

## Large Pelagic Fishes in the Northern Gulf of Mexico:

Who are they, why are they so important, how are they managed, and where do their young live?

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## *The Gulf of Mexico is "home" for large pelagic fish species*

The Gulf of Mexico is one of the world's most dynamic, biologically productive marine ecosystems. Its rich waters support an enormous variety of fish, including some of the world's largest and most spectacular species which inhabit the Gulf's offshore pelagic (pelagic: a term which refers to the entire water column \*1) environment. Those species are often referred to as "large pelagic fishes", and many of them support extremely valuable commercial and recreational fisheries.



## *Large pelagic fishes*

Due to the nature of past fishing practices and the growing demand on marine fish as a source of food and recreation, there is a general consensus within the scientific community that stocks of many large pelagic fish species throughout the world's oceans, including the Gulf of Mexico, are "overfished" and severely depleted, and some stocks may be in danger of collapse. \*2 Furthermore, "these large fishes are the apex predators in the ocean, and their collapse could bring about a complete re-organization of ocean ecosystems, with unknown global consequences". \*3

Declines in the number of large pelagic fishes are primarily the result of overfishing in combination with poor scientific understanding of their biology and ecology, as well as environmental factors related to their various life stages. This is particularly true for the young life stages.

## *What is an overfished species?*

Overfished species (fishes) are those species that are reached a non-sustainable status (i.e., cannot sustain their numbers or remain a viable stock at their current fishery harvest levels). \*4

The term "fishes" used throughout this lecture refers to "more than one species of fish".

*The following series of slides provides general overview information on large pelagic fishes in the Gulf of Mexico and includes information on:*

- Examples of species that are categorized as "large pelagic fishes"
- Large pelagic fisheries and fisheries management
- Note: Although some large shark species are considered to be "large pelagic fishes" or "highly migratory species" and are extremely important components of the Gulf's offshore ecosystem, this lecture will focus only on species which are categorized as "bony fishes" (a category that does not include sharks) and which support valuable commercial and/or recreational fisheries.

Also, the terms "large pelagic species" and "large pelagic fishes" will be used interchangeably in this lecture.

## *Large pelagic fishes in the Gulf of Mexico*

(Examples of key species which are managed as fishery resources in the Gulf; commercially, recreationally or both)

Marlins  
(Blue & White)



Artist D. R. Peebles

Sailfish



Swordfish



Tunas  
(Yellowfin, Blackfin,  
Bluefin)



Wahoo



## *Large Pelagic Species Commercial and Recreational Fisheries*

- The large pelagic species fisheries in the Gulf are "Big Business". The commercial and recreational fishing sectors each generate annual economic revenues estimated in the 100's of millions of dollars.
- The commercial sector is characterized by several fleets of large fishing vessels, as well as smaller, independently operated boats, all of which use a variety of fishing methods, the most prevalent being the "pelagic longline".\*5 This fishing gear is a robust fishing line system which can extend horizontally for great distances (>10 miles) across the Gulf's surface, is supported by in the upper water column by a series of buoys, and contains 100's of strategically placed hooks.
- The recreational sector is comprised of tens of 1,000s of anglers who fish on 1,000s of private and charter vessels ranging in size from 25-90' in length. Large pelagics are caught for food and sport, primarily using hook-and-line gear.

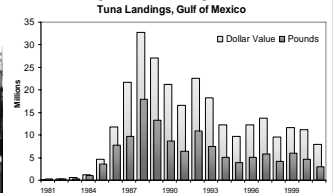
## **Commercial Fisheries** An example: the tuna fishery



The Gulf's commercial tuna fishery includes yellowfin tuna and other large tuna species that occur within the region. Tuna landings (pounds of fish brought to the docks) represents a significant portion of the overall commercial landings of large pelagics from Gulf. The majority of Gulf tuna are harvested from northern Gulf waters and landed at Louisiana docks.

In recent years, the tuna harvest from the Gulf averaged ~5 million pounds and \$12 million in dock-side value (only the first step in the commercial fish marketing process), somewhat less than during in the mid-1980/early1990's. The decline may be the result of a depressed stocks and/or more stringent harvest regulations.

Long-line fishing boats in the Gulf's commercial tuna fishery



## **Recreational Fisheries**

The recreational fishery targets all of the large pelagic species, many of which are released alive, either because of new regulations or a growing conservation ethic expressed by anglers. Much of the fishing for large species occurs at offshore petroleum platforms. Competition fishing is a growing sport, as demonstrated by the increasing number of big game fishing tournaments in the Gulf. Big game tournament fishing represents a major economic sector of the recreational fishery.



## *Who owns the large pelagic fishes and how are they managed?*

- In the marine waters of the United States, such as the U.S. region of the Gulf of Mexico, large pelagic fishes are common property resources and are managed for the people by state and/or federal government fisheries agencies. Fisheries management plans are "ever-evolving", some of which are specific to tunas and sharks, while others pertain to billfish species.

Other nations use a variety of plans and strategies to manage large pelagic species (and their fisheries) within their own territorial marine waters.

- In the U.S., the conservation and management of ocean fishing is officially governed by the Magnuson-Stevens Fishery Conservation and Management Act (see the next slide).

## *Magnuson-Stevens Fishery Conservation and Management Act \*6*

*(Public Law 94-265; amended as the Sustainable Fisheries Act of 1996)*

- U.S. Legislative Act which established exclusive authority (regulation, management, and conservation) over fishing and fishery resources within the U.S. Exclusive Economic Zone (EEZ), an area which encompasses the territorial waters of the U.S., extending from each coastal state's seaward boundary out to 200 nautical miles.
- Provides the tools to build sustainable fisheries and includes requirements to: 1) reduce the destructive, incidental catch of fish in various fisheries ("bycatch"); 2) stop overfishing; 3) rebuild overfished stocks; and 4) protect "Essential Fish Habitat".
- The National Marine Fisheries Service, U.S. Coast Guard, and state marine patrols enforce U.S. marine fisheries laws and regulations.

(con't.)

## *Regulation options (tools) for the management of large pelagic fishes (and their commercial and recreational fisheries) in U.S. marine waters: apply to the Gulf of Mexico*

- Licenses and permits
- Limits on the size of fish that can be retained
- Bag limits (# of fish retained per person per fishing trip)
- Exemption from commercial or recreational harvest
- Vessel catch limits (limited by weight and/or number)
- Restrictions on fishing gear
- Moratoria on fishing activities
- Seasonal fishing closures and fishing area closures

(Note: Many of the large pelagic fishes (and their fisheries) are managed in the U.S., as well as internationally, by some of the above listed management "tools". Management strategies using the above regulatory options are subject to periodic review and change). \*7

(con't.)

### *Additional management of large pelagic fishes in U.S. waters, including the Gulf of Mexico*

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Many nations which border the Atlantic Ocean, such as the United States, are participants in the intergovernmental fisheries organization ICCAT (International Commission for the Conservation of Atlantic Tunas). ICCAT is responsible for the conservation of Atlantic tunas and tuna-like species (including billfishes), in the Atlantic Ocean and adjacent seas (including the Gulf of Mexico) and formulates international fishery regulations for most of the large, highly migratory species. The U.S. National Marine Fisheries Service (NOAA Fisheries) is responsible for implementing ICCAT regulations in U.S. offshore waters, and U.S. fisheries management of large pelagics must be consistent with ICCAT regulations and recommendations.

### *Research on large pelagic species and their fisheries*

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Marine fisheries biologists study (research) large pelagic species and their respective fisheries in the Gulf of Mexico to develop a better scientific understanding of their life history stages, environmental requirements and stock status. The research is typically focused on the following four components of a fishery, as well as the inter-relationships among them:

- Biology and life history aspects (age, growth, spawning, food requirements, migrations, etc.);
- Habitat (habitat requirements of all life stages);
- Other species with which the "species of interest" interacts;
- Human aspects (fishers, exploitation rates, impacts of fishing techniques & gear, and users of the fishery resource)

*The following series of slides provides a general overview of three key offshore habitats utilized by young life stages of large pelagic fish species in the northern Gulf of Mexico. Although the young of large pelagic fishes most likely utilize similar habitat in other offshore regions of the Gulf of Mexico, the information presented in the following slides is based on current research that is documenting the association of young fishes with the three offshore habitats.*

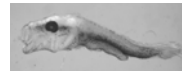
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### *Habitats of Young Life Stages (Larval and Juvenile) of Large Pelagic Fishes: "Where do they live"?*

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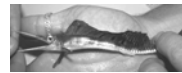
By definition, pelagic fishes are those species which live throughout the water column, as opposed to species which live near or on the seafloor (demersal and benthic species). Large pelagic species spend much of their lives near the ocean's surface (the epipelagic zone), particularly during their young life stages (larval and juvenile).

Larva:



Life stage that follows hatching from an egg; typical stage duration of only a few days; the beginning of the ability to capture food organisms

Juvenile:



Life stage when organ systems and fins are fully formed or near so; this stage lasts until the fish grows to reproductive maturity

Photo: Cary Chen

### *Where do the young fish live?* (con't.)

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Scientific research in offshore waters of the northern Gulf of Mexico shows that young life stages of big pelagic species are associated with at least three (on-going research may reveal others) unique habitats that occur in the pelagic marine environment. Those habitats are:

- Oceanic frontal zones
- The Loop Current
- Pelagic *Sargassum*

### *Oceanic Frontal Zones*

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- Terms frequently used to describe oceanic frontal zones:
  - Convergent zones, upwellings, downwellings, current boundaries, temperature discontinuities, 'color change'
- Oceanic frontal zones are dynamic (quite often temporary / days in duration) hydrographic phenomena that occur throughout the northern Gulf's offshore region and can best be characterized as oceanic ecosystem features formed by the "meeting" of different masses of oceanic water which differ in their physical oceanographic characteristics (e.g., current flow patterns) and hydrologic composition (e.g., salinity, temperature, & water clarity).
- Oceanic frontal zones, particularly their boundary areas (edges), are:
  - Biologically productive, nutrient rich areas where planktonic organisms (including fish eggs and larvae) concentrate;
  - Nursery areas for young stages of large pelagic fishes

## Oceanic Frontal Zones (con't.) (an example)

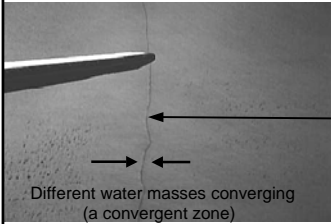


Photo of a frontal zone taken from Space Shuttle Atlantis (STS-46): NASA, 1994

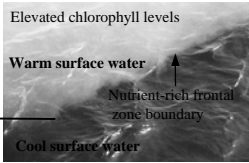
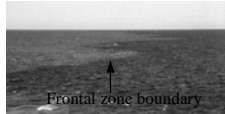
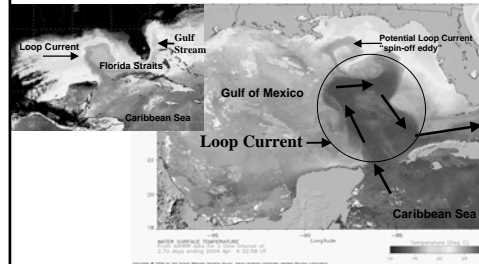


Photo: J. Yoder, 1994, RV Thompson



Frontal zone boundary

## The Loop Current



The Loop Current (shown within the blue circle) is one of the world's most dynamic oceanic currents. It forms as very warm water from the Caribbean Sea enters the southern Gulf, flows northward into the upper Gulf, loops clockwise eastward, then flows southward to exit the Gulf via the Florida Straits to become the Gulf Stream. As the Loop Current extends into the northern Gulf, its northern-most region periodically develops ("spins-off") large, mobile, dynamic water masses (referred to as eddies) that typically remain within the northern Gulf region for many months.

## Loop Current (con't.)

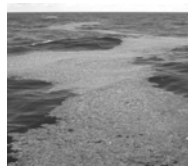
The Loop Current is the major current system in the Gulf and is a permanent oceanographic feature (unlike the smaller, often temporary oceanic frontal zones) in the region, although its movements and intrusions into the northern Gulf vary from year to year. The Loop's outer boundary area (edge), as well as the boundary areas of the Loop's northern Gulf "spin-off eddies", typically consist of nutrient-rich waters which provide food and serve as nursery habitat for early life stages of large pelagic fishes.\*8

## Sargassum



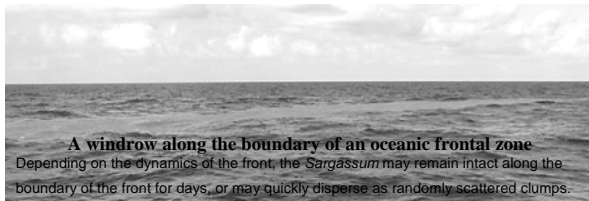
- A pelagic, floating brown algae that originates in the Sargasso Sea, a region in the western Atlantic Ocean, and is transported on surface currents and winds into the Gulf of Mexico
- Commonly referred to as "Gulf weed"
- Two predominant species in the Gulf of Mexico (*Sargassum natans* & *Sargassum fluitans*)
- Reproduces by vegetative fragmentation
- Uses gas-filled (CO<sub>2</sub>) pods to float at or near (within the upper meter) the surface of the ocean. Occurs as isolated clumps, large or small mats, and windrows (which often extend for many miles along the boundaries of oceanic frontal zones in the northern Gulf)

## Sargassum (con't.)



Scattered clumps

Large mats



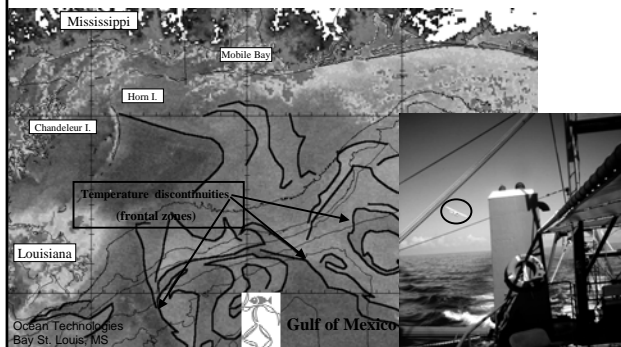
### A windrow along the boundary of an oceanic frontal zone

Depending on the dynamics of the front, the Sargassum may remain intact along the boundary of the front for days, or may quickly disperse as randomly scattered clumps.

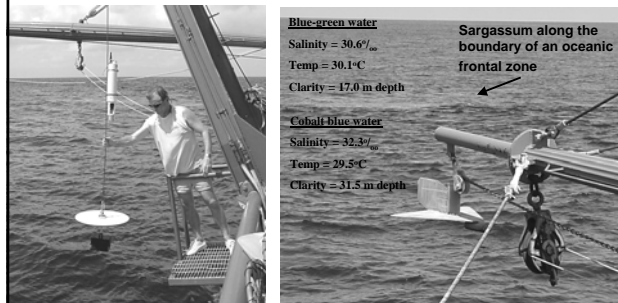
### Sargassum functions as habitat for various life stages of large pelagic fishes in the northern Gulf as follows:

- In an otherwise featureless ocean surface environment, *Sargassum* represents "surface structure" where young fishes can aggregate.
  - *Sargassum* provides young fishes shelter and protection from predators.
  - *Sargassum* is a highly productive habitat which provides prey for adult and early life stages alike, and, in particular, serves as critical feeding habitat for young fishes, which helps ensure their survival. Young fishes inhabit Sargassum seasonally, depending upon the spawning season of the adults of the large pelagic species.
  - *Sargassum* may serve as spawning habitat for large pelagics (as yet undocumented).
- Note: *Sargassum* is managed as pelagic habitat and designated as Essential Fish Habitat in U.S. Atlantic Ocean waters.\*9  
*Sargassum* is not managed in the Gulf of Mexico.

**Determining potential fish collecting locations: satellite imagery and aerial surveys assist researchers in locating young pelagic fish habitat in the northern Gulf**

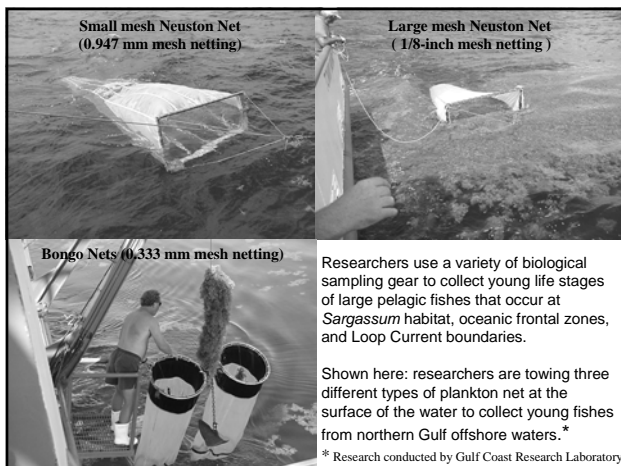


**Investigating habitat characteristics where young pelagic fishes are collected**



Using oceanographic instrumentation to determine habitat conditions at a young fish collection location

Photos taken at a GCRL research site (research vessel R/V Tommy Munro)



**Removing Sargassum and associated young fishes from neuston net collections taken at a frontal zone containing Sargassum**



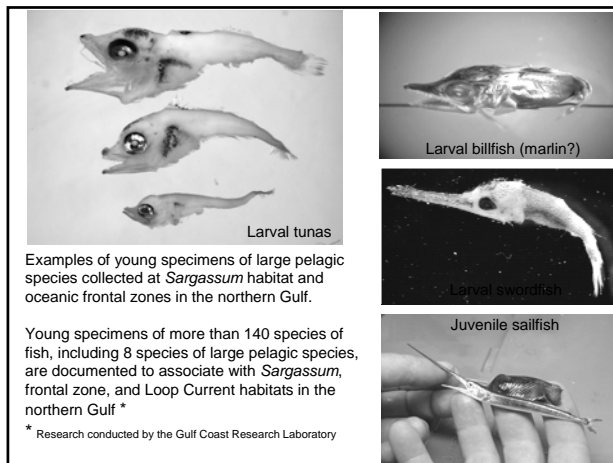
**Laboratory processing of young fish collections**



After young fishes are collected at frontal zone, Loop Current, and Sargassum habitats, they are removed from the collection nets and preserved in alcohol for future study and analysis.

The preserved collections of young fishes are processed and analyzed in the laboratory.

- Fishes are identified, counted and measured
- Fish samples are archived for future study and analysis, including an evaluation of the environmental data recorded at the offshore collection sites to help describe habitat requirements of the young fishes.



### Thoughts & Observations

- Although research has revealed that larval and juvenile pelagic fishes utilize the three habitat types just described, it is unclear how they initially encounter those habitats.
- Adults of large pelagic species are known to frequent the three habitats, as documented by years of successful commercial and recreational fishing at the three habitats \*10. It is "hypothesized" that the adults of some large pelagic species periodically spawn at the three habitats, in which case their fertilized eggs and recently hatched larvae could have immediate access to the habitats.  
  
Also, larvae may reach the habitats from areas located away from the three habitats via "passive drift", i.e., the mechanism whereby larvae (and fish eggs) are passively transported by currents across the ocean's surface until they ultimately encounter the appropriate habitat.
- Once at the appropriate habitat, larvae may grow into juveniles without leaving the habitat, or because juvenile fishes are mobile they may encounter one of the three habitats during random swimming activity (either as individuals or as schools of juveniles).
- Finding appropriate habitat is critical to the survival of the young fishes, and represents an aspect of their life history that requires scientific investigation.

### Conclusion

- Scientific knowledge about the large pelagic fish species, and their environment, in the Gulf of Mexico is somewhat scant at the present time, however research studies are investigating many aspects of their biology and ecology, as well as the problem of overfishing and the response of their stocks to fisheries management actions.
- New scientific research and information is essential to a better understanding of these magnificent fishes and is critical to their effective management and sustainability in the offshore waters of the Gulf of Mexico.

### Web-site Reference Materials

- \*1  
<http://www.marbef.org/outreach/whereis/pelagic.html>
- \*2  
<http://www.edcnews.se/Research/FisheriesNature.html>
- \*3  
[http://news.nationalgeographic.com/news2003/05/0515\\_030515\\_fishdecline\\_2.html](http://news.nationalgeographic.com/news2003/05/0515_030515_fishdecline_2.html)
- \*4  
<http://www.un.org/events/tenstories/story.asp?storyID=800>  
[http://www.yptenc.org.uk/docs/factsheets/env\\_facts/overfishing.html](http://www.yptenc.org.uk/docs/factsheets/env_facts/overfishing.html)  
<http://www.savethefish.org/>  
<http://en.wikipedia.org/wiki/Overfishing>
- \*5 (read for a variety of opinions on longline fishing: a controversial issue)  
<http://www.edcnews.se/Research/FisheriesNature.html>  
<http://www.aboutseafood.com/faqs/longline5.html>  
<http://www.flmnh.ufl.edu/fish/innews/longlineoct2002.htm>  
<http://www.fishingni.org/techll.htm>  
<http://www.sportfishingmag.com/article.jsp?ID=36590&destinationID=>  
<http://www.flyfishingsalt.com/article.jsp?ID=36509&destinationID=>

### Web-site reference materials (con't.)

- \*6  
<http://www.nmfs.noaa.gov/sfa/>
- \*7  
<http://www.gulfcouncil.org/fishrules.htm>
- \*8  
<http://oceancurrents.rsmas.miami.edu/atlantic/loop-current.html>  
<http://www-ocean.tamu.edu/Quarterdeck/QD6.1/spin.html>  
[http://www.oilonline.com/news/features/oe/20040201.Current\\_.13502.asp](http://www.oilonline.com/news/features/oe/20040201.Current_.13502.asp)
- \*9  
<http://www.safmc.net/library/sargFMP.pdf>  
<http://www.marlinmag.com/article.jsp?ID=17095>  
<http://www.scienceblog.com/community/older/2002/B/20026685.html>
- \*10  
[http://www.floridasportsman.com/regions/we/FR\\_0203\\_Fishing](http://www.floridasportsman.com/regions/we/FR_0203_Fishing)