THE PEW CHARITABLE TRUSTS

Chairman Joe Smith
Chair, Menhaden Advisory Committee
Gulf States Marine Fisheries Commission
2404 Government St.
Ocean Springs, MS 39564

October 10, 2013

Re: Results of Southeast Data, Assessment and Review 32A[1] (SEDAR 32A) for Gulf Menhaden (*Brevoortia patronus*) and the Establishment of Appropriate Biological Reference Points and Management Goals

Dear Chairman Smith, and members of the Menhaden Advisory Committee:

On behalf of The Pew Charitable Trusts, we offer the following recommendations for consideration at your October 2013 meeting. Menhaden supports the region's largest fishery and the nation's largest industrial reduction fishery. It is also a crucial food source for many species of recreationally and commercially valuable fish, as well as other marine wildlife including sharks, dolphins and seabirds. Despite the large volume and economic importance of the menhaden fishery to the region, the fishery lacks a management system designed to meet the needs of the Gulf of Mexico's marine ecosystem, or even protect the menhaden population. Thus, we strongly recommend that the Gulf States Marine Fisheries Commission (Commission) take the opportunity provided by the completion of SEDAR 32A to define explicit ecologically-based goals for this fishery and establish fishing limits and other management measures designed to achieve these goals.

Biological reference points are benchmarks against which to measure population or fishery status that are designed to prevent overexploitation.[2] Their use is recognized both nationally and internationally as fundamental to effective fisheries management.[3] Therefore, we urge the Commission to develop formal reference points and establish fishing limits that not only protect against overexploitation but also account for menhaden's role in the Gulf of Mexico food web. This would enable the Commission to better track fishing mortality and population levels and take pro-active steps to avoid depleting an important ecosystem species. **A review of the SEDAR 32A draft assessment by Dr. Robert O'Boyle indicates that it may be possible to establish reference points that achieve multiple objectives for the fishery and the ecosystem**

[1] A. Schueller, J. Smith, and S. VanderKooy (2013), *SEDAR 32A Draft Assessment Report*, August 2013, 399 pp. Available at: http://www.sefsc.noaa.gov/sedar/Sedar_Workshops.jsp?WorkshopNum=32A.

[2] NRC (2006), Committee on Ecosystem Effects of Fishing: Phase II, *Dynamic Changes in Marine Ecosystems: Fishing, Food Webs, and Future Options*, National Academies Press, Washington, D.C.,153 pp. Available at: http://www.nap.edu/catalog.php?record_id=11608.

[3] T. Picther *et al*. (2008), *Safe Conduct? Twelve Years Fishing under the. UN Code (*WWF, Gland, Switzerland), 66pp.

with minimal impact on the fishery, given the current conditions of the population. Thus, this is an ideal time to begin moving management of Gulf menhaden towards an ecosystem-based approach.

With that in mind, to better manage and assess Gulf menhaden, we specifically recommend:

- Inclusion of more precautionary fishing mortality reference points of $F_{45\%}$, $F_{50\%}$ and $F_{60\%}$ in the draft revisions to the regional management plan. This would give the Commission the option to adopt reference points that are in line with recommendations from recent scientific literature for management of forage species to account for their ecological role.
- Selection of more precautionary biomass reference point limits that correspond to the above fishing mortality reference points.
- Establishment of Gulf-wide annual catch limits based on these ecosystem-based reference points, with consideration of sub-regional catch limits if appropriate.
- Development of accountability measures to ensure compliance with the annual catch limit. This could include slowing fishing down as the limit is approached, halting fishing when the limit is reached, or a reduction in allowable landings the year following an overage.
- Monitoring the fishery and population levels closely on an annual basis and updating the assessment model with new information (*e.g.*, indices of abundance and catch) to ensure the fishery avoids depleting the population of a species important for the entire ecosystem.
- Obtaining the necessary data to more explicitly incorporate menhaden's ecosystem role in future stock assessments and management plans.

Below we provide further explanation for these recommendations.

Establishing Biological Reference Points to Account for Menhaden's Role as Forage Fish: Basis for an Ecosystem-Based Approach

Gulf menhaden are an important forage species found in estuarine waters during most of their first year and near shore as adults. They are prey for numerous predators that include economically important fish species, dolphins, and seabirds.[4] Though the population ranges throughout the Gulf of Mexico, the central abundance occurs in the northern Gulf from eastern Texas to western Alabama.

Accounting for the role that forage species play within ecosystems is a key consideration of an ecosystem-based approach to fishery management,[5] but has not been addressed in the

[4] D.S. Vaughan, K.W. Shertzer, and J.W. Smith (2007), *Gulf menhaden (Brevoortia patronus) in the U.S. Gulf of Mexico: Fishery characteristics and biological reference points for management*, Fisheries Research 83. 263-275.

[5] NRC (2006), Committee on Ecosystem Effects of Fishing: Phase II, *Dynamic Changes in Marine Ecosystems: Fishing, Food Webs, and Future Options*, National Academies Press, Washington, D.C.,153 pp.

management of Gulf menhaden up to now. To protect menhaden's role as prey, and the predators that rely on it, their management must begin accounting for food web interactions and the dietary needs of competing species in the ecosystem. Given their prominence in the Gulf of Mexico ecosystem and ubiquitous ecological service as prey, this essential forage species deserves special attention and more careful management. Also, given the uncertainty regarding the impact on the menhaden population of the Deepwater Horizon disaster and the subsequent use of chemical dispersants, additional precaution would be prudent.

Presently, there are no formal, Gulf-wide limits on catch or effort of any kind – only Texas has established an overall cap on the allowable catch from state waters. At the current level of effort, catches fluctuate primarily in response to the strength of year classes recruiting to the fishery. For instance, catches increased recently largely due to the entry of the strong 2010 year-class into the fishery. Without direct controls on the amount of menhaden taken out of the water each year (*e.g.*, catch quotas), changes in fishing effort and thus fishing mortality are mostly economically driven. In 2011, purse-seine landings of gulf menhaden for reduction amounted to 613,261 metric tons (mt) – the largest landed catch since 1999 when 684,271 mt were landed. This is also an increase of 62% from total landings in 2010 (379,727 mt) and up 41% from the previous 5-year mean (436,170 mt).[6] Although landings in 2012 were down 6% from 2011, they nevertheless remained far above the recent average (Figure 1 below).[7]

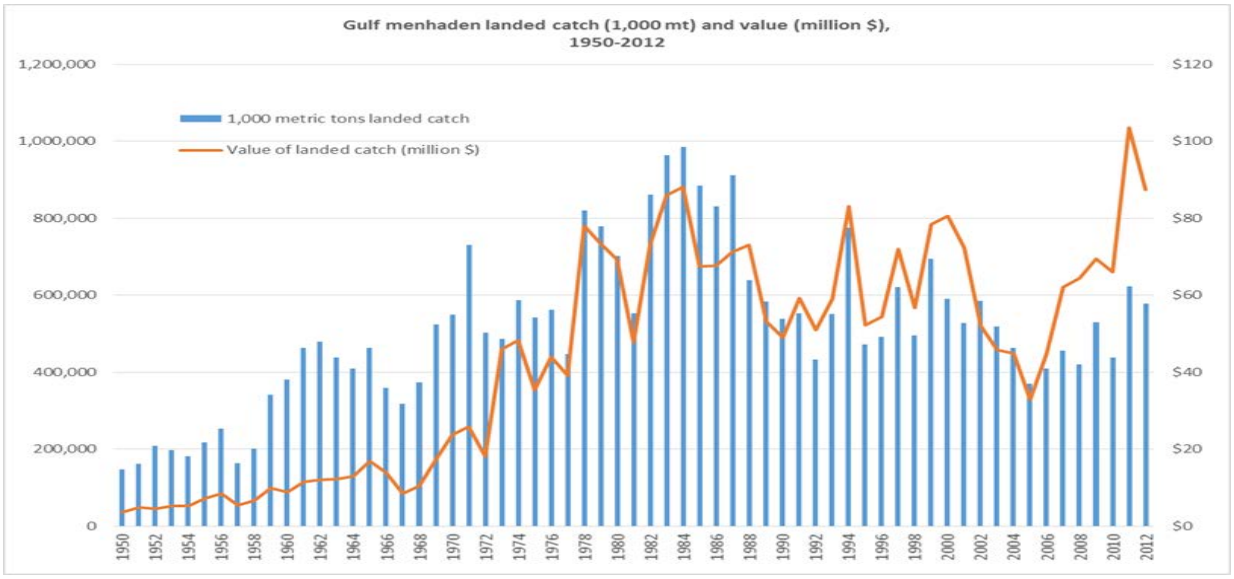

Figure 1 – Gulf menhaden landed catch (metric tons) and value (million $), 1950-2012. Catches increased nearly five-fold from the 1950s to the early 1980s while more recent catches have ranged from 2-3 times the 1950s

[6] NMFS Forecast for the 2013 Gulf and Atlantic Menhaden Purse-Seine Fisheries and Review of the 2011 Fishing Season (March 2012), Sustainable Fisheries Branch, NMFS Beaufort, NC. Available at: http://www.st.nmfs.noaa.gov/st1/market_news/menhaden_forecast_2012.pdf.

[7] NMFS Forecast for 2013 Gulf and Atlantic Menhaden Purse-Seine, Fisheries and Review of the 2012 Fishing Season (March 2013), Sustainable Fisheries Branch, NMFS Beaufort, NC. Available at: http://www.st.nmfs.noaa.gov/Assets/commercial/market-news/Menhaden_Forecast_Report-2013.pdf.

average. The value of the fishery has fluctuated in response to the global supplies of fishmeal and oil, driven largely by Peruvian anchoveta, but has increased markedly over time.[8]

While the SEDAR 32A assessment report indicates that the Gulf menhaden stock is not experiencing overfishing and is not overfished when considered in a single-species context, the assessment panel did not attempt to incorporate consideration of menhaden's critical role as forage fish into the model, citing a lack of data to estimate predation.[9] However, there is ample evidence that Gulf menhaden (like Atlantic menhaden) are consumed by a wide variety of species at every life stage. This is reflected in the high natural mortality assumed in the assessment's base model. The Commission's 2002 regional management plan provided a brief summary of past research documenting the importance of menhaden as prey for other fish, birds and marine mammals,[10] but the plan has not been updated since 2002 and additional research is available in the scientific literature that should be included in the Commission's consideration of appropriate reference points for the fishery.

A recently completed, extensive review of that literature [11] indicates that many of the Gulf's commercially and recreationally important fish species rely on abundant schools of menhaden along the Gulf coast, including:

- King mackerel, Spanish mackerel, dorado, crevalle jack, tarpon and bonito all prey on menhaden.[12,13]
- Historically menhaden have been important in the diet of red drum.[14]
- Several known species of shark (blacktip, spinner, finetooth, and Atlantic sharpnose) feed heavily on menhaden during all or part of their life cycles.[15,16,17,18]
- The diet of Louisiana's state bird, the brown pelican, has been found to consist of over 95% menhaden in some studies.[19]

[8] NMFS commercial landings statistics, available at http://www.st.nmfs.noaa.gov/commercial-fisheries/commercial-landings/annual-landings/index.

[9] A. Schueller, J. Smith, and S. VanderKooy (2013), p. xxv.

[10] GSMFC (2002), *The Menhaden Fishery of the Gulf of Mexico: A Regional Management Plan*, 2002 Revision, No. 99. p. 3-11.

[11] Tess M. Geers (2012), *Developing an ecosystem-based approach to management of the Gulf menhaden fishery using Ecopath with Ecosim*, Master of Science Thesis, Stony Brook University (December 2012), 103 pp.

[12] H.B. Franklin (2007), *The Most Important Fish in the Sea*, Island Press, Washington, D.C., 265 pp.

[13] W. Dailey, A.M. Landry, F.L. Kenyon (2008), *The Louisiana Recreational Tarpon Fishery*, pp. 57-68 *in:* J.S. Ault (ed.), Biology and Management of the World Tarpon and Bonefish Fisheries, CRC Press, Boca Raton, FL.

[14] R.N. Boothby, J.W. Avault Jr. (1971), *Food habits, length-weight relationship, and condition factor of the red drum (Sciaenops ocellatus) in southeastern Louisiana*. Transactions of the American Fisheries Society 100: 290-295.

[15] E.R. Hoffmayer and G.R. Parsons (2003), *Food habits of three shark species from the Mississippi Sound in the northern Gulf of Mexico*, Southeastern Naturalist 2: 271-280.

[16] D.M. Bethea, J.A. Buckel, and J.K. Carlson (2004), Foraging ecology of the early life stages of four sympatric shark species, Marine Ecology Progress Series 268: 245-264.

[17] D.M. Bethea, J.K. Carlson, J.A. Buckel, and M. Satterwhite (2006), *Ontogenetic and site-related trends in the diet of the Atlantic sharpnose shark (Rhizopriondon terraenovae) from the Northeast Gulf of Mexico*, Bulletin of Marine Science 78: 287-307.

[18] K.P. Barry, R.E. Condrey, W.B. Driggers, and C.M. Jones (2008), *Feeding ecology and growth of neonate and juvenile blacktip sharks (Carcharhinus limbatus) in the Timbalier-Terrebone Bay complex, LA, USA,* Journal of Fish Biology 73: 650-662.

[19] T.M. Hingtgen, R. Mulholland, A.V. Zale (1985), *Habitat suitability index models: eastern brown pelican*, Biological Reports 82, U.S. Fish and Wildlife Service, 20 pp.

- Numerous other piscivorous birds are known to prey heavily on menhaden.[20,21]
- Coastal bottlenose and spotted dolphins are common in the northern Gulf of Mexico and are likely to be important predators of menhaden.[22]

This list of species is by no means complete, but this published evidence clearly supports the importance of menhaden as prey for a wide variety of species, particularly those important economically, in the Gulf of Mexico ecosystem.

An ecosystem-based approach to Gulf menhaden management is required to account for its pivotal role in the Gulf food web. This entails a more conservative approach to fishing than is found in conventional single-species approaches based on maximum sustainable yield (MSY). The National Research Council (NRC)'s Committee on Ecosystem Management for Sustainable fisheries (NRC 1999) and Committee on Ecosystem Effects of Fishing (NRC 2006) both concluded that conventional management goals for fisheries based on achieving MSY can result in adverse ecosystem effects even when the target species is not depleted. They further found that such approaches are likely to be inadequate in an ecosystem context because these measures do not take into account trophic interactions and food web effects of fishing, among other things.[23,24]

Although stock assessments of Gulf menhaden have been conducted periodically since the 1970s and despite being the second largest fishery by volume in the nation, no formal biological reference points have been adopted for Gulf menhaden as a basis for monitoring the status of the population and setting management targets and limits for the fishery. The SEDAR 32A assessment provides a suite of potential fishing mortality reference point options for consideration, including spawning per recruit (SPR) based values of $F_{30\%}$, $F_{35\%}$, and $F_{40\%}$.[25] The assessment panel was careful to note that these values were provided simply to illustrate a range of typical options from the literature and that none of these options are necessarily endorsed by the assessment panel.

The Commission's Menhaden Advisory Committee (MAC) has the ability to recommend reference points and is not constrained to consideration of just this range of values. Established in 1949 (P.L. 81-66) to promote better management and utilization of marine resources in the Gulf of Mexico, the Commission is fully empowered to recommend actions and develop regional management plans for important Gulf species such as menhaden, including reference points for management.[26] Specifically, its Compact directs the Commission to jointly promote

[20] GSMFC (2002), *The Menhaden Fishery of the Gulf of Mexico: A Regional Management Plan*, 2002 Revision, No. 99. p. 3-11.
[21] See summary by Geers (2012), pp. 12-15.
[22] See summary by Geers (2012), p. 15.
[23] National Research Council, Committee on Ecosystem Management for Sustainable fisheries (1999), *Sustaining Marine Fisheries*, National Academies Press, Washington, D.C., 164 pp. Available at: http://www.nap.edu/catalog.php?record_id=6032.
[24] NRC (2006), Committee on Ecosystem Effects of Fishing: Phase II, *Dynamic Changes in Marine Ecosystems: Fishing, Food Webs, and Future Options*, National Academies Press, Washington, D.C., 153 pp. See p. 75 for this discussion.
[25] A. Schueller, J. Smith, and S. VanderKooy (2013). See Sections 6.2.1.8 (p. 185) and 7.1.6 (pp. 203-204), as well as Table 7.10 for options provided in the assessment report.
[26] S.J. VanderKooy and J.W. Smith (2002), *The Menhaden Fishery of the Gulf of Mexico, A Regional Management Plan*, 2002 Revision. Gulf States Marine Fisheries Commission, Number 99 (March 2002), 143 pp.

the preservation of fisheries under its jurisdiction while protecting these fisheries from overfishing and depletion.[27] Since the Commission jointly manages several species concurrently, protecting menhaden from depletion should be paramount to preserving other species such as red drum and spotted seatrout which are known to prey on menhaden.

Pew urges the Commission to adopt an approach that includes an explicit framework of biological reference points to monitor the status of menhaden as an ecosystem species as well as a precautionary system of fishery reference points to ensure that the fishery does not damage its role in the ecosystem. The intent is to provide greater insurance against stock collapse in a single-species context and greater protection of the other species in the ecosystem that depend on menhaden as food.

Recommendations for Forage Fish Management in Recent Studies

In the absence of a fully developed multispecies ecosystem model that can provide detailed analysis of the impacts of the fishery on the Gulf menhaden food web, the Commission should adopt an approach that addresses menhaden's importance as prey proactively. Recent studies by Smith *et al.* (2011) [28] and Pikitch *et al*. (2012) [29] provide extensive analysis and justification for such an approach from a broader perspective on forage species. Both studies recommend a system of precautionary biological reference points, fishing limits and targets that are intended to leave more fish in the water as prey. They recommend doing so by reducing fishing mortality and establishing a higher minimum target stock size for rebuilding depleted forage populations more rapidly. Specifically, they recommend that target fishing mortality rates on heavily fished, lower trophic level forage species (such as Gulf menhaden) should be reduced from the theoretical MSY to half that rate in order to reduce impacts on the marine food web. This recommendation has also been adopted into policy by the Marine Stewardship Council (MSC) for lower trophic level species.[30]

The Lenfest Forage Fish Task Force (Pikitch *et al*. 2012) conducted the most comprehensive worldwide analysis of forage fish populations to date. Based on the Task Force's food web simulations, the only fishing strategies that reliably sustain predators and forage populations are those that leave more forage fish in the water by reducing fishing mortality to half the conventional level that fishery managers typically aim for to achieve maximum yield for the fishery in a single-species context.[31] In addition, Pikitch *et al*. (2012) recommend establishing rules to ramp down fishing mortality when stock biomass drops below the target and approaches the limit, as a precautionary measure – the so called 'hockey-stick' approach.

[27] A Compact authorizing the creation of the Gulf States Marine Fisheries Commission, Article IV. Available at http://www.gsmfc.org/#:links@11:content@10.
[28] A. Smith *et al*. (2011), *Impacts of Low-Trophic Level Species on Marine Ecosystems*, Science 333: 1147-1150.
[29] E. Pikitch *et al*. (2012), *Little Fish, Big Impact: Managing a crucial link in ocean food webs*, Lenfest Ocean Program, Washington, DC, 108 pp. Available at: http://www.lenfestocean.org/foragefish.
[30] MSC Certification Requirements. Ver 1.3 14 January 2013.
[31] E. Pikitch *et al*. (2012).

Another key finding of the Lenfest Forage Fish Task Force is that the fishing mortality rate (*F*) on forage species should not exceed the natural mortality rate (*M*) and in general fishing mortality should be substantially lower than natural mortality.[32] In the case of Gulf menhaden, the SEDAR 32A assessment report estimates a value for M of 1.10 for age-2 fish,[33] measured as instantaneous mortality. This translates into an annual mortality rate of about 63%[34] – higher than estimates of natural mortality in the Atlantic menhaden assessment. SEDAR 32A indicates that the terminal year fishing mortality rate (F_{2011}=2.36) was more than twice the estimate of the natural mortality for fully selected age-2 fish. If these estimates of fishing mortality on fully selected age-2 fish reflect reality, then the fishery is removing nearly all the age-2 fish from the population in a given year – with unknown consequences for predators that may rely on large schools of age-2 fish. Such fishing mortality rates are extremely aggressive even by conventional single-species standards, and they do not take into account menhaden's ecological role as a major prey species in an ecosystem context.

SEDAR 32A recognizes that development of ecosystem-based reference points for menhaden must disaggregate predatory mortality from ''lost" yield in the conventional assessment approach and allocate this portion of "yield" to ecosystem services.[35] However, the range of fishing mortality "options" provided for the Commission's consideration in the SEDAR 32A assessment report (*i.e.*, F_{MSY} proxies of $F_{30\%}$, $F_{35\%}$, $F_{40\%}$ and F_{MED}) would exceed the base model's estimate of natural mortality on fully selected age-2 fish by a very wide margin, and would also exceed the estimated fishing mortality in 2011 by a wide margin.[36] Such high levels of fishing mortality on age-2 fish would not account for needs of predators that might rely on age-2 fish.

The assessment report does not specify whether the fishing mortality options mentioned in the SEDAR 32A review workshop are limits or targets, but if they are treated as targets then spawning biomass would be approximately 30-40% of what would be expected on average in an unfished population for age-2+ fish. This level is only about half of what Smith *et al*. (2011) and Pikitch *et al*. (2012) recommend for forage species like menhaden, based on an analysis by O'Boyle (2013). Achieving a spawning biomass target level more in line with recent scientific recommendations for forage fish (*i.e*., 75-80% of unfished biomass) would entail reducing fishing mortality on fully recruited fish from the recent average fishing mortality rate of 2.66 to about 0.37, resulting in long-term yield that is 65% less than recent average yield of 479,000 mt.[37]

[32] Ibid, p. 13. With total mortality expressed as $Z = M + F$, this implies that fishery exploitation rates, F/Z, should be ≤ 0.5
[33] A. Schueller, J. Smith, and S. VanderKooy (2013), pp. 26, 179.
[34] A. Cooper, A Guide to Fisheries Stock Assessment, New Hampshire Sea Grant College Program, NOAA grant #NA16RG1035. Available at: http://www.seagrant.unh.edu/sites/seagrant.unh.edu/files/media/pdfs/stockassessmentguide.pdf. See p. 23 for table of conversion rates used to convert M and F to annual mortality rates.
[35] A. Schueller, J. Smith, and S. VanderKooy (2013), pp. 305-306.
[36] Ibid. See Table 7.10, p. 216-7, for the suite of benchmark options presented and terminal year values.
[37] R. O'Boyle (2013), p. 61.

However, age-1 fish comprise a large percentage of total stock biomass and they are sometimes the dominant age class in the fishery, as noted in Table 1 (below).[38] **Due to the unique life history characteristics of Gulf menhaden, by including age-1 fish in the fishing mortality rate calculations as further explained below, it appears possible to achieve the objectives for forage fish conservation proposed by Smith *et al*. (2011) and Pikitch *et al*. (2012) at minimal cost to the fishery in terms of allowable catch.**

Table 1. Percentage composition, estimated total numbers of fish caught, and total landings for the gulf menhaden fishery, 2008-2012.[39]

Year	Age-0	Age-1	Age-2	Estimated total number of fish caught (billions of fish)	Landings (1,000 mt)
2012	<1%	27%	67%	6.57	578.4
2011	1%	63%	32%	7.21	613.3
2010	-	53%	40%	3.89	379.7
2009	-	13%	73%	3.62	457.5
2008	-	27%	68%	3.61	425.4

The review of the SEDAR 32A assessment report by O'Boyle (2013) outlines an approach to the development of Gulf menhaden reference points that is consistent with federal guidelines for forage fish conservation and in line with recent scientific recommendations by Smith *et al.* (2011) and Pikitch *et al.* (2012). In the case of Gulf menhaden, the species is extremely short-lived. Immature age-1 fish comprise a large percentage of the total stock biomass that is available to menhaden predators in the ecosystem. When age-1 fish are considered, O'Boyle (2013) finds that adopting a range of $F_{45\%}$-$F_{50\%}$ would result in fishing mortality of 0.40 to 0.50 on total biomass. This is less than half of the estimated natural mortality rate. Such a strategy would result in total biomass that is 73-77% of the unfished biomass. Thus, setting the fishing mortality rate at $F_{45\%}$, as proposed, would appear to leave approximately three-quarters of the total stock biomass (when age-1 fish are included in the fishing mortality calculations) in the water for ecosystem services. Doing so could provide comparable or slightly higher allowable catch compared to recent average catch in metric tons during the period 2002-2011.

Therefore, reference point options for $F_{45\%}$, $F_{50\%}$, and $F_{60\%}$ (Table 2, below) should also be included in the draft management plan revisions for consideration by the Commission, in addition to the reference points discussed in the SEDAR 32A assessment report. These are consistent with the goal of establishing reference points incorporating the recommendations of recent forage fish reports by Smith *et al*. (2011) and Pikitch *et al*. (2012). **Specifically, Pew**

[38] See: NMFS Forecast for 2013 Gulf and Atlantic Menhaden Purse-Seine, Fisheries and Review of the 2012 Fishing Season (March 2013), Sustainable Fisheries Branch, NMFS Beaufort, NC. Available at: http://www.st.nmfs.noaa.gov/Assets/commercial/market-news/Menhaden_Forecast_Report-2013.pdf.

[39] NMFS Forecast for 2013 Gulf and Atlantic Menhaden Purse-Seine, Fisheries and Review of the 2012 Fishing Season (March 2013), Sustainable Fisheries Branch, NMFS Beaufort, NC.

recommends that fishing mortality rate and biomass limits be established at least at the $F_{45\%}$ level and an annual gulf-wide quota set accordingly to maintain catch under those limits.

Table 2. Population, biomass and yield associated with a range of Gulf Menhaden fully recruited fishing mortality options; first column indicates row with recommendation of Pikitch *et al.* (2012) biomass target, Smith *et al.* (2011) biomass target, conditions associated with 2002-2011 average F and SEDAR 32 options which are shaded (From R. O'Boyle (2013)).

	Fishing Mortality			Biomass		Yield	
Recommendations	Full F	Average F	%F of 2002-2011 Avg (2.66)	SSB (%MSP)	Total (% Unfished)	Long-term Catch (kt)	% of 2002-2011 Avg (479 kt)
Pikitch et al (Biomass Target)	1.07	0.22	40%	60%	81%	341	71%
Smith et al (Biomass Target)	1.88	0.33	71%	50%	76%	446	93%
2002-2011 Avg	*2.66*	0.40	*100%*	*45%*	*73%*	*505*	*105%*
	2.72	0.40	102%	45%	73%	508	106%
	4.32	0.51	162%	40%	71%	576	120%
SEDAR 32	6.77	0.64	255%	35%	68%	634	132%
	9.76	0.78	367%	30%	65%	679	142%

Recommendations for Improvement of Future Assessments and Management

Going forward, the Commission should set the stage to fully integrate ecosystem based fishery management for the Gulf menhaden fishery. To achieve this, new diet and food habit studies are needed specific to menhaden and their predators, along with efforts to develop a multispecies ecosystem model similar to the approach taken with Atlantic menhaden, to better understand and account for menhaden's role as prey in the Gulf food web.[40] This information can better inform stock assessment models and management decisions for menhaden and other species. In addition, it would feed into ecosystem models to produce more accurate estimates of natural mortality and provide a more holistic picture of this important species. Both new diet studies and ecosystem modeling are recommended in SEDAR 32A. Given the importance of menhaden to the ecosystem, these needs should be elevated to high priority.

Additionally, to improve data collection and reduce uncertainty in future iterations of the assessment model the Commission should:

- Fully evaluate potential biases in the catch sampling design to ensure that port-sampled catch data are representative of all the fish in the hold.[41]
- Further test the reliability of the all-important juvenile and adult indices of abundance used in the base model, since the model is calibrated to fit these indices.
- Account for the effects of environmental, cyclical, and periodic events including ecological and biological impacts from the 2010 Deepwater Horizon event, annual hypoxia off Louisiana, and environmental variables such as freshwater flow and climate change on menhaden productivity and recruitment.

[40] R. O'Boyle (2013), p. 13.
[41] R. O'Boyle (2013), pp. 18-19.

- Obtain at-sea observation data to better monitor catch and bycatch from a statistically valid proportion of vessel trips.
- Further develop new indices of juvenile and adult abundance across menhaden's range.
- Incorporate and prioritize other research, monitoring, and assessment needs that were recommended by O'Boyle (2013).

Conclusions

Gulf menhaden, like its cousin the Atlantic menhaden (*Brevoortia tyrannus*), is a small coastal forage fish with a big impact on the health of coastal waters and marine ecosystems in the Gulf of Mexico. As filter-feeding consumers of microscopic marine algae that can foul coastal waters, menhaden play a role in keeping those waters clean and healthy. As forage for larger predator fish and many species of birds and marine mammals, menhaden are vital to the marine food web. We have outlined a feasible strategy for action that would provide greater insurance against the risk of ecosystem overfishing. It would also establish a formal set of reference points that address menhaden's pivotal role in the ecosystem in a precautionary manner. This is a necessary interim step until there is better information on the specific needs of predators. This strategy would provide greater protection of menhaden's role in the ecosystem at minimal cost to the fishery. **Therefore, we urge the Commission to adopt precautionary biological reference points that account for menhaden's important ecosystem role and a corresponding Gulf-wide catch quota.**

Thank you for the opportunity to provide input into the management of one of the nation's largest fisheries and the region's most important forage species. We look forward to working with the Commission in a constructive manner to ensure the Gulf menhaden population and the very important fishery for this species remains healthy and viable.

Sincerely,

Holly Binns
Director, US Oceans, Southeast
The Pew Charitable Trusts

Cc: Commissioners, Gulf States Marine Fisheries Commission