Some thoughts on dividing the northern Gulf of Mexico red snapper stock into eastern and western components at the statistical area 9/10 border

Benny J. Gallway and Peter A. Mudrak

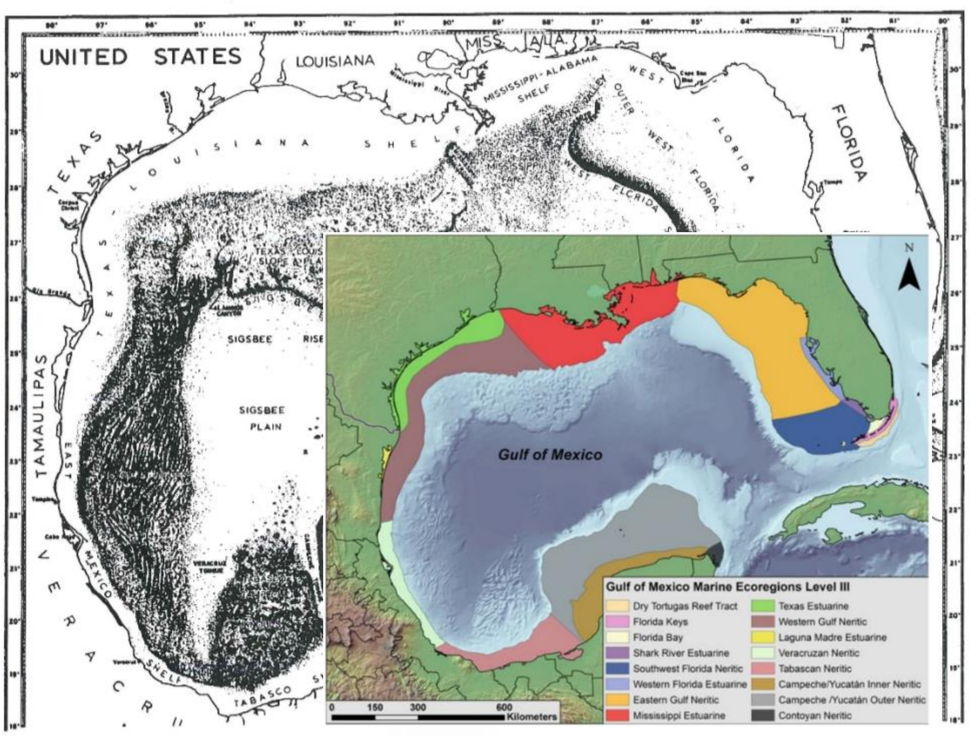
SEDAR74-SID-06

30 July 2021

Please cite this document as:

Gallway, Benny J. and Peter A. Mudrak. 2021. Some thoughts on dividing the northern Gulf of Mexico red snapper stock into eastern and western components at the statistical area 9/10 border. SEDAR74-SID-06. SEDAR, North Charleston, SC. 11 pp.

SOME THOUGHTS ON DIVIDING THE NORTHERN GULF OF MEXICO RED SNAPPER STOCK INTO EASTERN AND WESTERN COMPONENTS AT THE STATISTICAL AREA 9/10 BORDER



Cover Figure: The old (Upchupi 1967, black and white map) and new (Ward 2017, color map) data suggest the major faunal break between the East and West Gulf of Mexico occurs at DeSoto Canyon.

By

Benny J. Gallaway and Peter A Mudrak

LGL Ecological Research Associates, Inc.
4103 South Texas Ave, Suite 211
Bryan, TX 77802

July 30, 2021

INTRODUCTION

The Mississippi River has a large influence on the Gulf of Mexico (GOM), and prevailing currents carry most of the freshwater inputs from the Mississippi River to the west. As a result, the western GOM shelf tends to have high turbidity, and the sediments are largely terrigenous in origin. The eastern GOM receives much less freshwater, and has more carbonaceous sediment types. Due to different environmental conditions, distinct faunal assemblages occupy different regions of the GOM. Currently, Red Snapper in the GOM are managed as a single stock (SEDAR 2018). However, the stock is modeled with the mouth of the Mississippi River as a division between eastern and western components of the stock. While the mouth of the Mississippi River is a convenient location to divide the eastern and western GOM, it does not correspond to the major ecological and faunal divide between the eastern and western GOM. The Mississippi/Alabama shelf also receives large freshwater inputs from the Mississippi and Mobile Rivers, resulting in habitats much more similar to the western GOM than areas farther east (Ward 2017; Figure 1). Here we present evidence that the ecological division between the eastern and western GOM for Red Snapper and other reef fish corresponds to DeSoto Canyon (approximately the shrimp statistical Area 9/10 border), rather than the current division at the mouth of the Mississippi River, and discuss the management implications of moving the divide.

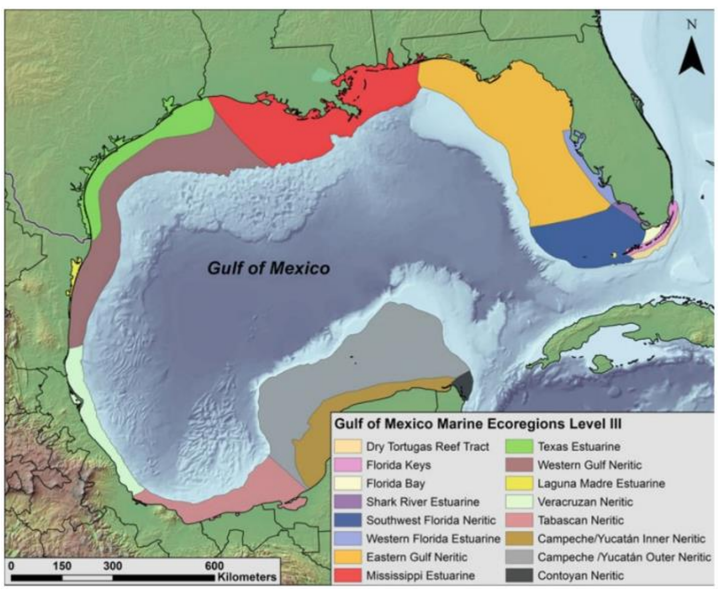


Figure 1. From Ward (2017), a map showing the different ecoregions of the Gulf of Mexico. Note that the areas west of DeSoto Canyon have the same Mississippi Estuarine habitats as the western Louisiana shelf.

FAUNAL ASSEMBLAGES

West Gulf

The shelf of the western GOM can be split into several different faunal assemblages. However, one of the more useful splits is based on the major shrimp fisheries of the GOM, Brown and White Shrimp in the west and Pink Shrimp in the east Gulf. Both White Shrimp and Brown Shrimp are West Gulf shrimp (namely Statistical Areas 10-21) that have life cycles with juvenile stages that are dependent on estuaries. Juveniles make use of the abundant Spartinia salt marsh habitats in the western GOM (Figure 2). The habitat preferences of subadult and adults of these two shrimp species differ. White Shrimp prefer lower salinity habitats compared to Brown Shrimp. The White Shrimp Grounds are nearshore areas where freshwater inputs are large enough to extend estuarine conditions into the GOM (Gallaway 1981). Generally, these areas are less than 20 m deep (Figure 3). The White Shrimp Ground Faunal Assemblage is characterized by a suite of estuarine dependent fishes, and the dominant benthic fishes are members of the family Sciaenidae (Gallaway et al. 1981). The Brown Shrimp Grounds are located further offshore in higher salinity waters. With the exception of Brown Shrimp, most members of the Brown Shrimp Ground Assemblage are not dependent on estuaries, and complete their life cycles in offshore habitats (Gallaway et al. 1981).

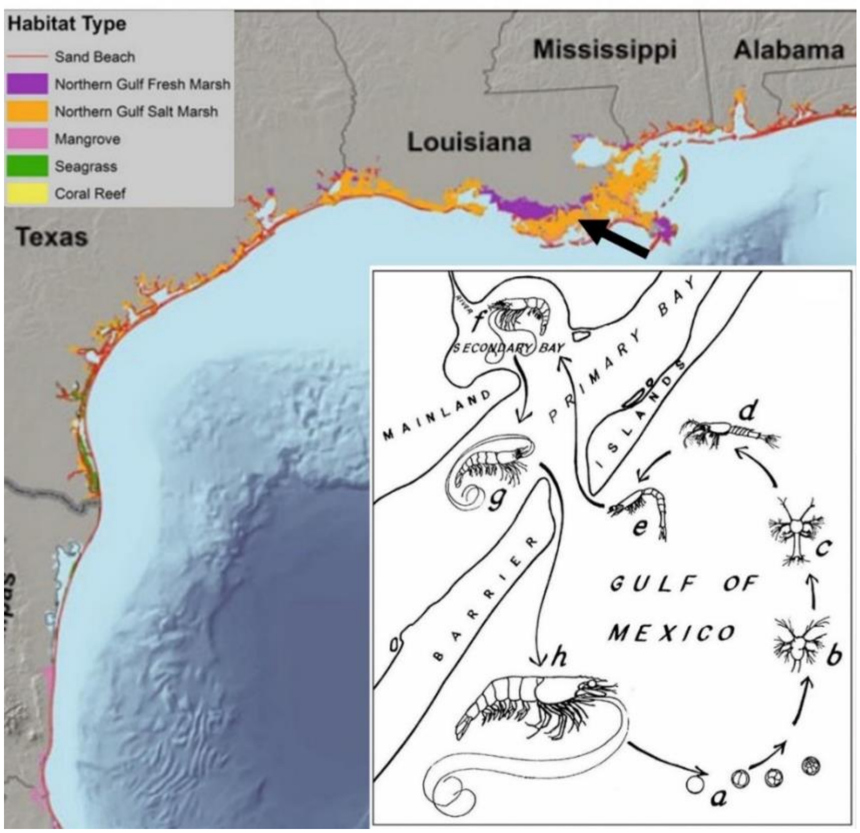


Figure 2. The inshore habitat types found in the western Gulf of Mexico, and the life cycle of penaeid shrimp, which are support a large fishery in the region (Ward 2017; Fisher 2017).

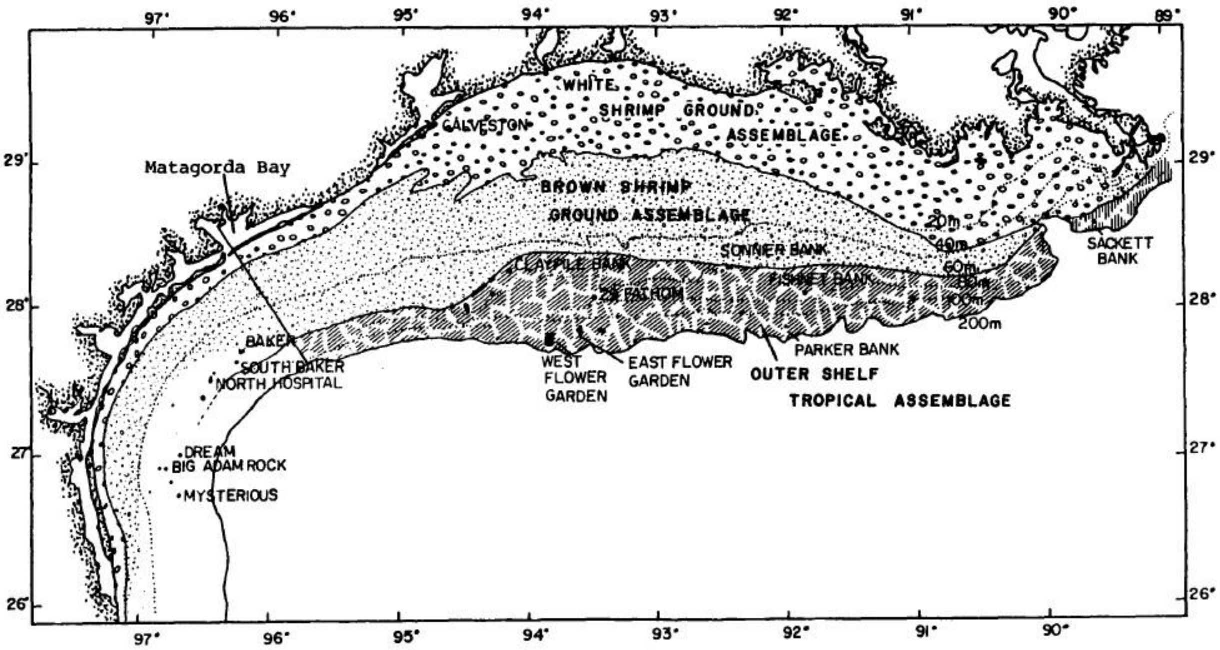


Figure 3. From Gallaway (1981). A depiction of the western Gulf of Mexico showing the nearshore areas characterized by the White Shrimp Ground Assemblage, and the mid-shelf region characterized by the Brown Shrimp Ground Assemblage.

Reef fish landings in the western GOM are dominated by Red Snapper which are also a dominant Brown Shrimp ground assemblage species (NMFS Self-Reported Commercial Coastal Logbook; Table 1). Like most species found in the Brown Shrimp Grounds, Red Snapper have a life cycle that is completed entirely in offshore environments. Red Snapper can live for over 50 years, but they begin to spawn relatively early in life around age 2. Red Snapper are batch spawners, and spawn repeatedly between April and September, with peak spawning activity occurring between June and August. The buoyant eggs hatch after about one day, and the larvae spend approximately one month in the pelagic plankton before settling to benthic habitats. Juvenile Red Snapper are found in open habitats, often inhabiting small low relief structures such as shell rubble within open expanses of sand or mud substrate. Juvenile Red Snapper are most abundant in depths of 18 to 55 m, which largely overlaps with the depths preferred by adult Red Snapper. As juvenile Red Snapper grow, they seek out progressively larger structures, and recruit to high relief reef structure by age 2. Red Snapper reside on natural or artificial reef habitats for the remainder of their life. However, lager individuals over age 8, that have outgrown many of their predators, may utilize smaller structures or open habitats. A more thorough review of Red Snapper life history can be found in Gallaway et al. (2009). Suitable habitats for all life stages of Red Snapper are found in the western Gulf, but habitats suitable for juveniles when they settle to the bottom do not appear abundant or are not present in the east Gulf. Small relief structures in the east Gulf are heavily covered by epibiota and surrounded by sandy substrates having low productivity as compared to the detrital-rich mud bottoms in the west Gulf.

Table 1. The mean catch per unit effort (CPUE = number of fish caught per hour) of Red Snapper for each shrimp statistical zone in the Fall and Summer SEAMAP trawl surveys conducted between 2008 and 2020, and mean landings in pounds reported in the NMFS Self-Reported Commercial Coastal Logbook of Red Snapper, Red Grouper, and Gag between 1992 and 2016.

Shrimp Statistical Zone	1	2	3	4	5	6	7	8	9	10	11
Fall SEAMAP CPUE	0.3	2.1	0.3	0.1	0.5	1.3	0.7	3.7	1.1	3.1	7.9
Summer SEAMAP CPUE	-	0.6	0.1	0.2	0.3	0.6	0.4	0.6	1.8	1.5	4.9
Red Snapper Landings	1,716	8,642	28,192	43,793	83,022	100,595	112,383	316,740	156,893	418,945	493,975
Red Grouper Landings	32,900	317,337	965,617	1,764,313	2,948,627	2,032,377	812,114	297,938	66,017	14,594	6,895
Gag Landings	2,567	28,206	84,051	209,531	463,222	527,599	417,758	208,754	32,177	17,461	11,092

Shrimp Statistical Zone	12*	13	14	15	16	17	18	19	20	21
Fall SEAMAP CPUE	0.0	8.1	2.8	2.4	3.5	6.9	18.5	25.0	25.7	14.7
Summer SEAMAP CPUE	0.5	2.0	2.2	0.8	2.1	4.2	6.1	4.6	4.2	4.9
Red Snapper Landings	37,147	507,078	429,323	463,440	722,347	878,788	1,093,216	495,889	403,368	200,324
Red Grouper Landings	2,100	3,920	1,574	1,587	1,290	474	581	119	715	12
Gag Landings	1,357	5,934	4,810	9,064	7,268	3,815	2,591	1,372	510	1,007

- Largely inshore barrier islands.

In Reef Fish/Shrimp Amendment 28/14, GMFMC and NMFS (2009) also summarized Habitat Suitability Indices (HSI) published by Gallaway et al. (1999) in their Figure 3.2.1.1 which shows high value HSI habitat for juvenile Red Snapper clearly extends eastward from the mouth of the Mississippi River to the split between Statistical Areas 9 and 10.

The Gallaway et al. (1999) HSI values were based on habitat-related density for age 0 and age 1 Red Snapper and other data collected by NMFS beginning in 1985. Collectively the data included a systemic measure of abundance, temperature, salinity, dissolved oxygen depth as well as data describing “hang” and platform habitat. Recognizing that, at the time, there were little or no comparable data for more easterly areas, it is nevertheless clear the good habitat for juvenile Red Snapper extends to the Statistical Area 9-10 split.

East Gulf

The eastern GOM also supports a Pink Shrimp fishery, and the Pink Shrimp have an estuarine dependent life cycle similar to the Brown Shrimp of the western GOM (Hart et al. 2012). However, Pink Shrimp prefer the carbonaceous sediments found in the eastern GOM. Reef fish landings in the eastern GOM are more diverse than the western GOM, and are dominated by Red Grouper and Gag (NMFS Self-Reported Commercial Coastal Logbook; Table 1). The dominant grouper species in the eastern GOM have different life histories than the Red Snapper. Both Red Grouper and Gag, as well as Goliath Grouper have juvenile life stages that require inshore habitats, such as seagrass beds and mangroves (Johnson and Koenig 2005; Koenig et al. 2007; Grüss et al 2014). For example, Gag use a diverse range of habitats over the course of their life cycle (Figure 4). Gag first mature as females around age 4 and later transition into males around age 10 (Lowerre-Barbieri et al. 2021). Gag spawn near the edge of the continental shelf in February or March, and the larvae spend 35 to 45 days in the plankton before settling in high saline inshore estuaries in April or May (Johnson and Koenig 2005; Lowerre-Barbieri et al. 2021). After settlement, Gag spend 5 to 6 months in seagrass beds before migrating out of estuaries, to shallow offshore habitats in the fall (Johnson and Koenig 2005). By the time they mature, Gag have moved to deeper offshore reef habitats. Red grouper also utilize inshore habitats as juveniles, and migrate further offshore later in life. Red Grouper do use seagrass beds and estuaries as juvenile habitat. However, unlike Gag, juvenile Red Grouper will also inhabit shallow offshore hard bottom areas less than 30 m deep (Grüss et al 2014). Juvenile Goliath Grouper are dependent on inshore mangrove habitat, and spend up to six years in mangroves before moving to offshore reefs (Koenig et al. 2007).

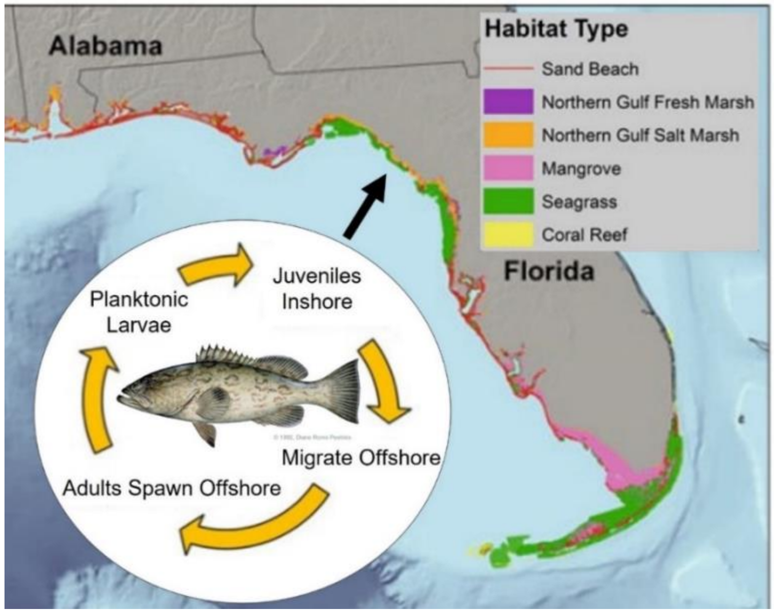


Figure 4. The inshore habitat types found in the eastern Gulf of Mexico, and the life cycle of grouper species, which are the dominant reef fish in the region (Ward 2017; Coleman Lab 2021).

East-West Gulf Split

Gallaway (1981) split the faunal assemblages of the eastern and western GOM at DeSoto Canyon, based on the work of Defenbaugh (1976; Figure 5). This essentially corresponds to the proposed split between statical areas 9/10. Fishery dependent and independent data show a similar split in the GOM reef fish assemblage. Landings data from the NMFS Self-Reported Commercial Coastal Logbook show a divide between reef fish landings in the western GOM dominated by Red Snapper, and reef fish landings in the eastern GOM dominated by Red Grouper and Gag (Table 1). The landings dominated by Red Snapper occur in areas west of DeSoto Canyon (Statistical Areas 10-21), and landings dominated by grouper occur in areas east of Cape San Blas (Statistical Areas 1-7). The landings data also show a transitional zone in shrimp Statistical Zones 8 and 9 with substantial landings of all three species (Table 1; Figure 6). Similarly, the Summer and Fall SEAMAP trawl surveys have relatively high juvenile Red Snapper catch per unit effort (CPUE) in the western GOM, and relatively low juvenile Red Snapper CPUE in the eastern GOM (Table 1). The Juvenile data from SEAMAP show the same pattern as Red Snapper landings, with abundant Red Snapper in areas west of DeSoto Canyon and low Red Snapper abundances east of Cape San Blas, with shrimp statistical zones 8 and 9 as a transitional area between the eastern and western GOM. Similarly, Dance and Rooker (2019) modeled Red Snapper distributions based on SEAMAP trawl surveys. The model predicted high juvenile abundances off Texas, a second area of high abundance between the mouth of the Mississippi River and the western edge of the DeSoto Canyon, and low abundances on the west Florida shelf. Karnauskas and Paris (2021) modeled Red Snapper larval dispersal in the GOM, and found a partial dispersal barrier at the mouth of the Mississippi River, where less than 2% of larvae are able to successfully cross, and a second weaker dispersal barrier at Cape San Blas, that only 2 to 3% of larvae are able to successfully cross.

Overall, there is a clear pattern of abundant Red Snapper in the Brown Shrimp Grounds west of DeSoto Canyon, transitioning to abundant grouper with estuarine dependent life histories east of Cape San Blas. Management efforts may improve if the Red Snapper stock is split at the DeSoto Canyon, allowing the abundant Red Snapper, and their directed fisheries, in their preferred habitats of the western GOM to be managed independently from the few fish inhabiting the eastern GOM. Management strategies in the eastern GOM will largely depend on the source of the Red Snapper residing there. If the Red Snapper in the eastern GOM are not successfully reproducing, they simply represent spill over from the populations in the western GOM, and do not contribute to the health of the stock. These excess fish could be heavily harvested with no adverse effect on the population as a whole, and landings from the eastern GOM would not need to be subtracted from quotas in the western GOM. If self-recruitment is occurring in the eastern GOM (Vecchio and Peebles 2020), this smaller population would benefit from separate management. Currently, under the one stock management system, the fish in eastern GOM are heavily harvested, and rely on lower harvest rates in the western GOM to bring up the average health of the stock (SEDAR 2018). If the eastern GOM were managed separately, the eastern portion of the stock would recover faster due to decreased harvest, and fisheries in the western GOM would no longer be penalized for overfishing occurring in the eastern GOM.

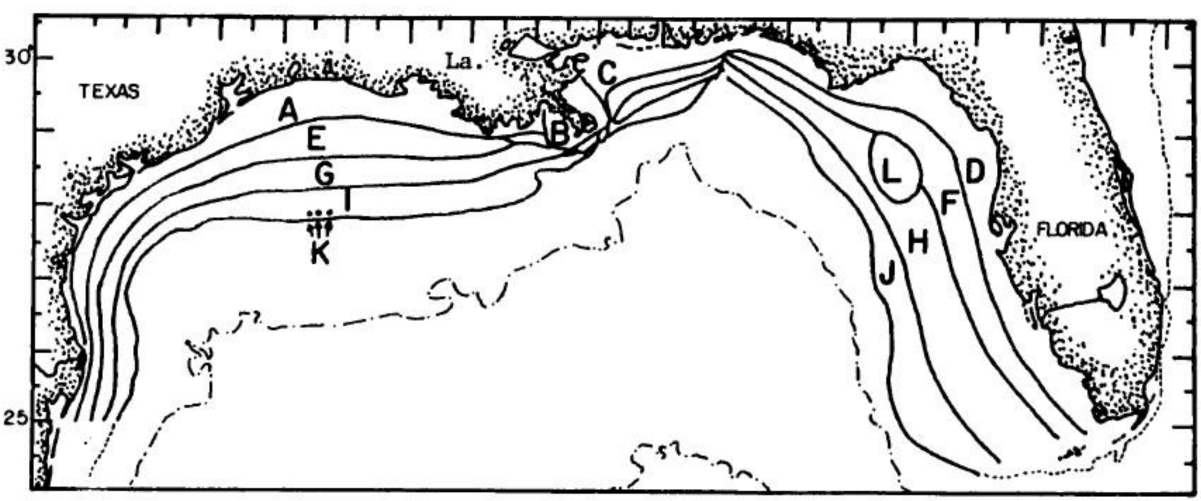


Figure 5. From Gallaway (1981). Faunal assemblages of the Gulf of Mexico (after Defenbaugh 1976). A. Inner shelf assemblage, Texas-Louisiana Shelf; B. Pro-delta fan assemblage; C. Pro-delta sound assemblage; D. Inner shelf assemblage, West Florida Shelf; E. Intermediate shelf assemblage, Texas-Louisiana Shelf; F. Intermediate shelf assemblage, West Florida Shelf; G. Outer shelf assemblage, Texas-Louisiana Shelf; H. Outer shelf assemblage West Florida Shelf; I. Upper slope assemblage, Texas-Louisiana Shelf; J. Upper slope assemblage West Florida Shelf; K. Submarine bank assemblage, Texas-Louisiana Shelf; L Florida Middle Ground assemblage.

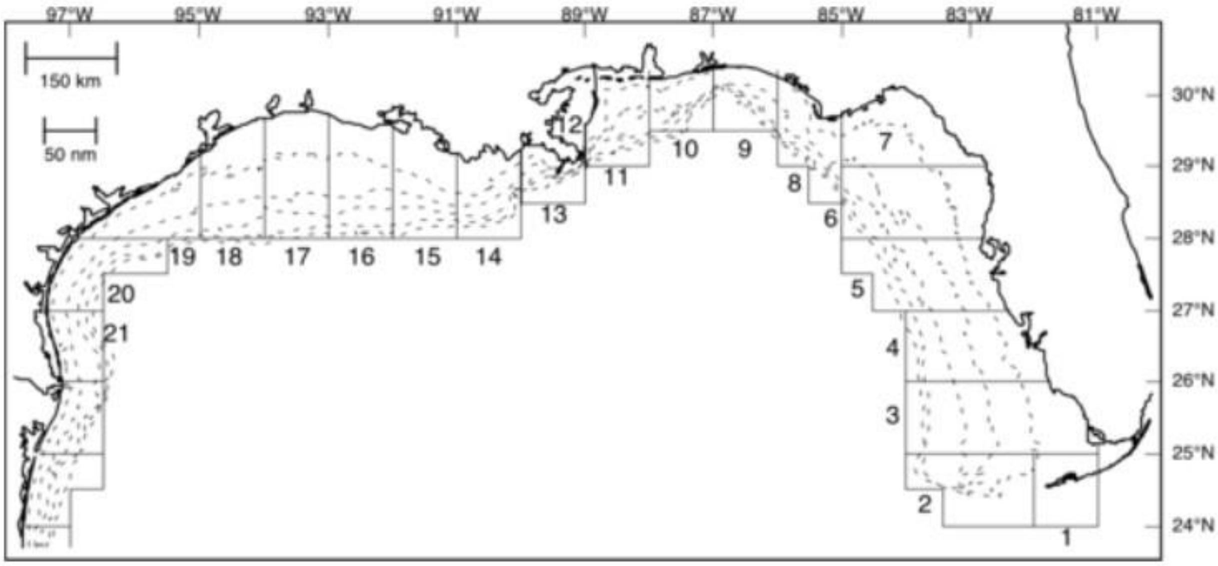


Figure 6. Shrimp statistical zones in the Gulf of Mexico. From NOAA, https://www.fisheries.noaa.gov/bulletin/noaa-fisheries-announces-changes-allowable-fishing-effort-gulf-mexico-shrimp-fishery.

REFERENCES

Coleman Lab. 2021. Groupers on the edge. Accessed 7/21/2021. Available at https://marinelab.fsu.edu/labs/coleman/research/grouper-ecology/.

Defenbaugh, R.E., 1976. A Study of the benthic macroinvertebrates of the continental shelf of the northern Gulf of Mexico. Ph.D. dissertation. Texas A&M University, College Station TX.

Fisher, M. 2017. Brown Shrimp Life History and Management in Texas. Available at: https://www.texassaltwaterfishingmagazine.com/fishing/education/texas-parks-wildlife-field-notes/brown-shrimp-life-history-and-management-in-texas. Accessed 7/23/2021

Gallaway, B.J., 1981. An ecosystem analysis of oil and gas development on the Texas-Louisiana continental shelf. U.S. Fish and Wildlife Service FWS/OBS-81/27.

Gallaway, B.J., J.C. Cole, R. Meyer and P. Roscigno. 1999. Delineation of essential habitat for juvenile Red Snapper in the Northwestern Gulf of Mexico. Transactions of the American Fisheries Society 128: 713-726.

Gallaway, B.J., and J.C. Cole. 1999. Reduction of juvenile Red Snapper bycatch in the U.S. Gulf of Mexico shrimp trawl fishery. North American Journal of Fisheries Management 19: 342-355.

Gallaway, B.J., S.T. Szedlmayer, and W.J. Gazey. 2009. A life history review for Red Snapper in the Gulf of Mexico with an evaluation of the importance of offshore petroleum platforms and other artificial reefs. *Rev. Fish. Sci*. 17:48–67.

Grüss, A., M. Karnauskas, S.R. Sagarese, C.B. Paris, G. Zapfe, J.F. Walter III, W. Ingram, and M.J. Schirripa. 2014. Use of the Connectivity Modeling System to estimate the larval dispersal, settlement patterns and annual recruitment anomalies due to oceanographic factors of Red Grouper (*Epinephelus morio*) on the West Florida Shelf. SEDAR42-DW-03. SEDAR, North Charleston, SC. 24 pp.

Gulf of Mexico Fishery Management Council and National Marine Fisheries Service. (2009).

Hart, R.A., Nance, J.M. and Primrose, J.A., 2012. The US Gulf of Mexico pink shrimp, *Farfantepenaeus duorarum*, fishery: 50 years of commercial catch statistics. Marine Fisheries Review, 74(1):1-6.

Johnson, A.G. and C.C. Koenig. 2005. Age and size structure of the fishery and juvenile abundance of Gag (*Mycteroperca microlepis*) from the northeastern Gulf of Mexico. Proceedings of the Gulf and Caribbean Fisheries Institute 47:906-913.

Karnauskas, M. and C.B. Paris. 2021. A Lagrangian biophysical modeling framework informs stock structure and spawning-recruitment of Red Snapper (*Lutjanus* *campechanus*) in the northern Gulf of Mexico. SEDAR74-SID-02. SEDAR, North Charleston, SC. 9 pp.

Koenig, C.C., F.C. Coleman, A. Eklund, J. Schull, and J. Ueland. 2007. Mangroves as essential nursery habitat for Goliath Grouper (*Epinephelus itajara*). Bulletin of Marine Science 80(3):567-586.

Lowerre-Barbieri, S., H. Menendez, and C. Friess. 2021. Gag Grouper reproduction in the Gulf of Mexico. SEDAR72-DW-08. SEDAR, North Charleston, SC. 26 pp.

SEDAR (Southeast Data Assessment and Review). 2018. SEDAR 52: Stock assessment report Gulf of Mexico Red Snapper, June 2013. SEDAR, North Charleston, SC.

Upchupi, E. 1967. Bothynetry of the Gulf of Mexico. Transactions of the Gulf Coast Association of the Geological Society 17: 161-172.

Vecchio, J. L. and E.B. Peebles. 2020. Spawning origins and ontogenetic movements for demersal fishes: An approach using eye-lens stable isotopes. Estuarine, Coastal and Shelf Science 246: 107047. https://doi.org/10.1016/j.ecss.2020.107047.

Ward, C. H. (2017). Habitats and biota of the Gulf of Mexico: Before the deepwater horizon oil spill, Volume 1: Water quality, sediments, sediment contaminants, oil and gas seeps, coastal habitats, offshore plankton and benthos, and shellfish. Springer.