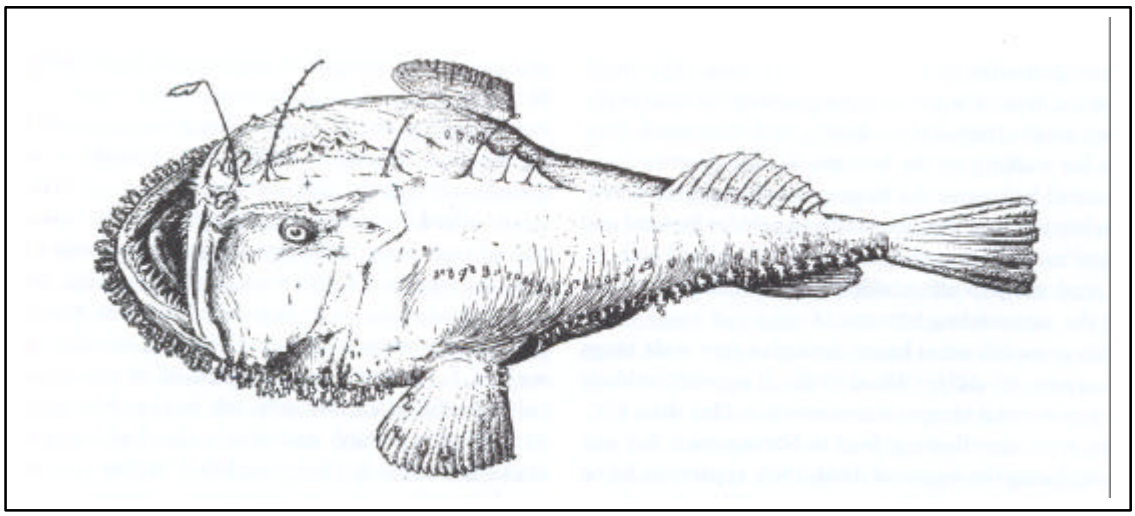
GOOSEFISH / ***Lophius americanus*** **Valenciennes 1837** /Monkfish, Angler, Allmouth, Molligut / Bigelow and Schroeder 1953:532-541



Description. Body greatly flattened dorsoventrally, much like a skate or a ray (Fig; 143). Head rounded from above, about as broad as long, enormous compared to body, which is narrow and tapering back of pectoral fins, giving the fish a tadpolelike appearance when viewed from above. Mouth enormous, directed upward, lower jaw projecting so far beyond upper jaw that most lower teeth are freely exposed even when mouth is closed. Both jaws armed with long, slender, curved teeth, alike in form but of various sizes, very sharp, mostly depressible, all pointing inward toward gullet. Some teeth as long as a few centimeters in a large fish. Lower jaw teeth mostly large, in one to three rows. Upper jaw teeth few in middle (a toothless space in the midline) largest, with a single row of smaller ones flanking them. Several rows of thornlike teeth on roof of mouth. Gill openings below, behind, and just slightly in front of pectoral fins. Eyes on top of head, directed upward. pectoral fins distinctive, their bases like thick fleshy arms bearing fins proper at outer edge. Finlike parts fanlike when spread, so thick-skinned that rays hardly visible except in scalloping of margins. Top of head with three stiff, slender spines (representing anterior part of spinous dorsal fin) hardly thicker than bristles; first (illicium) close behind tip of snout; second a little in front of eyes; third on nape of neck. First and second spines movable from recumbent to erect; third sloping backward with its basal half or more embedded in skin. Relative lengths of spines vary; first two about equal in length on most fish, or second a little longer, third shortest. Illicium bears an irregular, leaflike flap of skin (esca) at tip, playing important role as lure for prey; second and third spines with small triangular membranes at bases, and one or both may be fringed with short lobes of skin. Behind these spines are two additional, well-developed dorsal fins: the postcephalic spinous dorsal fin of three spines situated at level of pectoral fins, and second, or soft dorsal fin, on rear part of trunk. Anal fin below soft dorsa! fm; pelvic fms on lower surface of head, well in front of pectorals. Caudal fin small and broorn-shaped. Dorsal fms with thin delicate membranes; caudal, anal, and pelvic fms thick and fleshy, like the pectoral fins. Skin naked, very smooth, and slippery; a row of fleshy flaps of irregular shape runs around margin of head and around edge of lower jaw, besides smaller tags that fringe sides of trunk back to base of caudal fm. Upper side of head bears numerous low conical tubercles or spines, which vary in prominence from fish to fish (for detailed discussions of cranial spine morphology, see Caruso 1981, 1983).

Meristics. Dorsal fin rays VI, 9-12; anal fin rays 8-10; pectoral fin rays 25-28; pelvic fin rays I, 5; branchiostegals 6; vertebrae 26-31 (Caruso 1983; Fahay 1983; Scott and Scott 1988).
Color. The numerous goosefish observed by Bigelow and Schroeder were chocolate brown above, variously and finely mottled with pale and dark. The dorsal fins, the upper sides of the pectoral fins, and the caudal fin are of a darker shade of the same color as the back, except nearly black at the tips. The whole lower surface of the fish is white or dirty white, except the distal third of the pectoral fins gradually darkens to the color of the dorsal surface, and the pelvic fins become dusky distally. The esca is greenish in life and has a dark spot at its base. Very small goosefish are described as mottled and speckled with green and brown. In an aquarium, the European L. *piscatorius* is able to match both its color and its color pattern closely to the sand and gravel on which it lies (Wilson 1937).

Size. Adults run from 610 to 1,220 mm, weighing up to at least 27 kg (Scott and Scott 1988). One 965 mm long, caught at Woods Hole inJuly 1923, weighed 14.5 kg alive. The all-tackle game fish record is a 22.56-kg fish caught in Perkins Cove, Ogunquit, Maine, in July 1991 (IGFA 2001).

Distinctions. The depressed body and huge mouth distinguish goosefish from all other fishes in the Gulf of Maine.

Taxonomic Remarks. Goosefish of the western North Atlantic were once thought to be identical with the widespread eastern Atlantic angler *(L. piscatorius).* In 1923 Taning observed that the late larval stages of L. *americanus* do not resemble those of L. *piscatorius* as closely as they do those of the other European angler, L. *budegassa.* For this reason Berrill (1929) recognized goosefish in the western Atlantic as a distinct species and resurrected the name L. *americanus.* There are distinct morphological differences between the European anglers L. *budegassa* and L. *piscatorius,* and the American L. *americanus* (Wheeler et al. 1974; Caruso 1983).
Habits. The depth range extends from just below the tide line (Bigelow and Schroeder) to depths of at least 840 m (Markle and Musick 1974), but few large individuals are taken below 400 m (Wenner 1978). Adults are found on hard sand, pebbly bottoms, the

gravel and broken shells of good fishing grounds, and soft mud, where they have been trawled in the deep basins of the Gulf.
European goosefish kept in the aquarium at Plymouth, England, spent most of the time resting quietly (Wilson 1937). When they swam they did so slowly, and they used their paired fins for walking on the bottom. Wilson described one digging a small hollow in the bottom when it settled down, using its pelvic fins to shovel the sand and pebbles forward and outward and using its pectorals, almost like webbed hands, to push the sand away to either side until its back was almost flush with the surrounding bottom.
American goosefish are at home through a very wide range of temperatures, 00-24°C (Wood 1982). It appears unlikely that they can survive temperatures much colder than 0°C, since many were seen floating dead in Narragansett Bay and on the shore during the winter of 1904-1905, apparently killed by the unusually severe cold (Tracy 1906). They have been found to be most abundant in Canadian waters at 3°-9°C Uean 1965), in the Mid-Atlantic Bight at around 9°C (Edwards 1965), and on the continental slope off Virginia at 7°-11°C (Wenner 1978).
At the other temperature extreme, goosefish caught by commercial fishermen in shoal water near Cape Lookout, N.C., are exposed to temperatures higher than 21°C for part of the season, perhaps as high as 24°C. Reports that the inshore contingent of goosefish population of Rhode Island waters moves offshore (i.e., deeper) in July and inshore again in October suggest that they tend to avoid extreme summer heat if they can do so by moving into deeper water (Tracy 1906). In his study of the seasonal distribution of L. *americanus* in the Gulf of St. Lawrence, Jean (1965) found the greatest winter concentrations at depths of 180-225 m (3° -6°C), and the greatest summer concentrations at 25-220 m, with the greatest abundance at 25-92 m (5°-9°C).
Although they may appear tolerant to a relatively wide range of salinities, occurring from estuaries out to the upper part of the continental slope, Bigelow and Schroeder noted that "we have never heard of one in brackish water." Since their kidneys are aglomerular, it seems unlikely that they could tolerate low-salinity conditions for very long.

Food. Goosefish feed mostly on fishes after they take to the bottom: 65.1% by weight bony fishes, 24.9% cephalopods, and 8.8% elasmobranchs (Bowman et al. 2000). Over two dozen fish species and two squid species are listed from 872 goosefish captured from the Scotian Shelf to the Middle Atlantic states between 1977 and 1980. Goosefish caught in the Gulf of Maine consumed 15 fish species and one squid species, the most important of which were squid, unidentified clupeids, silver hake, squirrel hake, and American plaice. Off southern New England the most important of the 16 species of fishes in the diet of goosefish were little skate, red hake, goosefish, and sand lance (Armstrong et al. 1996).
Goosefish capture seabirds, as their vernacular name implies: cormorant, herring gulls, widgeon, scoter, loon, guillemot, and razor-billed auk are in its recorded diet. Bigelow and Schroeder also found grebe and other diving fowl, such as scaup duck and merganser, in goosefish from Pamlico Sound, N.C. **It** is questionable, however, whether even the largest of them would be able to master a live goose, as rumor has it, nor do the local fishermen believe they ever do so in Pamlico Sound, although the abundance of wild geese there in winter would afford them every opportunity. Goode (1884), however, tells of one that a fisherman saw struggling with a loon, and one was even found with a sea turtle (Schroeder 1947).
Goosefish have often been cited for their remarkable appetites. Bigelow and Schroeder reported one that had made a meal of 21 flounders and a dogfish, all of marketable size; of half a pailful of cunner, tomcod, and sea bass in another; of 75 herring in a third; and of one that had taken seven wild ducks at one meal. They stated that "in fact it is nothing unusual for one to contain at one time a mass of food half as heavy as the fish itself." With its enormous mouth (about 1 m long gaping about 230 mm horizontally and 203 mm vertically), it is able to swallow fish of almost its own size. Fulton (1903b), for instance, found a codling 585 mm long in a British goosefish of only 660 mm, and Field (1907) took a winter flounder almost as big as its captor from an American specimen. One that Bigelow and Schroeder gaffed at the surface on Nantucket Shoals contained a haddock 787 mm long, weighing 5.5 kg; they cited Capt. Atwood as having long ago seen one attempting to swallow another as large as itself. wilson's (1937) observations, however, indicate that they are no more gluttonous than any other rapacious fish, for those that he watched in the aquarium usually refused food for 2 or3 days after a meal. His observation that they evidently preferred small fishes is in line with their normal habits, for they feed mostly on small fishes, not on large, and even the largest of them take very small fry on occasion.
Goosefish, especially at smaller sizes, are also known to eat invertebrates such as lobsters, crabs of several species, hermit crabs, squids, annelid worms, shellfish, starfish, sand dollars, and even eelgrass. The most important invertebrates in small (up to 200 mm TL) goosefish off southern New England (Sedberry 1983; Armstrong et al. 1996) were red shrimp *(Dichelopandalus leptocerus),* sand shrimp *(Crangon septemspinosus),* and long-finned squid *(Loligo pealeii).* Invertebrates became less important at 200-400 mm TL, and the diet of goosefish over 400 mm TL was dominated by teleosts (Armstrong et al. 1996; Bowman et al. 2000).
Part of the angler's reputation for gluttony is due to anglers swallowing food in the cod-end of trawls after capture. Goosefish frequently open their mouths widely when disturbed, a response that could account for some of the more unlikely stomach contents that have been recorded (Caruso 1977; Armstrong et al. 1996). The projecting lower jaw, dorsally directed mouth, and sharp slender teeth of lophiids are ill-suited for capturing benthic organisms, and most of these organisms are not likely to strike at a rapidly moving lure.
The most interesting habit of goosefish is the use of the highly modified first dorsal fin spine as an angling apparatus to lure small fishes within seizing distance, much as Aristotle described. W.F. Clapp (the first observer to watch American goosefish feeding, according to Bigelow and Schroeder) described individuals in Duxbury Harbor as lying motionless among the eelgrass, with the "bait" or esca at the tip of the first dorsal fm spine (illicium) swaying to and fro over the mouth. When a tomcod (the only fish he saw them take) chances to approach, it usually swims close up to the esca, but never (in his observation) actually touches it, for the goosefish opens its vast mouth as soon as the victim comes within a few inches and closes it again, instantly engulfing its prey.
Further details added by observations on European anglers in aquariums at Port Erin, Isle of Man (Chadwick 1929), and Plymouth, England (Wilson 1937) are that the illicium, with its terminal esca, is held down along the top of the head, to be raised at the approach of a prospective victim; the esca may be jerked to and fro quite actively in

front of its owner's head; the victim is usually taken in headfirst; a fish swimming close enough may be snapped up without the bait being brought into play; and some anglers use the bait often, others seldom. Wilson also made the interesting observation that touching the esca does not cause a reflex snapping of the jaws, showing that angler feed by sight. Gudger (1945) gave an interesting and readable survey of observations on use of the bait.

Predators. Adult goosefish cannot have many enemies, but small goosefish are no doubt eaten by various predacious fishes, including swordfish (Scott and Tibbo 1968) and larger goosefish (Armstrong et al. 1996). Other predators include sharks (dusky, sandbar, spiny dogfish, and smooth dogfish), of which spiny dogfish are the most significant, and cod (Rountree 1999). Goosefish larvae in aquarium jars at Plymouth, England, were devoured by larvae of spiny lobster *(Palinurus),* large copepods, ctenophores, and hydroids when they came close enough to the walls of the jar to be seized (Lebour 1925).

Parasites. Goosefish parasites include a protozoan, six trematodes, and larvae of a nematode *Phocanema* sp. (Margolis and Arthur 1979). A protozoan, *Haemogregarina* infects immature goosefish in the Gulf of Maine (Bridges et al. 1975; Khan and Newman 1982). The microsporidian *Glugea americanus* (often referred to as *Spraguea lophii,* a similar species that occurs in L. *piscatorius)* infects spinal and cranial ganglia of American goosefish (Takvorian and Cali 1986)

Reproduction. Both sexes begin to mature at about 30 cm TL at ages between 3 and 4; males generally attain 100% maturity by about 50 cm, females by about 60 cm (Almeida et al. 1995). Mean lengths at which 50% of the males matured averaged about 40 cm and females about 44 cm.

Goosefish spawn in spring, summer, and early autumn, according to the latitude, and through a long season. Eggs and larvae have been taken near Cape Lookout, N.C., in March and April (Hildebrand, pers. comm. to Bigelow and Schroeder); in May off Cape Hatteras (Taning 1923); and as early as May at Woods Hole. But spawning may not commence until early summer in the Gulf of Maine, for 24 June is the earliest date eggs have been seen north of Cape Cod (Connolly 1921); 18 September (off Seguin Island, Maine) is the latest recorded date for American waters.

The locality of spawning of L. *americanus* has been the subject of discussion, whether inshore in shoal water or offshore in deeper water. Eggs reported from the Bay of Fundy (Connolly 1921), from Passamaquoddy Bay (Berril11929), and from Frenchman Bay near Mount Desert (Procter 1928) were in such early stages of incubation that they must have been spawned close at hand. This also applies to some isolated eggs that were collected at about the 20-fathom (36.6 m) contour line off northern North Carolina by the *Dana* (Taning 1923). Neither is there any reason to suppose that eggs farther advanced in incubation that have been taken in the inner parts of the Gulf of Maine, at Woods Hole, and at Newport, had come from any great distance. Furthermore, large adult fish are present in abundance inshore throughout the spawning season, which would not be the case if they moved offshore or into deep water to spawn. Recently spawned eggs have been reported near the 2,000 m contour line of the continental slope south of the Newfoundland Banks (Murray and Hjort 1912), and over similar depths off North Carolina (36°16' N, 74°33' W; Taning 1923). However, the latter could also have been produced by L. *gastrophysus.*

Presence of lophiid eggs off North Carolina, near Newport (Agassiz 1882), near Woods Hole, in the Gulf of Maine, and over the continental slope south of the Newfoundland Bank, and the capture of a very small (10-cm) specimen on the Grand Banks show that American goosefish breed throughout the range. However, egg veils found off North Carolina could also have been produced by L. *gastrophysus.*

As in nearly all anglerfishes for which the mode of egg production is known, eggs are shed in remarkable, buoyant, ribbonlike, nonadhesive, mucoid veils, which in goosefish may be 6-12 m long, and 0.15-1.5 m wide (Martin and Drewry 1978). Within each veil eggs are arranged in a single layer, lying one to three or even four in separate hexagonal compartttnents, with an oil globule uppermost. Each compartment has an opening that provides water circulation (Fulton 1898; Gill 1905; Rasquin 1958; Ray 1961; and Armstrong et al. 1992). In an egg veil found near St. Andrews, N.B., between 10 and 11 m long, about 200 mm wide and 3 mm thick, and about 26.5 liters in volume, about 5% of the eggs were single, about 80% were in pairs, and about 5% were in threes, per compartment. This veil was estimated to contain about 1,320,000 eggs (Berril11929), and Fulton (1898) estimated roughly the same numbers (1,345,848 and 1,317,587) in the ovaries of two European goosefish from Scottish waters.

The veils are light violet-gray or purplish brown, made more or less blackish by embryonic pigment of the eggs, ac. cording to their stage of development. They are so conspicuous when floating at the surface that fishermen have long been familiar with them, although it was not until about 1871 that Alexander Agassiz *(tide* Baird 1871) demonstrated their true parentage. The eggs occasionally become isolated, perhaps when a storm shreds the mucous veil to pieces, and when this happens they float like any ordinary buoyant fish eggs. Bigelow and Schroeder did not actually find them in this condition in the Gulf of Maine, but Agassiz and Whitman (1885) saw isolated eggs at Newport, and Taning reported others from North Carolina waters.

Egg veils have been reported within the Gulf of Maine from Campobello Island at the entrance to the Bay of Fundy; from Passamaquoddy Bay (Connolly 1921; Berrill 1929); in Frenchman Bay, Maine (Proctor 1928); about 24 km off Seguin Island, Maine, 18 September 1925 (with eggs nearly ready to hatch), found by Capt. Greenleaf of the U.S. Bureau of Fisheries; and at Provincetown, Mass., where Bigelow and Schroeder found a veil within 1 m of the shore, on 26 June 1925. There have been fewer captures of pelagic larvae within the Gulf; , three were taken near Brazil Rock off southwestern Nova Scotia and two very small ones (5 and 6.5 mm) were collected by Bigelow and Schroeder on the *Grampus* in Massachusetts Bay, one in July 1912, the other in September 1915.

Early Life History (Fig. 144). The eggs are 1.61-1.84 mm in longest diameter (Fahay 1983) as they lie in their mucous compartments (Fig. 144A). The yolk is straw-colored, and they have either one copper-colored or pinkish oil globule of 0.4-0.56 mm or several smaller ones. Incubation takes 7-22 days at temperatures as low as 5°C to as high as 17.5°C, and probably at higher temperatures. The larvae, which float with the yolk uppermost at first, are 2.5-4.5 mm long at hatching.

The first of the dorsal fin spines (which will become the second cephalic dorsal fin spine of the adult) appears within 4 days or so after hatching, as a lobe at the margin of the embryonic finfold on the nape of the neck. The pectoral fins form at about 7 days, when the larva is 5.5 mm long; the pelvic fins have now appeared as two long conical processes below and behind the pectorals; and pigment has become congregated in three or four masses behind the vent (Fig. 1440), the last being a very conspicuous feature that the larvae of the European species do not share. The yolk is absorbed at a length of 6-8 mm, a second dorsal spine forms behind the first, and the pelvic fins become two-rayed. The third and fourth dorsal spines appear while there are still only two pelvic rays in the American goosefish, but not until the third rays have developed in the pelvic fins in the European species.

A fifth dorsal spine next appears behind those that have developed already; and a sixth in front of these, all of them being interconnected with membrane at their bases but free at their tips. The pectoral fins assume a great breadth and fanlike outline; the second dorsal, anal, and caudal fins take definite form; the pelvic rays become filamentous at their tips, streaming far out behind the tail; and a complete row of teeth appears in the lower jaw, with a few in the upper. The goosefish pictured at this stage by Agassiz (Fig. 144F) was 30 mm long, and one much like it taken off Brazil Rock, described by Connolly; was 27 mm long, but, according to Stiasny (1911, 1913), larvae of Mediterranean goosefish attain this stage when they are only 13-18 mm long.

Older posdarval stages of American goosefish develop in a fashion similar to *L.budegassa;* that is, the foremost dorsal fin spine becomes brisdelike with the esca appearing at its tip; the last three of the free spines on the nape of the neck join together to form the postcephalic spinous dorsal fin; lappets of skin appear around the margin of the lower jaw and along the cheeks; and the head broadens and flattens while the young fish are still pelagic, with enormous pectoral fins and with threadlike pelvic fins (Fig. 144F).

The largest free-swimming Mediterranean larva seen by Stiasny (1911) was 50 mm long. Probably the young take to the ground shortly after this stage, for Bowman (1919) described European goosefish fry of about 65 mm that were trawled on the bottom off Scotland as of adult form, except that their pectorals were proportionately larger. To attain this state entails growth of the head out of proportion to the rest of the body; enlargement of the mouth; "shrinkage" of all the fins (of the pelvic fins most of all); alteration of the second and third free dorsal rays into spines (they are soft previously); and a general flattening of the whole fish. Young of 76 mm taken at Halifax, one of 114 mm from Campobello (both pictured by Connolly), and others as small as 100-114 mm that were trawled by Bigelow and Schroeder, were at about this stage in their development.

Age and Growth. Capture of a 64-mm specimen in October and of another of 76 mm (date not recorded [Connolly 1921]), both in Halifax Harbor, suggests that goosefish may reach about that length by the onset of their first winter in Gulf waters. One 114 mm long from Halifax studied by Connolly seemed from the thickness of its otoliths to have been in its second summer or autumn; that is, one full year old, which probably applies to three others of 100-114 mm trawled in August and seen by Bigelow and Schroeder.

Fry of European goosefish may be 127-140 mm long by November off Scotland (Fulton 1903b), where spawning commences in March or earlier; this is as large as fry of the American species in their second summer in Gulf waters, where the first growing season is at least 3 or 4 months shorter. Fulton's measurements also point to more rapid growth by the larger Scottish fish than by American goosefish in the Bay of Fundy; namely to 229-406 mm at 1.5 years; to 368-470 mm at 2.5 years; and to about 533 mm at 3 years.

One of the larger fish studied by Connolly showed four concentric rings in its vertebrae; one 787 mm long seemed to have nine rings; one 940 mm seemed to have ten rings; and one 1,016 mm seemed to have twelve rings. It is not certain if these vertebral rings are laid down regularly, one per year. Both European species of *Lophius* have been aged from sections of the illicium (Duarte et al. 1997). In their samples, L. *piscatorius* reached a length of about 70 cm at age 8, L. *budegassa* grew more slowly; reaching a length of a little over 60 cm at age 16.

The relationship between total length and total weight (in grams) calculated from 1,216 individuals (Almeida et al. 1995) was W= 0.0000410£2.849, r2 = 0.983.

General Range. Coast of eastern North America from the southern and eastern parts of the Grand Banks off Newfoundland and the northern side of the Gulf of St. Lawrence south to the coast of Florida (approximately 29° N [Caruso 1983]). Widespread throughout the Mid-Atlantic Bight out almost to the 1,000 m line (Wood 1982: Map 30). Records from the Gulf of Mexico, Caribbean Sea, and Atlantic Ocean south of Florida (Goode and Bean 1896; Bigelow and Schroeder; Longley and Hildebrand 1941) represent misidentifications (Caruso 1983); specimens collected by Longley and reported as £. *piscatorius* (Longley and Hildebrand 1941) are *Lophiodes beroe* (USNM 116967) and L. *gastrophysus* (USNM 116968).

Occurrence in the Gulf of Maine. This is a familiar fish throughout the Gulf of Maine both along the shore and on the outer fishing banks (Map 21).

Importance. In 1953, Bigelow and Schroeder stated: "No regular commercial use has been made of the goosefish in America up to the present time. But it is an excellent food fish, white-meated, free of bones, and of pleasant flavor, as Dr. Connolly assures us from personal experience. In 1948 (most recent year for which the international fisheries statistics are readily available), English and Scottish vessels landed about 7 million lb of the European species, as 'monk' which fetched nearly as high a price as haddock in English markets, though it brings only about one-half as high a price as haddock in Scotch ports." However, for many years, some New England restaurants surreptitiously used goosefish in recipes requiring lobster meat. In the early 1970s goosefish began appearing on the market "legitimately" as "mock-lobster," and shortly thereafter under the British epithet as "monkfish." By the middle to late 1970s, its popularity as a food fish in its own right, and not as a lobster substitute, had spread across the northeastern and midwestern United States.

Total landings remained at low levels until the mid-1970s, increasing from a few hundred metric tons to around 6,000 mt in 1978 (Idoine 1998a). Landings remained stable at between 8,000 and 10,000 mt until the late 1980s and then increased to a peak level of 26,800 mt in

1996 (Fig. 145). Usually only the tails are landed. Reported landings of tails have increased dramatically since about 1972 (A1meida et al. 1995); landings rose to about 2,300 mt in 1980, and to more than 5,300 mt by 1991-1992.

An export market for goosefish livers developed, increasing steadily from 10 mt in 1982 to 600 mt in 1996. Ex-vessel prices for livers rose from an average of $0.97 per Ib to more than $5.00 per Ib, with seasonal variations as high as $19.00 per Ib (Idoine 1998a), but this export market has dropped off recently.

The NEFSC autumn bottom trawl survey biomass index has declined sharply over the last 15 years (Idoine 1998a) (Fig. 145).

Average size of goosefish has decreased in almost all areas, and size at maturity has also been reduced significantly; leading to the conclusion that the goosefish stock is overexploited and at low levels of abundance (Almeida et al. 1995; ldoine 1998a).

Goosefish are not under management in federal waters but a management plan is under development by the New England and Mid-Atlantic Fishery Management councils.