Appendix G. Shrimp Amendment 9 Bycatch Practicability Analysis

Bycatch is defined as fish harvested in a fishery, but not sold or retained for personal use. This definition includes both economic and regulatory discards and excludes fish released alive under a recreational catch-and-release fishery management program. Economic discards are generally undesirable from a market perspective because of their species, size, sex, and/or other characteristics. Regulatory discards are fish required by regulation to be discarded, but also include fish that may be retained but not sold.

Agency guidance provided at 50 CFR 600.350(d)(3) identifies ten factors to consider in determining whether a management measure minimizes bycatch or bycatch mortality to the extent practicable. These are:

1. Population effects for the bycatch species;
2. Ecological effects due to changes in the bycatch of that species (effects on other species in the ecosystem);
3. Changes in the bycatch of other species of fish and the resulting population and ecosystem effects;
4. Effects on marine mammals and birds;
5. Changes in fishing, processing, disposal, and marketing costs;
6. Changes in fishing practices and behavior of fishermen;
7. Changes in research, administration, and enforcement costs and management effectiveness;
8. Changes in the economic, social, or cultural value of fishing activities and non-consumptive uses of fishery resources;
9. Changes in the distribution of benefits and costs; and
10. Social effects.

The Councils are encouraged to adhere to the precautionary approach outlined in Article 6.5 of the Food and Agriculture Organization of the United Nations Code of Conduct for Responsible Fisheries when uncertain about these factors.

The South Atlantic penaeid shrimp fishery is based almost entirely on three shallow-water species of the family Penaeidae: the white shrimp, *Litopenaeus setiferus*, the brown shrimp, *Farfantepenaeus aztecus* and the pink shrimp, *Farfantepenaeus duorarum*. The allowable gear type used to harvest penaeid shrimp in the South Atlantic is trawl gear. Management measures regulating harvest in the fishery include requirement of bycatch reduction devices (BRDs), turtle excluder devices (TEDs), and a minimum mesh-size restriction. The owner or operator of a vessel that fishes for shrimp in the South Atlantic exclusive economic zone (EEZ) or in adjoining state waters, or that lands shrimp in an adjoining state, must provide information for any fishing trip, as requested by NOAA Fisheries, including, but not limited to, vessel identification, gear, effort, amount of shrimp caught by species, shrimp condition (heads on/heads off), fishing areas and depths, and person to whom sold. A vessel for which a federal commercial permit for South Atlantic penaeid shrimp has been issued must carry a NOAA Fisheries- approved observer, if the vessel's trip is selected by NOAA Fisheries for observer coverage.

Population Effects for the Bycatch Species

The population effects of bycatch mortality are the same as fishing mortality from directed fishing efforts. If not properly managed and accounted for, either form of mortality could potentially reduce stock biomass to an unsustainable level. According to Belcher and Jennings (2011), the Gulf of Mexico and South Atlantic penaeid shrimp trawl fisheries have the highest ratio of bycatch to target species, with 8 kg of bycatch to 1kg of shrimp in waters off the southeastern coast of the United States. One important difference in the effects of the shrimp trawl fishery and directed fisheries on finfish is fishes taken in shrimp trawls are generally small and young. Shrimp trawling is size-selective, which means the primary bycatch age of finfish is 0 (Saillant 2006). Juvenile finfish are more expendable in one respect because they occur in high numbers and relatively few actually survive to adulthood. But the reproductive potential of a stock can be compromised if fish are not provided sufficient opportunities to reproduce before they are exposed to fishing or bycatch mortality. The risk of stock collapse increases markedly if the fish are subject to fishing or bycatch mortality before they mature (Myers and Mertz 1998). Species composition of bycatch in shrimp trawls is wide ranging, but the number of species represents a relatively small number of families, some of which are found in many parts of the world (FAO 1997).

The current level of bycatch in the penaeid shrimp trawl fishery continues to be substantial despite advancements in bycatch reduction. However, bycatch mortality is incorporated in assessments of finfish stocks if estimates are available (e.g., weakfish, Spanish mackerel, and sharks). Additionally, the sustainability of finfish species taken as bycatch in shrimp trawls does not appear to be threatened by this source of mortality (Nance 1998). Additionally, research conducted in the Gulf of Mexico from 1972-2002 demonstrated a precipitous decline in shallow water coastal sharks where shrimping effort what highest (Shepherd and Meyers 2005). Removal of predators such as sharks due to bycatch in shrimp trawls, regardless of where trawling occurs, can upset the balance of predator-prey relationships.

Because of improvements in TED designs, interactions between sea turtles and otter trawls in the years leading up to this consultation were also thought to be declining because of reductions of fishing effort unrelated to fisheries management actions. Over the past ten years, low shrimp prices, rising fuel costs, competition with imported products, and the impacts of hurricanes in the Gulf of Mexico have all impacted shrimp fleets; in some cases reducing fishing effort by as much as 50 percent in offshore waters of the Gulf of Mexico (GMFMC 2007). For example, the estimated annual number of interactions and mortalities between sea turtles and shrimp trawls in the Gulf shrimp fisheries (state and federal) under the new regulation (68 FR 8456, February 21, 2003) based on Epperly et al. (2002) estimated CPUEs and updated 2007 effort data in Nance et al. (2008) were significantly less than predicted in the 2002 opinion. However, given elevated strandings in the northern Gulf of Mexico during the springs of 2010 and 2011, necropsy information indicating that drowning may have contributed to many of the mortalities, and evidence of TED compliance issues in the fisheries, these estimates likely underrepresented actual past effects from shrimp fisheries in the action area.

Table 1. Estimated annual number of interactions between sea turtles and shrimp trawls in the Gulf of Mexico shrimp fisheries associated estimated mortalities based on 2007 Gulf effort data taken from Nance et al. (2008) (December 8, 2008, Memorandum from Dr. Ponwith to Dr. Crabtree; Data Analysis Request: Update of turtle bycatch in the Gulf of Mexico shrimp fishery) (Source: Shrimp Biological Opinion NMFS 2012)

Species	Estimated Interactions	Estimated Mortalities
Leatherback	520	15
Loggerhead	23,336	647
Kemp's ridley	98,184	2,716
Green	11,311	319

NOAA Fisheries completed a biological opinion in 2012 evaluating the impacts of the continued authorization of the Southeast U.S. shrimp fisheries in federal waters under the Magnuson-Stevens Act (including the federal South Atlantic shrimp trawl fishery) and the continued implementation of the sea turtle conservation regulations (e.g., turtle excluder device regulations) on ESA-listed species. The opinion concluded that these fisheries, as proposed to be managed, would adversely affect sea turtles, smalltooth sawfish, Gulf sturgeon, and Atlantic sturgeon, but were not likely to jeopardize their continued existence. Most other listed species and their critical habitats were found not likely to be adversely affected (i.e., blue, sei, sperm, fin, humpack, and North Atlantic right whales, shortnose sturgeon, elkhorn and staghorn corals, and designated critical habitats for Gulf sturgeon and elkhorn and staghorn corals). No effects were anticipated on Johnson's seagrass or designated critical habitats for North Atlantic right whales, smalltooth sawfish, and Johnson's seagrass (see NMFS 2012 for discussion on these species and critical habitat).

Ecological Effects Due to Changes in Bycatch

Incidental catch of sub-adult shark species in shrimp trawl gear has been identified as a large source of shark mortality (Belcher and Jennings 2011). Bycatch of predatory fish such as sharks in shrimp trawl fisheries can alter abundance of prey species. A study conducted by Ward and Myers (2005) in the tropical Pacific Ocean indicates that large predator populations declined proportionately with increased industrial fishing activities. This decline in predatory fish resulted in increases in populations of several smaller fish species over time (Shepherd and Myers 2005).

Shrimp trawls have the highest discard/bycatch ratios of all fisheries, are perceived as having a high potential to disturb habitat and benthic communities (Hall, Alerson, and Mituzals 2000). Destruction of benthic habitat and disruption of benthic communities could alter special distribution and overall productivity of species that inhabit hard and soft bottom structures that are easily impacts by bottom trawl fisheries.

Additionally imbalances in the ecosystem may result from the fact that some bycaught finfish are hardier than others, and thus have a higher survival rates if they are returned to the water after being captured (Hall, Alerson, and Mituzals 2000). Improved handling techniques for more fragile fish species that are commonly caught in shrimp trawls may help improve survival rates

of less hardy bycaught species (Hall, Alerson, and Mituzals 2000).

Changes in Bycatch of Other Fish Species and Resulting Population and Ecosystem Effects
In 1989, NOAA Fisheries required shrimp trawlers in the Southeast to use TEDs to reduce mortalities of sea turtles, and in the late 1990's NOAA Fisheries required the use of BRDs to reduce finfish mortalities due to incidental capture (Belcher and Jennings 2011). If affected finfish are shrimp predators, reductions in bycatch due to BRDs may result in increased predation on shrimp. During NOAA Fisheries offshore bycatch surveys on commercial vessels from 1992-1996, only 14 of 161 fish species were identified as predators on penaeid shrimp. These are the Atlantic croaker, sand seatrout, spotted seatrout, silver seatrout, ocellated flounder, inshore lizardfish, bighead searobin, smooth puffer, red snapper, lane snapper, Spanish mackerel, rock sea bass, dwarf sand perch, and Atlantic sharpnose shark (Nance 1998).

Predator-prey relationships largely depend on the size structure of predator and prey populations. Juvenile fish that are too small to prey on large shrimp may be able to do so later if their exclusion from trawl gear allows them to grow larger. However, it is also possible some fish will reduce predation on shrimp as they grow and their dietary habits change (Nance 1998).

Changes in the bycatch of non-shrimp invertebrates (e.g., crustaceans and mollusks) also could have ecosystem effects. These species have ecological functions in addition to serving as prey for other invertebrates and fishes. For example, some species, like barnacles and hydrozoans, condition habitat for other organisms by providing a growing surface or by contributing to the bioturbation of bottom sediments.

Effects on Marine Mammals and Birds
State and federal shrimp fisheries are collectively called the "Southeastern U.S. Atlantic and Gulf of Mexico shrimp trawl fishery" in the MMPA List of Fisheries (LOF). Under the LOF the Southeastern U.S. Atlantic and Gulf of Mexico shrimp trawl fishery is listed as a Category II fishery (76 FR 73912, November 29, 2011). It is categorized as such, based on observer reports, stranding data, and fisheries research data indicating that interactions are occurring, with multiple strategic and non-strategic marine mammal stocks. In lieu of more complete data on the potential impacts to marine mammals, NMFS classified the fishery as a Category II fishery based on a qualitative analysis. Even with low observer coverage, NMFS observed 12 dolphin takes (of which 11 were serious injuries or mortalities) since 1993; 11 of which were taken since 2002. Further, Marine Mammal Authorization Program records list 1 dolphin take in shrimp trawl gear in South Carolina in 2002.

No documented seabird-gear interactions were recorded on 1,310 trips in the Gulf of Mexico and southeastern Atlantic penaeid and shrimp fisheries between February 1992 and December 2003 (E. Scott-Denton, NOAA Fisheries, personal communication). However, the potentially high level of bycatch in the penaeid fishery could be affecting some seabird species. Cook (2003) notes the availability of discards and offal has been linked to population increases in a number of species.

Changes in fishing, processing, disposal, and marketing costs
The potentially high bycatch in the penaeid shrimp fishery could adversely affect production by

unnecessarily increasing drag time, culling time, and crew fatigue. Regulatory measures implemented to reduce bycatch have direct costs related to purchasing and installing new technology or limiting where and/or when a vessel could operate. But such measures could result in long-term benefits if they increase the efficiency of shrimp trawl operations. BRD technology reduces shrimp trawl bycatch with minimal cost to shrimp fishermen.

Changes in Fishing Practices and Behavior of Fishermen

At least some participants in the penaeid shrimp fishery deny a bycatch problem exists. Consequently, regulatory requirements to reduce bycatch could provide a disincentive to responsible participation in the fishery. For example, fishermen could potentially ignore a BRD or closed season requirement.

Changes in Research, Administration, and Enforcement Costs and Management Effectiveness

Bycatch in southeastern shrimp trawl fisheries has been a priority issue for scientists and administrators for a number of years. This focus is likely to continue as the Council addresses future management needs in the fishery.

Changes in the Economic, Social, or Cultural Value of Fishing Activities and Non-Consumptive Uses of Fishery Resources

Otter trawl effort in the South Atlantic has also declined since 2001. Between 2002 and 2005 otter trawl effort declined steadily. It rose from 2005 through 2006 to near 2004 levels, but hasdeclined steadily since then, albeit minimally. Overall otter trawl effort reduction in the South Atlantic between 2002 and 2009 was approximately 38 percent. There is no data to indicate that otter trawl effort levels will increase in the future from recent levels. Likewise, the skimmer trawl fisheries have witnessed similar declines (NMFS 2012).

Table 2. 2001-2009 Shrimp Trawl Effort Year Gulf of Mexico South Atlantic #Days Fished # Trips (Source: Shrimp Biological Opinion NMFS 2012)

Year	Gulf of Mexico	South Atlantic
#Days Fished	# Trips	
2001	277,888	21,780
2002	276,059	25,320
2003	224,597	21,247
2004	189,241	17,813
2005	131,650	13,305
2006	116,710	16,860
2007	107,671	14,495
2008	87,952	13,763
2009	108,501	13,464

The U.S. Congress recognized the need to balance the costs of bycatch reduction with the social and economic benefits provided by the shrimp fishery when it mandated the study of shrimp trawl bycatch (and potential gear modifications) through the 1990 Magnuson-Stevens Act reauthorization. The resulting cooperative bycatch research program identified gear options that could reduce shrimp trawl bycatch with minimum loss of shrimp production.

While BRD and TED requirements certainly present direct costs to participants in the shrimp fishery, they could reduce overall costs by increasing efficiency. Additionally, studies suggest the use of BRDs or similar techniques to reduce finfish capture would not negatively affect shrimp production in the long-term if finfish exhibit even moderate selectivity against shrimp as prey (Nance 1998). Decreases in bycatch mortality attributed to these technologies are believed to have contributed to the survival and recovery of at least some sea turtle populations and finfish stocks. The societal benefits associated with recovering these species are not easily quantified, but are believed to outweigh any short-term costs to penaeid shrimp fishermen related to the required bycatch reduction technology.

Changes in the Distribution of Benefits and Cost

Prior to the mandated use of bycatch reduction technology in the penaeid shrimp fishery, people perceived benefits and costs as not being equitably distributed between the directed finfish fisheries and between the shrimp trawl fisheries and the broader public. Some finfish fishery participants feel that incidental catch of commercially important finfish species in shrimp trawls limits the number and type of marketable fish available to them; however, other less commercially important species are more common in incidental catch (FAO 2000). Commercial and recreational fishermen who target finfish taken incidental to the trawl fishery believe shrimp fishermen should share the regulatory burden needed to sustain declining fish stocks (Nance 1998). Some members of the public view bycatch as unnecessary waste. The mandated use of BRDs and TEDs was intended to address these perceived inequities while maintaining a productive, high value shrimp fishery.

Social Effects

Few data are available to adequately define the social effects of BRD and TED requirements. Shrimp fishermen could experience negative effects related to the costs of installing and using the devices and to feeling overregulated. They also could experience positive effects related to improved efficiency. The concerned public is likely to experience social benefits related to knowing that the organisms they value for aesthetic and existence reasons are better protected. However, some members of the public may believe bycatch is not sufficiently reduced through BRD and TED requirements.

Conclusion

This section evaluates the practicability of taking additional action to minimize bycatch and bycatch mortality in the South Atlantic penaeid shrimp fishery by using the ten factors provided at 50 CFR 600.350(d)(3)(i). In summary, technological devices mandated for use in the South Atlantic shrimp trawl fishery are estimated to reduce finfish bycatch by at least 30% and to reduce sea turtle bycatch by as much as 97%. More data are needed to improve the reliability of information on the current level of bycatch, which generally continues to exceed the catch of shrimp. However, no evidence exists to indicate the mortality of finfish caused by the penaeid

shrimp trawl fleet (with BRDs and TEDs implemented) is having a significant adverse affect on finfish stocks. Therefore, the Council concluded that current management measures minimize bycatch and bycatch mortality to the extent practicable in the penaeid shrimp fishery.

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