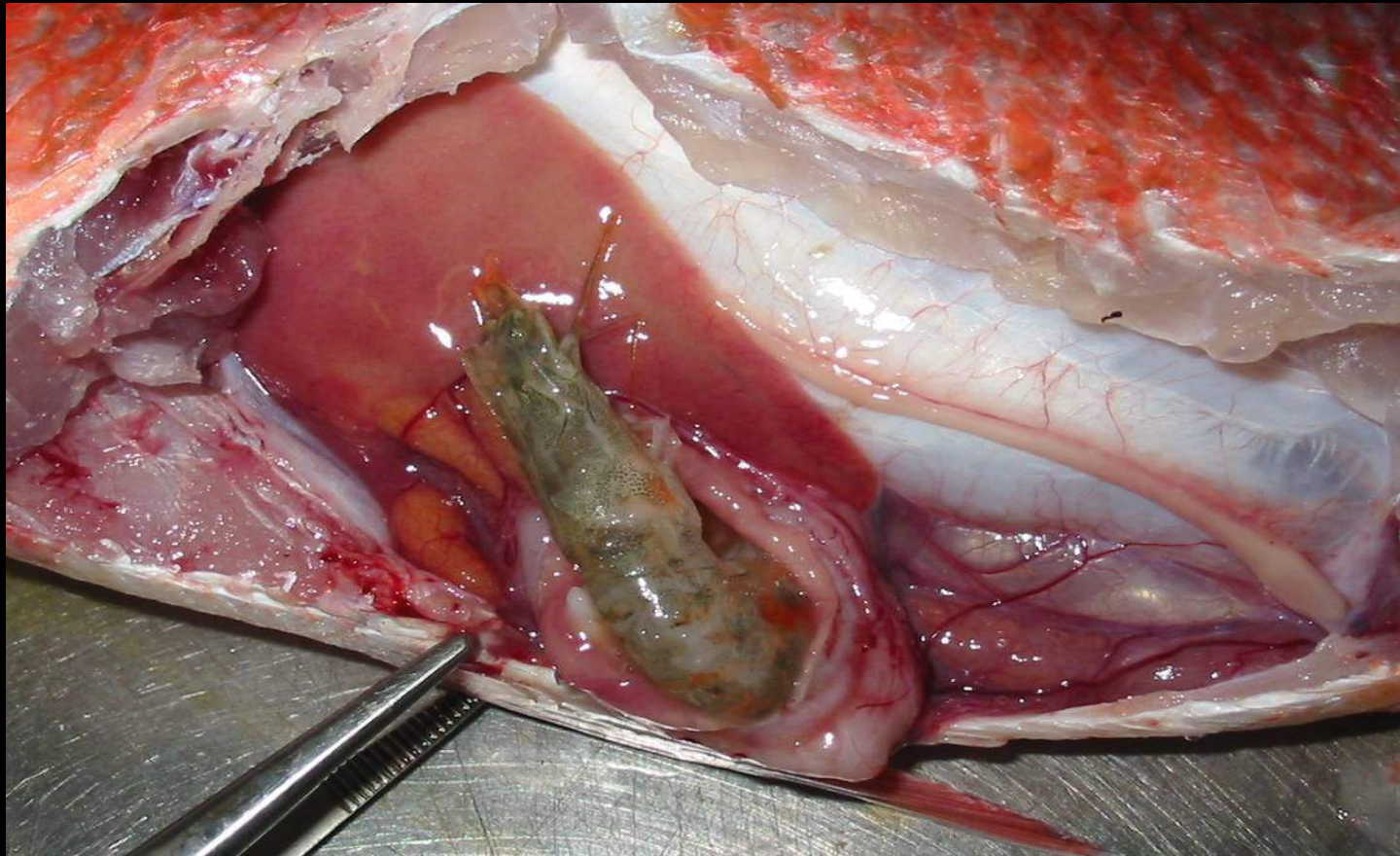
Stomach Prolapse in Red Snapper

Esophageal Ring in Red Snapper



Species	Depth (m)	Time (hrs)
Red Grouper	21.3	2
	27.4	2
	42.7	12-24
Red Snapper	21.3	1
	27.4	1
	42.7	4

Red Snapper 7 Days After Rupture at 61 m Depth Simulation



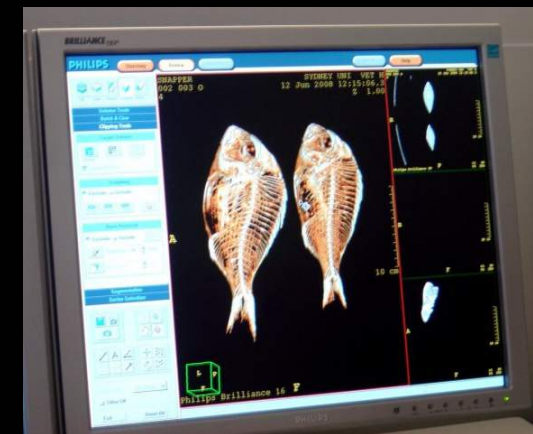
Red Grouper Caught on the Same Long-line Set Exhibiting Various Degrees of Exophthalmia.



- Snapper and mulloway are two of the most highly prized target species in coastal waters of SE Australia. and suffer decompression trauma (barotrauma)
Both are overfished and are regulated by size limits requiring undersized fish to be discarded..

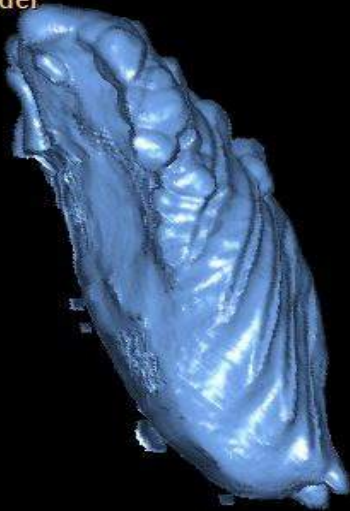
OBJECTIVES:

- Determine key effects of barotrauma on snapper and mulloway by comparing CT scans of fish caught at different depths.
- Determine effects of gear type on barotrauma in snapper by comparing CT scans of fish caught by hook and line vs versus traps.



CT scan of air in a) the swim bladder and b) swim bladder and body cavity of a snapper caught at 7 m. The ruptured swim bladder still contains over 75% of the total air volume.

Snapper
016 0
311-1 swim bladder



HAR

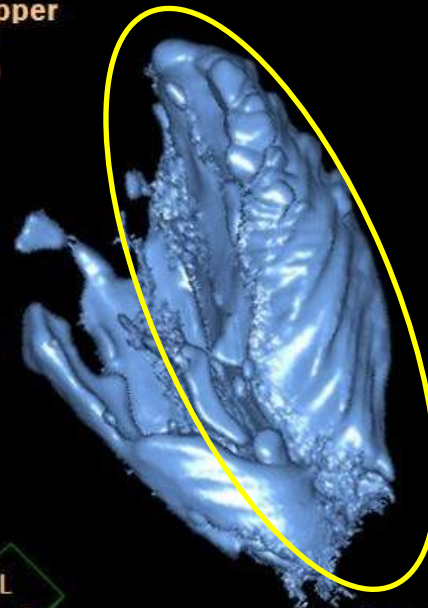


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Snapper
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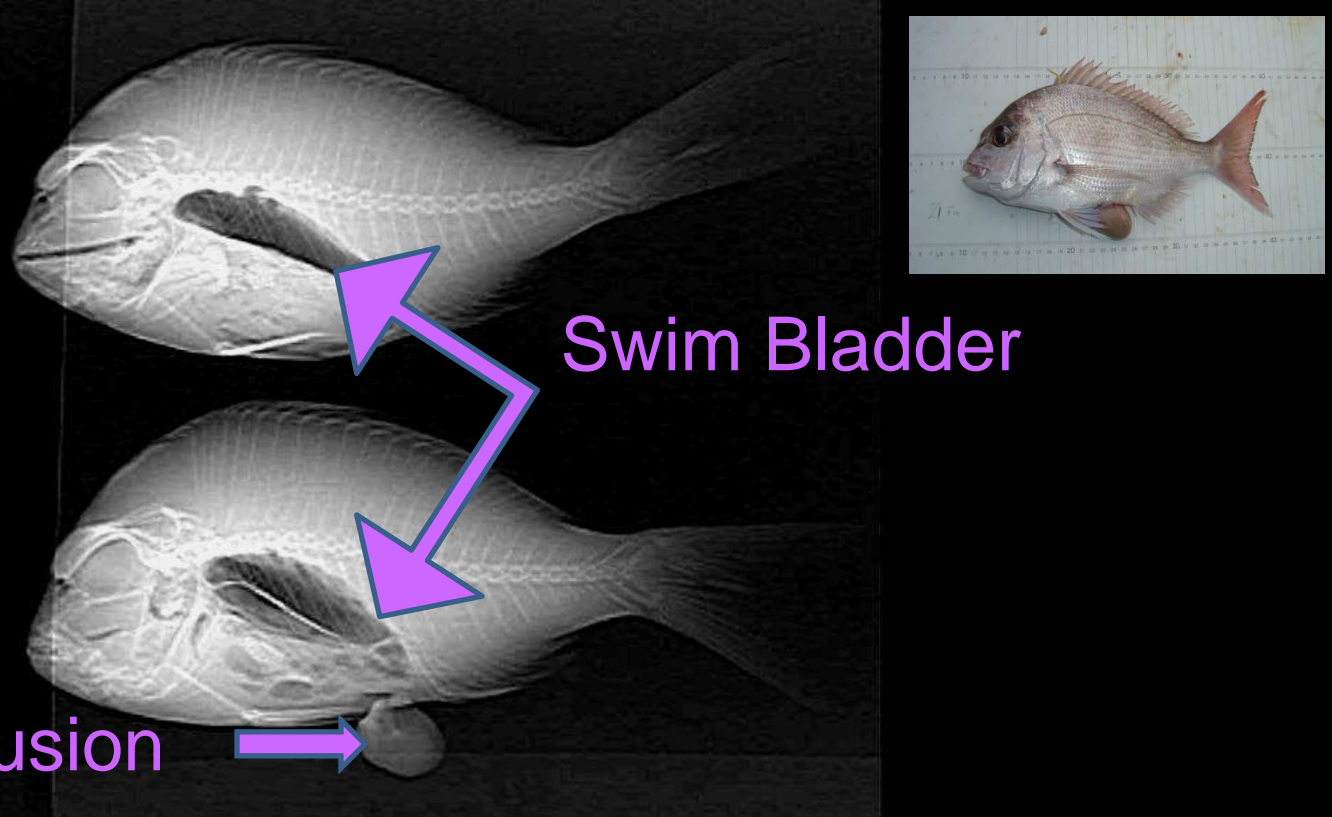
Volume 47.2 cc

FA

SYDNEY UNI VET H
Phillips, Brilliance 16
7 May, 2009 14:26:08.27
Z 2.78

Diamond, S.L., J. Stewart, D. Ferrell, and R. Wrigley. 2011. Fish and barotrauma: what causes the variability in symptoms? MS in prep.

CT Scan of Snapper Caught in Traps. Lower Fish Has Intestinal Protrusion and Twice the Volume of Air in the Swim Bladder, Although Caught at the Same Depth



Intestinal Protrusion

Swim Bladder

Sandra Diamond 1,2, Mark Greco 1, John Stewart 3, and Doug Ferrell 3: 1=University of Western Sydney, Hawkesbury Campus; 2=Texas Tech University, Lubbock, TX, USA; 3=NSW Department of Primary Industries, Cronulla Fisheries Research Centre

Trap Studies GOM Fish Captured at 180 ft.



Most, but not all reef fishes caught in fish traps, did not exhibit outward signs of barotrauma and were able to return to capture depth unaided



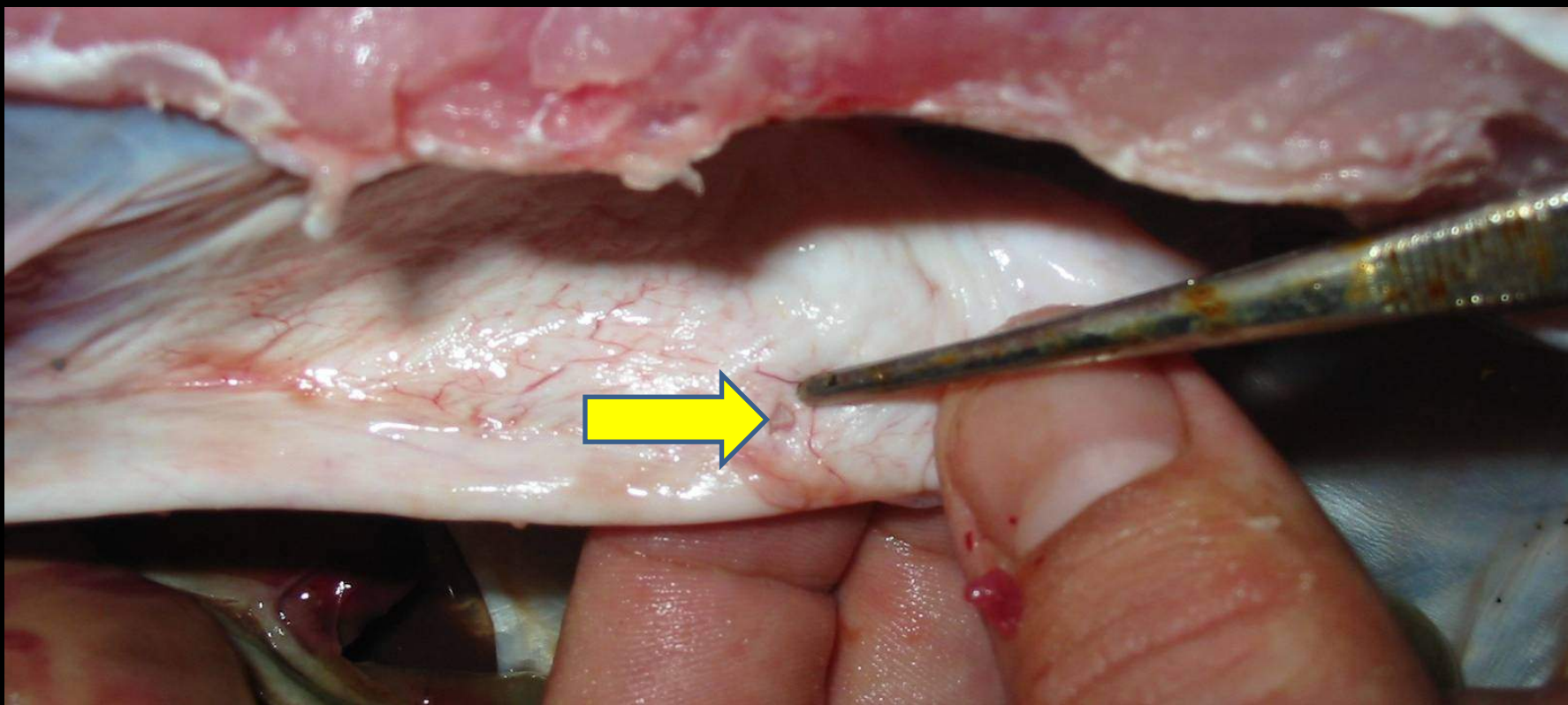
Red Grouper Caught in Commercial Fish Traps at 54.9 and 61 m



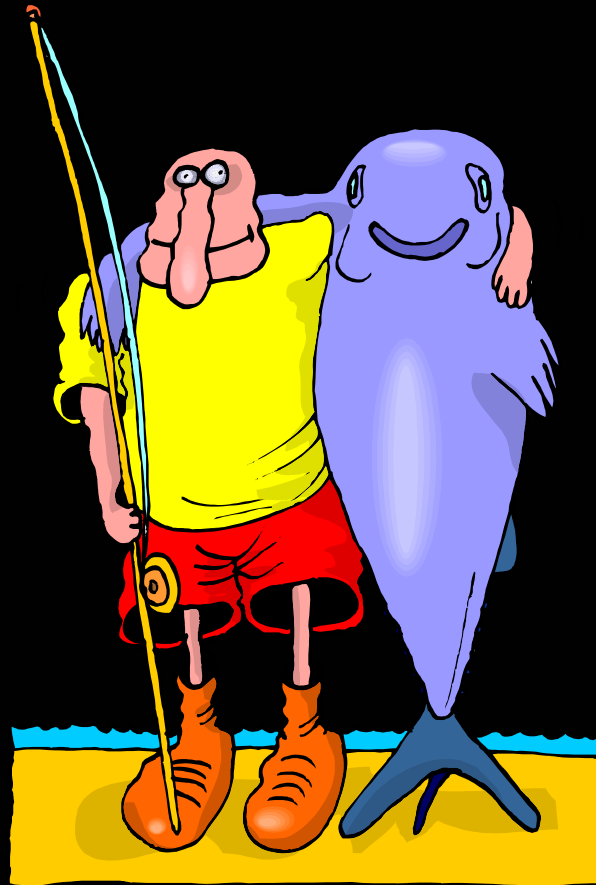
Excised Inflated Swim Bladder from 700 mm FL
Trap Caught Red Grouper Captured at 61 m



Trap Caught (62 m) Red Grouper Exhibiting Pinhole Wound in Deflated Swim Bladder



In Conclusion

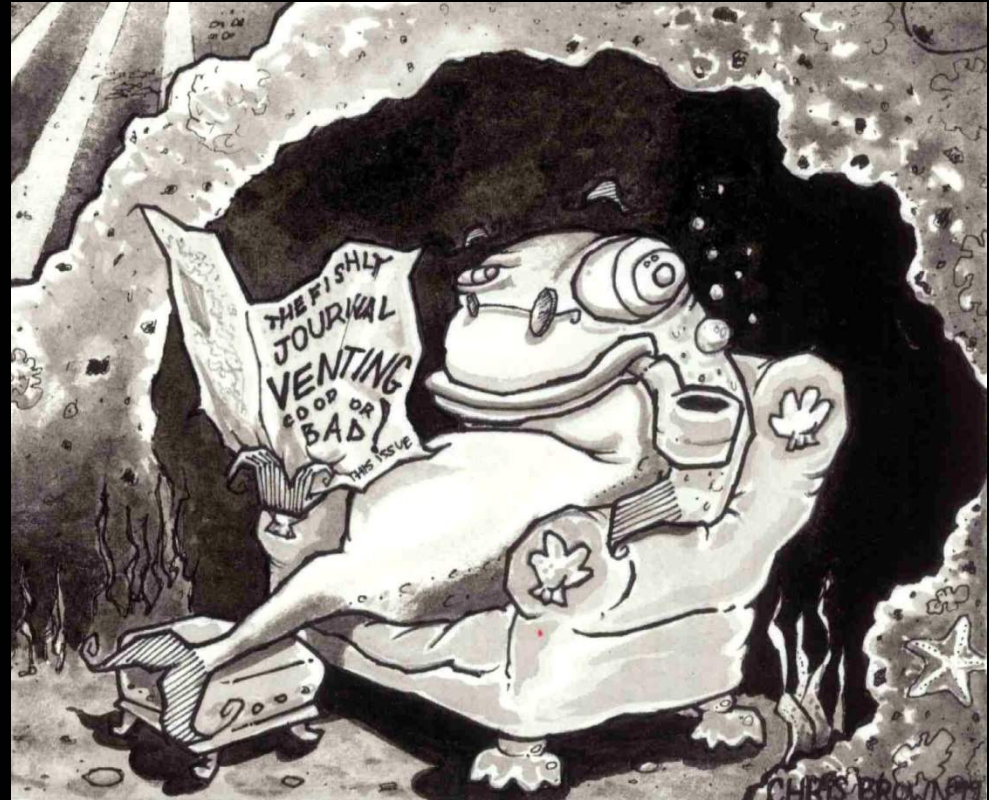


Conclusions

Factors affecting mortality can be synergistic so each factor must be identified and its impacts assessed

Survival is both depth and species specific

Differences in trauma and survival occur among and within gear types



Conclusions From Down Under:

- Symptoms of barotrauma vary with species, gear type, depth of capture, and among individuals caught under the same conditions.
 - Some symptoms such as exophthalmia are relatively rare in snapper and mullet at the depths tested.
- Stomach eversion and intestinal protrusion may be related to gut fullness, diet (hard vs soft particles), and feeding method that changes the amount of gas in the stomach and intestines.
 - The caudal lobes may be caused by spaces between the rear muscles that are filled by the swim bladder when it expands due to barotrauma.



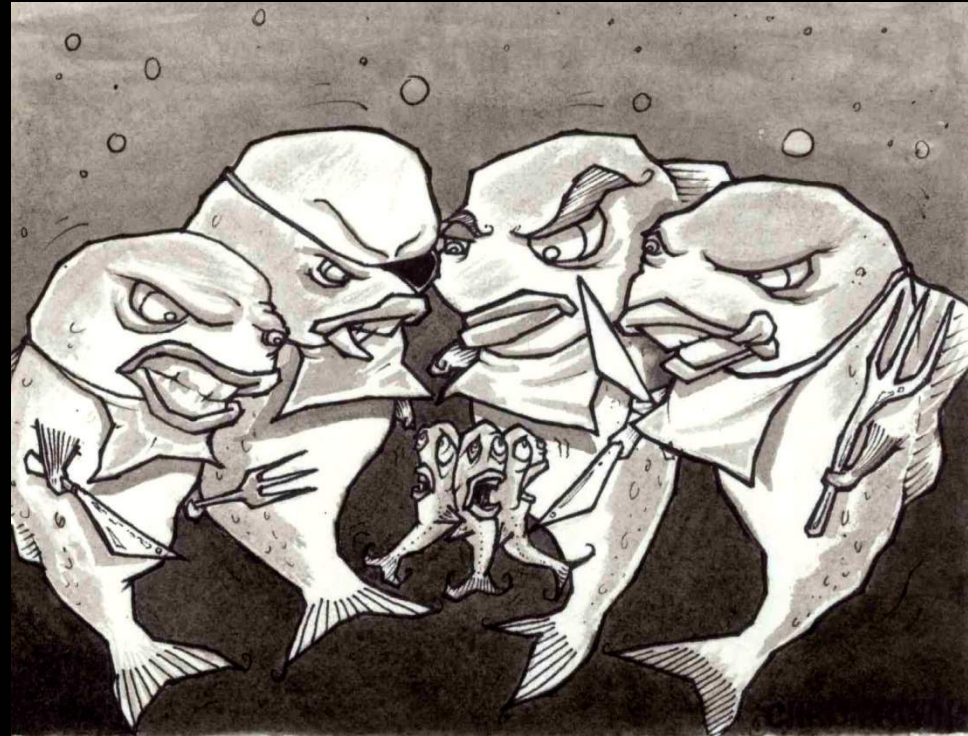
Conclusions

Hook mortality can be a greater factor than barotrauma for some species because it occurs at all depths and a range of fish sizes



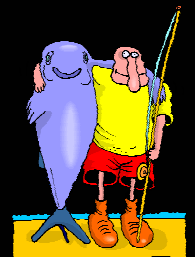
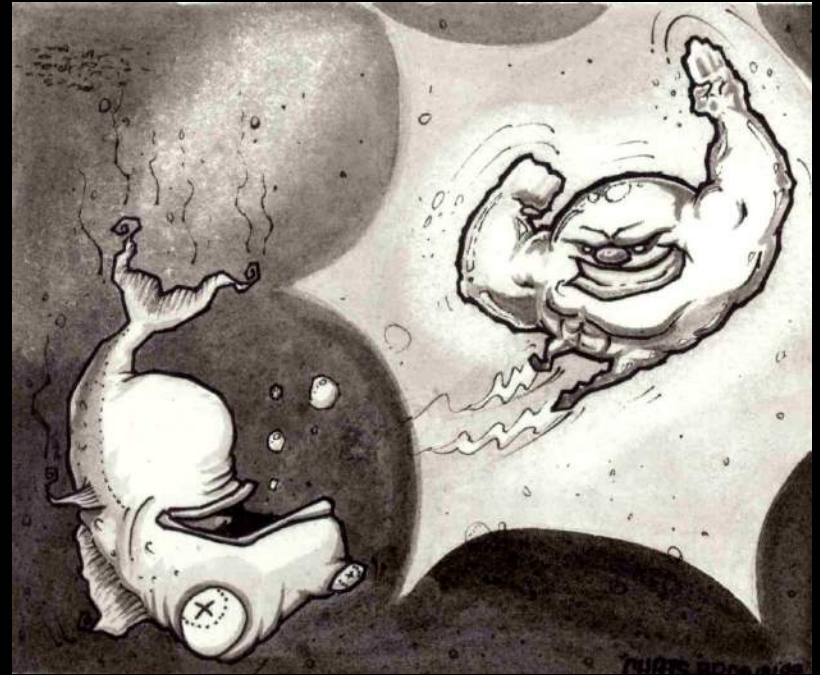
Conclusions

Predation is an important and often overlooked factor in the survival of released fish that needs to be studied



Conclusions

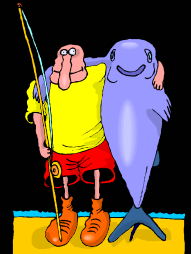
Barotrauma affects individual species differently. A fish's anatomy, eco-morphology, physiology, and behavior appear to affect its response. Species have evolved to occupy different niches and these differences appear to determine responses to fishing and fishing gear.



Gulf of Mexico Accounted for > 40%
of All U.S. Marine Recreational
Fishery Catches in 2006

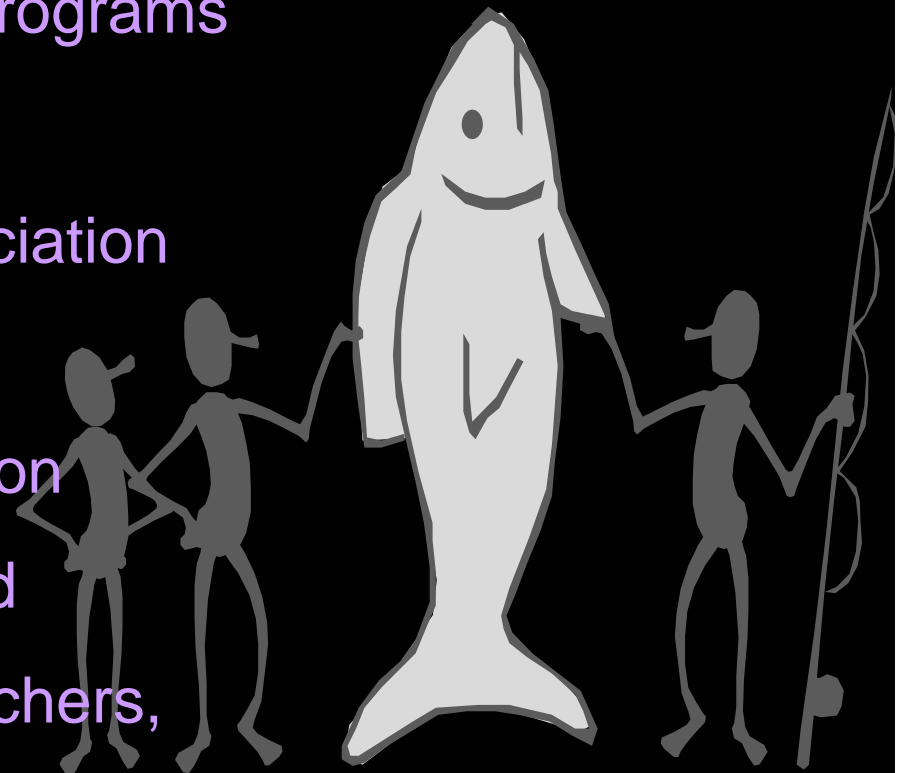
56% of Marine Recreational Fishing
Catch in 2006 in the Gulf of Mexico
Was Released Out of A Total of
Catch 193 Million Fish,
Not Including Texas

Source: NOAA



Acknowledgements of Help from A Cast of Thousands

- All Gulf of Mexico Researchers researchers
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- Florida Offshore Anglers
- Florida Sports Fishing Association
- Fishermen's Environmental Fund
- All Participating Fishers, Researchers,
➤ and Student Interns



Thank you

