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Northeast Multispecies Fishery Management Plan Resource Guide: Ocean pout (Macrozoarces americanus)

Bibliography

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Background & Scope
The Northeast Multispecies Fishery Management Plan (FMP) was implemented in 1986 to reduce fishing mortality of heavily fished groundfish stocks and to promote rebuilding to sustainable biomass levels. Thirteen species are managed through plan amendments and framework adjustments to the original plan, including: Atlantic cod, haddock, yellowtail flounder, American plaice, witch flounder (grey sole), winter flounder (black back), Acadian redfish, white hake, Pollock, windowpane flounder, ocean pout, Atlantic halibut, and the Atlantic wolffish. This bibliography focuses on Ocean pout, and is intended as a primer and reference resource for staff of the National Marine Fisheries Service, Greater Atlantic Regional Fisheries office. It is organized into four sections: Biology (life history), Ecology (interaction with the environment), Fishery, and Management.

Section I - Biology
Section one is intended to provide an overview of the life history of Ocean pout. The research in this area is a compilation of basic facts including diet, lifespan and habitat; as well as current research on Ocean pout biology.

Section II – Ecology
Section two is intended to provide an overview of how Ocean pout interacts with the environment. The citations in this area focus on how temperature, food resources and predation affect Ocean pout.

Section III – Fishery
Section three is intended to provide an overview of the Ocean pout fishery. It is divided into two sections: Modern and Historical. The Modern section contains both news articles and scientific publications about the current state of the Ocean pout fishery. The Historical section contains resources on the peak of Ocean pout fisheries in the 1960s-80s.

Section IV – Management
Section four is intended to provide an overview of the management of the Ocean pout fishery. It includes news articles and research concerning plans and policies intended to protect and restore the Ocean pout population.

Sources Reviewed
Along with a web search for news items and other relevant materials the following databases were used to identify sources: Clarivate Analytics' Web of Science: Science Citation Index Expanded, Nexis.com, ProQuest's Science and Technology, and JSTOR. Only English language materials were included. There was no date range specification in order to cover any relevant research, although priority was given to publication in the last twenty years focusing on wild populations in the Atlantic region.

Section I: Biology

Image from: https://www.nefsc.noaa.gov/sos/spsyn/og/pout/

Also known as: Zoarces americanus, eel pout, muttonfish

Region: Northwest Atlantic from Labrador to Delaware, two existing stock identified in the Bay of Fundy-northern Gulf of Maine region east of Cape Elizabeth, and a second stock ranging from Gulf of Maine/Cape Cod Bay south to Delaware (Olsen and Merriman, 1946).

Habitat: Ocean pout prefer depths of 15 to 80 m (8 to 44 fm.) and temperatures of 6° to 7° C (43° to 45° F). Tagging studies and NEFSC bottom trawl survey data indicate that ocean pout do not undertake extensive migrations, but rather move seasonally to different substrates.

Size: Ocean pout may attain lengths up to 98 cm (39 in.) and weights of 5.3 kg (14.2 lb).

Physical description: Ocean pout are a demersal eel-like species with a subterminal mouth, a yellow-brown mottled dorsal surface, and a pale ventral surface. Dark, irregular vertical bars extend from dorsal fin to lateral sides.

Lifespan: There are estimates of Ocean pout attaining 18-20 years, at 70 cm in length, but can probably live longer based on reported lengths of nearly 100 cm. Median length at maturity for females was 26.2 cm and 31.3 cm for the Gulf of Maine area and Southern New England area, respectively, with a possible three-year egg development period (O'Brien et al. 1993). Mercer et al. (1993) and Yao and Crim (1995) indicate that ocean pout eggs are internally fertilized.

Diet: The diet consists primarily of invertebrates, with fish being only a minor component (Stemile et al. 1999).

Predators: Squid, spiny dogfish, sea raven, cod, barndoor skate, harbor seals, cormorants, and sandbar shark.

Sources: NOAA. (3/1/2018) Status of Fishery Resources off the Northeastern US. https://www.nefsc.noaa.gov/sos/spsyn/og/pout/

Killen, S. S., Brown, J.A., & Gamperl, A.K. (2008). Lack of metabolic thermal compensation during the early life stages of ocean pout Zoarces americanus (Bloch & Schneider): a benthic, cold-water marine species. *Journal of Fish Biology, 72*(3), 763-772. https://doi.org/10.1111/j.1095-8649.2007.01735.x

The present study investigated the metabolic response of young ocean pout Zoarces americanus to temperature acclimation (3 v. 11 degrees C), and to acute changes in water temperature from 3 to 17 degrees C. The Q(10) value for standard metabolic rate between acclimation temperatures was 5.3, warm-acclimated fish displayed higher rates of oxygen uptake at all temperatures during the acute thermal challenge, and changes in whole-body citrate synthase activity were qualitatively similar to those seen for metabolism. These results indicate that, in contrast to temperate species, young ocean pout from Newfoundland do not show thermal compensation in response to long-term temperature changes.

Moskin, J. (2006, July 26). Can a bit of Arctic pep up ice cream? - Health & Science - International Herald Tribune. *The New York Times*. https://nyti.ms/2GnBeEY

The ice cream industry uses the Ocean pouts' blood's unique "ice-structuring protein" as inspiration to genetically modify yeast to achieve similar results. This protein contributes to creamier ice cream which is not as affected by temperature fluctuations, which the Ocean pout leverages for their habitat.

Steimle, F.W., Morse, W.W., Berrien, P.L., Johnson, D.L., & Zetlin, C.A. (1999). Essential fish habitat source document: Ocean pout, Macrozoarces americanus, life history and habitat characteristics. NOAA. https://www.nefsc.noaa.gov/publications/tm/tm129/

NOAA technical memorandum complied of available information on the Ocean pout, its distribution, habitat requirements, and abundance as managed by the New England Fishery Management Council.

Yao, Z., & Crim, L. W. (1995). Copulation, spawning and parental care in captive ocean pout. *Journal of Fish Biology, 47*(1), 171-173. https://doi.org/10.1111/j.1095-8649.1995.tb01884.x

The ocean pout copulates through direct genital contact for internal fertilization. A complete spawning event consists of copulation, oviposition, and the female displaying parental care by wiping and wrapping herself around the eggs.

Methven, D. A., & Brown, J. A. (1991). Time of hatching affects development, size, yolk volume, and mortality of newly hatched Macrozoarces americanus (Pisces: Zoarcidae). *Canadian Journal of Zoology, 69*(8), 2161-2167. https://doi.org/10.1139/z91-302

The ocean pout, Macrozoarces americanus , is well developed at hatching and strongly resembles the adult. Developing embryos and newly hatched larvae have teeth, are well ossified and pigmented, and have a complete complement of fin rays. The feeding repertoire is simple and lacks the dramatic behavioural changes that usually occur in less-developed larvae of other species. Length and weight at hatching are positively correlated with time of hatch and differ significantly for early- and late-hatched individuals. Early-hatched individuals have no ossified bones, are smaller, and have higher rates of mortality than late-hatched individuals; however, early-hatched individuals have higher growth rates and larger yolk-sac volumes than late-hatched individuals. The large size at hatching, simple feeding repertoire, short time to first feeding (< 24 h), presence of numerous teeth, rapid yolk absorption, and low mortality are characteristic of newly hatched M.

americanus and suggest that the larval stage is of very short duration, if present at all. We suggest that a larval stage is absent and that M. americanus hatch as juveniles.

Section II: Ecology

El-Garhy, M., Cali, A., Morsy, K., Bashtar, A.R., & Al Quraishy, S. (2017). Ultrastructural characterization of Pleistophora macrozoarcidis Nigerelli 1946 (Microsporidia) infecting the ocean pout Macrozoarces americanus (Perciformes, Zoarcidae) from the gulf of Maine, MA, USA. *Parasitology Research 116*(1), 61-71. https://doi.org/10.1007/s00436-016-5261-5

Pleistophora macrozoarcidis, a microsporidian parasite infecting the muscle tissue of the ocean pout (Macrozoarces americanus) collected from the Gulf of Maine of the Atlantic Ocean, MA, USA, was morphologically described on the basis of ultrastructural features. Infection was detected as opaque white or rusty brown lesions scattered throughout the musculature of the fish mainly in the region anterior to anus. Transmission electron microscopy showed that in individual parasitized muscle cells, the infection progresses within parasite formed vesicles which are in direct contact with muscle cell elements. The earliest observed parasitic stages are the globular multinucleated proliferative cells or plasmodia limited by a highly tortuous plasmalemma with intervesicular finger-like digitations projecting into the parasite cytoplasm.

Cote, D., Stewart, H. M. J., Gregory, R. S., Gosse, J., Reynolds, J. J., Stenson, G. B., & Miller, E. H. (2008). Prey selection by marine-coastal river otters (Lontra canadensis) in Newfoundland, Canada. *Journal of Mammalogy, 89*(4), 1001-1011. https://doi.org10.1644/07-mamm-a-192.1

Previous studies have suggested that diets of river otters (Lontra canadensis) vary in response to seasonal shifts in prey availability, and that they select slowly moving fish of moderate size. To test these assumptions for marine-coastal river otters in Newfoundland, Canada, we reconstructed diets and estimated body length of important fish prey through analysis of otoliths and other hard parts recovered from scats collected in Bonavista and Placentia bays. Diet of otters in Bonavista Bay also was compared with the species and size composition of the nearshore fish community, as determined by concurrent beach-seine sampling. Diets were qualitatively similar but quantitatively different between bays. Otters consumed proportionally more cunner (Tautogolabrus adspersus) and stickleback (Gasterosteidae) in Placentia Bay, and more sculpin (Cottidae) and cod (Gadus) in Bonavista Bay, Flounder (Pseudopleuronectes americanus) was important in both bays, based on biomass, because individual fish in the diet were large. Fish-community composition in Bonavista Bay varied seasonally, a pattern that was not reflected in the diet, suggesting active selection of fish prey by otters. Slow-swimming fish (sculpin, flounder, and ocean pout [Macrozoarces americanus]/rock gunnel [Pholis gunnellus]) were overrepresented in the diet, and fast-swimming species (cod and hake [Urophycis]) were underrepresented. Otters also selected larger individuals within taxa. The lower limits at which size classes were incorporated into diet varied across fish species, and may reflect species differences in derectability by otters due to camouflage and behavior.

Link, J. S. (2007). Underappreciated Species in Ecology: "Ugly Fish" in the Northwest Atlantic Ocean. *Ecological Applications, 17*(7), 2037-2060. https://doi.org/10.1890/06-1154.1

Species shifts and replacements are common in ecological studies. Observations thereof serve as the impetus for many ecological endeavors. Many of the species now known to dominate ecosystem functioning were largely ignored until studies of those underappreciated species elucidated their critical roles. Recognizing the potential importance of underappreciated species has implications for functional redundancies in ecosystems and should alter our approach to long-term monitoring. One example of an applied ecological system containing species shifts, underappreciated species, and potential changes in functional redundancies is the topic of fisheries. The demersal component of many fish communities usually consists of high-profile and commercially valuable species that are targets of fisheries, plus a diverse group of lesser known species that have minimal commercial value and focus. Yet ecologically these traditionally nontargeted species are often a major biomass sink in marine ecosystems and can also be critical in the functioning of bentho-demersal food webs. I examined the biomass trajectories of several species of skates, cottids, lophiids, anarhichadids, zooarcids, and similar species in the northeast U.S. Atlantic ecosystem to determine whether their relative abundance has changed across the past four decades. Distribution and stomach contents of these species were also evaluated over time to further elucidate the relative importance of these species. Landings of these underappreciated bentho-demersal fish were also examined in comparison to those species that historically have been commercially targeted. Of particular emphasis was the evaluation of evidence for sequential stock depletion and the ramifications for functional redundancy for this ecosystem. Results indicate that some of these fish species are now the dominant piscivores, benthivores, and scavengers in this ecosystem. These formerly under-studied species generally have either maintained a consistent population size or have increased in abundance (and expanded in distribution) over the past several decades. Nontraditionally targeted fish species are an often overlooked but important component of bentho-demersal fish communities. Implications for the energy flow and resilience specifically for future fisheries and generally for harvesting biological resources are significant, remaining critical issues for the world's ecosystems.

Killen, S.S., & Brown, J.A. (2006). Energetic cost of reduced foraging under predation threat in newly hatched ocean pout. *Marine Ecology Progress Series 321*, 255-266. https://doi.org/10.3354/meps321255

Previous research has shown that young fishes will decrease foraging activity while in the presence of a predatory threat. In most of these studies, however, individuals have been exposed to acute pulses of predatory threat of short duration; thus, little is known about the long-term impacts of predatory threat on development in newly hatched fish. In the present study, newly hatched ocean pout (Macrozoarces americanus) were visually exposed to predatory juvenile Atlantic cod (Gadus morhua) for 6 h per day during the feeding period. At 3°C, 8 wk old pout not exposed to predators were significantly larger (standard length and wet mass), and had a higher hepatosomatic index than fish exposed to predators. Pout exposed to predators also had lower levels of whole-body phospholipids and triacyl-glycerol, as well as decreased levels of essential fatty acids (arachidonic acid and eicosapentaenoic acid). Interestingly, there were no differences in size, hepatosomatic index or lipid content between the 2 treatments when the experiment was performed at 8°C, despite a decrease in foraging activity of the pout exposed to predators at this temperature. These results suggest that frequent predatory threat can affect the development of newly hatched fishes, and that temperature can affect the ability to observe growth trade-offs when performing threat-sensitive foraging experiments with ectotherms.

Methratta, E., & Link, J. (2006). Seasonal variation in groundfish habitat associations in the Gulf of Maine-Georges Bank region *Marine Ecology Progress Series, 326*, 245-256. https://doi.org/10.3354/meps326245

Fish distributions are related to several habitat factors. We explored how the distribution of a 24 species assemblage is related to depth, temperature, substrate, season, and time-block using a 35 yr time series in the Gulf of Maine–Georges Bank region. We examined the relative importance of each factor, how it changes with season, and how individual species shift their relative distribution along environmental gradients on a seasonal basis. Distribution patterns were more strongly related to depth and temperature than to substrate type in both fall and spring. We observed 4 major patterns: (1) some species remained in relatively deep waters in both fall and spring; (2) some remained in relatively shallow habitats in both seasons and experienced wide temperature fluctuations as a result; (3) some moved from warmer shallow areas in the fall to warmer deep areas in the spring; (4) some traveled from the cool deep portion of the region in the fall to the cool shallow portion of the region in the spring. Of the 24 species examined, 19 declined in biomass over the study period in response to exploitation. The relationships between abundance and substrate type previously established for some species at local scales were weak at more synoptic spatial scales, although some trends in substrate associations were observed. Defining habitat at broad spatial scales remains a unique challenge. Compared to temperate systems, more refined habitat delineations for demersal marine fish have been established in tropical coral reef systems. Accordingly, much of our theory and the methodologies for applied spatial management have been derived from tropical systems. Differences between temperate and tropical systems necessitate modified approaches for temperate systems.

Methven, D. A. (1999). Annotated bibliography of demersal fish feeding with emphasis on selected studies from the Scotian Shelf and Grand Banks of the northwestern Atlantic: *Canadian technical report of fisheries and aquatic sciences 1488-5379 No. 2267* http://publications.gc.ca/pub?id=9.574014&sl=0

This document summarizes selected studies on the feeding ecology of demersal fishes from the Nova Scotian and Grand Banks regions of the northwestern Atlantic. Some studies from the eastern Atlantic and from Iceland are also included. The following information, if available, is recorded for each study; purpose, predator, predator size, dominant prey, prey size, location and time of study, how prey were quantified, number of predator stomachs examined, depth, bottom type, and calorific content of prey. Text describing the contribution of the dominant prey of each predator is also included and is summarized with respect to sources of variation known to influence prey selection. This includes: variation in the diet with respect to predator size, time of sampling, and sampling location. Eighty-nine studies are summarized. This feeding ecology of four species of Gadidae (Atlantic cod *Gadus morhua*; haddock *Melanogrammus aeglefinus*; pollock *Pollachius virens*; silver hake *Merluccius bilinearis*), three species of Pleuronectidae (American plaice *Hippoglossoides platessoides*; yellowtail *Pleuronectes ferrugineus* [=*Limanda ferruginea*]; winter flounder *Pleuronectes americanus* [*Pseudopleuronectes americanus*]), redfish *Sebastes* sp., wolffish *Anarhichas lupus*, and eelpout *Macrozoarces americanus* are outlined from these selected studies.

Keats, D. W., & Steele, D. H. (1993). Food of 0-group ocean pout (Macrozoarces americanus (Schneider)) in eastern Newfoundland: The importance of harpacticoid copepods. *Journal of Fish Biology 42*(1), 145-148. https://doi.org/10.1111/j.1095-8649.1993.tb00313.x

Stomachs of 0-group ocean pout from Newfoundland all contained harpacticoid copepods, which comprised 82% of the diet. 0-group ocean pout were found hiding among coarsely branched algae.

MacDonald, J. S. (1983). Laboratory observations of feeding behaviour of the ocean pout (Macrozoarces americanus) and winter flounder (Pseudopleuronectes americanus) with reference to niche overlap of natural populations. *Canadian Journal of Zoology/Revue Canadienne de Zoologie 61*(3), 539-546. https://doi.org/10.1139/z83-072

Laboratory observations of winter flounder (Pseudopleuronectes americanus) and ocean pout (Macrozoarces americanus) feeding on a variety of natural prey items provide an example of feeding methods influencing food resource division among syntopic fish. The ocean pout sorts mouthfuls of bottom sediment to obtain infaunal prey such as bivalves. The winter flounder relies more on vision to select prey exposed on the surface of the substrate. Winter flounder were also seen to remove the viscera from shells of bivalves that presumably were too large to swallow; however, the required increase in handling time may make bivalves a suboptimal prey.

Sheehy, D. J., Sissenwine, M.P., & Saila, S.B. (1974). Ocean pout parasites. *Marine Fisheries Review, 36*(5), 29-33. https://spo.nmfs.noaa.gov/content/ocean-pout-parasites

Approx 600 ocean pout, Macrozoarces americanus, were collected from 2 locations in Rhode Island Sound. Each specimen was skinned and filleted. The fillets were examined for visual lesions resulting from parasitic infections by the microsporidian, Plistophora macrozoarcidis. Of the specimens examined, 29 per cent had parasitic lesions, while 7.5 per cent had more than a single lesion. The incidence of infection was shown to be significantly correlated with the age, length and wt of the specimens, although most of the variability in the infection rate remains unexplained. No statistically significant differences in the rate of infection of infection between sexes or areas sampled were determined when the data were adjusted for variations in length. The incidence of lesions in the anterior ventral portion of the fillets was significantly higher than elsewhere, suggesting the possibility of removing the highly infected portions of the fillets as an inexpensive means of reducing the level of infection of the resulting product.

Section III: Fisheries

Historical: Commercial interest in ocean pout has waxed and waned. Ocean pout were marketed as a food fish during World War II, and landings peaked at 2,000 metric tons (mt) in 1944. However, an outbreak of a protozoan parasite that caused lesions on ocean pout eliminated consumer demand for this species.

From 1964 to 1974, an industrial fishery developed, and nominal catches by the U.S. fleet averaged 4,700 mt. Distant-water fleets began harvesting ocean pout in large quantities in 1966, and total nominal catches peaked at 27,000 mt in 1969. Foreign catches declined substantially afterward, and none have been reported since 1974. Commercial fisheries are conducted year round although peak activity occurs during the late winter and early summer. Otter trawl is the primary gear used.

United States landings declined to an average of 600 mt annually during 1975 to 1983. Catches increased in 1984 and 1985 to 1,300 mt and 1,500 mt respectively, due to the development of a small directed fishery in Cape Cod Bay supplying the fresh fillet market. Landings have declined more or less continually since 1987. In recent years, landings from the southern New England/Mid-Atlantic area have continued to dominate the catch, reversing landing patterns observed in 1986-1987, when the Cape Cod Bay fishery was dominant. The shift in landings is attributed to the changes in management (gear) regulations.

Modern: Ocean pout's total commercial landings in 2005 were 3.6 mt, a record low in the time series. Currently, there is no fishery for Ocean pout, but they are often caught incidentally while groundfishing is occurring. Based on the current 2014 assessment, the Ocean pout stock is overfished and overfishing is not occurring. Research needs are focused on understanding why the stock has not responded to low catch as expected and whether alternative biological reference points need to be explored.

Sources: NEFSC. (2015) Operational Assessment 20 Northeast Groundfish Stocks, Updated Through 2014. Reference Document 15-24 https://doi.org/10.7289/V5QC01G3

NOAA. (3/1/2018) Status of Fishery Resources off the Northeastern US. https://www.nefsc.noaa.gov/sos/spsyn/og/pout/

Pollack, A. (2015, November 19). Genetically Engineered Salmon Approved for Consumption. *The New York Times*. https://www.nytimes.com/2015/11/20/business/genetically-engineered-salmon-approved-for-consumption.html

An article offering a snapshot of responses to the FDA approval for genetically modified Atlantic salmon using Ocean pout and King Salmon.

Acheson, J., & Gardner, R. (2014). Fishing failure and success in the Gulf of Maine: lobster and groundfish management. *Maritime Studies, 13*(1), 1-21. http://dx.doi.org/10.1186/2212-9790-13-8

This article examines the reasons management of the New England groundfishery has failed, while management of the Maine lobster industry has succeeded. After 35 years of management, groundfish stock sizes and catches are lower than ever while lobster stocks are at record high levels. We argue that the New England groundfishing industry is caught in a prisoner's dilemma from which it has failed to escape. That dilemma is due to the interaction of social, political and economic variables that have lowered the benefits of investing in rules to conserve fish stocks. The lobster industry, once marked by a piracy ethic, has been able to escape from its dilemma and, over time, develop a strong conservation ethic and institutions. Our evolutionary game theory model indicates that three sets of factors are involved in this cultural transformation of the lobster industry, which has led to support for better conservation rules and for law enforcement.

Milazzo, M. J. (2011). Progress and problems in U.S. marine fisheries rebuilding plans. *Reviews in Fish Biology and Fisheries 22*(1): 273-296. https://doi.org/10.1007/s11160-011-9219-5

…This study is based primarily on a review of trends in the 2000-2010 period in fishing mortality and biomass levels of stocks in rebuilding programs, supplemented by recent US and international scientific literature. The major objectives of this study are, first, to assess progress achieved to date in these rebuilding plans, and, second, to identify the most significant obstacles to successful rebuilding. Sufficient data exists to monitor trends in fishing mortality and biomass levels number for just 35 stocks, out of a total 59 stocks that are currently rebuilding or have recently completed the rebuilding process…This report shows substantial progress in about two-thirds of the 35 rebuilding stocks included in this report. Progress is defined in two ways: either the rebuilding plan has reduced fishing mortality to an acceptably low level, or it has brought about stock recovery to a mandated target. Most significantly, the assessment of rebuilding plan case studies indicates that reductions in fishing mortality, especially when implemented early in the programs and maintained as long as necessary, lead to significant increases in stock abundance in roughly four of five stocks. At the same time, the case studies also show that, in about one-third of the rebuilding plans, recovery measures have not yet produced the desired outcomes. The two most common problems are failure to adequately control fishing mortality and low resilience (high susceptibility to fishing pressure) of certain categories of overfished stocks.

Brown, J. A., Somerton, D.C., Methven, D.A., & Watkins, J.R. (1992). Recent Advances in Lumpfish Cyclopterus lumpus and Ocean pout Macrozoarces americanus Larviculture. *Journal of the World Aquaculture Society 23*(4), 271-276. https://doi.org/10.1111/j.1749-7345.1992.tb00790.x

The aquaculture of marine finfish in Newfoundland presents a challenge due to the cold-water (<0 C) conditions which occur over a four to five month period. As part of a continuing research program on the culturing of cold-water marine finfish species we report on preliminary results of two “new” aquaculture species. The lumpfish and the Ocean pout both occur along the coast of Newfoundland and are adapted to a cold-water environment. Lumpfish have been reared from egg masses collected from the wild or from eggs stripped in the hatchery. Eggs and larvae are relatively large and larvae are well developed at hatch. Larvae will feed on day-old Artemia nauplii after four to six days. Survival over the first eight weeks is high but declines over the first year. Lumpfish cultured in the laboratory become sexually mature and produce eggs (roe) at the end of their second year. Ocean pout have been cultured only from egg masses collected from the wild. Eggs and larvae are extremely large compared to other marine finfish currently being cultured. Larvae hatch during the cold-water period, absorb the yolk-sac within 24 hours and are ossified at hatch. Juveniles feed on Artemia nauplii within two days at very low temperatures. Survival is comparatively high (75–80%) over the first year. Initial results are encouraging but more research is required before commercial production of these species would be feasible.

Jhaveri, S. N., Karakoltsidis, P.A., Shenouda, S.Y.K., & Constantinides, S.M. (1985). Ocean pout (Macrozoarces-Americanus) - Nutrient Analysis and Utilization. *Journal of Food Science 50*(3), 719-722. https://doi.org/10.1111/j.1365-2621.1985.tb13781.x

Ocean pout (Macrozoarces americanus), an underutilized marine species, was subjected to nutrient analysis, frozen storage stability studies and minced fish flesh evaluation. The nutritional quality of protein was higher than the reference casein, based on the protein efficiency ratio. A 3:1 ratio of unsaturated to saturated fatty acids was observed, making the product susceptible to rapid rancidity development. Mineral composition was low in calcium, magnesium and manganese but high in sodium and zinc, in comparison to other species. A decrease in water-holding capacity and an increase in free fatty acid and thaw drip volume of frozen fillets was observed. Mechanically deboned meat was acceptable by sensory evaluation, after 4 wk of frozen storage at −15°C. The effect of washing minced flesh was observed in the semi-fried product.

Sheehy, D. J., Shenouda, S.Y.K., Alton, A.J., Saila, S.B., & Constantinides, S.M. (1977). The ocean pout: an example of under utilized fisheries resource development. *Marine Fisheries Review*, *39*(6), 5-15. https://spo.nmfs.noaa.gov/mfr396/mfr3962.pdf

The results of a coordinated research and development effort, which addressed the biological, processing, and marketing problems involved in the development of a food fishery for ocean pout (Macrozoarces americanus), are described. Investigations indicated that the ocean pout is a substantial resource in southern New England waters, and suggest that there are unit stocks which experience little mixing. Chemical analysis and taste panel evaluation demonstrated that ocean pout is a lean fish, low in cholesterol content, and is highly acceptable to the US consumer. Marketing efforts which concentrated on a fresh fillet product have met with considerable success at both the retail and wholesale level. While only small amounts of pout for human consumption were landed in previous years, the 1976 landing in Pt. Judith, RI, alone approximated 1 million pounds. An extensive marketing program has been successful in expanding the marketing area and in significantly increasing sales volume.

Anonymous (1976). Something new on the seafood counters. *New England Marine Advisory Service Information.* (83): 3. Retrieved from ProQuest Earth, Atmospheric & Aquatic Science Databse.

The introduction of Ocean pout (Macrozarces americanus) onto the New England fish market at a time of high demand is reported. The fish, previously discarded by fishermen, is being sold in the markets in Rhode Island and New York at prices ranging from $1 a pound to $1.89. Efforts being made by a team at the University of Rhode Island to improve sales are discussed.

Section IV: Management

Witek, C. (2014, November 23). Ocean pout and windowpanes. *One Angler's Voyage.* Blog. Retrieved March 9, 2018, from: http://oneanglersvoyage.blogspot.com/2014/11/ocean-pout-and-windowpanes.html

An individual fisherman offers his opinion on a public blog about fishing laws and regulations pertaining to groundfish and Ocean pout are treated with specifically.

Sewell B (2013) Bringing Back the Fish: An Evaluation of U.S. Fisheries Rebuilding Under the Magnuson-Stevens Fishery Conservation and Management Act. *Natural Resources Defense Council*, New York, NY. https://www.nrdc.org/sites/default/files/rebuilding-fisheries-report.pdf

Report on the Magnuson-Stevens Fishery Conservation and Management Act that charts Ocean pouts progress since the species rebuilding plan began in 2004. Criticism of efforts for Ocean pout and others is recorded since the species has not increased the projected 25%.

Frulla, D., & Gehan S. (2012). Defining the new Magnuson-Stevens. *National Fisherman 92*(11): 9-10. Retrieved from, Proquest Earth, Atmospheric & Aquatic Science Database.

Oceana brought its own, recently decided, challenge to Amendment 16. While the organization did not prevail on many counts, it was far from the loss some press reports indicated. In a potentially significant ruling, the judge found unlawful Amendment 16's accountability measures for five minor species - ocean pout, windowpane flounder, Atlantic halibut, wolffish, and the Southern New England/Massachusetts winter flounder substock. Each has very low ACLs, and is found over relatively wide stock areas.

Pennington, M., & Volstad, J. H. (1991). Optimum Size of Sampling Unit for Estimating the Density of Marine Populations. *Biometrics, 47*(2), 717-723. http://doi.org/10.2307/2532157

Data from several trawling experiments and from some scallop dredge surveys indicate that, within limits, a smaller sampling unit can be more efficient than a larger unit for marine abundance surveys. Taking into account survey costs and sampling variability, the unit size is found that produces the most precise density estimate given a fixed amount of survey resources or, if a certain level of precision is required, the size of sampling unit that minimizes the total cost of the survey. As an illustration, the optimum sampling unit sizes are derived for surveys of some fish populations and for a scallop stock on Georges Bank.

Brown, J. A., Somerton, D. C., Hambrook, P. J., & Methven, D. A. (1989). Why Atlantic lumpfish and ocean pout are potential candidates for cold-water marine finfish aquaculture. *Bulletin of the Aquaculture Association of Canada*, pp. 50-52. Retrieved from ProQuest Earth, Atmospheric & Aquatic Science Database.

In order to diversify and broaden the base of the aquaculture industry, "new" species are being investigated to determine their potential for aquaculture. In this report we present the results of some preliminary experiments on two "new" species -- Atlantic lumpfish (Cyclopterus lumpus) and ocean pout (Macrozoarces americanus) -- being studied in Newfoundland to determine their potential for cold-water aquaculture.