SEDAR 77 HMS Hammerhead Sharks Review Workshop
Stock Identification

Aug 28, 2023

Three subgroups

1. **Movement and spatial distribution**
2. **Genetics**
3. **Life history**

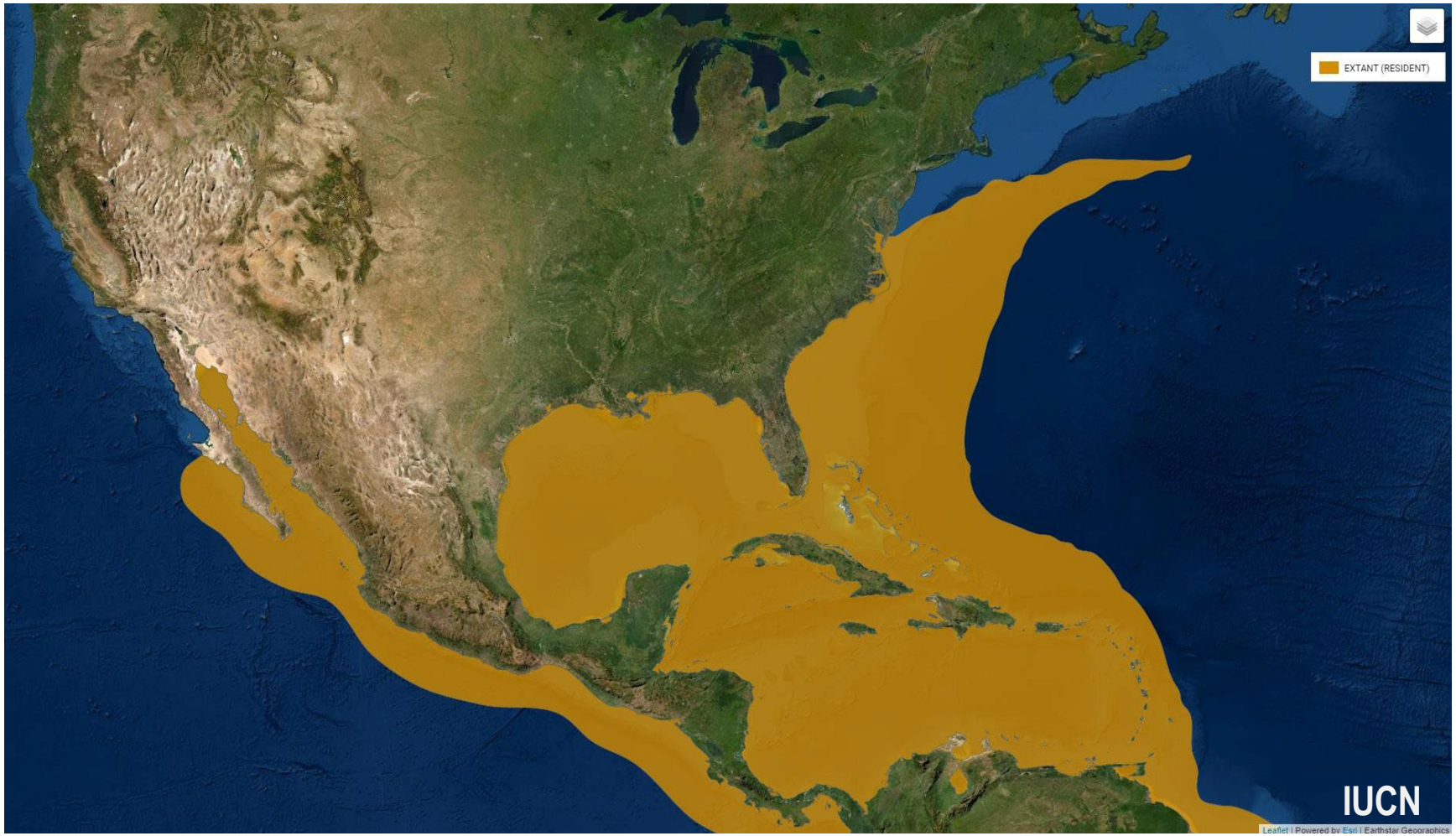
Movement and Spatial Information

- Conventional tagging (mark-recapture)
- Satellite telemetry
- Acoustic telemetry

Great Hammerhead

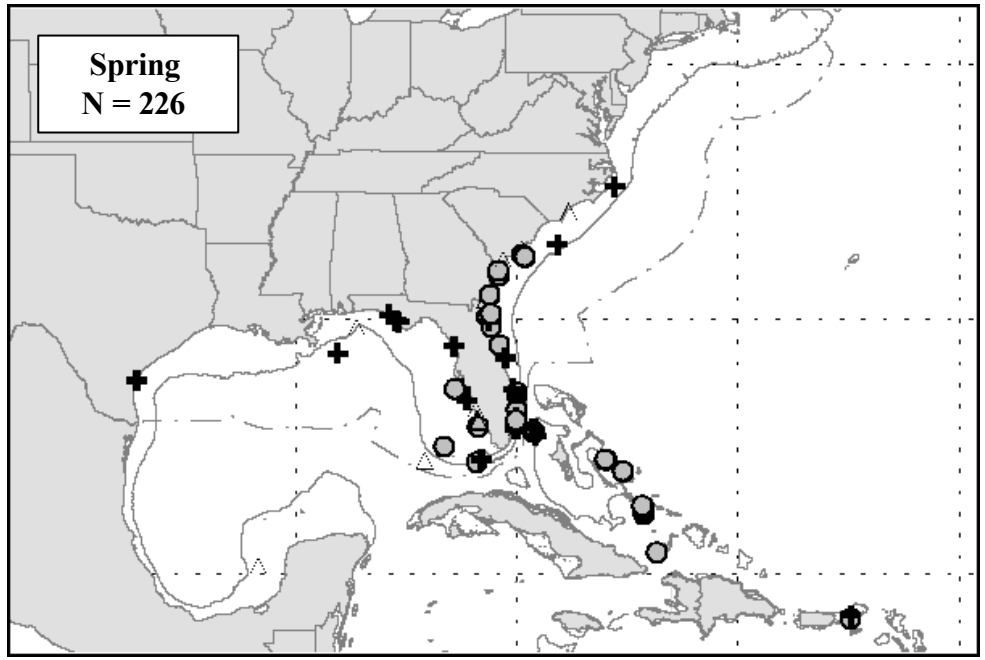
Overall Distribution Supported by

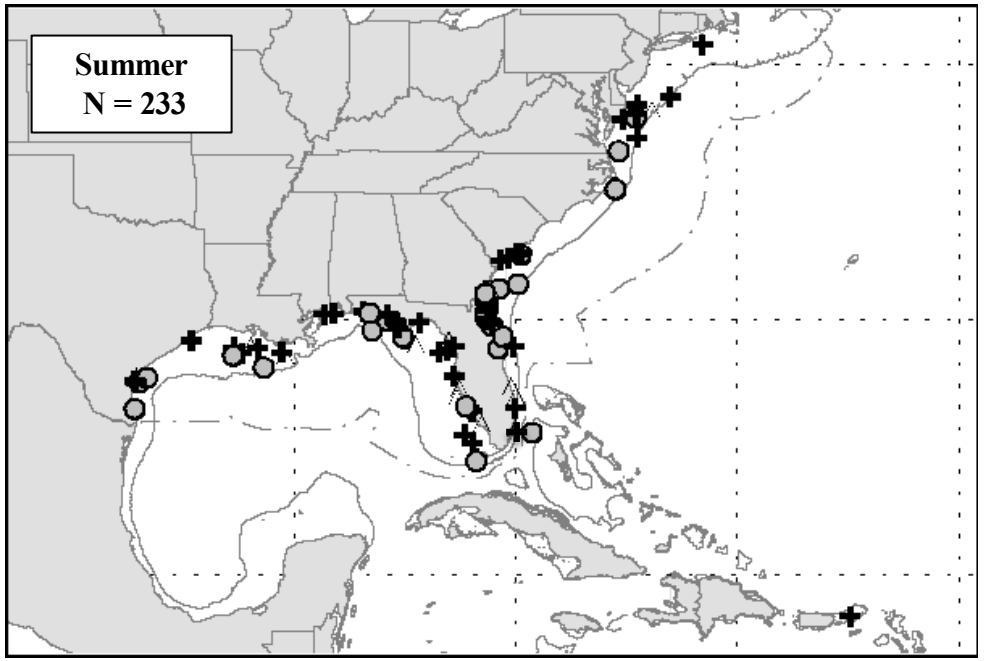
Banks & Stunz (SID04)
Barker et al (RD13)
Calich et al (RD04)
Chan et al (RD17)
Drymon & Wells (RD20)
Friess et al (RD05)
Gardiner et al (SID05)
Graham et al (RD03)
Guttridge et al (RD16)
Hammerschlag (SID07)
Heim et al (SID01)
Heim et al (SID03)
Kohler & Turner (RD23)
Macdonald et al (RD24)
Pollack (Data Scoping Web Pres)
Pollack & Hanisko (SID02)
Hoffmayer (Data Scoping Web Pres)

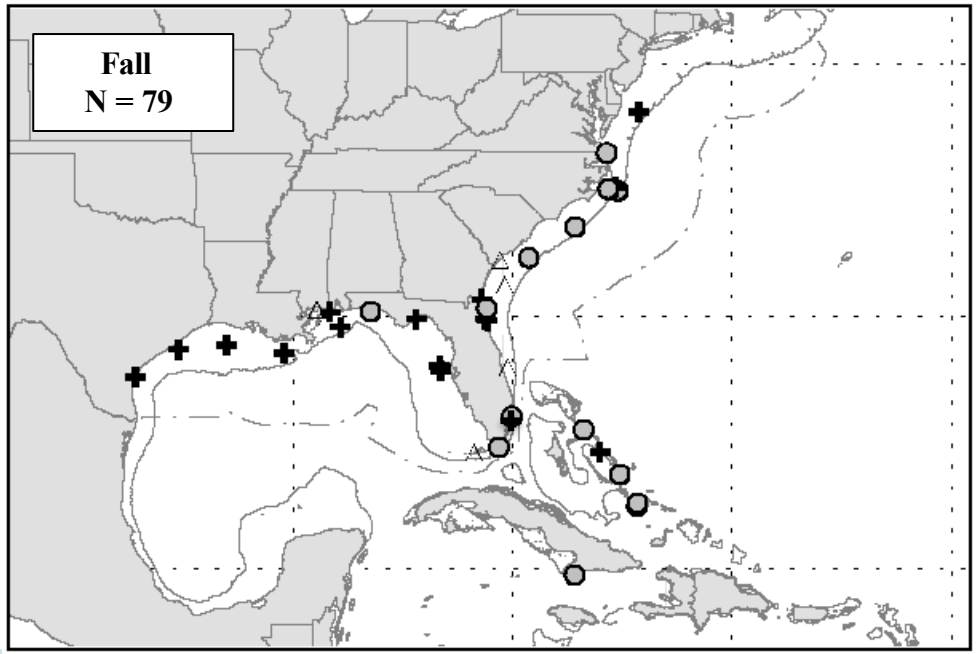


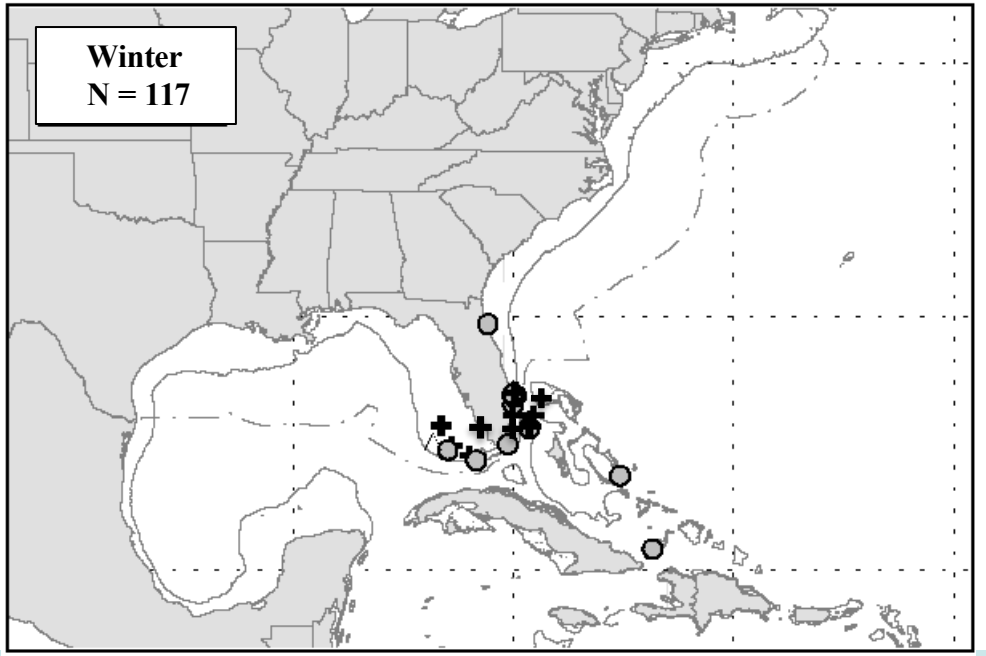
Great Hammerhead

Seasonal Distribution Based on CSTP Capture Locations









- Female
- Male
- Unknown

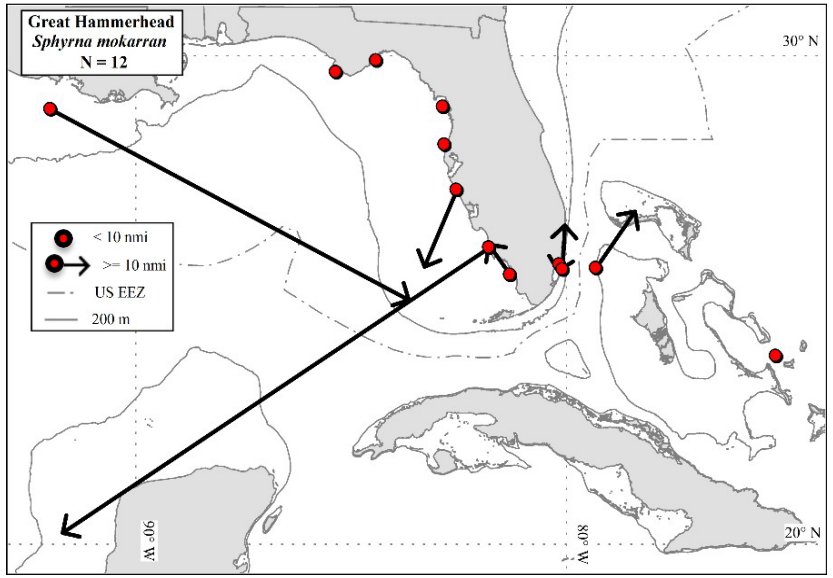
COOPERATIVE SHARK TAGGING PROGRAM
NOAA est. 1962
NMFS

NOAA FISHERIES

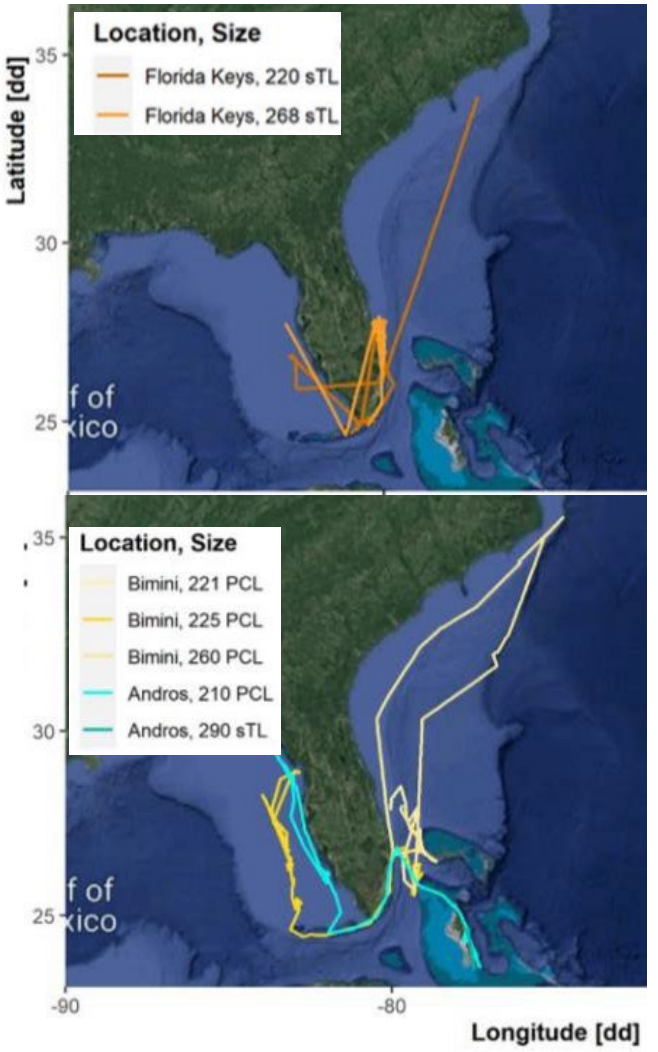
Great Hammerhead Movements

Conventional tag data: limited total recaptures (12) but show exchange between US and Mexican GOM

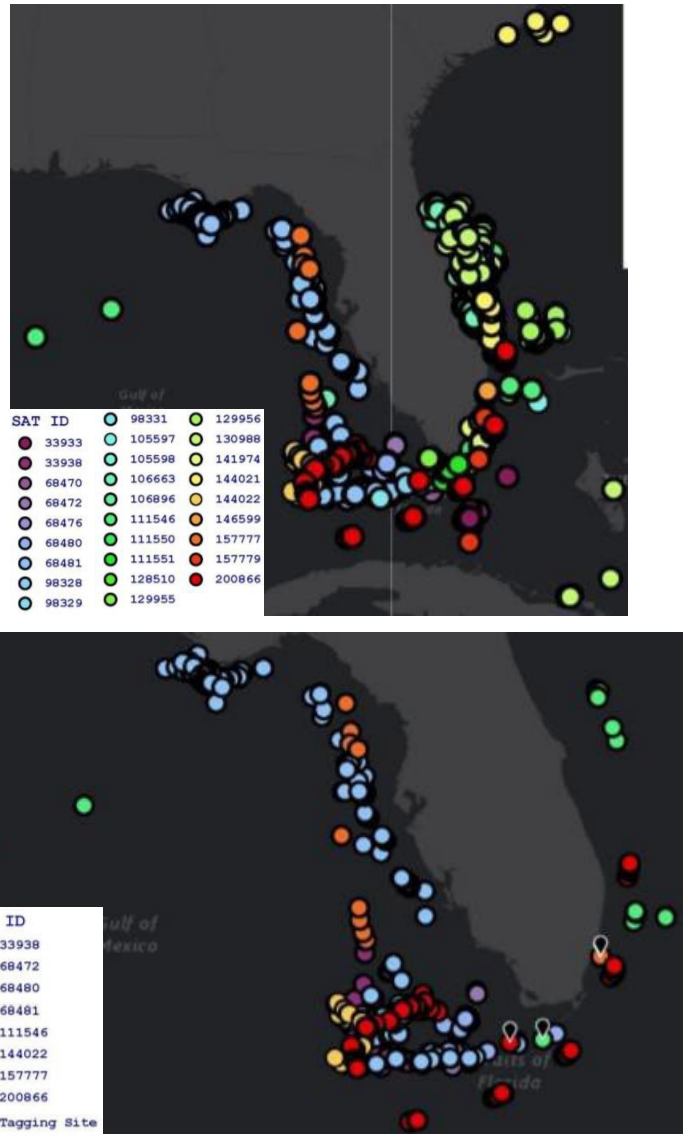
Satellite telemetry data: show exchange between GOM and Atlantic



Cooperative Shark Tagging Program (SEDAR77- RD23).
No exchange between GOM and Atlantic
Exchange between US and Mexican GOM



Heim et al. (SEDAR77- SID01)
Exchange b/t GOM and Atlantic

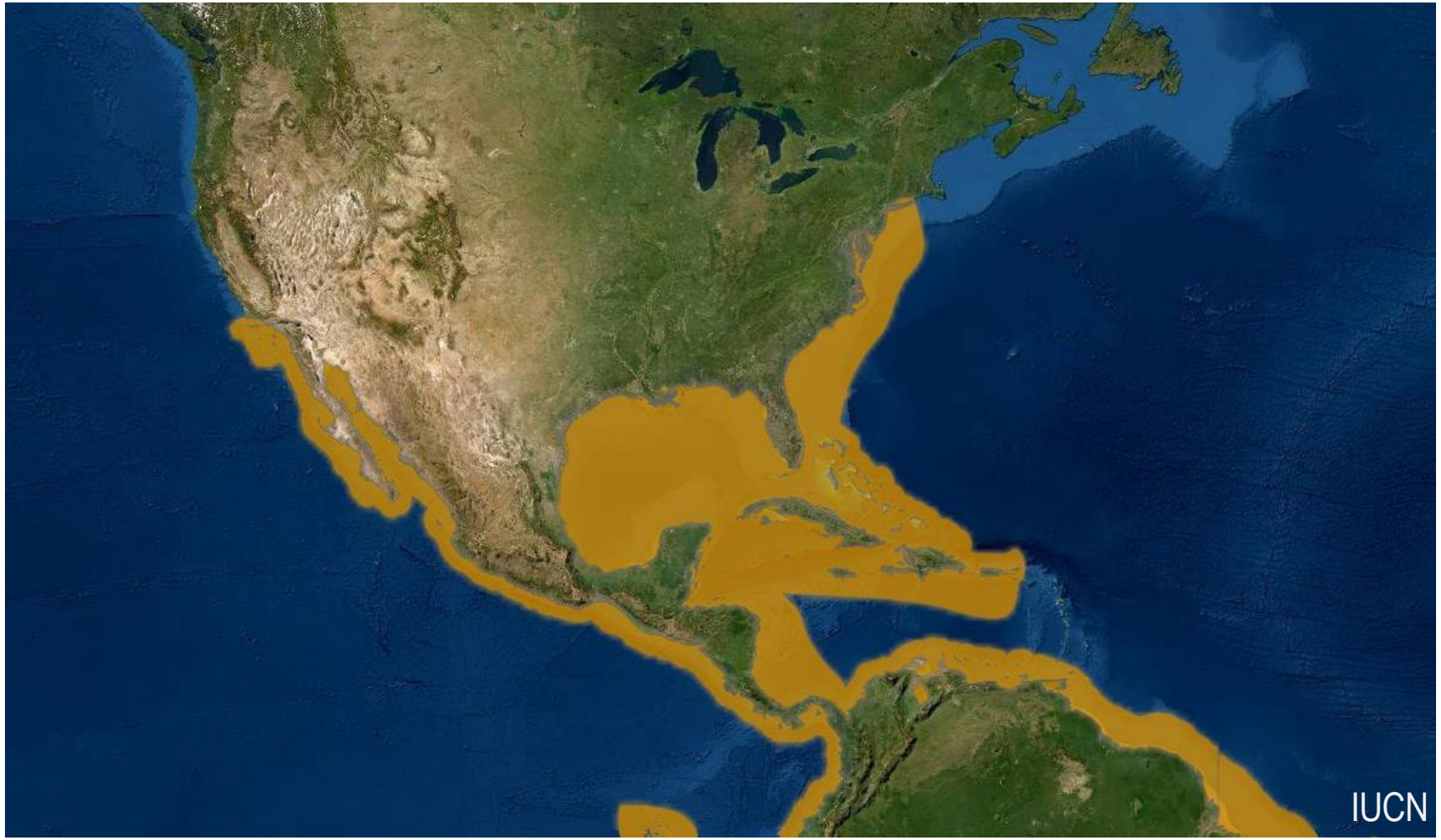


Hammerschlag (SEDAR77-SID07)
exchange b/t GOM and Atlantic

Scalloped Hammerhead

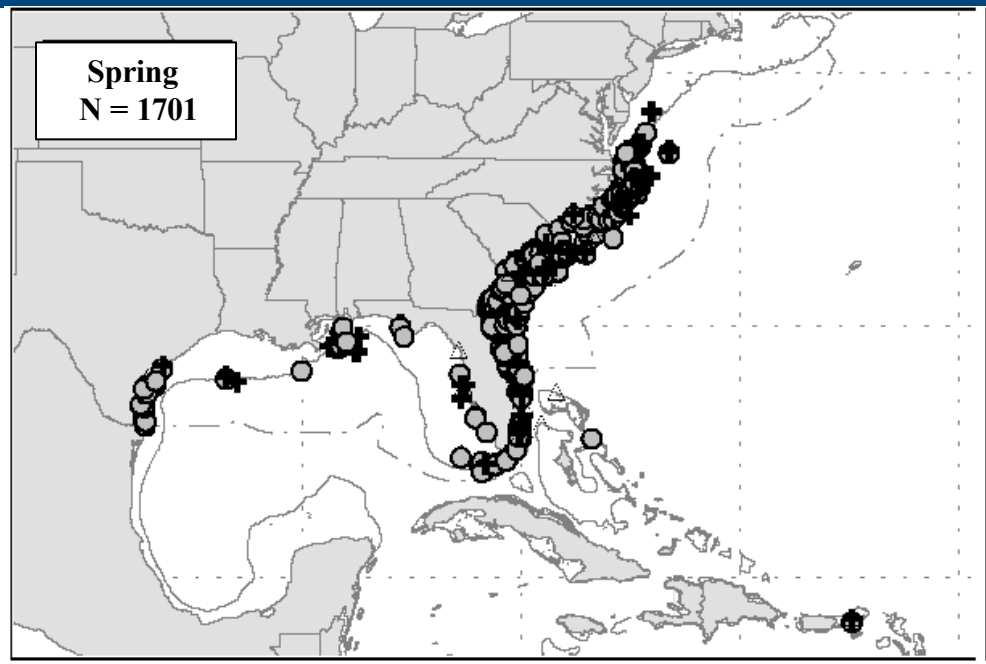
Overall Distribution Supported by

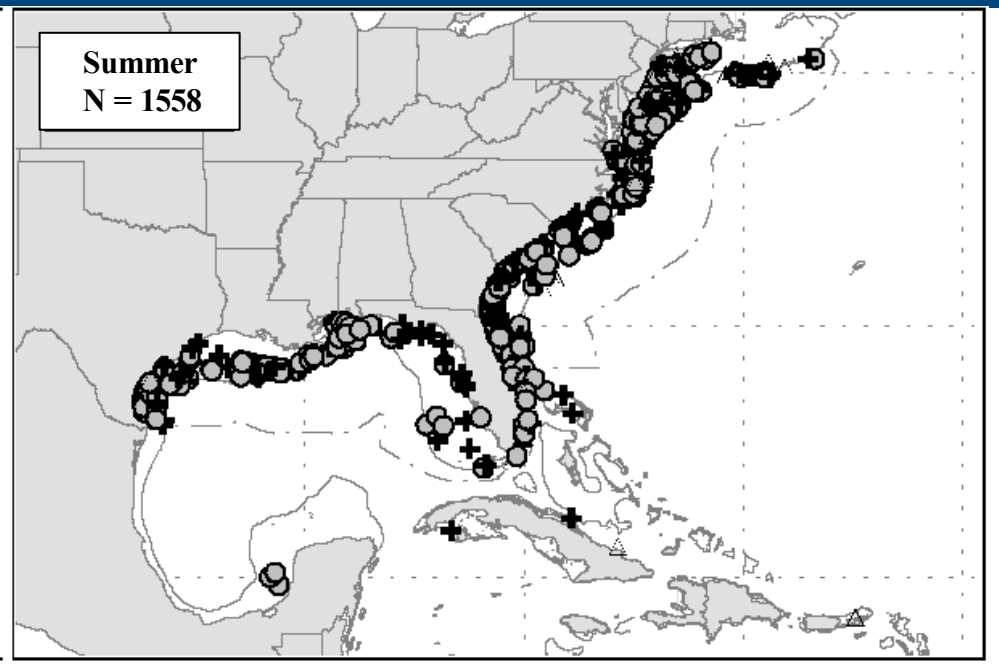
Banks & Stunz (SID04)
Chan et al (RD17)
Drymon et al (RD21)
Hammerschlag (SID07)
Heim et al (SID01)
Heim et al (SID03)
Kohler & Turner (RD23)
Macdonald et al (RD24)
Pollack (Data Scoping Web Pres)
Pollack & Hanisko (SID02)
Wells et al (RD01)

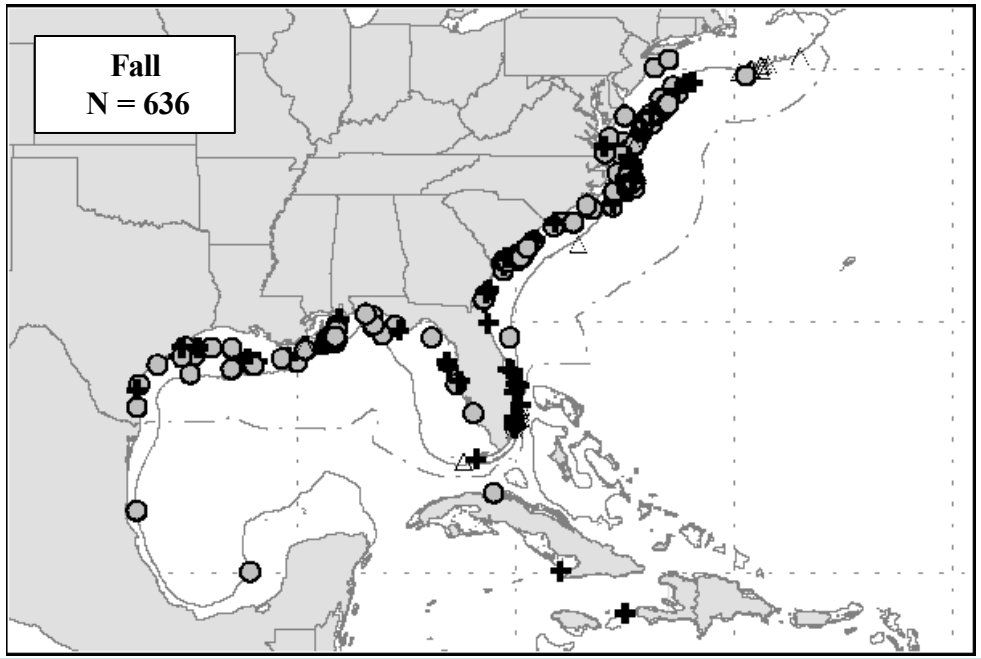


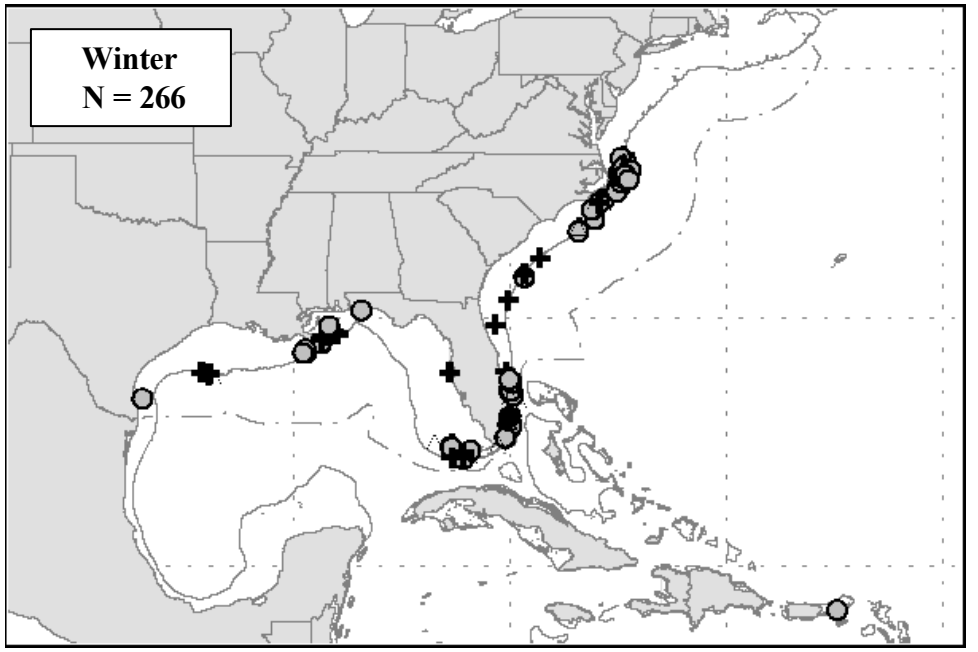
Scalloped Hammerhead

Seasonal Distribution Based on CSTP Capture Locations









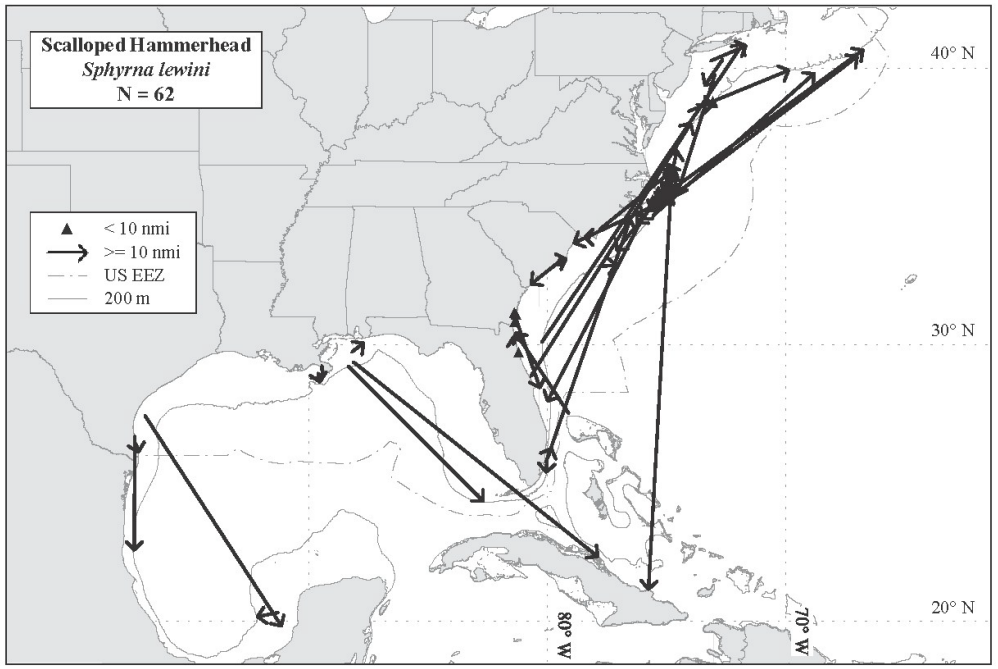
- ✚ Female
- ○ Male
- △ Unknown

COOPERATIVE SHARK TAGGING PROGRAM
NOAA est. 1962 NMFS

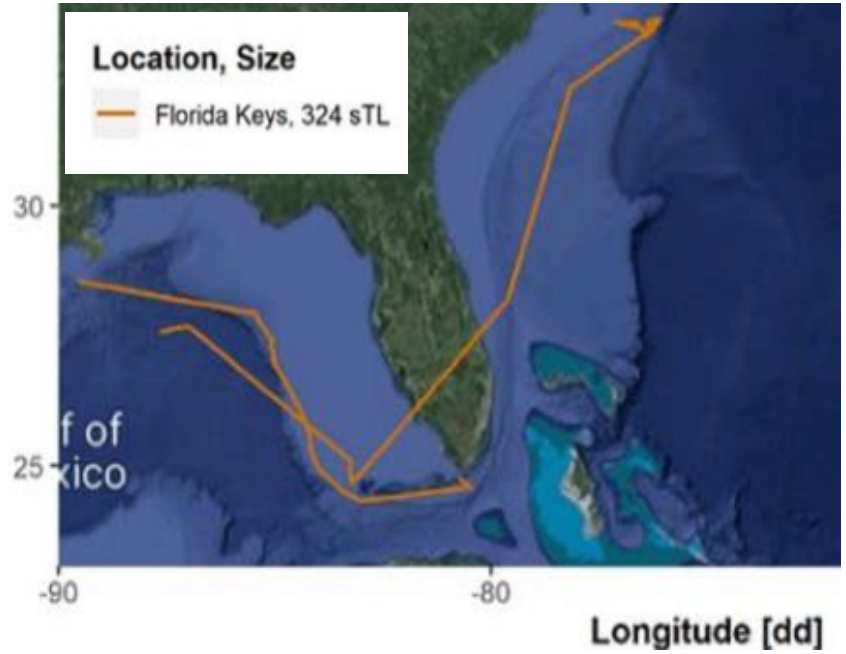
Scalloped Hammerhead Movements

Conventional tag data: recaptures show exchange between GOM and Atlantic and exchange between US and Mexican GOM

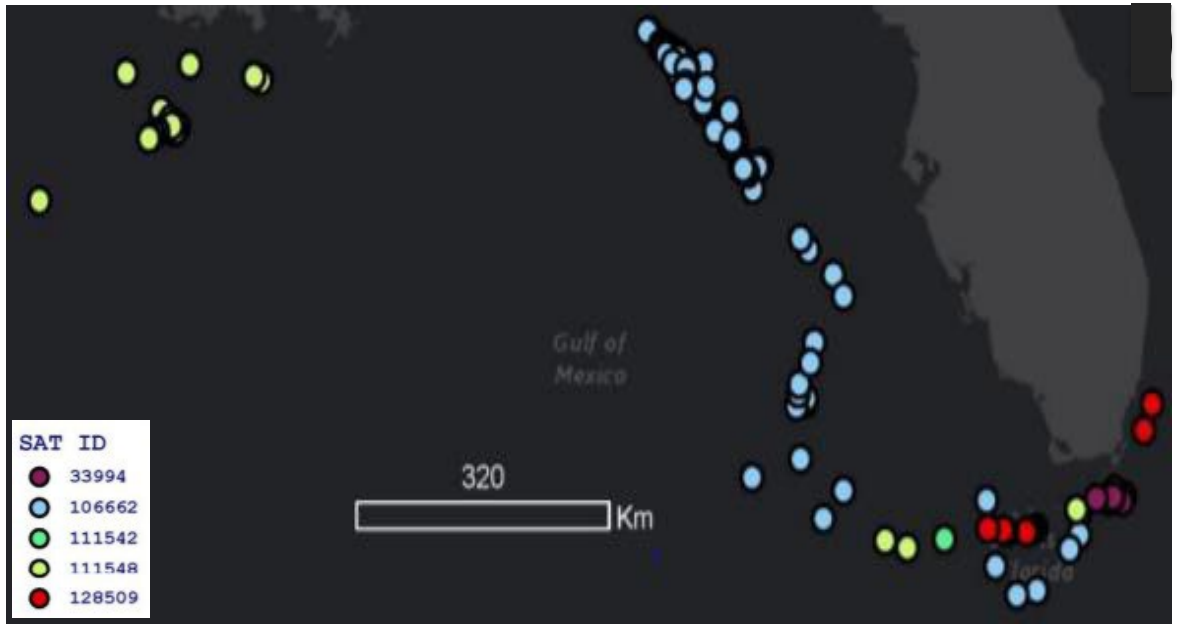
Satellite telemetry data: show exchange between GOM and Atlantic



Cooperative Shark Tagging Program (SEDAR77- RD23)
Exchange between GOM and Atlantic
Exchange between US and Mexican GOM



Heim et al. (SEDAR77- SID01)
Exchange between
GOM and Atlantic

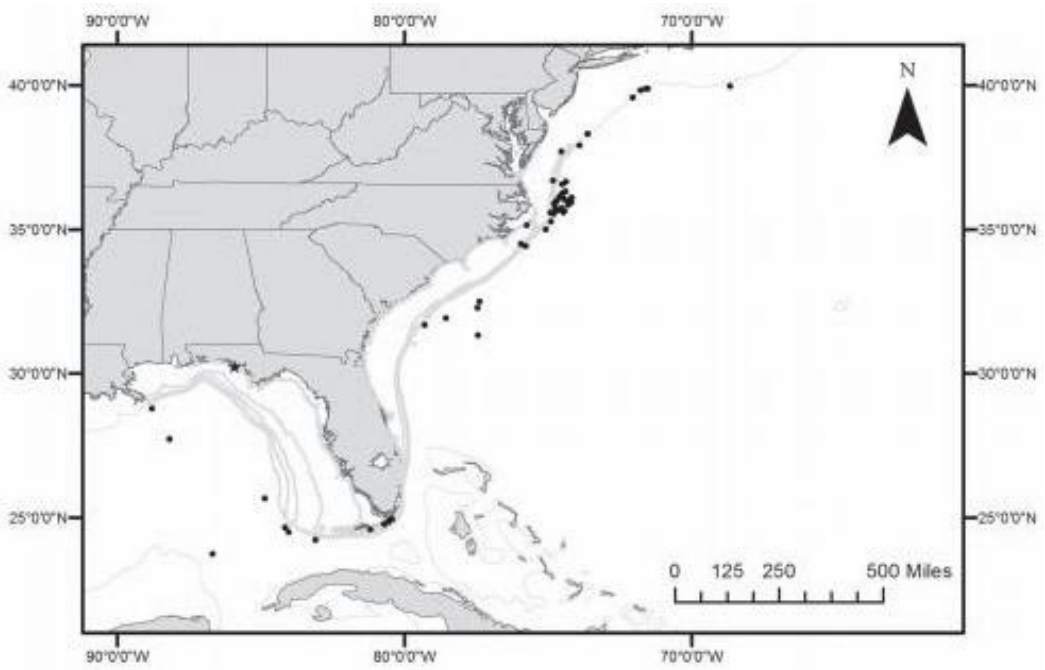


Hammerschlag (SEDAR77-SID07) exchange between GOM and Atlantic

Smooth Hammerhead

Overall Distribution Supported by

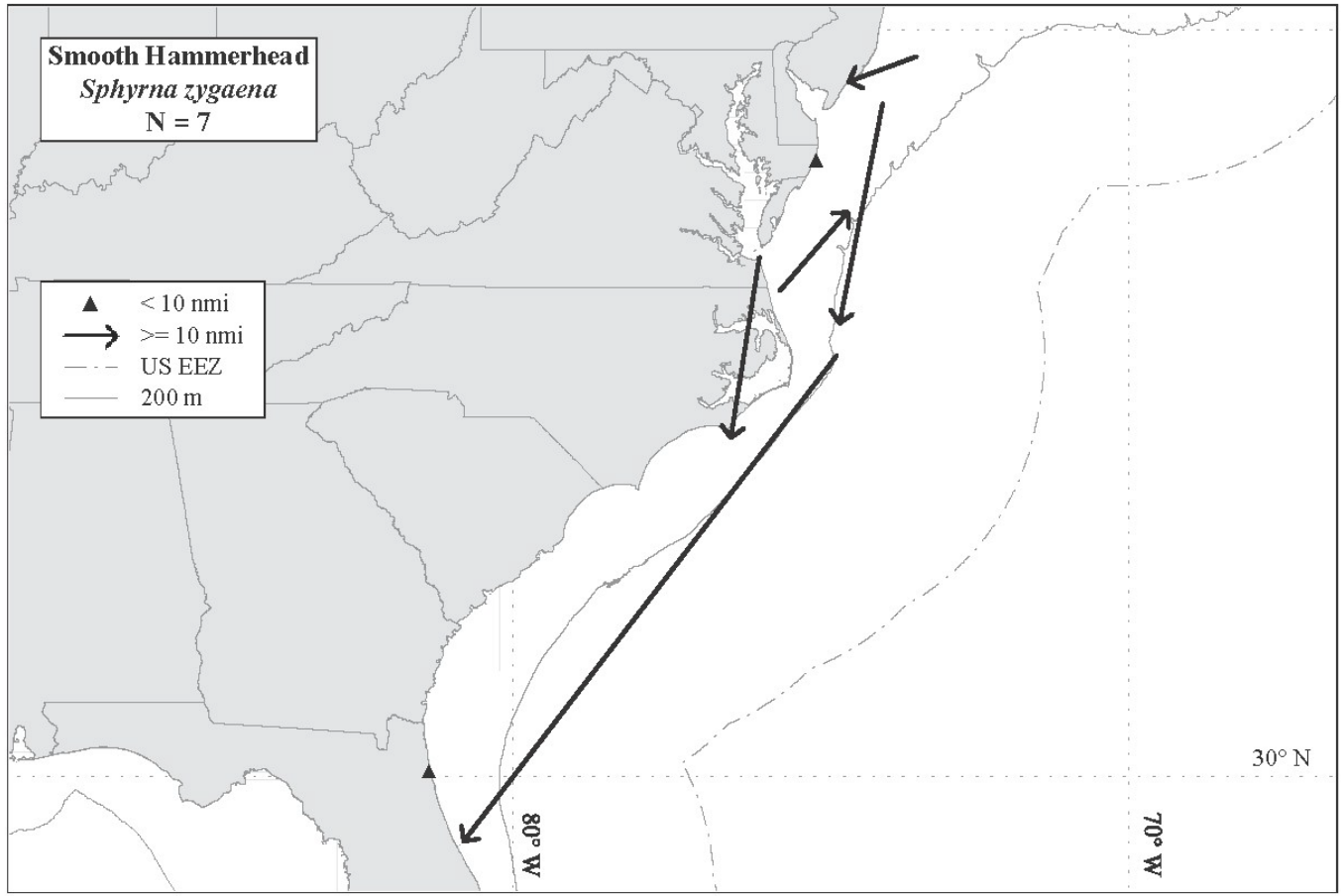
Deacy et al (RD02)
Kohler & Turner (RD23)
Logan et al (RD08)



Smooth Hammerhead Movements

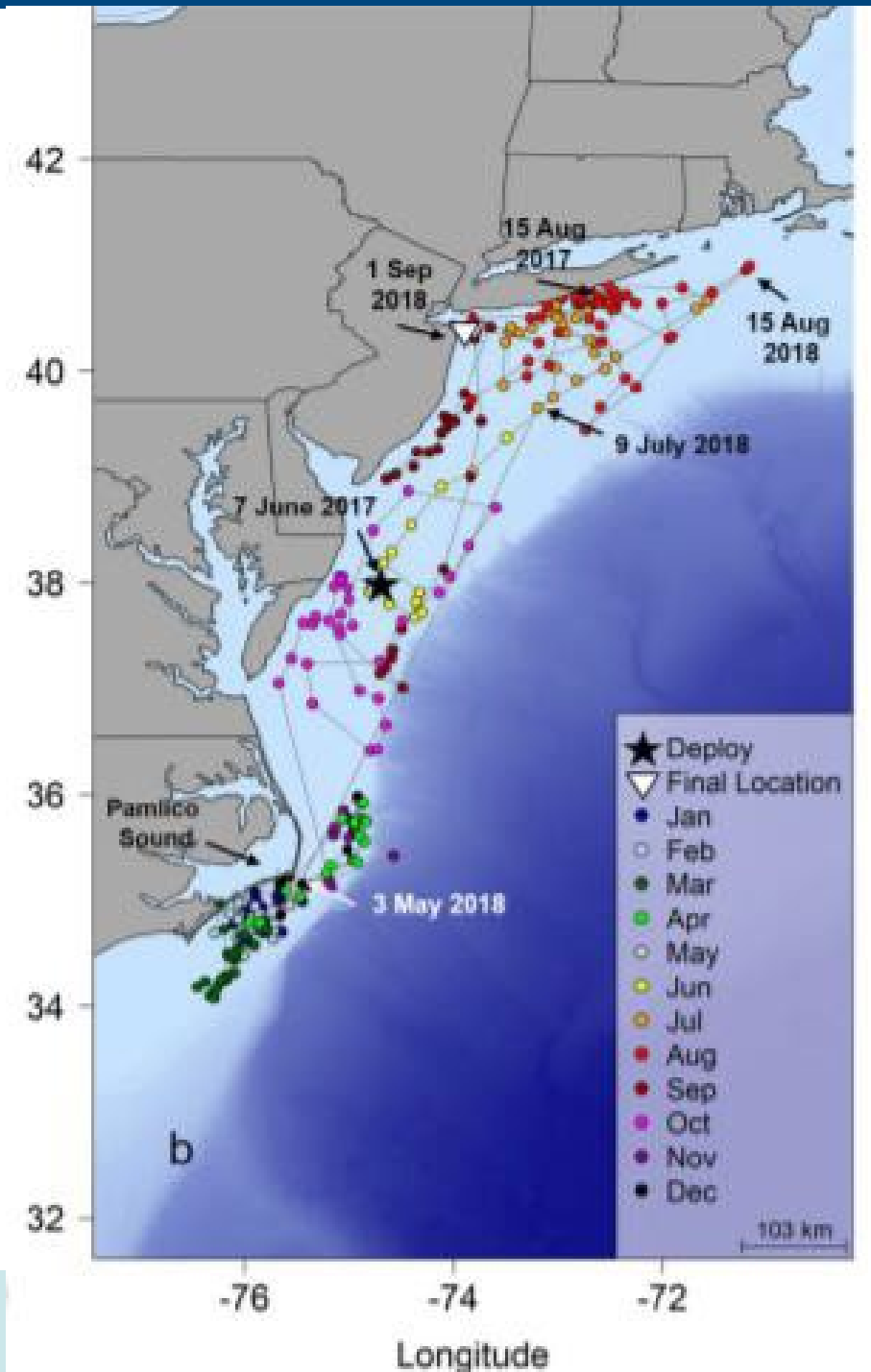
Conventional tag data: no exchange between GOM and Atlantic

Satellite telemetry data: no exchange between GOM and Atlantic



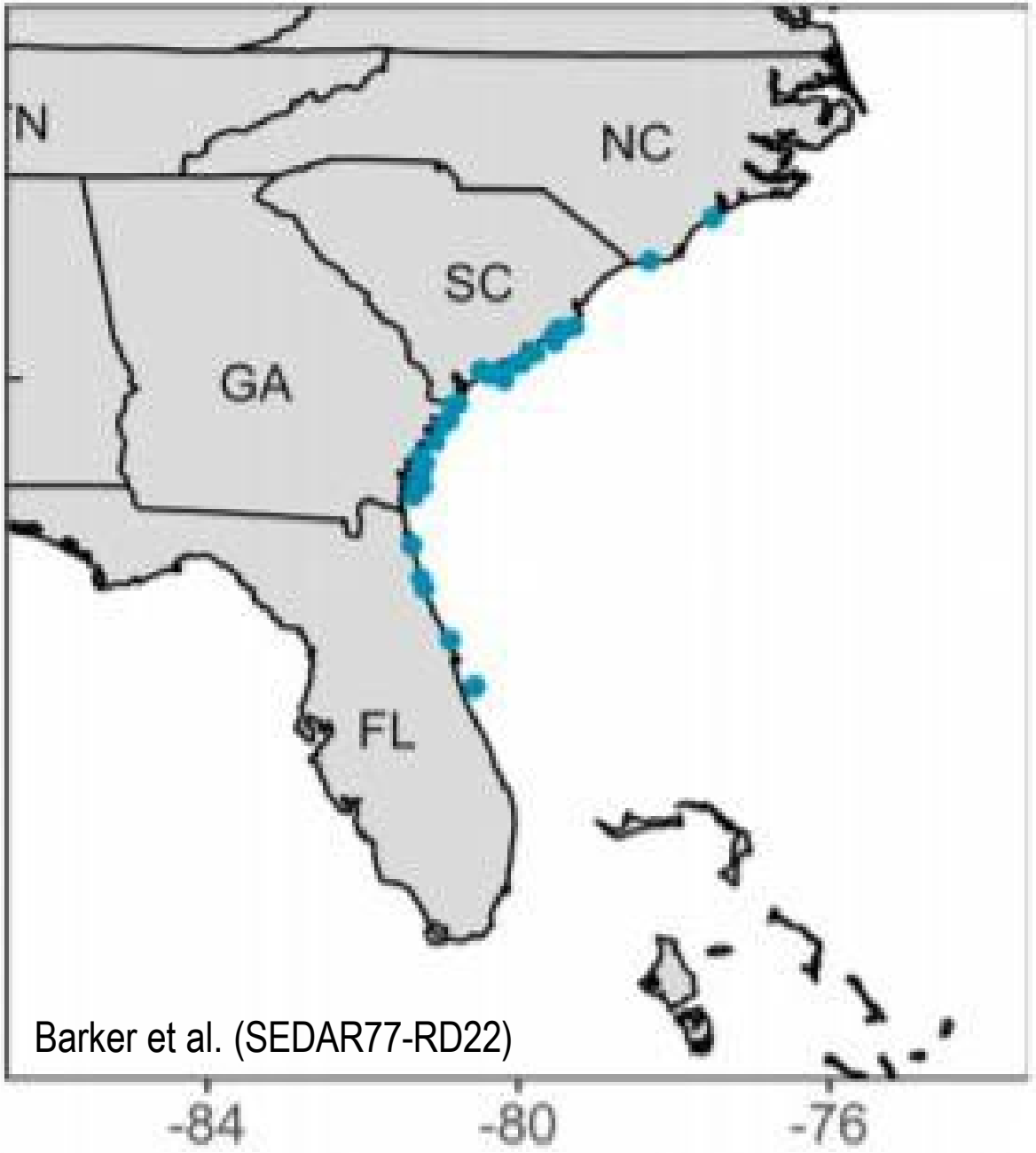
Cooperative Shark Tagging Program (SEDAR77- RD23)

Logan et al. (SEDAR77-RD08)



Carolina Hammerhead Distribution

- Cryptic species
- Indistinguishable from scalloped hammerhead using external morphology
- Spatially limited distribution in the Atlantic
- No evidence in GOM



Barker et al. (SEDAR77-RD22)

Movements/Spatial Sub-Working Group Recommendations

- **Great Hammerhead** – one stock based on exchange seen in movement data. No exchange between GOM and Atlantic seen in conventional tag data but only 12 recaptures. High post-release mortality could account for low recapture rate.

- **Scalloped Hammerhead** – one stock based on exchange seen in movement data. Exchange between GOM and Atlantic and between US and Mexican GOM.
- **Carolina Hammerhead** – assessed with scalloped hammerhead stock because overlap in distribution and indistinguishable (externally) from scalloped hammerhead.

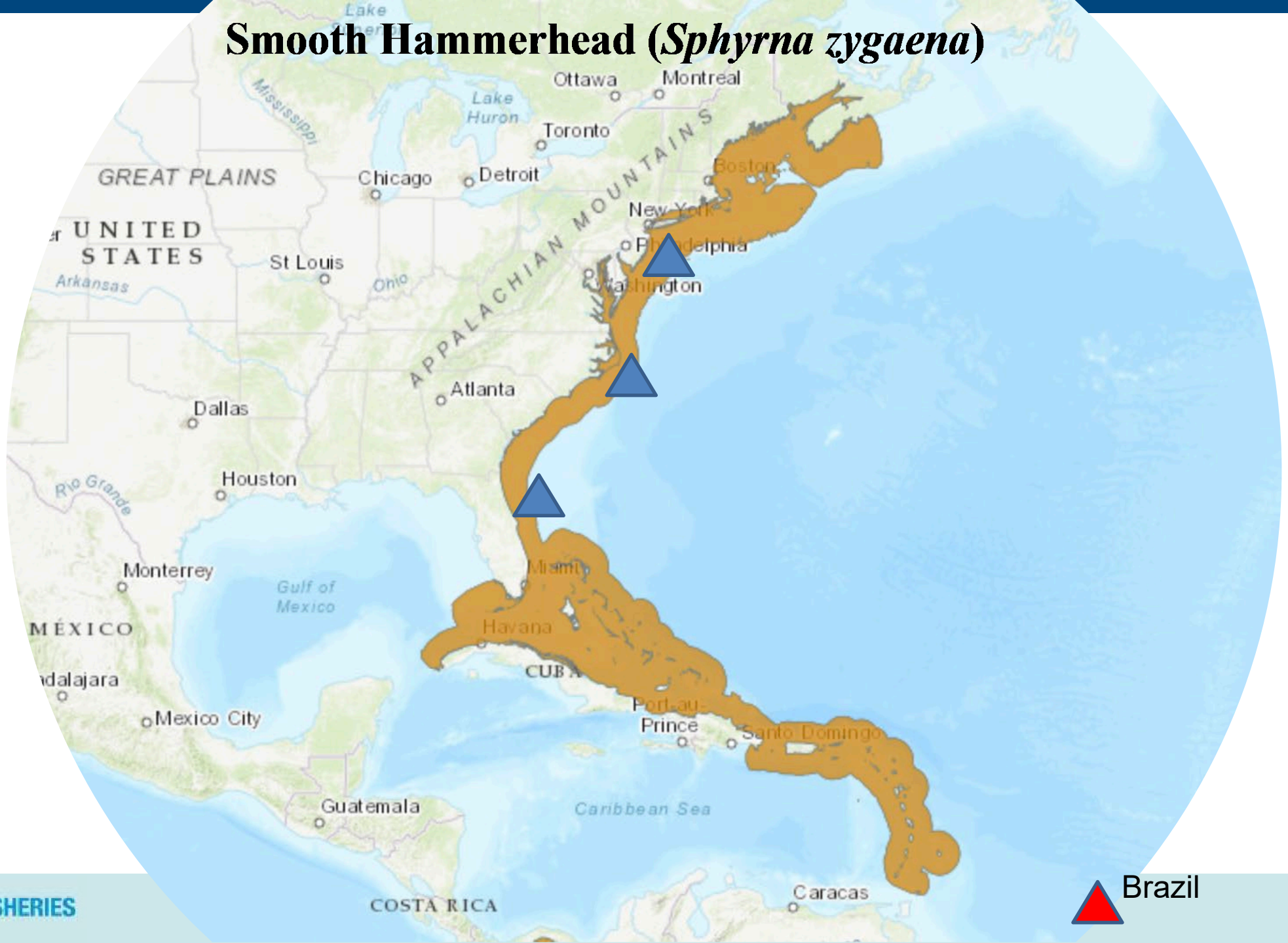
- **Smooth Hammerhead** – undetermined, limited data. Majority in Atlantic but confirmed presence in GOM. No evidence of exchange. Distribution extent in GOM and connectivity to other regions are unknown.

Genetics working group

- Duncan, K.M., Martin, A.P., Bowen, B.W. and De Couet, H.G., 2006. Global phylogeography of the scalloped hammerhead shark (*Sphyrna lewini*). Molecular ecology, 15(8), pp.2239-2251.
- Chapman, D.D., Pinhal, D. and Shivji, M.S., 2009. Tracking the fin trade: genetic stock identification in western Atlantic scalloped hammerhead sharks *Sphyrna lewini*. Endangered Species Research, 9(3), pp.221-228.
- Pinhal, D., Shivji, M.S., Vallinoto, M., Chapman, D.D., Gadig, O.B.F. and Martins, C., 2012. Cryptic hammerhead shark lineage occurrence in the western South Atlantic revealed by DNA analysis. Marine Biology, 159(4), pp.829-836.
- Daly-Engel, T.S., Seraphin, K.D., Holland, K.N., Coffey, J.P., Nance, H.A., Toonen, R.J. and Bowen, B.W., 2012. Global phylogeography with mixed-marker analysis reveals male-mediated dispersal in the endangered scalloped hammerhead shark (*Sphyrna lewini*). PLoS One, 7(1), p.e29986.
- Christine B. Testerman. 2014. Molecular Ecology of Globally Distributed Sharks. Doctoral dissertation. Nova Southeastern University. Retrieved from NSUWorks, Oceanographic Center. https://nsuworks.nova.edu/occ_stuetd/6.
- Barker, A.M., Adams, D.H., Driggers III, W.B., Frazier, B.S. and Portnoy, D.S., 2019. Hybridization between sympatric hammerhead sharks in the western North Atlantic Ocean. Biology letters, 15(4), p.20190004.
- Pinhal, D., Domingues, R.R., Bruels, C.C., Ferrette, B.L., Gadig, O.B., Shivji, M.S. and Martins, C., 2020. Restricted connectivity and population genetic fragility in a globally endangered Hammerhead Shark. Reviews in Fish Biology and Fisheries, 30, pp.501-517.
- Barker, A.M., Frazier, B.S., Adams, D.H., Bedore, C.N., Belcher, C.N., Driggers III, W.B., Galloway, A.S., Gelsleichter, J., Grubbs, R.D., Reyier, E.A. and Portnoy, D.S., 2021. Distribution and relative abundance of scalloped (*Sphyrna lewini*) and Carolina (*S. gilberti*) hammerheads in the western North Atlantic Ocean. Fisheries Research, 242, p.106039.

The genetics working group reviewed published literature relevant to the genetic population structure of four species of hammerhead sharks in U.S. Atlantic, U.S. Gulf of Mexico and U.S. Caribbean Some unpublished data that were relevant was also considered

Smooth Hammerhead (*Sphyrna zygaena*)

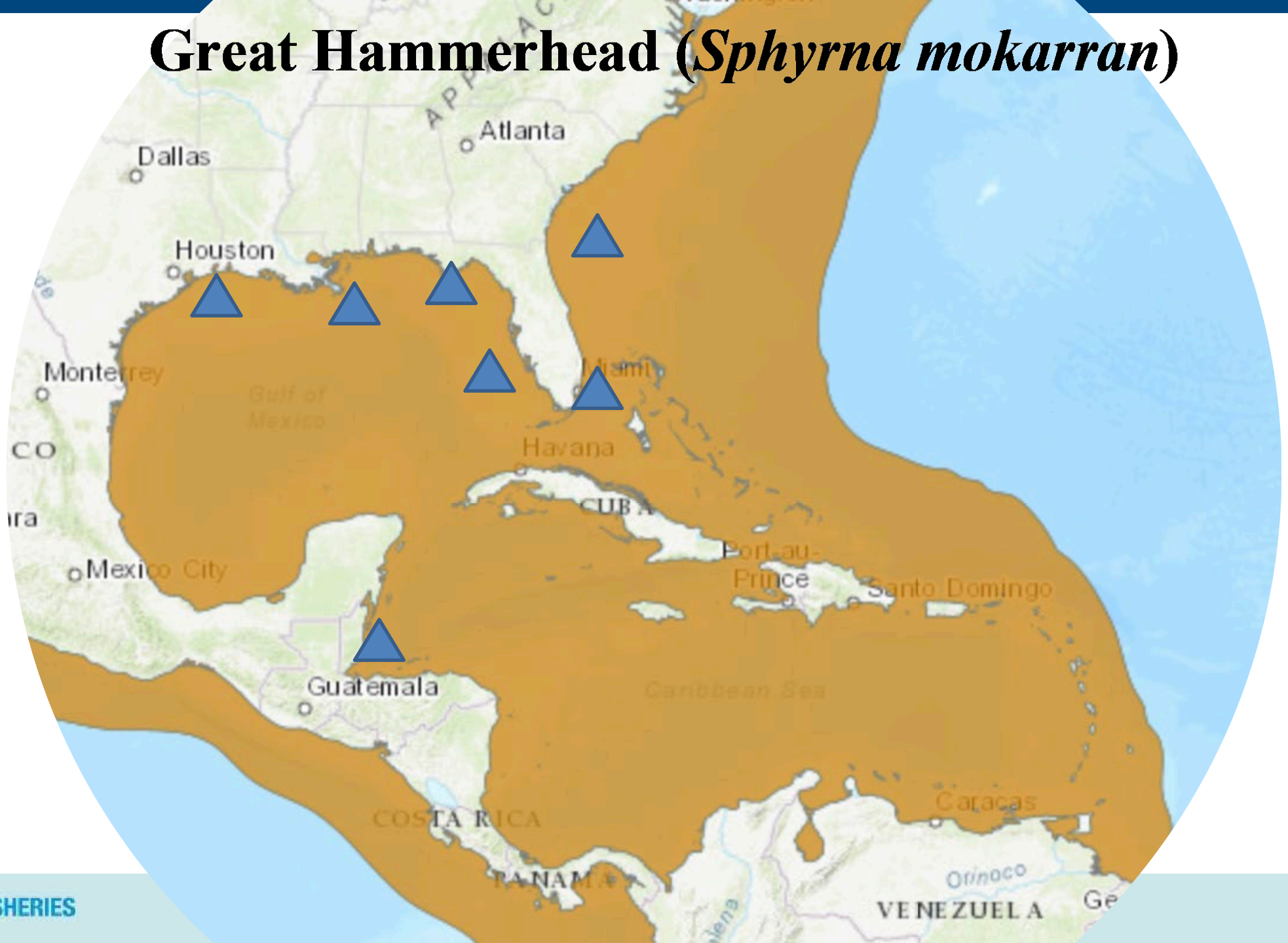


NOAA FISHERIES

There are no population genetic studies of Smooth Hammerhead sharks testing for differentiation between locations within U.S. jurisdictions. This species exhibits an anti-tropical distribution in the Atlantic and the species core U.S. distribution appears to be at higher latitudes in the U.S. Atlantic with rare records in the Gulf of Mexico and the U.S. Caribbean

The working group recommends assessing Smooth Hammerheads as one stock in the U.S. Atlantic (core U.S. range) and U.S. Gulf of Mexico

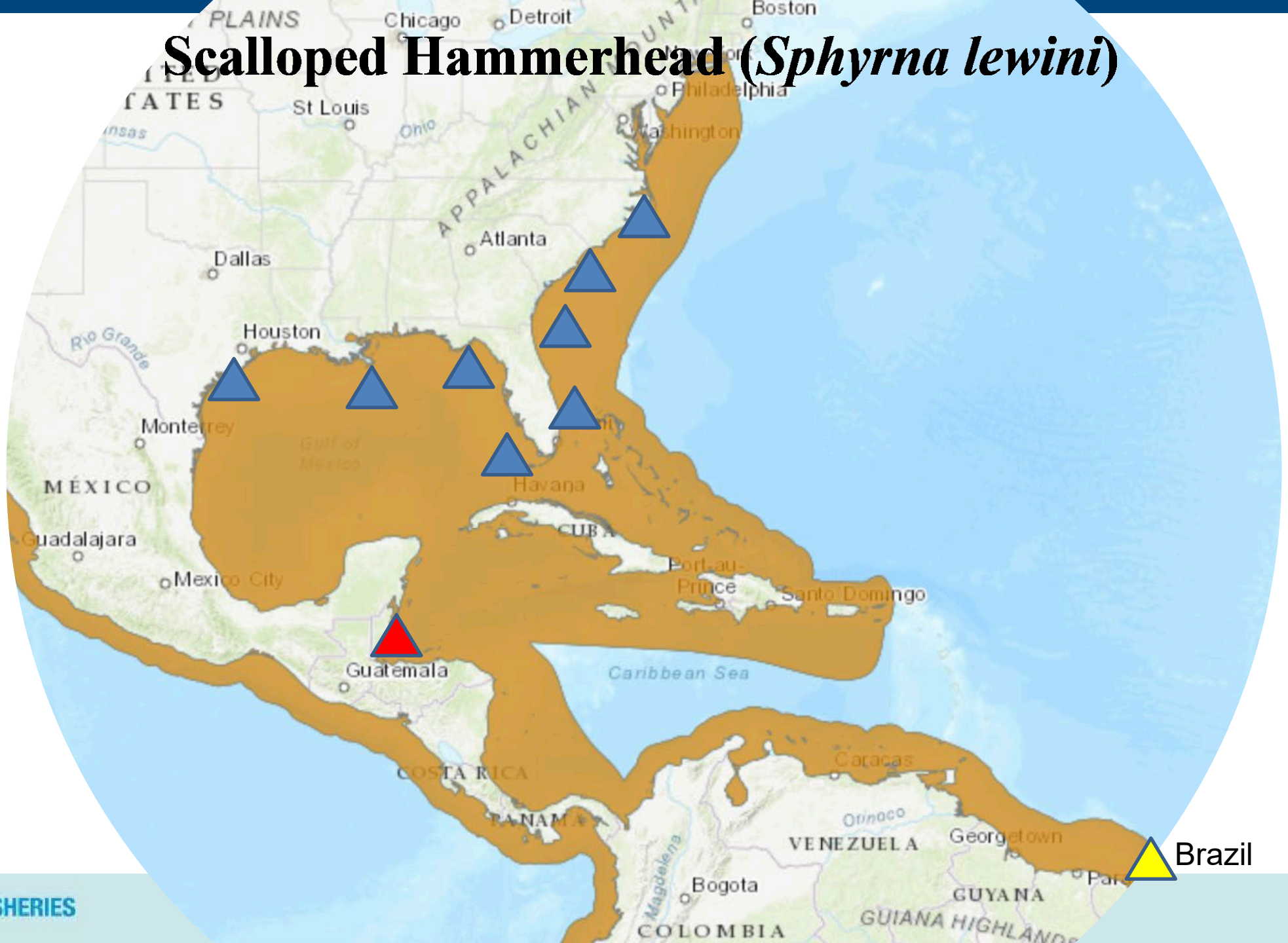
Great Hammerhead (*Sphyrna mokarran*)



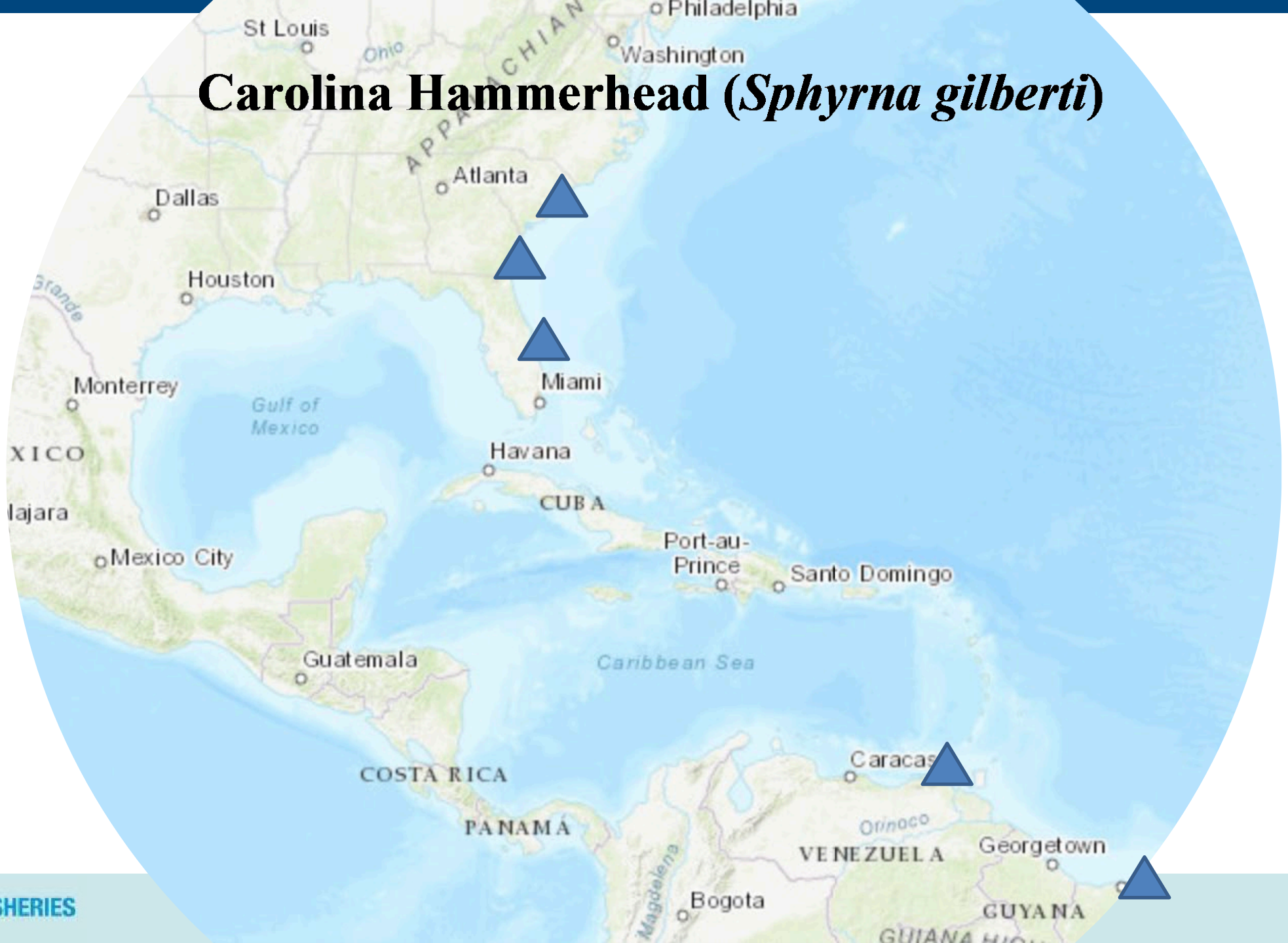
A large sample of mostly large juvenile and adult Great Hammerheads from the U.S. Atlantic, U.S. Gulf of Mexico, Bahamas, and Belize has been tested with multiple genetic. There was no significant differentiation observed in any comparison.

The working group recommends assessing Great Hammerheads as one stock in the U.S. Atlantic, U.S. Gulf of Mexico and broader Caribbean region

Scalloped Hammerhead (*Sphyrna lewini*)



Carolina Hammerhead (*Sphyrna gilberti*)



The Carolina Hammerhead occurs in sympatry with its morphologically indistinguishable sister species the Scalloped Hammerhead in the U.S. Atlantic, with a core distribution around Bulls Bay, South Carolina. Carolina Hammerheads made up 27% of a mixed species sample of these two species in the U.S. Atlantic but was not recorded in a sample from the Gulf of Mexico (Barker et al. 2021).

A large sample of Scalloped Hammerheads from the U.S. Atlantic, U.S. Gulf of Mexico, Belize and Brazil has been tested with multiple genetic markers. Mitochondrial control region sequences and microsatellite loci indicate the U.S. Atlantic and U.S. Gulf of Mexico forming one stock.

The working group recommends assessing Scalloped Hammerheads as two stocks in the U.S. mainland: one in the U.S. Atlantic and one in the U.S. Gulf of Mexico. This recommendation is not based on genetic differentiation between populations but rather because of the existence of the indistinguishable sympatric Carolina Hammerhead in the U.S

Life History Group conclusions:

- Significant differences in VBGF parameter estimates for great hammerheads
- Appears to also be the case for scalloped hammerheads
- Limited confidence that differences are real
- Low sample sizes in specific cases / counter to life history patterns in similar species
- In the case of scalloped hammerheads, no confidence that *S. gilberti* samples weren't included
- Problematic due to potential and likely life history differences between *S. gilberti/lewini*

Opinion of group participants that decision on <u>stock ID should not be based on life history</u>

FINAL RECOMENDATIONS

Great hammerhead

-the Spatial Distribution/Movement WG concluded Great Hammerhead comprise a single biological stock based on movements of individuals between regions
-the Genetics WG found no significant genetic differentiation between the Gulf of Mexico and U.S. Atlantic,
--the Life History WG determined it was not possible to conclude whether regional differences in life history exist.

The Stock ID Workshop recommended that one stock assessment be conducted for Great Hammerhead.

FINAL RECOMENDATIONS

Smooth hammerhead

-both the Life History and Genetics WGs recommended assessing Smooth Hammerheads as a single stock in the U.S. Atlantic and Gulf of Mexico.
-the Spatial Distribution/Movement WG also agreed that Smooth Hammerheads comprise a single biological stock in the U.S. Atlantic Ocean and Gulf of Mexico based on the fact that they are a wide-ranging species with the ability to move long distances (> 6,600 km; Santos and Coelho, 2018)

The Stock ID Workshop recommended that one stock assessment be conducted for Smooth Hammerhead.

FINAL RECOMENDATIONS

Scalloped hammerhead

Carolina Hammerhead

-the Carolina Hammerhead is very difficult to distinguish from Scalloped Hammerhead, even for trained biologists, and thus much of the catch data will likely represent both species in unknown overall proportions
--it is highly likely that Carolina Hammerhead is only found in the U.S. Atlantic

-Scalloped Hammerhead: the Life History WG determined it was not possible to conclude whether regional differences in life history exist. The Genetics WG found no significant genetic differentiation between the Gulf of Mexico and U.S. Atlantic, and the Spatial Distribution/Movement WG concluded Scalloped Hammerheads comprise a single biological stock based on movements of individuals between regions

The Stock ID Workshop recommended that if sufficient data are available. Carolina and Scalloped Hammerhead should be assessed as one stock in the U.S. Atlantic and another assessment should be conducted for the Scalloped Hammerhead in the Gulf of Mexico.
If it is determined that sufficient data are not available to conduct separate assessments, then a single stock assessment should be conducted for the combined Carolina and Scalloped Hammerhead for all areas in the Northwest Atlantic.