4.10.4 Consultation

The Councils twice convened its Law Enforcement Committee to evaluate and advise the Councils on Law Enforcement aspects of the plan[7]. The US Coast Guard has representation on this committee and also is a voting member of each Council. In addition, the Councils sent a copy of the Draft FMP and public hearing document to the US Coast Guard for comment. No concerns about the safety of life at sea have been raised by the Coast Guard or by the public.

4.10.5 Mitigation measures

Although the FMP requires no mitigation measures (its management measures actually promotes the safety of human life at sea and presents no new dangers or threats), there are management measures that increase flexibility and enable fishermen to choose fishing methods and seasons that are less dangerous. The foundation of day-at-sea management is to allow fishermen the flexibility to choose when they want to fish. If certain seasons or times present adverse weather conditions that would exceed a vessel's designed seaworthiness, then a fisherman could advance or postpone when he used the 40-day allocation. The only aspect of the day-at-sea program that could force a fisherman's decision to fish is at the end of the fishing year when he may have not fished all of his day-at-sea. To mitigate this potential problem, the FMP proposes to allow fishermen to carry forward up to 10 unused days into the next fishing year. As a result, a fisherman would not have the incentive to extend his last trip in the year to use up his days or to make a trip that he would not have otherwise made because the end of the fishing year was near.

Net limits and the day-boat gillnet category are other measures that have potentially mitigative or positive effects on safety. The FMP proposes net limits and limited access that will reduce the amount of gear that fishermen deploy. Thus, it removes the incentive to increase the amount of gear in response to less fishing time. At the same time, the day-at-sea program imposes some problems for leaving gear at sea while it continues to fish. To compensate for a requirement that all vessels bring their gear to port when they leave the fishing grounds, the FMP proposes to allow gillnet fishermen to declare into a trip- or day-boat category. If the vessel declares into a day-boat category, its time at sea is counted differently but it may leave its gear in the water between trips. This measure is intended to accommodate the various ways that fishermen operate and avoid forcing them to a new mode of fishing for which their vessel was not designed.

5.0 DESCRIPTION OF THE RESOURCE (AFFECTED ENVIRONMENT)

5.1 Biological Environment

5.1.1 Distribution

The goosefish (commonly referred to as monkfish) is a member of the family Lophiidae or anglerfishes. It is a widely distributed benthic fish that occurs in the Northwest Atlantic Ocean from the northern Gulf of St. Lawrence southward to Cape Hatteras, North Carolina. The species is known to inhabit waters from the tide-line to depths as great as 840 m (Markle and Musick 1974). They also tolerate a wide range of temperatures, being taken to the north on the Newfoundland Banks in water as cold as 32^{o} F and in the southern waters exceeding 70^{o} F. Adults inhabit the

[7] Two Law Enforcement Committee meetings were held to consider the proposed management measures:
July 16, 1996 – Review and discussion of the proposed monkfish management measures.
November 18, 1997 – Develop comments on the proposed monkfish management measures.

sea floor over the entire range of substrate types including hard sand, gravel, broken shell, and soft mud (Bigelow and Schroeder 1953).

Spatial and temporal distributions of goosefish from NEFSC spring and autumn bottom trawl survey data (inshore and offshore) illustrate the ubiquitous nature of the species (SAW 14). During spring and autumn, goosefish exhibit a widespread distribution both north and south of Georges Bank (Figs 3-4). In the northern portion of the survey area, spring and autumn survey catch distribution patterns were similar. South and west of Nantucket Shoals, however, seasonal survey patterns differed suggesting movement between inshore and offshore waters on the shelf. While there were consistent catches during both seasons south of Block Island Sound, goosefish were found primarily in the offshore waters in autumn but were distributed further inshore during spring. South of Chesapeake Bay (about 37°N), goosefish regularly appear in survey catches in the spring, but not in the autumn (SAW 14).

5.1.2 Age, growth, and reproduction

Armstrong et al. (1992) studied the age, growth, and reproductive biology of goosefish based on specimens collected from NMFS groundfish surveys and commercial fishing cruises between Georges Bank and Cape Hatteras. Maximum ages observed based on examination of vertebral annuli were 9 and 11 years for males and females, respectively. Males and females exhibited similar growth patterns up to age four, thereafter females were slightly larger than males with the difference becoming more pronounced at the oldest ages observed.

A description of the processing and ageing methods currently under examination by personnel from the NEFSC were presented at SAW 14. In a University of Massachusetts/NEFSC study begun in February 1992, 97 goosefish from the Gulf of Maine and the northern Georges Bank region were aged using a variety of age structures (primarily otoliths and vertebrae). In spite of the small sample size, a significant ($p<0.05$) fit of the vonBertalannfy growth equation to the data was obtained. Growth parameters were comparable to those of Armstrong et al. 1992.

Armstrong et al. (1992) reported the length at which 50% of the goosefish examined were mature (L_{50}) to be 14.5 inches (36.9 cm) for males and 19.2 inches (48.7 cm) for females. They observed spawning to occur in May and June in the area from Cape Hatteras to Southern New England. A peculiar aspect of the reproductive biology of female goosefish is their production of nonadhesive, mucoid egg rafts or veils. The egg veil produced can reach 18-36 ft. in length and 0.5 - 5.0 ft. in width. The large egg mass produced requires a considerable energy investment by the females and at the time of spawning can account for 50% of their body mass. The egg veil functions to improve geographic dispersal of the eggs, provides protection from predators, and may facilitate fertilization (Armstrong et al. 1992).

More recent maturity analyses were derived from data collected during NEFSC and MA Division of Marine Fisheries (DMF) bottom trawl survey cruises (SAW 14). Both sexes began to mature at about 30 cm (12 in) total length, with males generally attaining 100% maturity by about 50 cm (19.5 in) and females by about 60 cm (23.6 in). The distribution of maturity stages for mature fish in the spring suggested that goosefish inhabiting southern waters spawn earlier than their northern counterparts. L_{50}s were higher for goosefish inhabiting northern waters: 43 and 46 cm for males and females, respectively, compared to 37 cm for males and 42 cm for females in southern waters. It appeared that southern males mature at age 3 and females at ages 3 and 4. Males inhabiting Gulf of Maine - Northern Georges Bank mature at ages 3 and 4 and females at ages 3 to 5. The results of current SAW analyses for male goosefish in the Southern New England and Mid-Atlantic region are comparable to those reported by Armstrong et al. (1992). However, L_{50} reported for females in the SAW document is about 7 cm lower than that of Armstrong et al. (1992).

5.1.3 Stock status

Few data exist to conduct an age or length based analytical stock assessment for this species. While length-at-age data are available, size frequency data from the commercial landings are lacking. Consequently, direct estimates of annual mortality from fishery dependent data are not possible at this time. However, an initial assessment of the goosefish resource made by examining NEFSC fall and spring groundfish survey data (U.S. Dept. of Commerce 1992, SAW 14) reached the following conclusions:

"Northern area autumn biomass indices (abundance in weight,) indicate a significant decrease since the late 1970s; biomass apparently decreased to less than one third of the late 1970s level by 1991. Spring indices show a similar pattern. Autumn cruise data show that biomass fell by half from 1984 to 1991.

Southern area weight indices indicate a nine fold decrease in biomass from 1966 to 1991; the 1991 autumn index is 11% of the 1966 level. The 1991 summer weight abundance index is about 70% of the 1984 level.

Indices in terms of numbers of fish did not exhibit a corresponding downward trend in either area thus indicating a decrease in the average size of individuals occurred. Research cruise length frequency plots show the truncation of the size distribution through time in both areas, but particularly in the northern area. The truncation is reflected to a small degree in average length.

These abundance trends give reason to suspect that resource biomass is decreasing. The ongoing decrease concomitant with the landings described earlier (that were driven by large increases in ex-vessel price) provides substantial evidence that the resource is at least heavily exploited and that the possibility of over-exploitation should not be ruled out."

A preliminary yield per recruit analysis for goosefish for the northern area suggests that F_{max} is 0.2 (Figure 6 in the SAW 14 report). These results also indicate that substantial yield gains could result from fishing practices that release young fish (up to age 4) alive.

The assessment identified the following sources of uncertainty in the current analysis:

"The yield per recruit model is based, to a large degree, on a growth model generated from interpretations of the age of fish from visual inspections of their bony parts. Annular marks on goosefish tend to be unclear and difficult to decipher. Validation of age interpretations over the full range of sizes is lacking.

The extent of the resource beyond the shelf break is unknown, thus, substantial biomass might or might not exist beyond the fishery and research cruise coverage."

The Stock Assessment Review Committee Chairman pointed out that abundance and stock production estimates do not exist so: (1) whether or not current removals are in excess of stock production is uncertain; (2) appropriate removal levels cannot be projected.

He also noted that an estimate of the reproductive (adult) stock size is absent, hence the probability of continued reproductive success and consequent existence of the stock under current conditions (escalating removals and declining biomass) cannot be assessed."

The assessment included the following recommendations:

"1. *Size frequency samples must be collected from the landings if the resource is to be assessed adequately.*

2. *Age interpretations need to be validated over the entire size range if they are to be the basis of accurate growth modeling.*

3. *An effort should be made to determine the seaward extent of the resource beyond the shelf break.*

4. *Accurate abundance estimates (both juveniles and adults) and stock production estimates are acutely needed."*

In spite of the uncertainty noted, the assessment concluded that, *"Decreasing biomass indices concomitant with landings of small fish suggest that the resource is at least fully-exploited and might be over-exploited. The increased targeting of goosefish and displacement of fishing effort from other fisheries into the unregulated goosefish fishery is problematic. Preliminary yield per recruit analysis indicates that substantial gains can be realized by increasing the current size of recruitment to age four (30.5 cm/12 in tail length)."*

During plan development, the status of the stock was re-assessed by the 23rd Stock Assessment Workshop (U.S. Dept. of Commerce, 1997). This assessment updated SAW14 results and the methods used by the Technical Working Group for monkfish to estimate historic fishing mortality rates. This updated assessment estimated fishing mortality rates through 1995, recomputed the historic biological reference points, and gave advice relative to the biological reference points in the proposed overfishing definition.

SAW 23 concluded that, “The stock is at low levels of biomass and is over-exploited.” The report highlighted the continuing trend of fewer large fish that had been observed in the survey and in the commercial catch. It also highlighted the decline in calculated egg production associated with having fewer large fish in the population.

Compared to the fishing mortality rates and biological reference points estimated by the TWG, fishing mortality in the northern area remained high for the 1991-1995 period, about three times the maximum fishing mortality threshold of 0.05. Also the mean weight per tow (1.24 kg) in the northern area was 85 percent of the minimum biomass threshold selected by the Council to define when the stock was in an overfished condition.

In the southern area, fishing mortality between the 1989-1994 to the 1991-1995 periods increased from 0.45 to 0.51 (37% exploitation). The mortality rate was over three times the maximum fishing mortality threshold, 0.14 (12% exploitation). Stock biomass, measured by the survey, was only 57 percent (0.43 kg/tow) of the minimum biomass threshold defined by the Council to determine when the stock is in an overfished condition. The low biomass condition has persisted in the southern area since 1987.

Since the assessment indicated that monkfish mortality was too high and biomass was too low, the SAW 23 report (U.S. Dept. of Commerce 1997) gave the following management advice:

> *“Fishing mortality has exceeded all reference points for more than a decade in the northern area and since the early 1980s in the southern area. Fishing mortality should be decreased significantly and any redirection of displaced effort from other fisheries should be avoided to enhance prospects of stock rebuilding.”*

5.2 Ecological relationships

Goosefish were identified in only twenty-two stomachs from 1973-1990 NMFS research surveys (R. Rountree, pers. comm.). Prey sizes ranged from 30-175 mm fork-length. Most samples were collected during spring surveys.

Species of predator	Frequency	Total stomachs sampled	Percent frequency
Sandbar shark	1	66	1.52
Dusky shark	1	74	1.35
Thorny skate	2	1,294	0.15
Goosefish	2	2,135	0.09
Smooth dogfish	2	2,396	0.08
Spiny dogfish	12	24,876	0.05
Atlantic cod	2	9,398	0.02

5.3 Essential Fish Habitat

The Council updated the description of essential fish habitat for monkfish to develop an amendment for essential fish habitat. This description (Appendix IV) provides more detailed information than presented below and describes the distribution of monkfish eggs, larvae, and adult fish. The Council plans to bring its plans into compliance with the essential fish habitat requirements of the Sustainable Fisheries Act via a separate amendment to this plan. Although the Council has not yet approved a designation of essential fish habitat for monkfish, the draft description of monkfish habitat is provided in the FMP to augment the descriptive information given below.

No unique or special habitat is identified for the conservation of monkfish, due to their general life history and the wide distribution of adults and juveniles. Monkfish are widely distributed from the shoreline to the continental slope (to depths greater than 800 m, Markle and Musick 1974) and range from the Grand Banks and Gulf of St. Lawrence to Cape Hatteras, North Carolina. They tend to inhabit a wide variety of substrates where prey items are plentiful, including hard sand, sand/mud, gravel, and shell-littered areas (Bigelow and Schroeder 1953). Monkfish are less abundant in the shallow portions of Georges Bank (Almeida et al. 1995), presumably due to fast current, few prey items, or a combination of both. Their distribution is similar to, although broader than, the distribution of demersal groundfish in the Northwest Atlantic. A more detailed description of the physical environment for groundfish is given in NEFMC (1996).

Although less abundant in brackish waters, monkfish seem to tolerate a wide range of temperature and salinity. They have been observed in water temperatures ranging from 0 to 24 °C, but their preferred temperature range appears to vary with latitude. They are most abundant in temperatures of about 9°C in the Mid-Atlantic Bight (Edwards 1965), in 3 to 9 °C in Canadian waters (Jean 1965), and in 7 to 11 °C on the continental slope off of Virginia (Wenner 1978).

Monkfish are opportunistic piscivores as adults, consuming whatever species are available. They are also cannibalistic, monkfish being the largest (14%) part of their diet. Armstrong (1987) reports that the other major prey items include long-finned squid (Loligo pealeii), Atlantic cod (Gadus morhua), little skate (Raja erinacea), red hake (Urophycis chuss), silver hake (Merluccius bilinearis), sand lance (Ammodytes sp., butterfish (Peprilus triacanthus), and ocean pout (Macrozoarces americanus). The dominance of these species in the diet probably somewhat reflects the availability of prey, but food preference studies are unavailable. Immature monkfish have a greater portion of invertebrates in the diet, particularly red shrimp (Dichelopandalus leptocerus) in the specimens collected by Armstrong (1987). Thus, monkfish are not constrained by the availability of certain prey items.

Spawning appears to occur over most of the depths inhabited by monkfish, unlike other species of the same genus in the eastern Atlantic Ocean which migrate to deep water to spawn (Bowman 1919). Less developed egg veils have been collected in inshore waters as well areas along the continental shelf in 2,000 m (Bigelow and Schroeder 1953). Spawning occurs mainly during May and June (Armstrong et al. 1992) and gillnet fishermen report catching ripe females near banks and ledges during these months. Spawning may occur earlier or later in the Gulf of Maine or along the continental slope than these observations show.

Monkfish release large pelagic egg veils that can contain more than 1 million eggs. These egg veils float freely in the surface water and are directed by prevailing currents and wind-forced advection. The duration of development before hatching is unknown, but larvae 6-8 cm long have been reported in October (Connolly 1922). Little is known about areas where monkfish first become benthic.

Smaller monkfish appear to be a primary prey item of larger monkfish, but it is unknown whether certain substrates offer small monkfish better protection from predation than others, especially when one considers the way monkfish seek prey. Other benthic species that inhabit the Gulf of Maine and Georges Bank rely on gravel and cobble substrates to avoid predation, to spawn, and to feed (Wahle and Steneck 1991, Gotceitas and Brown 1993, Stevenson and Knowles 1988, Schneider et al. 1987). Adult monkfish have a wide distribution over many types of habitat as long as prey are abundant, perhaps owing to their feeding strategy (acting like a rock on open bottom may be more productive than acting like a rock on rocky bottom).

Young, benthic monkfish are vulnerable to predation, but it is not known whether gravel or cobble substrates offer any protection. Some have suggested that small monkfish are more abundant in very deep water. If small monkfish are more abundant on the continental slope, the area may serve as a refuge from predation by coastal species like cod and whiting. The abundance of small monkfish in this area is unknown, however, because most research surveys are conducted at shallower depths.

Areas of critical spawning and nursery habitat cannot, therefore, be identified because of the wide distribution of spawning, the pelagic existence of egg veils, the uncertain duration of development during the pelagic phase, and unknown characteristics of critical habitat when monkfish are most vulnerable to predation.