MID-ATLANTIC FISHERY MANAGEMENT COUNCIL

Mid-Atlantic Fishery Management Council
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P. Weston Townsend, Chairman | Michael P. Luisi, Vice Chairman
Christopher M. Moore, Ph.D., Executive Director

MEMORANDUM

Date: September 22, 2023

To: Chris Moore

From: Jason Didden, Staff

Subject: *Illex* Hold Framework

Please find the following documents that support Council final action on the *Illex* Hold Framework:

-Summary of September 18, 2023 Mackerel, Squid, and Butterfish (MSB) joint Committee and Advisory Panel (AP) Meeting (including Committee Motions)

-Comments received for this agenda item before the briefing book deadline

-Draft Framework Document

Staff Recommendations

Staff supports the Committee recommendation to adopt Alternatives 3 and 4, which would require a non-binding hold declaration for directed *Illex* and longfin permits during annual permit applications. Staff consulted with NMFS regulatory staff and NMFS Science Center staff (including Cooperative Research Branch staff) to confirm that a systematic record of squid processing type would be useful. Such a record would not replace important discussions with industry about processing and other factors when developing Catch Per Unit of Effort (CPUE) analyses, but would be a useful starting point.

Regarding the hold baseline alternatives, the Committee did not express a preference for an alternative at the September 18, 2023 meeting. There are compelling arguments on each side of potentially adding a hold baseline or not. Fisheries in our region are negatively affected by both overcapacity (which baselines slow but do not eliminate) and lack of flexibility (which baselines make worse but are probably not the primary issue).

Fleet fishing capacity is very challenging to reduce once added through new or modified vessels. However, any baselines or associated restrictions could be removed or modified relatively easily by a future Council Framework action. This suggests there may be a benefit in adopting a hold baseline now, and then re-evaluating periodically.

Mackerel, Squid, and Butterfish (MSB)

Joint Committee and Advisory Panel (AP) Meeting Summary

September 18, 2023 (webinar)

The Mid-Atlantic Fishery Management Council's (Council) Mackerel, Squid, and Butterfish (MSB) Committee and Advisory Panel (AP) met jointly on September 18, 2023 at 10:30am. The purpose of this meeting was to review alternatives for the *Illex* Vessel Hold Capacity Framework (FW) Adjustment action, consider AP input, and develop Committee recommendations on preferred alternatives if appropriate.

MSB Committee Attendees: Peter Hughes (Chair), Joe Cimino**,** Michelle Duval**,** Dan Farnham**,** Kris Kuhn**,** Ken Neill**,** Adam Nowalsky**,** Robert Ruhle**,** Emily Gilbert (NMFS) Melanie Griffin (New England Fishery Management Council Committee member), and Eric Reid (New England Fishery Management Council Committee member).

MSB AP Attendees: Dan Farnham Jr, Emerson Hasbrouck, Gerry O' Neill, Greg DiDomenico, Jeff Kaelin, Katie Almeida, Meghan Lapp, Peter Kaizer, and Sam Martin.

Other Attendees: Jason Didden, Alan Bianchi, Carly Bari, Jessica Blaylock, and Maria Fenton.

After Committee Chair Hughes opened the meeting, Jason Didden of Council staff provided an overview of the FW's purpose, alternatives, previous AP input, and next steps. The AP and Committee discussed several items of clarification, including:

There are 76 *Illex* limited access permits. The focus of the action is establishing a hold baseline and upgrade restriction for all of these permits. Since 30 already have a hold baseline and upgrade restriction due to their mackerel permit, the requirement would be new for 46 permits. 2a and 2b only differ in whether a permit "on the shelf" in Confirmation of Permit History (CPH) when hold certifications would be due, could use a pre-existing survey from the last vessel the permit was on to establish a baseline when the permit is re-activated (2a = could use; 2b = could not use). There are currently 6 *Illex* permits in CPH. Follow-up with NMFS indicates none of the 6 *Illex* permits currently in CPH have an existing hold capacity limitation triggered by a mackerel permit. We believe at least one of the 6 has a survey from the last vessel the permit was on.

The processing type declaration would only be an indication of intent, and not binding within or between years. Follow up after the meeting between Council and NMFS staff (regulatory and science) confirmed broad agreement that having a systematic record of processing type could assist future Catch Per Unit of Effort (CPUE) analyses (and that ongoing discussions with industry would also be important for future refinements to CPUE analyses). There was concern voiced about whether such a declaration could become binding in the future and whether regulations should be generally used to address a science need. Staff noted that whether or not the Council adopted such a declaration requirement now, a future Council could reconsider such a requirement and/or the details of the requirements.

AP comments summary:

There was AP input both in favor and against the hold baseline, with similar rationales as previously reported. The primary tension is concern about further overcapitalization by those in favor of versus concern about maintaining flexibility by those opposed. It was also noted that establishing hold sizes could help assessments in the future if used to standardize CPUE analyses.

The Committee passed the following motions:

1. I move that the Committee forward alternatives 2a and 2b to the Council for consideration. 7/1/2
2. I move that the Committee recommend to the Council that the Council adopt Alternatives 3 and 4. 8/0/0

Staff clarified during the meeting that staff interpreted the Committee's intent was not contrary to final Council action occurring in October 2023 (including possibly on 2a or 2b), but that the MSB Committee preferred to not make a recommendation during the September 18, 2023 MSB Committee meeting. No opposition to this interpretation was voiced by the Committee.

NMFS indicated during the meeting that baselines are checked during vessel replacements. Staff clarified after the meeting with NMFS staff, several related questions that came up during this or previous discussions:

Q: Can a vessel permanently relinquish one permit from a permit suite?
A: Yes, a vessel owner can relinquish one or more permits from a permit suite.

Q: Do all relevant Mack T1/T2 permits have fish hold baselines on file?
A: Yes, all suites with a limited access *Illex* and T1/T2 mackerel have a mackerel fish hold baseline measurement on file. We have fish hold determinations for the 30 *Illex* permits that have relevant mackerel permits

Q: Are all current vessels with Mack T1/T2 permits within their hold baselines + 10%?
A: It is collected once with their replacement application or it was collected once with their qualification application. Vessel owners are supposed to tell us if they alter or increase any of their baseline measurements so that we can assess if that alteration is within their specifications. We don't require vessels to provide their fish hold measurement every year.

Dear Council,

I am reaching out to oppose the Councils' framework on hold capacity for illex. We already have restrictions on how much we can upgrade our vessels by. If my vessel needs replacing, we need to be able to have a variety of vessels to choose from. Narrowing down our choices, which is what this action will do, will hamper that effort, and could delay or even prevent us from doing so. My vessel fishes in several fisheries and those fisheries shouldn't be held to these restrictions, which is what this will do. This framework has consequences that reach outside the illex fishery.

Thank you,

Jamie McCavanagh

F/V Suan Rose

1-302-674-5399

Dear Mid-Atlantic Council,

I am writing to oppose any further restrictions on the Illex permits. I oppose vessel hold capacity as it will make it much harder to replace the vessel I run. With vessels aging we need a wide range of vessel sizes, within the restrictions we are already held to, to choose from for replacement vessels.
Not only will this impact us with Illex, but we fish for other species as well.

Sincerely,
Dave Monahan
F/V Lightning Bay

Dear MAFMC,

I am not in favor of the Illex hold capacity framework. We have had increases in quota and have not even caught our quota the past two years. Any more restrictions on this fishery are unnecessary.

We are already held to length and horsepower restrictions on any upgrades. Illex is not the only fishery that I participate in and additional restrictions on illex can reduce the flexibility I need in other fisheries.

Thank you,
Jason Power
F/V Kassidy Lyn

From:	Meghan Lapp
To:	Moore, Christopher; Townsend, Wes
Cc:	Didden, Jason; DiDomenico, Gregory
Subject:	Freezer/Fresh vessel CPUE and Illex Framework
Date:	Monday, September 18, 2023 12:13:29 PM
Attachments:	Merceretal.2023_fmars-10-1144108.pdf

Hi Chris,

Just wanted to send you this for the Council meeting to include in the briefing materials/distribute to Council members. In today's MSB Committee meeting, there were quite a few people that didn't seem to know that this work existed re the freezer/fresh boat CPUE and existing as well as ongoing research on the topic of CPUE and illex/loligo science. Right now there is also continuing work, which Anna Mercer at the NEFSC and Mike Wilberg and Paul Rago from the SSC are also leading, if you wanted to reach out to them.

I don't think most people understood that science is going on already on this topic, cooperatively and without need for additional permit requirements. There seemed to be a disconnect between the regulatory folks and science folks at the agency as to what initiatives are ongoing and therefore what would be necessary as part of a Council action.

Thanks,
Meghan

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Bringing in the experts: application of industry knowledge to advance catch rate standardization for northern shortfin squid (*Illex illecebrosus*)

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Sources of fisheries information outside of fishery-independent surveys (e.g. fishery-dependent data) are especially valuable for species that support productive fisheries and lack reliable biological information, such as the northern shortfin squid (*Illex illecebrosus*). Fishery-dependent data streams are available for most species, however collaboration with industry members is critical to ensure that these fishery-dependent data are collected, applied, and interpreted correctly. Despite the need for collaboration and the frequency that fishery data are used in scientific research, there is limited literature on the structure of interactions and knowledge sharing that inform the analysis and application of fishery data. Between 2019 and 2022, a group of researchers collaborated with members of the northern shortfin squid fishing industry to bring together research data sets and knowledge from harvesters and processors to better describe the fishery dynamics, distribution, life history, and oceanographic drivers of the species. The collaboration focused on developing custom standardized fishery catch per unit effort (CPUE) indices to provide indicators of population trends that accounted for the impacts of technical and economic aspects of harvesting, processing and marketing on fishing effort, selectivity and landings of northern shortfin squid. We describe the methods used to inform and interpret the CPUE analyses, focusing on novel structure of interactions we had with industry members, and suggest best practices for integrating industry knowledge into CPUE standardization. The information shared and research products produced through this science-industry research collaboration advanced understanding of northern shortfin squid population and fishery dynamics, and contributed directly to the 2022 stock assessment and management process. Given the complex and stochastic nature of the northern shortfin squid population and fishery, we found it critical to maintain open communication and trust with processors and harvesters, who have unique insight into the factors that may be driving changes in catch, landings, and productivity of the valuable resource species.

KEYWORDS

shortfin squid, stock assessment, cooperative research, local ecological knowledge, northeast United States, catch per unit effort, fisheries dynamics

1 Introduction

For many marine resource species, it is infeasible to collect comprehensive fishery-independent data due to mismatches between survey scope and species distribution, phenology, or life history (short lived). For these species, fisheries science and management rely heavily on fishery-dependent data collected by harvesters, processors, and dealers, commonly included in the form of catch per unit effort (CPUE) indices in stock assessments (Hilborn and Walters, 1992; Maunder et al., 2006). These data sets contain valuable information about resource species, but are also influenced by the socioeconomic and technical aspects of fishing (Walters, 2003; Quirijns et al., 2008). Thus, it is essential to collaborate with the fishing industry to understand these data, inform analytical approaches, and interpret results (Steins et al., 2022; Calderwood et al., 2023). The statistical methods used for CPUE standardizations are well described (Maunder and Punt, 2004; Bishop et al., 2004; Bishop, 2006; Bentley et al., 2012; Cheng et al., 2023), however, the methods for effectively engaging with industry to identify relevant explanatory variables and interpret CPUE indices are rarely implemented and not well documented. Fishery data are used extensively in scientific research, but there is limited literature on the science-industry research collaborations that are key to informing the analysis and application of fishery data (Mangi et al., 2018; Steins et al., 2022; Calderwood et al., 2023). In this manuscript, we present recent research on the northern shortfin squid (*Illex illecebrosus*) that sought to establish best practices for gathering information from the fishing industry and integrating that information in CPUE standardizations.

Northern shortfin squid is a semi-pelagic squid with a lifecycle of less than a year that occupies Slope Sea and continental shelf habitats from Florida to northern Canada (Dawe and Hendrickson, 1998; Hendrickson, 2004; Jackson and O'Dor 2001). Their distribution and growth are highly variable, largely due to the impact of oceanographic dynamics on physiology and movements (Dawe and Warren, 1993; Boyle and Rodhouse, 2005; Salois et al., 2023). Northern shortfin squid are semelparous, with females dying shortly after they mate. Research suggests that they spawn throughout the year and produce multiple cohorts, but recruitment dynamics of northern shortfin squid are poorly understood (Hendrickson, 2004). Northern shortfin squid inhabit the Slope Sea (water mass between the Gulf Stream and the continental shelf) during the winter months and migrate onto the continental shelf during the late spring and early summer months (Dawe and Beck, 1985; Hatanaka et al., 1985; Perez and O'Dor, 1998). Spring and fall fishery-independent bottom trawl surveys of the continental shelf from Cape Hatteras, U.S. to Nova Scotia, Canada sample a portion of the population; however, these surveys do not occur during periods of peak northern shortfin squid abundance on the continental shelf (Hendrickson, 2004).

In the northeastern United States, northern shortfin squid are targeted by a bottom trawl fishery during summer months (May-September), with landings ranging from approximately 2,000 to 28,000 metric tons (Arkhipkin et al., 2015; Doubleday et al., 2016; Northeast Fisheries Science Center (NEFSC), 2021). Vessels targeting northern shortfin squid range from approximately 15 to 45 meters in length and harvest northern shortfin squid on the outer continental shelf at depths of 109-365 m (Lowman et al., 2021). The Mid-Atlantic Fishery Management Council sets an annual quota for northern shortfin squid that is shared by all permitted vessels.

Because of the species' variable abundance and its use of habitats beyond the range of fishery independent surveys, northern shortfin squid are difficult to assess and manage, as are many squid stocks around the world (Arkhipkin et al., 2021; Northeast Fisheries Science Center (NEFSC), 2006). In the absence of comprehensive survey data, many squid assessments rely upon fishery-dependent data to develop indicators of fishery and population dynamics and population condition (Pierce and Guerra, 1994; McAllister et al., 2004; Roa-Ureta, 2012; Arkhipkin et al., 2021). The interpretation of fishery CPUE as an indicator of population trend, however, is potentially confounded by global market drivers, management measures, technical constraints of fishing, and gear selectivity, among other factors (Maunder and Punt, 2004; Maunder et al., 2006). In order to identify the social and economic factors impacting catch rates and account for them in CPUE standardization, it is necessary to assimilate the experiential knowledge of harvesters and processors (Steins et al., 2020; Mackinson, 2022; Steins et al., 2022). Novel modeling tools, such as spatiotemporal delta-generalized linear mixed models, structured additive distributional regression, and simulations further enable researchers to identify bias in and derive population trends from fishery dependent data (Mamouridis et al., 2017; Clegg et al., 2022; Ducharme-Barth et al., 2022; Karp et al., 2022).

Over the years, researchers have developed collaborations with the northern shortfin squid industry to address specific research needs including biological data collection (Johnson, 2011). Several recent research efforts associated with the 2021 Northern Shortfin Squid Research Track Stock Assessment focused on developing science-industry research collaborations (SIRC) to increase our understanding of the species and inform science-based management of the fishery (Northeast Fisheries Science Center (NEFSC), 2021). These recent collaborations are rooted in a mutual recognition of, and appreciation for, the valuable knowledge that the northern shortfin squid industry has accumulated over many decades. The research collaboration we describe here leveraged industry knowledge to better understand the dynamics of the northern shortfin squid population, fishery, and associated environment. Specifically, this paper details a SIRC that integrated the technical and economic knowledge of northern shortfin squid harvesters and processors into the development of standardized CPUE indices as measures of abundance for northern shortfin squid. We describe the approaches to industry collaboration that were utilized to inform the CPUE standardization process, including a northern shortfin squid summit with both industry and scientists, as well as a series of semi-structured conversations. We also discuss how the information shared by industry was integrated in the stock assessment process. In the absence of a model-based stock assessment, the management of northern shortfin squid is informed by other research products, including the work presented in this manuscript. By describing this SIRC process and the strategies used, we hope to provide a model for bringing industry knowledge into assessments of other stocks.

2 Phases and outcomes of northern shortfin squid science-industry research collaboration (SIRC)

2.1 Overview

Here we describe four layers of collaboration with the northern shortfin squid industry that helped to facilitate the development of robust and high-resolution CPUE series: 1) an initial summit with industry, scientists, and managers, 2) a subsequent series of structured conversations with individual processors and harvesters, 3) quantitative application of industry knowledge to CPUE standardizations, and 4) sustained communication throughout the stock assessment process. These interactions occurred in sequence, and represented an organized framework for developing scientific products from fishery-dependent knowledge and data sources.

2.2 Initiating collaborations through northern shortfin squid summit

A two-day "Northern Shortfin Squid Population Ecology and Fishery Summit" hosted by members of the northern shortfin squid fishing industry was held in November 2019 to discuss current understanding of the northern shortfin squid and its fishery, and to identify research priorities leading up to the 2022 stock assessment. The Summit brought together over 30 harvesters, processors, academic scientists, government scientists, and fishery managers to discuss the ecology, population dynamics, and management of northern shortfin squid. The summit was sponsored by the fishing industry and was held outside of formal stock assessment and management proceedings. The goal was to develop a framework for establishing collaborative research products in the near term that could reduce scientific uncertainties limiting responsive fishery management (Manderson, 2020). The priorities identified and relationships formed during this summit kickstarted several science-industry collaborations that ultimately informed northern shortfin squid stock assessment and management. The information detailed below was obtained explicitly through the Northern Shortfin Squid Population Ecology and Fishery Summit, which exemplifies the value of such forums for sharing knowledge and data, and building relationships.

One major summit product was the definition of the different fleets participating in the northern shortfin squid fishery and description of fishing operations characteristic of each fleet. Specifically, northern shortfin squid processors and harvesters emphasized that fleet type is a critical factor influencing fishing behavior and catch rates, with the freezer trawler fleet that catches and freezes squid at sea operating significantly differently than the "wet boat" fleet that temporarily stores squid in Refrigerated Seawater Systems (RSW) or on ice before offloading fresh squid at shoreside processing plants. While it is rare for vessels to switch from one fleet to another, two freezer vessels have been retrofitted with RSW systems since 2010 to enable operational flexibility. This information is well known by the fishing industry, but is not well documented in the scientific literature or previous stock assessments. While the hold type of individual vessels could not be documented during the summit, general differences between fleet types were discussed. Since the late 1990s, the wet boat fleet has dominated the northern shortfin squid fishery during periods when the species is widely available, while the freezer boat fleet has been a stable component of the fishery in all years (Figure 1). In recent years, the freezer trawler fleet (<10 vessels, 23 - 45m in length) has been approximately one-third the size of the wet boat fleet (>30 vessels, 15 - 30m in length). Because they process and freeze squid at sea, freezer trawlers typically remain at sea for longer periods of time and search over larger areas compared to wet boats. Freezer trawler catch, effort, and landing rates are largely driven by the relatively long handling times associated with freezing squid at sea; freezer trawlers can only freeze a certain quantity of squid at a time, and thus, have to stop fishing to process squid after a certain amount are caught. Freezer trawler operations are less influenced by

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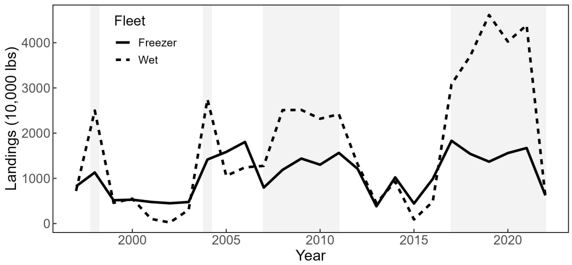

FIGURE 1
Northern shortfin squid (*Illex illecebrosus*) landings from 1997 to 2022. Dashed line represents wet boat landings. Solid line represents freezer trawler landings. Shaded grey areas highlight years in which the 'Wet Boat' fleet reported higher annual landings than Freezer Trawlers.

price than the wet boat fleet and are unlikely to switch species if northern shortfin squid are less available or if prices are low. Conversely, wet boats have short handling times and catch, effort, and landing rates can be high if northern shortfin squid, which are highly perishable, are available at locations less than about 72 hours from shoreside processing plants. Trip durations of the wet boat fleet are short, and effort is strongly driven by the price and availability of squid. Wet boats are more likely to switch to other species if northern shortfin squid prices or availability are low. An action item moving forward from the summit, and now being considered by the Mid-Atlantic Fishery Management Council (MAFMC) as a management requirement, was to document individual vessel hold types to be able to formally account for fleet type in CPUE calculations and other data analyses.

Another important summit product was the description of the global market dynamics that impact the northern shortfin squid fishery. Specifically, northern shortfin squid from the Northwest Atlantic compete in the global market with Argentine shortfin squid (*Illex argentinus)* squid caught in the Southwest Atlantic (Falkland Islands to Southern Brazil) and Japanese flying squid (*Todarodes pacificus)* caught in the North Pacific. Annual landings of squid in the Southwest Atlantic and North Pacific are typically 30-35 times larger than northern shortfin squid production in the Northwest Atlantic. The Argentine shortfin squid fishery in the Southwest Atlantic occurs during the austral summer and closes just before the beginning of the northern shortfin squid fishery season in the northwest Atlantic, which begins when northern shortfin squid migrate onto the continental shelf. As a result, the supply of squid from the Southwest Atlantic fishery regulates demand, and sets the baseline price and risk appetite for inventory for the U.S. northern shortfin squid fishery. Documenting annual trends and scale of landings of Argentine shortfin squid and Japanese flying squid for integration into CPUE standardizations and further analyses was, therefore, identified at the summit as an important next step (Table 1).

The summit also provided a valuable opportunity for members of the fishing industry and science community to share information about the dynamics of the northern shortfin squid population and fishery, develop priorities for research efforts going forward, and form industry-science relationships to facilitate ongoing collaboration. The research efforts prioritized at the summit included 1) quantify the overlap between the U.S. northern shortfin squid fishery and stock distribution to better estimate availability, escapement and the impact of fishery removals (Lowman et al., 2021); 2) define the hold type (freezer, RSW, ice) of each vessel participating in the fishery to enable explicit integration of the impacts of differences in handling in CPUE standardization and stock assessment modeling; 3) explore methods to quantify market dynamics impacting fishing behavior and include in CPUE standardizations; 4) explore how environmental conditions affect the distribution and productivity of northern shortfin squid; and 5) develop a streamlined mechanism to compile northern shortfin squid mantle length and body weight data collected by processors and use data to better understand northern shortfin squid movement, growth, and environmental drivers. In order to address these research priorities, additional conversations with individual harvesters and processors were required for data collection, hypothesis formulation, and interpretation purposes.

2.3 Documenting knowledge through targeted conversations with industry

Following the summit, we held semi-structured conversations with representatives of six northern shortfin squid processors and 17 northern shortfin squid harvesters. The six processors have been responsible for processing and marketing 75-90% of the total landings of northern shortfin squid in U.S. waters since 1997. Most of the 17 harvesters had participated in the northern shortfin squid fishery for at least a decade. The harvesters collectively represented all ports participating in the fishery and included six that fish out of New Jersey, eight that fish out of Rhode Island, and three that fish out of Massachusetts. Of the 17 harvesters consulted, four operate vessels that freeze squid at sea, seven operate vessels that store squid on ice, and six operate vessels with RSW systems. Thus, all vessel/processing types described above were represented. In addition to the 23 industry members consulted *via* semi-structured conversations, an additional 63 harvesters were contacted to characterize the hold type for each vessel that had participated in the fishery since 1997.

Conversations with harvesters were guided by a list of standard questions about technical and economic factors influencing catch and effort in the fishery developed collaboratively by members of

TABLE 1 Food and Agriculture Organization (FAO) capture production for northern shortfin squid, Argentine shortfin squid in the southwestern Atlantic and Japanese flying squid in the north Pacific and the relative scale of northern shortfin squid capture production to these fisheries (capture production ratio).

	FAO Capture Production (metric tons)			Capture Production Ratio	
Year	Northern Shortfin	Argentine Shortfin	Japanese Fying	Argentine Shortfin/ Northern Shortfin	Japanese Flying/ Northern Shortfin
1997	34,561	991,799	603,367	29	17
1998	26,989	700,443	378,605	26	14
1999	5,667	1,153,279	497,887	204	88
2000	6,245	984,589	570,427	158	91
2001	2,296	750,452	528,523	327	230
2002	3,044	540,414	504,438	178	166
2003	4,437	503,625	487,576	114	110
2004	18,234	178,974	447,820	10	25
2005	10,841	287,590	411,644	27	38
2006	16,868	703,804	388,087	42	23
2007	5,132	955,044	429,162	186	84
2008	9,526	837,935	403,722	88	42
2009	11,727	261,227	408,188	22	35
2010	20,654	189,967	359,322	9	17
2011	23,821	187,822	414,100	8	17
2012	14,696	311,754	350,381	21	24
2013	10,991	496,211	337,925	45	31
2014	7,568	862,867	339,685	114	45
2015	4,355	1,011,356	295,304	232	68
2016	9,094	146,645	197,252	16	22
2017	24,431	335,998	155,573	14	6
2018	28,350	301,157	97,180	11	3
			Median	35.5	33
			Minimum	8	3
			Maximum	327	230

Data from http://www.fao.org/fishery/statistics/global-capture-production/en.

the Northern Shortfin Squid Research Track Stock Assessment Working Group. The questions were sent to harvesters to review before conversations were held either by telephone, video meeting, or in person. Notes were compiled for each conversation, which were provided to each harvester to review for accuracy and completeness. Follow up conversations to clarify responses and mechanisms were *ad hoc* and numerous.

During semi-structured conversations with industry members, further details about freezer trawler and wet boat fleet dynamics were identified by the industry and discussed. For example, industry members described how the availability of northern shortfin squid and alternative stocks, changes in the global market, and investment in shoreside processing have caused the northern shortfin squid fishery to change from one dominated by trawlers freezing squid at sea, to a fishery in which vessels store squid in RSW systems or on ice and sell them to shoreside processor/dealers (Figure 1). Freezer trawlers can store up to 650,000 pounds of frozen squid in a 7-10 day fishing trip and usually complete around 12 fishing trips per year. Freezer trawlers generally make fewer trips in years when the global market is saturated with squid, prices are low, and large inventories are held in cold storage. While catch rates of freezer trawlers are limited by shipboard freezing rates, capacities to store large quantities of frozen squid shipboard allow the vessels to fish grounds distant from shoreside facilities. Alternatively, large RSW vessels can land up to 300,000 pounds in a 1-2 day fishing trip, usually completing well over 20 trips per fishing season. Since northern shortfin squid are highly perishable and the vessels generally need to return to port within 72 hours of first catch, RSW and ice vessels are profitable when the squid are concentrated on fishing grounds near enough to shoreside processing plants so that vessels can reach plants before squid begin to spoil. Rapid transit from fishing grounds to processing plants is particularly critical for vessels that store squid on ice, which is less effective than RSW at quickly reducing product temperature to maximize product quality. Thus, the perishability of squid combined with market demand for high quality product imposes constraints on the duration of fishing trips, location of fishing grounds, and the timing of landings for ice and RSW vessels that deliver to shoreside processors. Wet boats and shoreside processing are profitable when squid are persistently available in large quantities.

Beyond fleet type and market dynamics, industry members identified several other factors that impact northern shortfin squid catch and effort: fuel price, hold/tank capacity, length of time catch remains fresh, gear conflicts, recent increases in participation in the northern shortfin squid fishery, weather, time of day, and environmental conditions.

Fuel price was cited by several harvesters as an important determinant of fishing behavior. Specifically, when fuel price is high, harvesters are less likely to search over large areas, as the potential benefit of more productive fishing grounds is outweighed by the high cost of fuel. Thus, in years or weeks when fuel price is high, catch or landings per unit effort indices may be decoupled from the condition of the northern shortfin squid population, as vessels are more likely to continue to fish on lower densities of squid to conserve fuel.

Hold or tank capacity was also described as a major driver of fishing behavior. Vessels with larger hold or tank capacities are more likely to steam farther from port to fish in areas where northern shortfin squid densities are highest. This is particularly true for freezer vessels, which are not constrained by the perishability of fresh squid. RSW vessels with larger hold capacities can also benefit from larger area searches, as the benefit of highly productive tows outweighs the cost of the extra steam time as long as the squid can be kept from spoiling. Vessels with lower tank or hold capacity are more likely to fish closer to port where squid densities are lower, as they do not require high densities of squid to fill their hold/tanks.

The length of time that catch remains fresh was specifically identified as impacting fishing location, likelihood of changing fishing locations, and limits to catch per tow for ice and RSW vessels. As described above, the length of time that catch remains fresh depends on the vessel type, with ice vessels having the shortest time that catch remains fresh (48 hours), followed by RSW (72 hours), and freezer (weeks). Thus, wet boats are more likely to fish closer to port, even if northern shortfin squid are less productive in those areas. Wet boats are also less likely to change fishing locations, as time spent steaming between fishing grounds is time when squid quality is degrading and no additional catch is occurring. Finally, total catch per tow is limited by the amount that can be processed while staying cold enough to maintain quality.

In addition to the vessel-specific factors impacting northern shortfin squid catch and fishing effort described above, harvesters also identified several management-related factors that drive when, how, and where they fish. Restricted Gear Areas, which are intended to separate mobile gear and fixed gear, preclude mobile gear vessels from fishing along the shelf break from the northern edge of Hudson Canyon to Atlantis Canyon during the northern shortfin squid fishing season (Figure 2). Fishing regulations (e.g. small mesh restricted areas) and technical constraints also limit northern shortfin squid fishing throughout most of the Gulf of Maine.

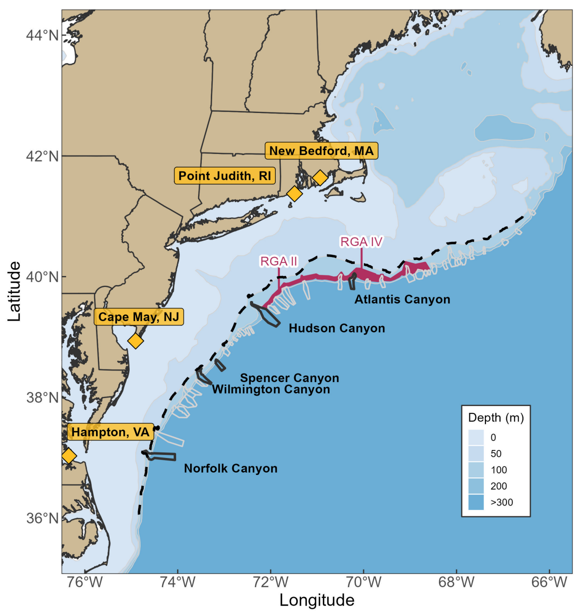

FIGURE 2
Map of the general extent of northern shortfin squid fishing grounds (dotted black line), Restricted Gear Areas (RGA - solid maroon polygons), ports with squid processing facilities (yellow diamonds), and major canyons (solid lines of black or grey) along the continental shelf (approximately 200 m isobath).

Thus, lack of landings from these areas are not due to the absence of northern shortfin squid, but due to the exclusion of mobile gear or all fishing. In addition to formal gear restricted areas, there are also areas where the density or location of fixed gear makes it impossible to fish mobile gear and harvest northern shortfin squid. These areas vary by year, following the distribution of the offshore lobster and crab fisheries.

As mentioned previously, there has been a significant change in the composition and number of participants in the northern shortfin squid fishery in recent years. The static and common quota for northern shortfin squid has always resulted in some level of competitive fishing. In 2017-2021, with more vessels harvesting northern shortfin squid and a limited and common quota, the quota was harvested faster. This has changed the dynamics of the fishery substantially.

Another factor affecting fishing behavior of northern shortfin squid harvesters is weather. Severe weather (strong winds, high seas) can impede vessels from safely sailing, from keeping their gear on the bottom, or from effectively catching squid. Severe weather also makes it difficult to maintain ship stability on RSW and ice boats when they transport large volumes of fresh squid to shoreside processing plants in rough conditions. Squid are also sensitive to the conditions of the water column and often disperse during large storms. Thus, northern shortfin squid catch and landings may decline or cease for weeks during years in which large storms have impacted the Mid-Atlantic or offshore Southern New England. Weather plays into a harvester's decision about whether to fish, but it is variable by vessel type, vessel size, port, and captain. Further research is needed on the threshold of weather conditions that prevent fishing or scatter northern shortfin squid, and therefore effectively shut the fishery down temporarily.

Many harvesters noted that the catch rate of individual tows varied greatly throughout the day. The most productive tows most commonly occur at dawn or dusk, with midday tows yielding lower catch rates. This is likely related to the diel vertical migration of northern shortfin squid, with squid more strongly associated with the seabed, and thus more available to bottom trawling, during daylight. Aggregation near the seabed is especially pronounced during morning and evening twilight on the outer edge of the shelf during the summer months (Benoit-Bird and Moline, 2021). In addition, harvesters noted that northern shortfin squid fishing is typically less productive on and around the full moon.

Finally, harvesters largely agreed that there are oceanographic drivers of northern shortfin squid. Specific oceanographic drivers discussed by harvesters included Gulf Stream position, Gulf Stream warm core rings, eddies, filaments, streamers, southerly winds, and upwelling zones. Although hypotheses were abundant, the harvesters consulted were not confident that pre-season oceanographic conditions could be used to forecast the productivity or availability of northern shortfin squid in a given year. While oceanographic features may be observed to be associated with high or low quantities of northern shortfin squid at one time, the relationships are often not consistent (Dawe et al. 2007; Rodhouse et al. 2014; Moustahfid et al. 2021). Harvesters recommended that additional research is needed on this topic to identify and test hypotheses related to the oceanographic drivers of northern shortfin squid.

2.4 Applying industry knowledge to Catch Rate standardization

The knowledge shared by members of the northern shortfin squid fishing industry were used to define how fishery dependent data were handled and which covariates were applied in the development of CPUE indices. For example, we used information provided by industry members to define and differentiate freezer trawler and wet boat fleets within the data, which enabled discrete CPUE modeling of the two fleets. We used a stepwise approach to prioritize the other factors that industry members described as important in driving catch and effort for inclusion as covariates in CPUE standardization. First, we determined which factors were consistently identified by members of the fishing industry. Second, we determined which factors were likely to be correlated due to similar underlying drivers. Third, we determined which factors were quantifiable with available data. These factors were then used as covariates in the CPUE standardizations.

Ultimately, three fishery dependent data sets maintained by the Northeast Fishery Science Center (NEFSC) were used for the landings and CPUE standardizations: dealer/logbook, Observer program, and Study Fleet program (Figure 3). The dealer/logbook data set is a census of landings that comprehensively describes northern shortfin squid landings, as they have been collected for every northern shortfin squid fishing trip since 1996 as part of federal reporting requirements. The spatial resolution and time step of the data set, however, are relatively coarse, with landed catch information recorded at the sub-trip level (i.e. one record of total landed catch per statistical area per fishing trip). As part of routine data auditing procedures, mandatory dealer reports are compared to the self-reported logbooks to verify reported landings. The Observer program data set comprises catch, bycatch, and fishing effort information for individual tows collected by independent observers through the Northeast Fisheries Observer Program during a subset of randomly selected northern shortfin squid fishing trips since 2011 (Wigley and Tholke, 2020). The observer data set covers 4-10% of northern shortfin squid fishing trips in a given year, with lower coverage in recent years, especially during the COVID-19 pandemic. Finally, the Study Fleet data set is composed of detailed catch, bycatch, fishing effort, and bottom water temperature data for individual tows that are self-reported by harvesters participating in the Study Fleet program (Jones et al., 2022). The Study Fleet data set covers up to 45% of northern shortfin squid fishing trips in recent years.

We used conventional statistical methods for building standardized CPUE indices. All statistical analyses were performed using R version 3.6.2 (R Core Team, 2019). Generalized additive models (GAMs) were fitted using the mgcv package (Wood, 2011). Based on histograms of CPUE and LPUE, we investigated several error distributions: lognormal, gamma (with log link), and negative binomial (with log link). Based on the most

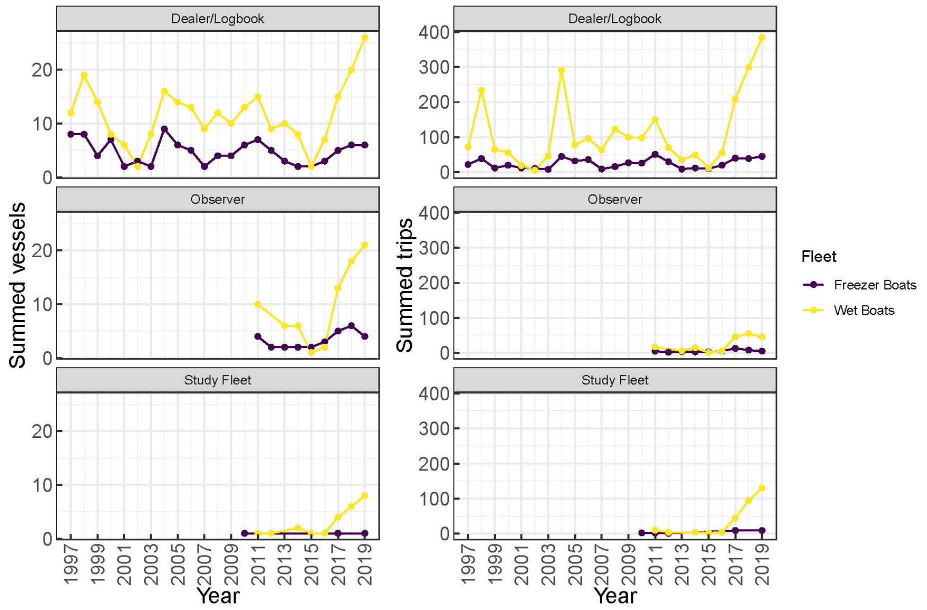

FIGURE 3
Time series of northern shortfin squid fishery participation (number of vessels, left panels) and effort (number of trips, right panels) across the Dealer/Logbook, Observer, and Study Fleet data sets. Purple lines indicate freezer vessels. Yellow lines indicate wet boats (ice and refrigerated sea water).

promising set of diagnostics (quantile-quantile plots, Cook's distance, and residuals), we built GAMs with the corresponding distribution using forward stepwise selection of explanatory variables with AIC and percent deviance explained as the selection criteria. For further detail on statistical methods, see Supplementary Material. Additional information is also available as a working paper supplement to the 2022 Illex Research Track Assessment (available online through the NEFSC Stock Assessment Support Information portal at https://apps-nefsc.fisheries.noaa.gov/saw/sasi.php).

A variety of social and environmental factors identified by the fishing industry at the summit and during individual conversations were considered as covariates in the CPUE standardization. These included year and week effects, weekly domestic squid and fuel

TABLE 2 Factors that impact northern shortfin squid catch and effort identified by industry collaborators and considered in CPUE standardization.

Factor	Source	Freezer Fleet CPUE		Wet Boat Fleet CPUE		
		Dealer/ Logbook	Observer	Dealer/ Logbook	Observer	Study Fleet
Fleet (freezer or wet boat)	Summit, Conversations	X	X	X	X	X
Year - factor	Summit	X	X	X	X	X
Weekly domestic price of Illex - smooth	Summit	X	X	X	X	X
Landing port - factor	Conversations	X		X		
Days absent - linear	Conversations	X		X		
Fishing location - two-dimensional smooth	Summit	X	X	X	X	X
Week of the year - factor	Summit					X
Distance (straight line, km) from fishing grounds to landing port - linear	Conversations		X			
Landing port state - factor (aggregated due to low sample size in individual ports)	Conversations				X	
Weekly diesel price	Conversations					
Global Ommastrephid landings	Summit					

The source of factors included in final CPUE models are marked with an X in the corresponding model column. Comparison of top catch rate standardization models for each fleet in each data set.

prices, the state and port where squid were landed, the number of days a vessel was absent from port, the location of the fishing activity, the distance from the landing port to the fishing location (a straight line distance estimate), and global Ommastrephid production. A subset of these variables were ultimately included in final models to each data set for each vessel hold type (freezer or wetboat: see Table 2). Models were fit to each data set, rather than a combined data set, due to differences in spatiotemporal resolution across data sets. For example, the Observer and Study Fleet data sets contain northern shortfin squid catches for individual fishing tows, while the dealer/logbook data set contains total northern shortfin squid catch from a fishing trip. Additionally, not all data sets include records of discarded catch, therefore we used landings per unit effort (LPUE) as the response variable in modeling. Because discards are negligible in the northern shortfin squid fishery, landings are nearly equivalent to catch and we therefore use the terms LPUE and CPUE interchangeably.

Domestic prices for northern shortfin squid by week are included in the CPUE and LPUE standardizations because some harvesters noted that they modified their fishing behavior based on fluctuations in price. For example, when price is high they may stay on a less dense aggregation of squid and accept a lower LPUE, when they would otherwise move on to search for denser fishing ground when prices are lower. Domestic price is calculated based on total landed value divided by the total landings (pounds) for each week. Prices were adjusted for inflation by standardizing to 2019 USD, using the Gross Domestic Product Implicit Price Deflator from the Federal Reserve Economic Data (U.S. Bureau of Economic Analysis). Prices from the week preceding a fishing trip were used to reflect the fact that fishing decisions are made based on the information available when boats leave the dock, not the price when they land.

Global harvest of Ommastrephids was consistently reported by industry members as a major factor affecting northern shortfin squid LPUE. Therefore, annual global landings of Argentine shortfin squid (*Illex argentinus*) and Japanese flying squid (*Todarodes pacificus)* were included in the CPUE and LPUE standardizations as indicators of the global Ommastrephid squid market (Tables 1; 2). The Argentine shortfin squid fishery occurs primarily in the first half of the year before the U.S. northern shortfin squid fishery, so Argentine shortfin squid landings were not lagged during covariate development. Conversely, the Japanese flying squid fishery occurs primarily in the second half of the year, so Japanese flying squid landings were used from the year previous to the northern shortfin squid fishing year.

Fuel price was reported by harvesters to impact fishing behavior in a similar way to the domestic northern shortfin squid price. When fuel is more expensive, harvesters are less willing to search or move off a moderately productive spot. Diesel price for the New England region of the U.S. was pulled from the Energy Information Administration and prices were adjusted for inflation by standardizing to 2019 USD using the Gross Domestic Product Implicit Price Deflator from Federal Reserve Economic Data.

Landing port and days absent (trip duration) were also included as covariates in the CPUE and LPUE standardizations, as harvesters noted longer trips were often associated with lower CPUE. In addition, the distance to fishing grounds was calculated as the straight line distance between the reported fishing location and the landing port.

Using the data sets described above and covariates highlighted by industry, we developed GAMs using forward stepwise selection with Akaike's Information Criterion (AIC) and percent deviance explained as the selection criteria (Wood, 2017). Ongoing discussions with fishing industry collaborators and the stock assessment working group produced suggestions for model adjustments, insight into the CPUE trends produced, and explanation of the non-linear effects of covariates. Feedback was received during one-on-one or small group conversations with fishing industry collaborators as well as during stock assessment working group meetings. The process was iterative, with the CPUE models and outputs taking many shapes along the way. Ultimately, the CPUE and LPUE indices developed were utilized to assess the general trends in northern shortfin squid abundance across years (Figure 4). Each distinct CPUE and LPUE series provided useful insight into the dynamics of the northern shortfin squid fishery in addition to species abundance. Further, congruence between these CPUE and LPUE with other indices developed for the northern shortfin squid stock assessment, provided confidence in the accuracy of the trends (Figure 5). For additional information on CPUE model building, see Supplementary Materials.

2.5 Integration of fishery knowledge into the stock assessment

Several members of our research team formally and informally participated in the Northern Shortfin Squid Research Track Stock Assessment Working Group, which was initiated several months after the summit. Industry members also regularly participated in stock assessment working group meetings, which were open to the public. To ensure that industry knowledge gathered both at the summit and through individual conversations was integrated into the stock assessment process, we developed a working paper detailing the technical and economic dynamics of the northern shortfin squid fishery, as well as the ecology and environmental drivers of the species, as reported by industry (Northeast Fisheries Science Center (NEFSC), 2021). This information was referenced regularly throughout the stock assessment process. We also engaged the Northern Shortfin Squid Research Track Stock Assessment Working Group in progressing application of industry knowledge to CPUE modeling. This enhanced the quality of the standardized CPUE model.

The knowledge shared and documented throughout this SIRC was also critical to the development, parameterization, and interpretation of a generalized depletion model for the northern shortfin squid stock assessment (Northeast Fisheries Science Center (NEFSC), 2021; Arkhipkin et al., 2021). Depletion modeling requires robust fishery dependent data, including documentation of the socioeconomic and technical factors that impact catch (Roa-Ureta, 2012; Roa-Ureta et al., 2015). The knowledge that industry shared during this SIRC was essential to determining the structure of the generalized depletion modeling and in interpreting the

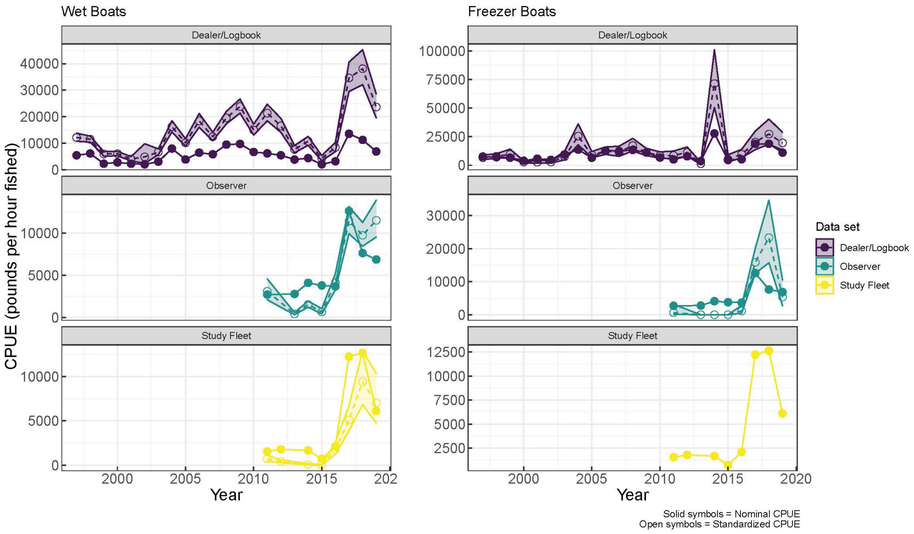

FIGURE 4
Nominal (solid symbols) and standardized CPUE (open symbols) series for the Wet Boat fleet and the Freezer Boat fleet. The shaded region indicates +/- SE. Top panel shows the dealer/logbook data, middle panel shows the observer data, and bottom panel shows the Study Fleet data.

outputs. Industry knowledge about gear selectivity and species catchability were also applied in the development of a mass balance model, an envelope model, and an escapement model for northern shortfin squid (Rago 2020; Northeast Fisheries Science Center (NEFSC), 2021).

The SIRC developed during this research evolved and expanded to cover several other topics that were identified as priorities during the stock assessment process. For example, it became clear throughout the stock assessment process that enhanced data on northern shortfin squid body size and weight are essential for understanding the structure of the population as well as the movement of cohorts onto and off of the continental shelf. In response to this need, industry collaborators shared insight on northern shortfin squid growth throughout the fishing season as well as squid body size and weight data collected by processors. This exchange of information initiated a formal research initiative to develop an electronic data collection system for use by the region's northern shortfin squid processors to collect individual squid size and weights during the vessel offload process. In 2021 and 2022, six northern shortfin squid processors collected over 60,000 northern shortfin squid mantle lengths and weights through this initiative.

Further research to evaluate the oceanographic drivers of northern shortfin squid was also prioritized during the stock assessment process. Thus, a team of researchers and industry members formed the "Squid Squad" to share observations and develop hypotheses to explore analytically. The "Squid Squad" collectively developed a conceptual model and identified oceanographic features and fishery data to explore, resulting in new hypotheses and areas for research (Salois et al., 2023). Regular (~weekly) meetings provided industry, scientists, and managers

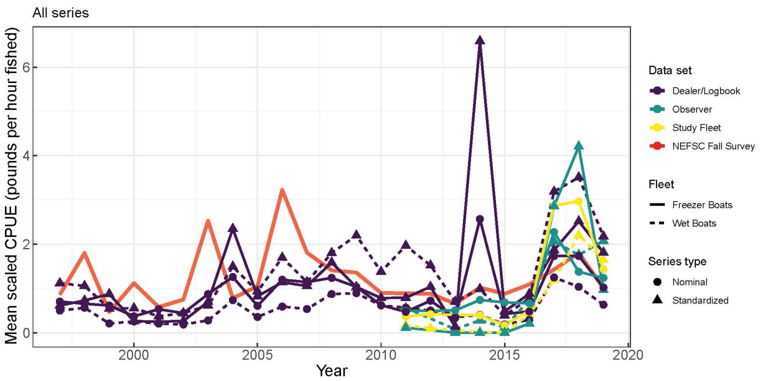

FIGURE 5
Comparison of standardized northern shortfin squid Catch Per Unit Effort (triangles), nominal northern shortfin squid Catch Per Unit Effort (circles), and NEFSC Fall Bottom Trawl Survey index (red line) from 1997 to 2019. For standardized CPUE time series, line color indicates data set (Purple = Dealer/logbook, Blue = Observer, Yellow = Study Fleet) and dash type indicates standardization approach (Short dashed = Freezer boat CPUE standardization; Long dashed = Wet boat CPUE).

with an informal opportunity to discuss the status of the fishery and the surrounding ecosystem. These meetings continue to be an effective tool for progressing this collaboration and pursuing multiple research questions related to the northern shortfin squid. In 2022, the "Squid Squad" executed a novel process-oriented research cruise, with a commercial fishing vessel sampling for northern shortfin squid within and around a mid-depth salinity maximum intrusion that was simultaneously being mapped by an oceanographic research vessel (Gawarkiewicz et al., 2022). The relationships developed and results produced throughout this process have laid the foundation for meaningful collaborations between the scientific and fishing communities in the future.

The 2021 northern shortfin squid research track stock assessment did not produce an acceptable stock assessment model for the species (Northeast Fisheries Science Center (NEFSC), 2021). Thus, the research products described above are critically important for informing management of the northern shortfin squid fishery.

3 Summary recommendations

As exemplified through this research, the insights and knowledge of members of the fishing industry are essential to the proper application and interpretation of fishery dependent data. In the case of northern shortfin squid, industry collaborators played a key role in identifying the factors that impact fishing selectivity, effort, and landings, as well as refining CPUE models and interpreting results. Northern shortfin squid processors and harvesters identified many technical and economic factors that drive the catch and landings of northern shortfin squid. The most frequently identified factors impacting northern shortfin squid catch and landings were 1) vessel type (freezer or wet boat), 2) market dynamics (global production of Ommastrephids), 3) price for northern shortfin squid, and 4) availability of northern shortfin squid to the fishery (abundance of northern shortfin squid in fishable areas, and proximity of productive fishing grounds to ports). With these factors explicitly accounted for, we believe CPUE and other fishery-dependent data analyses can be useful tools for assessing the trends in and condition of the northern shortfin squid population. Frequent and meaningful dialogue with members of the northern shortfin squid fishery is necessary to ensure that technical and socio-economic factors are accounted for appropriately.

In addition to identifying the factors that are important to consider when analyzing and interpreting northern shortfin squid fishery data, this research also highlights the importance of using the appropriate effort metrics when calculating CPUE for northern shortfin squid. Given the highly variable tow times, catch handling techniques and technical constraints on trip length, we suggest using tow time, rather than days absent or number of tows, as an effort metric in CPUE analyses. Accompanied with precise fishing locations and data on squid sizes and weights, CPUE indices can be a powerful tool for understanding the northern shortfin squid population and fishery.

Catch rate standardizations can be challenging to construct, as they require a nuanced understanding of fishing behavior and the fishery-dependent data sets collected within a region, which researchers and managers often do not independently possess. As demonstrated by this research, documenting and incorporating industry knowledge can be an effective means to advance catch rate standardizations. Furthermore, several existing CPUE standardization methods suggest enhanced integration of local ecological knowledge, but the types of approaches for engaging with industry members are not well described (Bishop, 2006; Bentley et al, 2012). In the research presented here, three phases of collaboration contributed to the effective integration of industry knowledge: 1) a summit of scientists and industry members, 2) a series of semi-structured conversations, and, 3) application of industry knowledge to CPUE standardization, and 4) ongoing discussions throughout the stock assessment process.

Each phase of collaboration provided insight into different aspects of the northern shortfin squid fishery and the biology of the species, together providing the comprehensive understanding needed for accurate catch rate standardization. The continued and constructive communication between science and industry partners throughout all phases was essential to building trust and laid the groundwork for information sharing. The summit allowed us to gain important insights into general trends in catch through time and high-level factors that may be important to collect at a higher resolution. For example, vessel hold type, which became a key variable in stratifying the data, was identified at this stage. Following this event, it was clear that follow up conversations were needed to generate data on vessel hold type for each vessel participating in the fishery, and while soliciting this information, additional questions about fishing practices could be asked as well. These follow up conversations allowed us to get more detailed information about the factors influencing catch rates and ensured that a diversity of perspectives was documented. Following the individual conversations, working through model development and iterative fitting during the stock assessment process allowed considerations about time series length, data set coverage, and other logistical considerations to be worked through such that insights from industry could best be translated into time series of catch or landings per unit effort. The industry's belief in the value of this research and trust in scientific collaborators grew throughout all phases of this research and was paramount to its success.

4 Conclusion

Overall, this work exemplifies the value of engaging the fishing industry in research to inform stock assessments and fisheries management. Members of the fishing industry hold valuable experiential knowledge that can inform data treatment and analysis, offer unique data collection opportunities to meet research needs, and have unique insights into and hypotheses about the environmental drivers of resource species that are derived from many years on the water. Initial focus on building trust and open communication and identification of mutually beneficial research products are essential to science and industry collaborations. Proper application and interpretation of fishery dependent data requires the insights and knowledge of members of the fishing industry.

This research highlights the unique benefits and outcomes of engaging with members of the fishing industry through large-group summits, one-on-one conversations, and during the formal stock assessment process. We suggest that large-group summits are most effective for developing initial relationships and trust between science and industry collaborators, gaining insight into the major factors influencing fishery dynamics, and identifying research priorities. Semi-structured conversations with individual industry members are immensely helpful to dig deeper into specific factors that influence fishery dynamics, identify potential covariates to be included in catch rate standardizations, and to review research results and identify areas for future work. Finally, bringing scientists and industry members together during the stock assessment process can be an effective method for refining catch rate standardization models and identifying other avenues for applying industry knowledge. Together, these approaches for building, maintaining, and applying science-industry research collaborations have been demonstrated to be highly effective at informing catch rate standardization and should be applied in this research area more regularly.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Ethics statement

Ethical review and approval was not required for the animal study because there was no interaction with live animals for this research.

Author contributions

JM and AM conceived of the study in collaboration with industry partners. AM, JM, BL, JP, SS, and KH collected and documented the knowledge shared by industry. RR, BB, TS, ML, JK, KA, and GD contributed knowledge and assisted with documentation. BL, AM, and AJ completed the CPUE analyses. AM and JM contributed the original draft. All authors contributed to the editing. All authors contributed to the article and approved the submitted version.

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Conflict of interest

Author BL was employed by company ERT, Inc.. Author ML was employed by company SeaFreeze Shoreside. Authors JK and GD were employed by Lunds Fisheries. Author KA was employed by The Town Dock.

The remaining authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

Supplementary material

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fmars.2023.1144108/full#supplementary-material

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2 State Street | PO Box 608
Narragansett, RI 02882

Dear Director Moore,

I am writing regarding the *Illex Hold Framework Final Action*.

I am the owner of several Federally Permitted Illex Squid catching vessels. Also, The Town Dock has been a significant buyer and processor of illex squid for many years. We purchase illex from our owned fleet of illex permitted boats, independently owned illex permitted boats, and other shoreside processors of illex squid.

After careful review of the options that have been discussed to date, we support **5.1 Altermative 1: No Action / Status Quo = Current Baselines and Reporting Only.** We urge the council to reject all other options.

Maintaining fishing flexibility is critical to our vessels. There are already rules for vessel upgrades in place for length and horsepower. These changes may limit or eliminate our ability to upgrade our fleet at a future date. Several of our boats were constructed in the 1970s and 1980s. We, along with many others vessel owners, plan on retiring older vessels and upgrading our fleet in the future. It is extremely difficult to find newer boats that are an exact match to our existing fleet. The current rules allow for limited, but much needed, flexibility to upgrade our fleet to newer boats in future years. Upgrading to a safer or newer vessel that lies within the existing regulations provides enough safeguards and putting vessel hold capacity limitations on squid catching boats will make the ability to upgrade more difficult and would eliminate upgradable options for us.

Currently, there is no legitimate purpose or need to enact new hold capacity restrictions for Illex permitted vessels. Over the past two years we have only caught about 10 percent of the overall quota. To enact a new restriction in years of an *increasing* Illex quota and landings that are only a fraction of that quota does not make sense, and certainly the disadvantages for my fleet and some other Illex permitted vessels outweigh the benefits of any hold capacity restriction.

The cost of measuring each and every fish hold of east coast illex participants is unknown, however common sense dictates that this unneeded expense will total up to tens of thousands of dollars, which could be invested elsewhere to benefit the captains and crews of these vessels.

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Thank you for your consideration.

Sincerely,

Ryan Clark
President and CEO

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45 STATE STREET | PO BOX 608
NARRAGANSETT, RI 02882

September 20, 2023

MAFMC
800 North State Street
Suite 201
Dover, DE 19901

Dear Chairman Townsand and the MAFMC,

I am writing to oppose the Illex Hold Framework. The Town Dock supports <u>**“No Action/Status Quo = Current Baselines and Reporting Only”.**</u>
As the alternative states, we already have restrictions on upgrading our vessels. We are being asked to restrict our vessels to a mackerel restriction, a fishery we do not prosecute. This will unfairly and unnecessarily restrict the flexibility needed when it comes to replacing a vessel.

The Town Dock does not support Alternative 2a, giving vessels in CPH the ability to <u>choose</u> whether they want to use a preexisting survey or not. As I mentioned in my verbal comment, if the Council is going to move towards capping effort, then they need to cap the effort and not make any special exemptions. The request and the reasoning for this exemption proves my point above on the need for flexibility. What 2a option is doing is allowing flexibility for a select few vessels, 6 as it was made clear on the Committee call, and the remaining 40 will be unfairly restricted. It was stated that the drive for option 2a is to “protect an investment”, we are all trying to protect an investment and should be allowed to do so equally.

The Town Dock does not support Alt #3 or Alt #4. We don’t see the need to require a declaration of gear use when we can provide it to those who need it when they need it. We successfully did this for the Illex Working Group.

The Town Dock still does not see the need to further restrict effort in a fishery that already has restrictions. This fishery hasn’t caught its quota in the past 2 years and has received increases in the quota the past few years.

Thank you for hearing my concerns regarding this Framework.

Sincerely,

Katie Almeida
Sr. Representative, Government Relations & Sustainability

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Illex Hold Framework

MACKEREL, SQUID, AND BUTTERFISH (MSB)
FISHERY MANAGEMENT PLAN

Measures to implement a volumetric vessel hold baseline and hold upgrade restriction; Measures to record expected processing types

Framework Draft Document 9/21/2023

Prepared by the

Mid-Atlantic Fishery Management Council (Council) in collaboration with the National Marine Fisheries Service (NMFS)

Council Address

Mid-Atlantic Fishery Management Council
Office 800 North State Street, Suite 201
Dover, DE 19901

NMFS Address

NMFS Greater Atlantic Regional Fisheries
55 Great Republic Drive
Gloucester, MA 01930

Framework Meeting 1: August 2023
Framework Meeting 2/final action: Planned October 2023

1.0 EXECUTIVE SUMMARY AND TABLE OF CONTENTS

This Framework would consider implementing a volumetric vessel hold baseline requirement and upgrade restriction for all *Illex* limited access permits. A similar volumetric requirement is in place for the directed mackerel fishery, and most regional (i.e. Mid-Atlantic and New England) limited access programs have other baselines (horsepower and length) to control increases in fishing power/capacity.

Overcapacity is a common characteristic of most fisheries except those managed with tradable quota systems (variously known as ITQ[1]s (e.g. surfclam/ocean quahog), IFQ[2]s (e.g. golden tilefish), and/or catch shares). Public perspectives on capacity in the *Illex* fishery have been consistently diverse starting from the early 2019 scoping of the largely disapproved *Illex* Permit Amendment[3] through to a recent November 2022 Joint MSB Committee/Advisory Panel (AP) Meeting that considered follow-up actions after the *Illex* Permit Amendment's disapproval. Comments have ranged from taking no action at all, to measures that would reduce the existing overcapacity by eliminating some existing limited access permits (overcapacity was indicated by NMFS' Northeast Fisheries Science Center staff technical analyses conducted as part of the *Illex* Permit Amendment).

The rationale/goal for baselines as described in the 1998 Consistency Amendment developed by NMFS is "capping fishing power." This aligns with issues mentioned in several national standards guidelines, especially #5 Efficiency: "Efficiency. In theory, an efficient fishery would harvest the OY with the minimum use of economic inputs such as labor, capital, interest, and fuel. Efficiency in terms of aggregate costs then becomes a conservation objective, where "conservation" constitutes wise use of all resources involved in the fishery, not just fish stocks." So capping additional vessel fishing power ("capital") to catch Optimum Yield (OY) becomes a conservation objective because the "wise use of all resources" is being addressed. (50 CFR 648.4(a)(5)(iii))

The objective of this action is therefore to consider requiring a volumetric vessel hold baseline requirement and upgrade restriction for all *Illex* limited access permits, with a similar purpose as other baseline requirements, i.e. to cap fishing power. There will be a tradeoff involved as the flexibility of the fleet is somewhat reduced, but the risks from uncontrolled fishing power in fishing fleets are well documented throughout fisheries literature and negative consequences of "increased fishing pressure" is a principal "finding" of Congress as enshrined in the Magnuson-Stevens Fishery Conservation and Management Act.

Two alternatives to add information collected during permit re-applications about vessel processing are also included for Council consideration – while they are not directly related to capacity issues, the relevant information has been discussed frequently as likely to be useful for various squid assessment analyses.

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[1] ITQ = Individual Transferable Quota
[2] IFQ = Individual Fishing Quota
[3] This action would have reduced permits in the fishery based on updated catch-based qualification criteria

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2.0 LIST OF COMMON ACRONYMS AND ABBREVIATIONS

ABC	**Acceptable Biological Catch**
ACL	**Annual Catch Limit**
ACT	**Annual Catch Target**
ASMFC	**Atlantic States Marine Fisheries Commission or Commission**
B	**Biomass**
CFR	**Code of Federal Regulations**
CPH	**Confirmation of Permit History**
CV	**coefficient of variation**
DAH	**Domestic Annual Harvest**
DAP	**Domestic Annual Processing**
EEZ	**Exclusive Economic Zone**
EFH	**Essential Fish Habitat**
EIS	**Environmental Impact Statement**
ESA	**Endangered Species Act of 1973**
F	**Fishing Mortality Rate**
FMP	**Fishery Management Plan**
FR	**Federal Register**
GB	**Georges Bank**
GOM	**Gulf of Maine**
IOY	**Initial Optimum Yield**
M	**Natural Mortality Rate**
MAFMC	**Mid-Atlantic Fishery Management Council**
MMPA	**Marine Mammal Protection Act**
MSA	**Magnuson-Stevens Fishery Conservation and Management Act (as amended)**
MSB	**Atlantic Mackerel, Squid, Butterfish**
MSY	**Maximum Sustainable Yield**
MT (or mt)	**Metric Tons (1 mt equals about 2,204.62 pounds)**
NE	**Northeast**
NEFSC	**Northeast Fisheries Science Center**
NEPA	**National Environmental Policy Act**
NMFS	**National Marine Fisheries Service (NOAA Fisheries)**
NOAA	**National Oceanic and Atmospheric Administration**
OFL	**Overfishing Level**
PBR	**Potential Biological Removal**
SARC	**Stock Assessment Review Committee**
SAW	**Stock Assessment Workshop**
SNE	**Southern New England**
SSC	**Scientific and Statistical Committee**
US	**United States**
VTR	**Vessel Trip Report**

3.0 LISTS OF TABLES AND FIGURES

3.1 LIST OF TABLES

3.2 LIST OF FIGURES

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4.0 INTRODUCTION, BACKGROUND, AND PROCESS

The Council established management of *Illex* in 1978 and the management unit includes all federal East Coast waters.

Access is limited with about 76 moratorium permits; Between 5-40 permits may be active in a given year. Six permits are currently "on the shelf" in Confirmation of Permit History (CPH) status. Incidental permits are limited to 10,000 pounds per trip. Additional summary regulatory information is available at https://www.fisheries.noaa.gov/new-england-mid-atlantic/resources-fishing/resources-fishing-greater-atlantic-region.

The 2023 quota is 38,631 MT, based on a 40,000 MT Acceptable Biological Catch (ABC) and a set-aside for possible discards. The fishery closes when 96% of the quota is projected to be landed. In 2021 the fishery closed effective August 30, 2021 – there was not a closure in 2022 or 2023 and relatively small fraction of the quota was landed.

Recreational catch of *Illex* is believed to be negligible. There are no recreational regulations except for party/charter vessel permits and associated reporting.

A 2020 action to reduce *Illex* permits given overcapitalization in the fishery was disapproved: https://www.fisheries.noaa.gov/bulletin/amendment-22-mackerel-squid-and-butterfish-fishery-management-plan-decision. Good *Illex* availability and increased vessel participation in 2017-2021 triggered early closures, highlighting the issue of overcapacity in this fishery, which was also described in the disapproved *Illex* Permit Amendment via technical capacity analyses.

As a high volume fishery, vessel fishing power or "capacity" may be substantially increased within the existing length and horsepower restrictions by modifying the vessel's hold capacity, leading the Council to further consider vessel hold restrictions for the fishery.

4.1 OBJECTIVES, PURPOSE, AND NEED

The objective of this action is to consider requiring a volumetric vessel hold baseline requirement and upgrade restriction for all *Illex* limited access permits, with a similar purpose as other baseline requirements, i.e. to cap fishing power. There will be a tradeoff involved as the flexibility of the fleet is somewhat reduced, but the risks from uncontrolled fishing power in fishing fleets are well documented throughout fisheries literature and negative consequences of "increased fishing pressure" is a principal "finding" of Congress as enshrined in the Magnuson-Stevens Fishery Conservation and Management Act. This action is needed because effective caps on vessel fishing power in the *Illex* fishery do not currently exist.

4.2 REGULATORY AUTHORITY / PROCESS

The discretionary provisions of the MSA allow Councils to include measures that restrict the types of fishing vessels, and those provisions have led to the current baseline specifications.

The Council uses "framework adjustments" to amend measures previously used or considered, and permitting and vessel size restrictions are noted frameworkable options, as well as "Any other management measures currently included in the FMP." Vessel hold capacity restrictions are specifically used in the FMP already for the mackerel fishery. Vessel hold capacity restrictions were also considered specifically for the *Illex* fishery in the disapproved *Illex* Permit Amendment, so hold capacity restrictions are not a new concept for this FMP or fishery.

For frameworks, "The MAFMC shall develop and analyze appropriate management actions over the span of at least two MAFMC meetings. The MAFMC must provide the public with advance notice of the availability of the recommendation(s), appropriate justification(s) and economic and biological analyses, and the opportunity to comment on the proposed adjustment(s) at the first meeting and prior to and at the second MAFMC meeting."
[50 CFR 648.25(a)(1)]

Section 301 of the Magnuson-Stevens Fishery Conservation and Management Act requires that FMPs contain conservation and management measures that are consistent with the ten National Standards: *In General. – Any fishery management plan prepared, and any regulation promulgated to implement any such plan, pursuant to this title shall be consistent with the…national standards for fishery conservation and management.*

(1) Conservation and management measures shall prevent overfishing while achieving, on a continuing basis, the optimum yield from each fishery for the United States fishing industry.

The measures in this action should not affect the probability of overfishing, and the current fleet has more than enough capacity to catch the current quotas.

(2) Conservation and management measures shall be based upon the best scientific information available.

The data sources considered and evaluated during the development of this action include, but are not limited to: permit data, landings data from vessel trip reports, information from resource trawl surveys, sea sampling (observer) data, data from the dealer weighout purchase reports, peer-reviewed assessments including the recent *Illex* assessment, original literature, and descriptive information provided by fishery participants and the public. To the best of the MAFMC's knowledge these data sources constitute the best scientific information available.

(3) To the extent practicable, an individual stock of fish shall be managed as a unit throughout its range, and interrelated stocks of fish shall be managed as a unit or in close coordination.

The FMP addresses management of *Illex* throughout the range of the species in U.S. waters.

(4) Conservation and management measures shall not discriminate between residents of different States. If it becomes necessary to allocate or assign fishing privileges among various United States fishermen, such allocation shall be (A) fair and equitable to all such fishermen; (B) reasonably calculated to promote conservation; and (C) carried out in such manner that no particular individual, corporation, or other entity acquires an excessive share of such privileges.

None of the proposed measures would discriminate between residents of different States or assign/allocate fishing privileges among U.S. fishermen.

(5) Conservation and management measures shall, where practicable, consider efficiency in the utilization of fishery resources; except that no such measure shall have economic allocation as its sole purpose.

There is no allocation proposed. The proposed actions are efficient in that they should facilitate full utilization of the relevant quotas. National Standard 5 Guidelines also note: "Efficiency. In theory, an efficient fishery would harvest the OY with the **minimum use** of economic inputs such as labor, **capital**, interest, and fuel. Efficiency in terms of aggregate costs then becomes a conservation objective, where "conservation" constitutes wise use of all resources involved in the fishery, not just fish stocks." So capping additional vessel fishing power ("capital") to catch Optimum Yield (OY) becomes a conservation objective because the "wise use of all resources" is being addressed. (50 CFR 648.4(a)(5)(iii)). The proposed baselines should discourage additional capital being added to catch OY.

(6) Conservation and management measures shall take into account and allow for variations among, and contingencies in, fisheries, fishery resources, and catches.

Changes in fisheries occur continuously, both as the result of human activity (for example, new technologies or shifting market demand) and natural variation (for example, oceanographic perturbations). In order to provide the greatest flexibility possible for future management decisions, the FMP includes a framework adjustment mechanism with an extensive list of possible framework adjustment measures that can be used to adjust the plan as conditions in the fishery change. Specifications are also reviewed annually and measures can and have been amended as appropriate.

(7) Conservation and management measures shall, where practicable, minimize costs and avoid unnecessary duplication.

The MAFMC considered the costs and benefits associated with the management measures proposed in the action when developing this action. This action should not create any duplications related to managing the MSB resources. A hold baseline is not duplicative of other baselines due to the high volume nature of the *Illex* fishery and the ability of permits to considerably expand fishing power despite the length and horsepower baselines via hold modifications.

(8) Conservation and management measures shall, consistent with the conservation requirements of this Act (including the prevention of overfishing and rebuilding of overfished stocks), take into account the importance of fishery resources to fishing communities in order to (A) provide for the sustained participation of such communities, and (B) to the extent practicable, minimize adverse economic impacts on such communities.

The human community impacts of the action are described in Section 7.5. No changes to quotas are proposed, which should enable ongoing participation by relevant communities. The baselines are designed to freeze the capacity footprint of the *Illex* fishery, and avoid additional overcapitalization, which should help sustain participation in the fishery.

(9) Conservation and management measures shall, to the extent practicable, (A) minimize bycatch and (B) to the extent bycatch cannot be avoided, minimize the mortality of such bycatch.

There is minimal bycatch in the *Illex* fishery and this action should not change that.

(10) Conservation and management measures shall, to the extent practicable, promote the safety of human life at sea.

Fishing is a dangerous occupation; participants must constantly balance the risks imposed by weather against the economic benefits. According to the National Standard guidelines, the safety of the fishing vessel and the protection from injury of persons aboard the vessel are considered the same as “safety of human life at sea.” The safety of a vessel and the people aboard is ultimately the responsibility of the master of that vessel. Each master makes many decisions about vessel maintenance and loading and about the capabilities of the vessel and crew to operate safely in a variety of weather and sea conditions. This national standard does not replace the judgment or relieve the responsibility of the vessel master related to vessel safety. Any existing or new baseline potentially reduces flexibility to modernize vessels which could affect safety, but it is not practicable to avoid this effect while also using baselines to cap fishing power.

5.0 WHAT ALTERNATIVES ARE BEING CONSIDERED?

5.1 ALTERNATIVE 1: No Action/Status Quo = Current Baselines and Reporting Only

Vessel replacements/upgrades for *Illex* squid moratorium permits are limited relative to a vessel's baselines:

(1) The upgraded vessel's horsepower may not exceed the horsepower of the vessel's baseline specifications by more than 20 percent.

(2) The upgraded vessel's length overall may not exceed the vessel's baseline specifications by more than 10 percent.

The vessel baseline specifications are the respective specifications (length, horsepower) of the vessel that was initially issued a limited access permit as of the date the initial vessel applied for such permit (i.e. **not** the specifications of the current vessel), and the baseline specifications are recorded in NMFS databases.

Also, no changes would be made to the information collected during the annual permit re-application process for squid permits.

5.2 Hold Baselines

Alternatives 2a and 2b are nearly identical – they only differ whether a permit in Confirmation of Permit History (CPH) can use a pre-existing hold survey to establish its baseline.

ALTERNATIVE 2a: Additional Volumetric Vessel Hold Baseline, can use pre-existing survey

If a vessel possesses a volumetric hold baseline related to its Tier 1 or Tier 2 mackerel permit, that hold baseline would automatically be incorporated for its *Illex* moratorium permit also.

For other *Illex* moratorium permit vessels, NMFS would publish notice that:

In addition to other baseline specifications (which remain in force unchanged regardless of this action), the volumetric fish hold capacity of a vessel at the time it submits a hold baseline certification (a date would be published by NMFS, likely 12 months would be allowed for completion) will be considered a baseline specification. The fish hold capacity measurement must be certified by one of the following qualified individuals or entities: An individual credentialed as a Certified Marine Surveyor with a fishing specialty by the National Association of Marine Surveyors (NAMS); an individual credentialed as an Accredited Marine Surveyor with a fishing specialty by the Society of Accredited Marine Surveyors (SAMS); employees or agents of a classification society approved by the Coast Guard pursuant to 46 U.S.C. 3316(c); the Maine State Sealer of Weights and Measures; a professionally-licensed and/or registered Marine Engineer; or a Naval Architect with a professional engineer license. The fish hold capacity measurement submitted to NMFS must include a signed certification by the individual or entity that completed the measurement, specifying how they meet the definition of a qualified individual or entity.

If an *Illex* moratorium permit is "on the shelf" in Confirmation of Permit History (CPH) when hold certifications are due, the default hold capacity baseline for such CPH permits will be the hold capacity of the first replacement vessel after the permit is removed from CPH (the vessel would have to be measured as described above before fishing under the permit). See below for how CPH permits with pre-existing hold certifications (but no documented pre-existing hold baseline) would be treated.

Replacement/upgraded vessels' re-certified volumetric fish hold capacity may not exceed 110% of the permit's baseline hold specification (i.e. there can only be an increase of + 10% beyond the baseline). The modified fish hold, or the fish hold of the replacement vessel, must be resurveyed by a surveyor as described above unless the replacement vessel already had an appropriate certification on file with NMFS. All other baseline restrictions for the permit would apply in standard fashion.

If a permit in CPH happened to have an existing volumetric hold measurement for the vessel immediately preceding the permit's placement into CPH, which met the measurement certification requirements, that hold measurement **could** be used to establish a vessel hold baseline for the *Illex* permit within the 12-month implementation period (alternatively, the first replacement vessel could be certified for hold capacity – either option would be acceptable).

ALTERNATIVE 2b: Additional Volumetric Vessel Hold Baseline, cannot use pre-existing survey

If a vessel possesses a volumetric hold baseline related to its Tier 1 or Tier 2 mackerel permit, that hold baseline would automatically be incorporated for its *Illex* moratorium permit also.

For other *Illex* moratorium permit vessels, NMFS would publish notice that:

In addition to other baseline specifications (which remain in force unchanged regardless of this action), the volumetric fish hold capacity of a vessel at the time it submits a hold baseline certification (a date would be published by NMFS, likely 12 months would be allowed for completion) will be considered a baseline specification. The fish hold capacity measurement must be certified by one of the following qualified individuals or entities: An individual credentialed as a Certified Marine Surveyor with a fishing specialty by the National Association of Marine Surveyors (NAMS); an individual credentialed as an Accredited Marine Surveyor with a fishing specialty by the Society of Accredited Marine Surveyors (SAMS); employees or agents of a classification society approved by the Coast Guard pursuant to 46 U.S.C. 3316(c); the Maine State Sealer of Weights and Measures; a professionally-licensed and/or registered Marine Engineer; or a Naval Architect with a professional engineer license. The fish hold capacity measurement submitted to NMFS must include a signed certification by the individual or entity that completed the measurement, specifying how they meet the definition of a qualified individual or entity.

If an *Illex* moratorium permit is "on the shelf" in Confirmation of Permit History (CPH) when hold certifications are due, the default hold capacity baseline for such CPH permits will be the hold capacity of the first replacement vessel after the permit is removed from CPH (the vessel would have to be measured as described above before fishing under the permit). See below for how CPH permits with pre-existing hold certifications (but no documented pre-existing hold baseline) would be treated.

Replacement/upgraded vessels' re-certified volumetric fish hold capacity may not exceed 110% of the permit's baseline hold specification (i.e. there can only be an increase of + 10% beyond the baseline). The modified fish hold, or the fish hold of the replacement vessel, must be resurveyed by a surveyor as described above unless the replacement vessel already had an appropriate certification on file with NMFS. All other baseline restrictions for the permit would apply in standard fashion.

If a permit in CPH happened to have an existing volumetric hold measurement that met the measurement certification requirements, that hold measurement **could NOT** be used to establish a vessel hold baseline for *Illex* permits (the first replacement vessel would have to be certified for hold capacity).

5.3 ALTERNATIVE 3: Annual Processing Type Reporting: *Illex*

Information on processing has the potential to be used for catch per unit of effort (CPUE) analyses in squid fisheries (some processing types are not directly comparable for CPUE analyses). Each year when an *Illex* moratorium permit re-applies, it would have to state its intended primary processing type for *Illex* for that year. NMFS will specify relevant processing types, including freezing at-sea, refrigerated sea water, fresh/iced, etc. The statement of intent would not be limiting upon a vessel if it decides to change processing methods mid-year, and there would not be a requirement to notify NMFS of changes mid-year.

5.4 ALTERNATIVE 4: Annual Processing Type Reporting: Longfin

Information on processing has the potential to be used for catch per unit of effort (CPUE) analyses in squid fisheries (some processing types are not directly comparable for CPUE analyses). Each year when a Tier 1 longfin permit re-applies, it would have to state its intended primary processing type for longfin for that year. NMFS will specify relevant processing types, including freezing at-sea, refrigerated sea water, fresh/iced, etc. The statement of intent would not be limiting upon a vessel if it decides to change processing methods mid-year, and there would not be a requirement to notify NMFS of changes mid-year.

6.0 DESCRIPTION OF THE AFFECTED ENVIRONMENT AND FISHERIES

6.1 Description of the Managed Resource (*Illex*) and Non-Target Species

Illex

Illex is a semi-pelagic/semi-demersal schooling cephalopod species that lives less than one year and is distributed between Newfoundland and the Florida Straits. *Illex* is a semelparous, terminal spawner whereby spawning and death occur within several days of mating. The northern stock component (also highly variable) in NAFO Subareas 3 and 4, is assessed and managed separately by the Northwest Atlantic Fisheries Organization (NAFO). The southern/U.S. stock component is located in NAFO Subareas 5 and 6 between the Gulf of Maine and Cape Hatteras, NC and is managed by the Mid-Atlantic Fishery Management Council (the Council or MAFMC) and NMFS. Additional life history information is detailed in the EFH document for the species, located at: http://www.nefsc.noaa.gov/nefsc/habitat/efh/.

The 2021 research track assessment (RTA) was unable to develop a method to resolve stock status, so the stock will officially remain "unknown" with respect to being overfished or overfishing. The RTA Review Panel agreed with the RTA Working Group Report that indications from the various assessment approaches were that the stock was lightly fished in 2019. However, the review report stated that the term "lightly fished" should be interpreted with caution because it has no specific definition relating to sustainable exploitation. After evaluating related analyses, the MAFMC's Scientific and Statistical Committee (SSC) recommended continuing the 2022 40,000 metric ton (MT) *Illex* Acceptable Biological Catch (ABC) to start 2023. In March 2023 the SSC will review updated analyses and may revise their 2023 ABC recommendation

In light of the failure of the assessment to produce accepted reference points to guide ABC setting, the SSC had to rely on an ad-hoc approach to setting a 2023 ABC that would meet the Council's risk policy to avoid overfishing and achieve optimum yield. Alternative quotas were examined with respect to their consequences for risk of exceeding escapement targets ranging from 40% to 50%, as has been used for other squid fisheries. In addition, harvest rates of F=2/3 M (natural mortality) have been used for forage species in various assessments around the world. The methodology allowed the SSC to examine the probability of violating the reference point for various levels of catch limits ranging from 24,000 to 60,000 mt. A 40,000 MT ABC was associated with an approximately 5% chance of exceeding a ⅔ F:M generic guidance for data poor species. Model results suggested a 40,000 MT ABC provided greater than 50% escapement for *Illex* squid, and a catch of 60,000 MT increases the chance of less escapement in some years. Previous SSC review (March 2022) of the analyses allowed them to conclude that:

• Escapement has been relatively high over the last 10 years, suggesting a relatively small impact of the fishery on the component of the stock that is exploited.

• Assumptions regarding parameters that were inputs to the analyses were thought to lead to minimum likely estimates.

• Distributions of the joint estimate of F:M suggests that exploitation rate in the fishery is likely low.

• By comparison to empirical escapement reference points used to manage squid fisheries elsewhere globally, the current ABC levels are associated with low risks of exceeding those escapement standards.

• A 40,000 MT ABC will lead to a low risk of overfishing.

(MAFMC SSC 2022, MAFMC 2022b)

While *Illex* is biologically a unit stock, the U.S. and Canadian assessments and quotas are currently analyzed, set, and monitored independently (unlike for example Atlantic mackerel where U.S. and Canadian data are integrated into both assessments), so the focus is on the U.S. component of the fishery. More information on the Canadian component is available at https://www.nafo.int/Science/Stocks-Advice and the potential usefulness of the NAFO assessment for U.S. management was considered previously by the Council's SSC, e.g. https://www.mafmc.org/s/g_NAFO_Didden.pdf at https://www.mafmc.org/ssc-meetings/2020/may-12-13.

Landings and survey information developed for 2022 specifications setting is presented below (Table 1, Figures 1-4).

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Table 1. Illex catches and landings limits (TACs) (mt) in NAFO Subareas (SA) 5+6 (within the U.S. EEZ after 1976) and Subareas 3+4 (NAFO and Canadian waters) 1963-2021

	Cape Hatteras to the Gulf of Maine SA 5+6 Landings			SA 3+4	SA 3-6 Total	SA 5+6		SA 3-6 Total			SA 5+6		
Year	Domestic (mt)	International (mt)	**Total (mt)**	Landings (mt)	**Landings (mt)**	Discards (mt)	**Catches (mt)**	**Catches (mt)**	**TAC (mt)** SA 3+4	SA 5+6	% of TAC Harvested	Fishery Closure Dates	% of SA 3-6 Landings
1963	810		**810**	2,222	**3,032**								
1964	358	2	**360**	10,777	**11,137**								
1965	444	78	**522**	8,264	**8,786**								
1966	452	118	**570**	5,218	**5,788**								
1967	707	288	**995**	7,033	**8,028**								
1968	678	2,593	**3,271**	56	**3,327**								
1969	562	975	**1,537**	86	**1,623**								
1970	408	2,418	**2,826**	1,385	**4,211**								
1971	455	6,159	**6,614**	8,906	**15,520**								
1972	472	17,169	**17,641**	1,868	**19,509**								
1973	530	18,625	**19,155**	9,877	**29,032**								
1974	148	20,480	**20,628**	437	**21,065**					71,000			98
1975	107	17,819	**17,926**	17,696	**35,622**					71,000			50
1976	229	24,707	**24,936**	41,767	**66,703**				25,000	30,000	83		37
1977	1,024	23,771	**24,795**	83,480	**108,275**				25,000	35,000	71		23
1978	385	17,207	**17,592**	94,064	**111,656**				100,000	30,000	59		16
1979	1,593	15,748	**17,341**	162,092	**179,433**				120,000	30,000	58		10
1980	299	17,529	**17,828**	69,606	**87,434**				150,000	30,000	59		20
1981	615	14,956	**15,571**	32,862	**48,433**				150,000	30,000	52		32
1982	5,871	12,762	**18,633**	12,908	**31,541**				150,000	30,000	62		59
1983	9,775	1,809	**11,584**	426	**12,010**				150,000	30,000	39		96
1984	9,343	576	**9,919**	715	**10,634**				150,000	30,000	33		93
1985	5,033	1,082	**6,115**	673	**6,788**				150,000	30,000	20		90
1986	6,493	977	**7,470**	111	**7,581**				150,000	30,000	25		99
1987	10,102	0	**10,102**	562	**10,664**	517	**10,619**	**11,181**	150,000	30,000	34		95
1988	1,958	0	**1,958**	811	**2,769**	100	**2,058**	**2,869**	150,000	30,000	7		71
1989	6,801	0	**6,801**	5,971	**12,772**	498	**7,299**	**13,270**	150,000	30,000	23		53
1990	11,670	0	**11,670**	10,975	**22,645**	341	**12,011**	**22,986**	150,000	30,000	39		52
1991	11,908	0	**11,908**	2,913	**14,821**	1,150	**13,058**	**15,971**	150,000	30,000	40		80
1992	17,827	0	**17,827**	1,578	**19,405**	248	**18,075**	**19,653**	150,000	30,000	59		92
1993	18,012	0	**18,012**	2,686	**20,698**	443	**18,455**	**21,141**	150,000	30,000	60		87
1994	18,350	0	**18,350**	5,951	**24,301**	354	**18,704**	**24,655**	150,000	30,000	61		76
1995	13,976	0	**13,976**	1,055	**15,031**	58	**14,034**	**15,089**	150,000	30,000	47		93
1996	16,969	0	**16,969**	8,742	**25,711**	243	**17,212**	**25,954**	150,000	21,000	81		66
1997	13,356	0	**13,356**	15,614	**28,970**	1,002	**14,358**	**29,972**	150,000	19,000	70		46
1998	23,568	0	**23,568**	1,902	**25,470**	586	**24,154**	**26,056**	150,000	19,000	124	8/28	93
1999	7,388	0	**7,388**	305	**7,693**	1,094	**8,482**	**8,787**	75,000	19,000	39		96
2000	9,011	0	**9,011**	366	**9,377**	106	**9,117**	**9,483**	34,000	24,000	38		96
2001	4,009	0	**4,009**	57	**4,066**	466	**4,475**	**4,532**	34,000	24,000	17		99
2002	2,750	0	**2,750**	260	**3,010**	157	**2,907**	**3,167**	34,000	24,000	11		91
2003	6,391	0	**6,391**	1,133	**7,524**	166	**6,557**	**7,690**	34,000	24,000	27		85
2004	26,097	0	**26,097**	2,574	**28,671**	1,402	**27,499**	**30,073**	34,000	24,000	109	9/21	91
2005	12,011	0	**12,011**	578	**12,589**	1,850	**13,861**	**14,439**	34,000	24,000	50		95
2006	13,944	0	**13,944**	6,981	**20,925**	1,556	**15,500**	**22,481**	34,000	24,000	58		67
2007	9,022	0	**9,022**	246	**9,268**	639	**9,661**	**9,906**	34,000	24,000	38		97
2008	15,900	0	**15,900**	534	**16,434**	1,529	**17,429**	**17,963**	34,000	24,000	66		97
2009	18,418	0	**18,418**	718	**19,136**	672	**19,090**	**19,808**	34,000	24,000	77		96
2010	15,825	0	**15,825**	120	**15,945**	569	**16,394**	**16,514**	34,000	24,000	66		99
2011	18,797	0	**18,797**	126	**18,923**	690	**19,487**	**19,613**	34,000	23,328	81		99
2012	11,709	0	**11,709**	47	**11,756**	502	**12,211**	**12,258**	34,000	22,915	51		100
2013	3,792	0	**3,792**	27	**3,819**	315	**4,107**	**4,134**	34,000	22,915	17		99
2014	8,767	0	**8,767**	21	**8,788**	575	**9,342**	**9,363**	34,000	22,915	38		100
2015	2,422	0	**2,422**	14	**2,436**	451	**2,873**	**2,887**	34,000	22,915	11		99
2016	6,684	0	**6,684**	152	**6,836**	320	**7,004**	**7,156**	34,000	22,915	29		98
2017	22,516	0	**22,516**	365	**22,881**	855	**23,371**	**23,736**	34,000	22,915	98	9/15	98
2018	24,117	0	**24,117**	1,545	**25,662**	1,407	**25,524**	**27,069**	34,000	22,915	105	8/15	94
2019	27,164	0	**27,164**	2,914	**30,078**	1,331	**28,495**	**31,409**	34,000	24,825	109	8/21	90
2020	28,447	0	**28,447**	3,099	**31,546**	1,365	**29,812**	**32,911**	34,000	28,644	99	8/31	90
2021	30,886	0	**30,886**	11,455	**42,341**	535	**31,421**	**42,876**	34,000	31,478	98	8/30	73

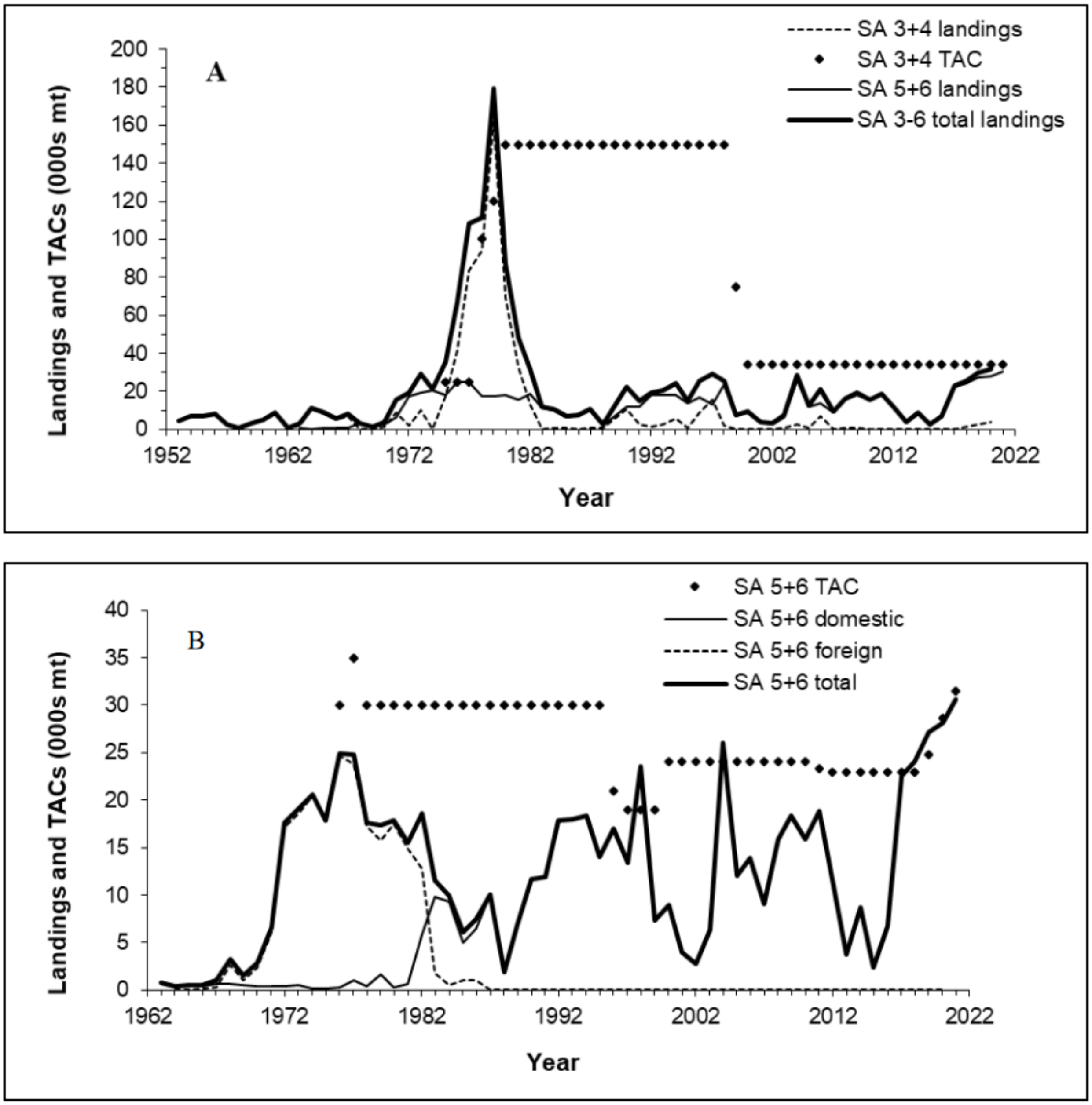

Figure 1. Landings of Illex illecebrosus in (A) NAFO Subareas 3-6 and (B) NAFO Subareas 5+6, with respect to landings limits 1963-2021.

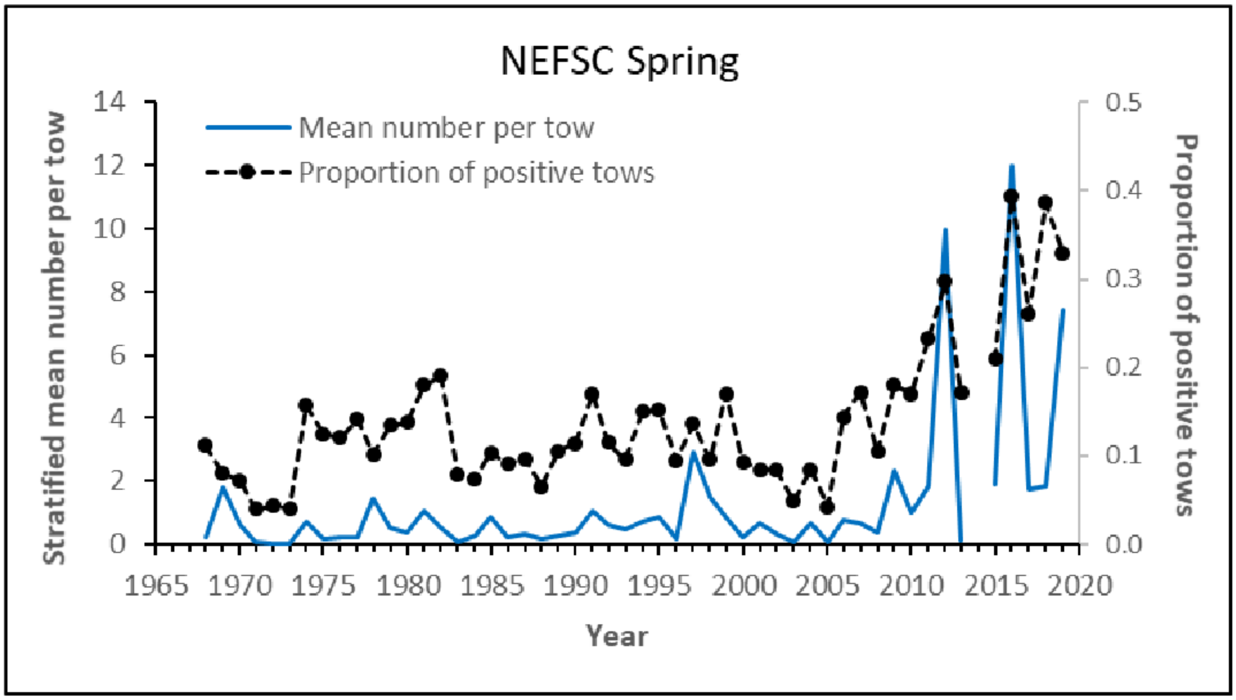

Figure 2. Trends in Illex relative abundance indices and the proportion of positive tows derived with data from NEFSC ***spring*** *bottom trawl surveys conducted on the U.S. shelf during 1968-2019.*

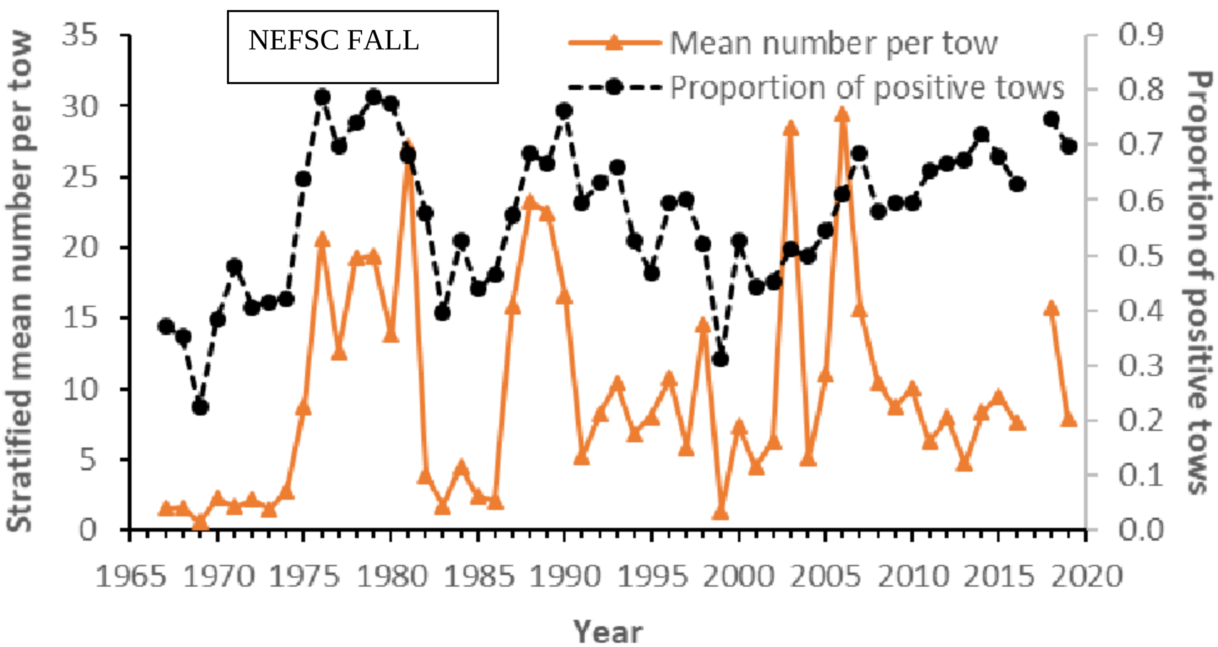

Figure 3. Trends in Illex relative abundance indices and the proportion of positive tows derived with data from NEFSC ***fall*** *bottom trawl surveys conducted on the U.S. shelf during 1967-2019.*

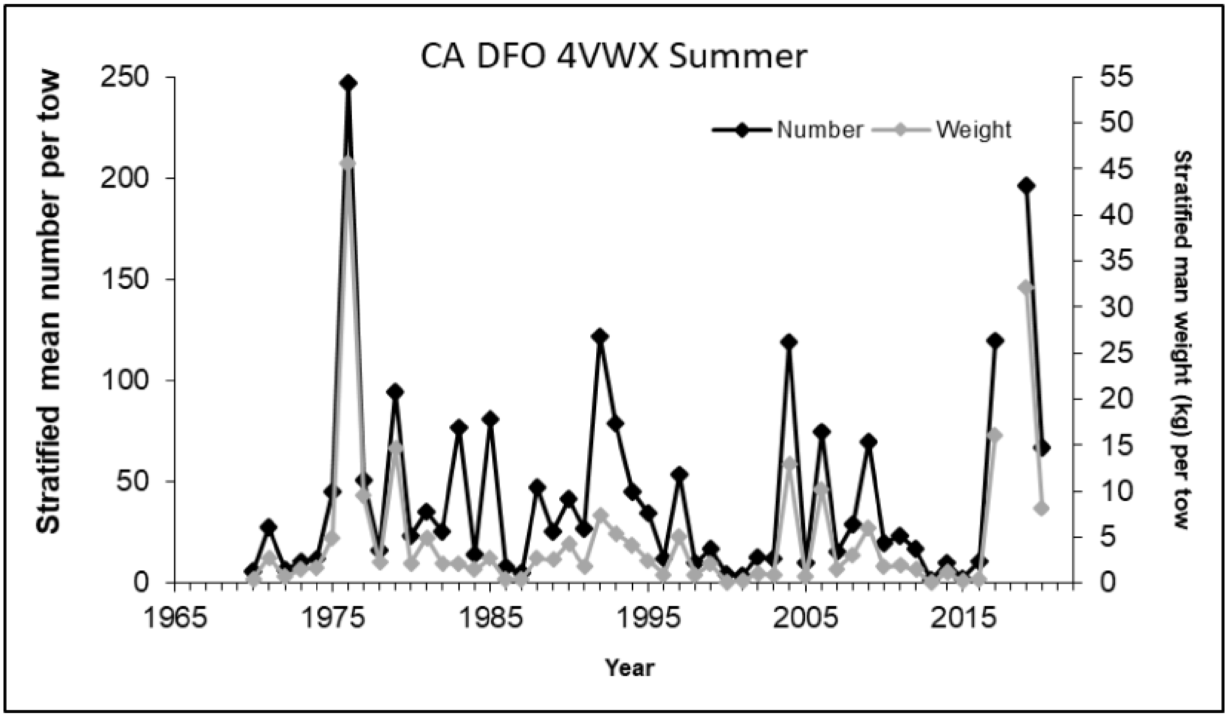

*Figure 4. Illex illecebrosus relative abundance (stratified mean number per tow) and biomass (stratified mean kg per tow) indices derived with data from the Canada DFO summer (July) bottom trawl surveys conducted in Division 4VWX during 1970-2019.**

*Indices were not computed for the 2018 survey because large areas of *Illex* habitat could not be sampled due to survey vessel mechanical problems.

<u>Non-Target Species</u>

Due to reduced observer coverage in 2020-2022 due to Covid-19, observer data from 2017-2019 still best describe incidental catch in the *Illex* fishery. On the *Illex* trips identified in this analysis, the 2017-2019 overall discard rate was 2%. For non-target species that are managed under their own FMP, incidental catch/discards are also considered as part of the management of that fishery.

The primary database used to assess discarding is the NMFS Observer Program database, which includes data from trips that had trained observers onboard to document discards. One critical aspect of using this database to describe discards is to correctly define the trips that constitute a given directed fishery. A flexible criteria of what captains initially intend to target, how they may adjust targeting over the course of a trip, and what they actually catch would be ideal but is impracticable. From 2017-2019 there were on average 61 observed trips annually where *Illex* accounted for at least 50% of retained catch, and those trips form the basis of the following analysis. These trips made 1,298 hauls of which 93% were observed. Hauls may be unobserved for a variety of reasons, for example transfer to another vessel without an observer, observer not on station, haul slipped (dumped) in the water before observing, etc.

The observed *Illex* kept on these trips accounted for approximately 15% of the total *Illex* landed (this is the overall coverage rate based on weight). While a very rough estimate, especially given non-accounting for spatial and temporal trends, one can use the information in the table immediately following and the fact that about 24,597 mt of *Illex* were caught annually 2017-2019 to roughly estimate annual incidental catch and discards for the species in the table. Readers are strongly cautioned that while this is a reasonable approach for a quick, rough, and relative estimate given the available data, it is highly imprecise and does not follow the protocol used for official discard estimates. As a minimum threshold, only species estimated to be caught at a level more than 10,000 pounds per year are included (captures 92% of all discards). Species with a "*" are overfished, subject to overfishing, or otherwise considered depleted (none are caught in substantial quantities in the *Illex* fishery).

As listed in the table below the amounts of the various species (that are within this FMP or others) discarded in the *Illex* fishery, while rough approximations, are very low, including for the species noted to be overfished or otherwise depleted (Atlantic mackerel, bluefish, and red hake[4]). The amounts discarded for other species including those in the FMP (*Illex* squid, longfin squid, butterfish, and chub mackerel) all comprise a negligible portion of the catch and/or catch limits for those species.

Table 2. Incidental Catch and Discards in the Illex Squid Fishery.

NE Fisheries Science Center Common Name	Pounds Observed Caught	Pounds Observed Discarded	Of all discards observed, percent that comes from given species	Percent of given species that was discarded	Pounds of given species caught per mt Illex Kept	Pounds of given species discarded per mt Illex Kept	Rough Annual Catch (pounds) based on 3-year (2017-2019) average of Illex landings (24,597 mt)	Rough Annual Discards (pounds) based on 3-year (2017-2019) average of Illex landings (24,597 mt)
SQUID, SHORT-FIN	24,472,176	236,856	52%	1%	2,226	22	54,757,008	529,970
SQUID, ATL LONG-FIN	137,434	1,266	0%	1%	13	0	307,510	2,833
DORY, BUCKLER (JOHN)	59,564	15,045	3%	25%	5	1	133,275	33,663
MACKEREL, CHUB	50,659	18,909	4%	37%	5	2	113,349	42,310
BUTTERFISH	41,301	37,276	8%	90%	4	3	92,411	83,406
HAKE, SPOTTED	35,344	32,203	7%	91%	3	3	79,082	72,054
DOGFISH, SMOOTH	19,930	19,892	4%	100%	2	2	44,595	44,508
BEARDFISH	14,033	5,541	1%	39%	1	1	31,398	12,398
HAKE, SILVER (WHITING	9,919	8,168	2%	82%	1	1	22,194	18,275
FISH, NK	8,332	8,310	2%	100%	1	1	18,642	18,595
SEA ROBIN, NORTHERN	8,078	8,078	2%	100%	1	1	18,075	18,075
MACKEREL, ATLANTIC *	7,902	5,374	1%	68%	1	0	17,682	12,024
SCUP	7,774	5,561	1%	72%	1	1	17,395	12,443
SQUID, NK	6,020	6,020	1%	100%	1	1	13,470	13,470
BLUEFISH *	5,052	1,836	0%	36%	0	0	11,303	4,108
MONKFISH (GOOSEFISH)	4,742	2,211	0%	47%	0	0	10,609	4,947
HAKE, RED (LING) *	4,637	4,280	1%	92%	0	0	10,376	9,576

The observer program creates individual animal records for some fish species of interest, mostly larger pelagics and/or elasmobranchs, as well as tagged fish. Counts of these individual fish records from the same trips are provided in the table below.

[4] The 2023 ABC for Atlantic mackerel is over 17 million pounds, the 2023 bluefish ABC is over 30 million pounds, and the 2023 combined red hake ABCs are over 10 million pounds.

Table 3. Counts of fish in Individual Animal Records on observed Illex trips from 2017-2019

COMNAME	count
DOLPHINFISH (MAHI MAH	4
GROUPER, SNOWY	3
MARLIN, WHITE	1
MOLA, NK	4
MOLA, OCEAN SUNFISH	31
MOLA, SHARPTAIL	1
RAY, TORPEDO	37
SHARK, ATL ANGEL	1
SHARK, BASKING	14
SHARK, BLUE (BLUE DOG	1
SHARK, CARCHARHINID,N	4
SHARK, GREENLAND	2
SHARK, HAMMERHEAD, SC	14
SHARK, HAMMERHEAD,NK	7
SHARK, NIGHT	3
SHARK, NK	3
SHARK, SANDBAR (BROWN	48
SHARK, SPINNER	1
SHARK, THRESHER, BIGE	1
SHARK, TIGER	17
STINGRAY, ROUGHTAIL	19
SWORDFISH	108
TUNA, BLUEFIN	1
TUNA, LITTLE (FALSE A	9
TUNA, YELLOWFIN	3
WRECKFISH	1

6.2 Human Communities and Economic Environment

This section describes the performance of the *Illex* fishery to allow the reader to understand its socio-economic importance. The EA for the rejected *Illex* Permit Amendment contains additional detail about the *Illex* fishery, including demographic information on key ports – see https://www.mafmc.org/supporting-documents. Also see NMFS' communities page at: https://www.fisheries.noaa.gov/new-england-mid-atlantic/socioeconomics/socioeconomic-cultural-and-policy-research-northeast.

The most obvious way that human communities are affected by the *Illex* fishery is from the revenues generated, and the jobs created. The affected communities include both individuals directly involved in harvesting and processing as well as indirect support services (e.g. vessel maintenance, insurance, ice, etc.). While the direct data points that are most available are landings and revenues, it is important to keep in mind that by contributing to the overall functioning of and employment in coastal communities, the fishery has indirect social impacts as well. Social impacts are strongly aligned with changes to fishing opportunities and while difficult to measure can include impacts to families from income changes/volatility, safety-at-sea (related to changes in fishery operations due to regulation changes), job satisfaction, and/or frustration by individuals due to management's impacts (especially if they perceive management actions to be unreasonable or ill-informed).

Recent Fishery Performance

This section establishes a descriptive baseline for the fishery with which to compare actual and predicted future socio-economic changes that result from management actions. The 2022 *Illex*

Fishery Information Document and 2022 MSB Fishery Performance Report have details on recent commercial *Illex* fishing activity, summarized below. These are available at https://www.mafmc.org/msb. There is negligible recreational catch.

Figure 5 below, from a previous Science Center data update, describes *Illex* catch 1963-2019 and highlights the early foreign fishery and then domestication of the fishery. Figures 6-7 describe domestic landings, ex-vessel revenues, and prices (inflation adjusted) 1996-2022. Data since 1996 is more reliable than previous data due to improvements in reporting requirements. The Gross Domestic Product Implicit Price Deflator was used to report revenues/prices as "2022 dollars." Figure 8 illustrates preliminary weekly 2021 (yellow-orange) and 2022 (blue) landings through the year.

Most recent *Illex* landings occurred in RI, NJ, and MA, but further breakdown may violate data confidentiality rules. Table 4 provides preliminary information on *Illex* landings by statistical area for 2022. Table 5 describes vessel participation over time.

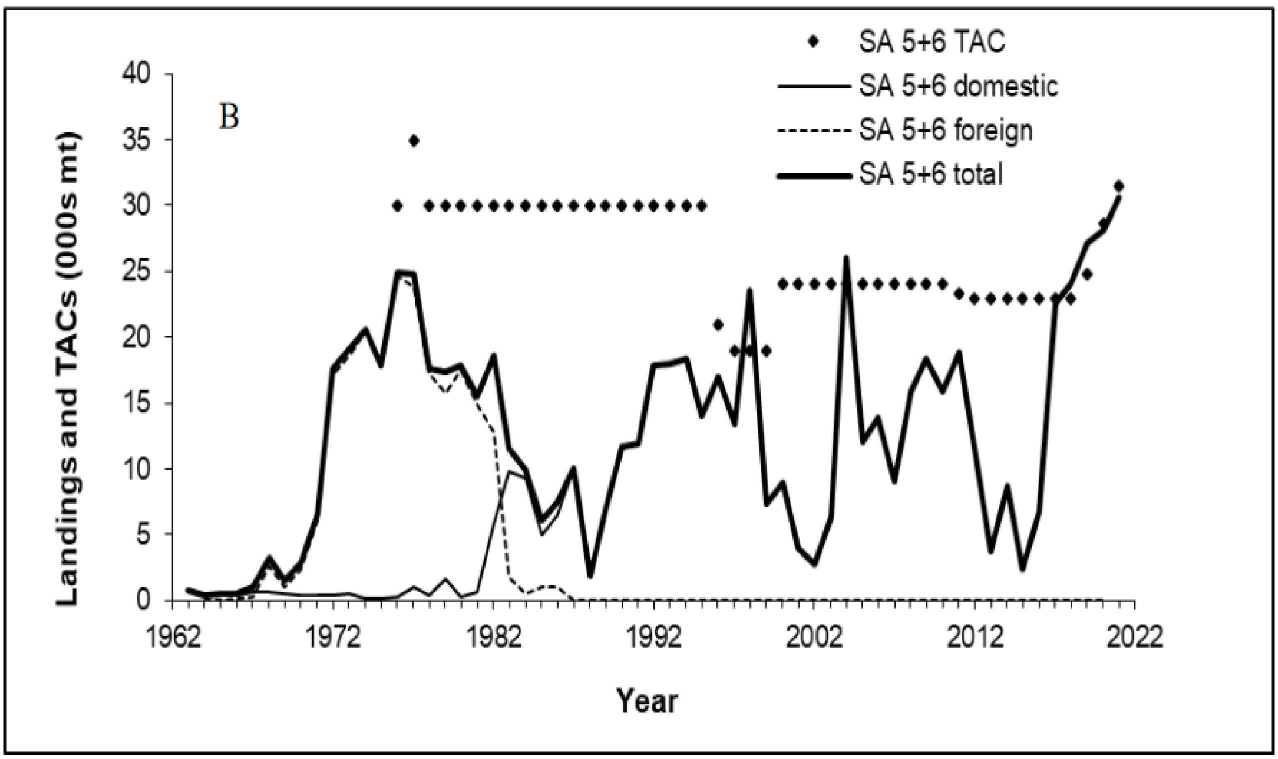

Figure 5. Total annual U.S. Illex catches (mt) by the U.S. and other countries for 1963-2021.

Sources: NEFSC Illex Data update, available at https://www.mafmc.org/ssc-meetings/2022/july-25-26 and NMFS unpublished dealer data.

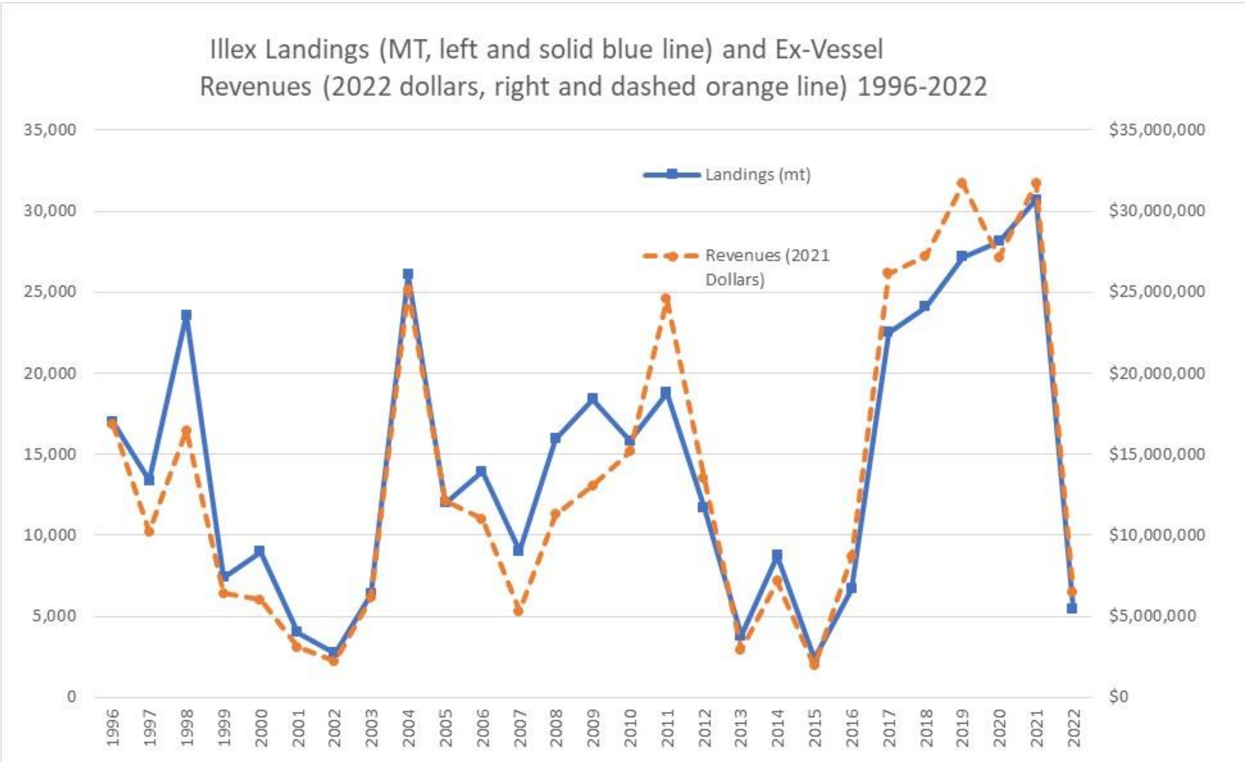

Figure 6. U.S. Illex Landings and Ex-Vessel Values 1996-2022. Source: NMFS unpublished dealer data.

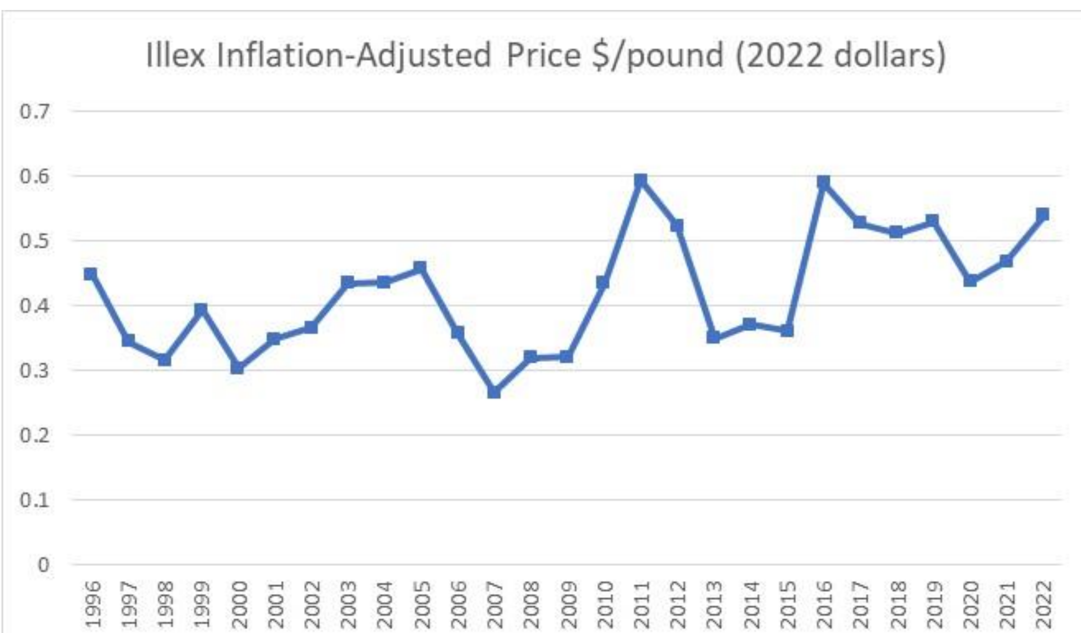

Figure 7. Ex-Vessel Illex Prices 1996-2022 Adjusted to 2021 Dollars Source: NMFS unpublished dealer data.

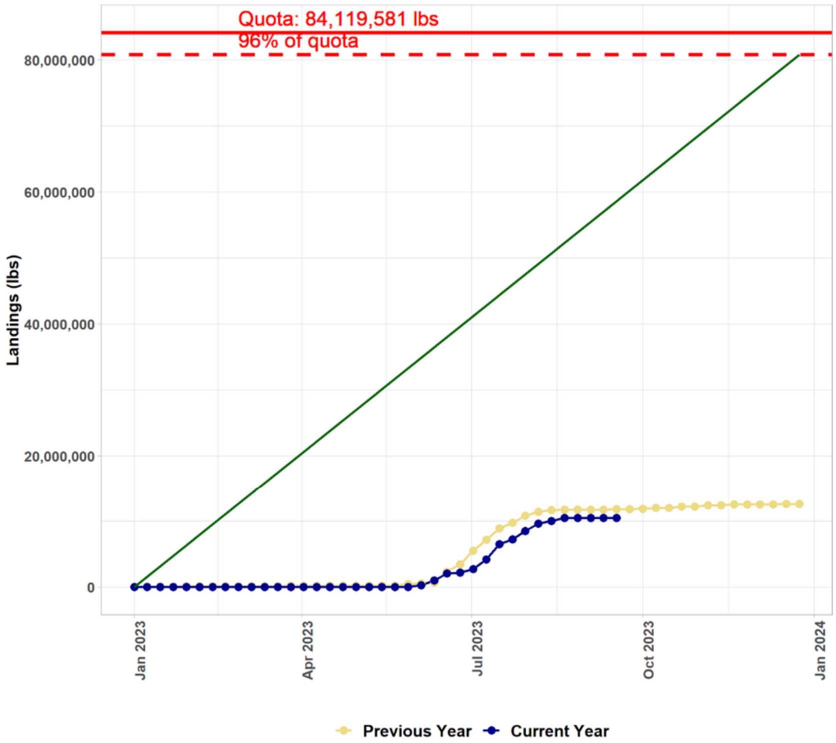

Figure 8. U.S. Preliminary Illex landings; 2023 in dark blue, 2022 in yellow-orange. Source: https://www.fisheries.noaa.gov/new-england-mid-atlantic/commercial-fishing/quota-monitoring-greater-atlantic-region

Table 4. Commercial Illex landings by statistical area in 2022. Source: NMFS unpublished VTR data.

Stat Area	MT
537	94
616	347
622	3,198
623	421
626	859
632	323
Other	168
Total	5,410

Table 5. Vessel participation over time in the Illex Fishery based on annual landings (pounds)

YEAR	Vessels landing more than 50,000 pounds in year
1982	14
1983	16
1984	23
1985	12
1986	18
1987	19
1988	7
1989	14
1990	15
1991	14
1992	17
1993	23
1994	33
1995	31
1996	35
1997	24
1998	30
1999	17
2000	14
2001	8
2002	6
2003	12
2004	30
2005	22
2006	18
2007	11
2008	17
2009	14
2010	18
2011	23
2012	13
2013	12
2014	10
2015	4
2016	10
2017	20
2018	26
2019	32
2020	31
2021	31
2022	13

6.3 Habitat, Including Essential Fish Habitat (EFH)

EFH information from recent squid specifications documents will be brought into the document during document finalization. See https://mafmc.squarespace.com/s/Illex-specs-2023-06-21.pdf.

6.4 Protected Species

Protected Species information from recent squid specifications documents will be brought into the document during document finalization. See https://mafmc.squarespace.com/s/Illex-specs-2023-06-21.pdf.

7.0 WHAT ARE THE IMPACTS (Biological and Human Community) FROM THE ALTERNATIVES CONSIDERED IN THIS DOCUMENT?

This action would primarily impact the *Illex* fishery. The permit information requirements would have no direct impacts except for possible future improvements to *Illex* and longfin squid assessments and some reporting burden for participants. Landings of the other species in the FMP (butterfish, longfin squid, Atl. mackerel, and chub mackerel) are monitored and controlled separately and should be negligibly affected by this action (https://www.fisheries.noaa.gov/new-england-mid-atlantic/commercial-fishing/quota-monitoring-greater-atlantic-region). These other FMP species are also not discarded in sufficient amounts by the *Illex* fishery to be substantially impacted by this action (see Non-Target data and discussion in Section 6.1 above). Because catch of the other FMP species will thus be negligibly affected by this action, they are not discussed further. Recent specifications actions and supporting documents for those other FMP species can be consulted for more information (https://www.mafmc.org/msb). Related to this action and its alternatives (see Section 5 for details), the key determinant of biological impacts on *Illex* is how much *Illex* is caught, and how that catch impacts stock status. The 2021 *Illex* RTA continued to note that discards are a small portion of catch compared to landings.

For habitat and non-target species impacts, the key determinant is the amount and character of the related effort, and the impact of that effort on the non-target's stock status and the quality/quantity of habitat. The availability of the target species can drive effort as much as any quota change, and as effort changes so would impacts on habitat, protected resources, and non-target species. Since limits on catch do cap effort however, measures that limit catch to varying degrees are a factor related to effort. For protected resources (i.e., ESA-listed, and MMPA protected), the key determinant is the status of the species, and the amount and character of effort. Even under reduced effort scenarios, some level of negative impacts are expected to ESA-listed species and non-listed MMPA protected species whose potential biological removal (PBR) levels have been exceeded (as any take can negatively impact the species recovery and/or sustainability). For MMPA protected species (non-ESA listed) with PBR levels that have not been exceeded, alternatives not expected to change fishing behavior or effort relative to no action may have positive impacts by maintaining takes below the PBR level and approaching the zero mortality rate goal. The table below summarizes the guidelines used for each VEC to determine the magnitude and direction of the impacts described in this section.

Table 6. General definitions for impacts and qualifiers relative to resource condition (i.e., baselines)

General Definitions				
VEC	**Resource Condition**	**Impact of Action**		
		Positive (+)	Negative (-)	No Impact (0)
Target and non-target Species	Overfished status defined by the MSA	Alternatives that maintain or are projected to result in a stock status above an overfished condition*	Alternatives that maintain or are projected to result in a stock status below an overfished condition*	Alternatives that do not impact stock / populations
ESA-listed protected species (endangered or threatened)	Populations at risk of extinction (endangered) or endangerment (threatened)	Alternatives that contain specific measures to ensure no interactions with protected species (i.e., no take)	Alternatives that result in interactions/take of listed species, including actions that reduce interactions	Alternatives that do not impact ESA listed species
MMPA protected species (not also ESA listed)	Stock health may vary but populations remain impacted	Alternatives that maintain takes below PBR and approaching the Zero Mortality Rate Goal	Alternatives that result in interactions with/take of marine mammals that could result in takes above PBR	Alternatives that do not impact MMPA protected species
Physical environment / habitat / EFH	Many habitats degraded from historical effort	Alternatives that improve the quality or quantity of habitat	Alternatives that degrade the quality/quantity or increase disturbance of habitat	Alternatives that do not impact habitat quality
Human communities (socioeconomic)	Highly variable but generally stable in recent years (see condition of the resources table for details)	Alternatives that increase revenue and social well-being of fishermen and/or communities	Alternatives that decrease revenue and social well-being of fishermen and/or communities	Alternatives that do not impact revenue and social well-being of fishermen and/or communities
	Impact Qualifiers			
A range of impact qualifiers is used to indicate any existing uncertainty	Negligible		To such a small degree to be indistinguishable from no impact	
	Slight (sl), as in slight positive or slight negative		To a lesser degree / minor	
	Moderate (M) positive or negative		To an average degree (i.e., more than "slight", but not "high")	
	High (H), as in high positive or high negative		To a substantial degree (not significant unless stated)	
	Significant (in the case of an EIS)		Affecting the resource condition to a great degree, see 40 CFR 1508.27.	
	Likely		Some degree of uncertainty associated with the impact	
*Actions that will substantially increase or decrease stock size, but do not change a stock status may have different impacts depending on the particular action and stock. Meaningful differences between alternatives may be illustrated by using another resource attribute aside from the MSA status, but this must be justified within the impact analysis.				

7.1 Biological Impacts on the Managed Resource - *Illex*

Baseline condition: The 2021 *Illex* Research Track Assessment (RTA) was not able to develop a basis for stock status determination. The 2019 stock status designation resulting from the 2021 RTA was "Unknown" with respect to both overfished and overfishing, due to the lack of an accepted method of estimating F and B and the lack of appropriate Biological Reference Points for this subannual species. The RTA Review Panel agreed with the RTA WG Report that indications from the various assessment approaches were that the stock was lightly fished in 2019. However, their report stated that the term "lightly fished" should be interpreted with caution because it has no specific definition relating to sustainable exploitation.

This action would primarily affect the *Illex* fishery, which is predominantly a commercial fishery. As discussed above, the availability of the targeted species, market conditions, and input costs (especially fuel and labor) may drive effort (and catch and revenues) as much as any regulations, though quotas were limiting from 2017-2021. Given the lack of a defined formal stock status, in determining impacts to target species this analysis is also considering factors that affect the health and sustainability of the stock including relative escapement, mortality rates, overfishing risk, and general population size based on available information. Analyses described above in Section 6.1 suggest that recent catches are unlikely to have caused overfishing even though there is no formal overfishing definition.

All alternatives should restrict *Illex* squid catch at or below the SSC-recommended ABC, thus maintaining the baseline condition in an approximately similar fashion (SSC recommendations are designed by the MAFMC's risk policy to avoid overfishing and thus avoid development of an overfished condition. As such, all alternatives should have a slightly positive, if unquantifiable, impact on the *Illex* stock by maintaining the current condition.

7.2 Habitat Impacts

Impacts on the habitat for the managed species (7.2.1) and other species (7.2.2) are addressed separately. The word "habitat" encompasses essential fish habitat (EFH) for the purposes of this analysis. The MAFMC has already minimized to the extent practicable impacts to habitat from the MSB fisheries through closure of several canyon areas in MSB Amendment 9 (http://www.mafmc.org/fmp/history/smb-hist.htm) and Tilefish Amendment 1 (http://www.mafmc.org/fmp/history/tilefish.htm), and protections for Deep Sea Corals via Amendment 16 (http://www.mafmc.org/fmp/history/smb-hist.htm). As a baseline, many habitats in the area of operation of the MSB fisheries are degraded from historical fishing effort (both MSB and other) and from non-fishing activities (Stevenson et al. 2004).

7.2.1 Impacts on Managed Species Habitat

Illex fishing takes place mostly with bottom otter trawling and some mid-water trawling. Habitat for the managed species (MSB) generally consists of the water column, which is not significantly impacted by fishing activity. The exception to the habitat location being the water column is longfin squid eggs, which are attached to sand, mud, or bottom structure (manmade or natural). However, as determined in Amendment 9, there is no indication that squid eggs are preferentially attached to substrates that are vulnerable to disturbance from bottom trawling, so no impacts on habitat for longfin squid eggs are expected from any increase or decrease in fishing effort by bottom trawls. Trawling won't impact the water column itself and there is no information to suggest that *Illex* trawling impacts on substrate will degrade it for purposes of longfin squid egg laying or survival. This means that bottom trawl effort is unlikely to further impact MSB species' habitat regardless of intensity.

7.2.2 Impacts on Other Federally Managed Species Habitat

The bottom trawling used in this fishery can adversely impact some habitat types. However, since the MAFMC has considered habitat impacts in the past and has already restricted MSB fishing to protect sensitive habitats (e.g. Tilefish habitat canyon closures and coral protections), the impact of maintaining the current fishery effort levels, which should occur in a similar fashion for all alternatives, is best characterized as overall slight negative, similar to past years, because effort is not expected to change based on this action.

7.3 Protected Resources Impacts

The impacts of the alternatives on protected species take into account impacts to ESA-listed species, as well as impacts to MMPA protected species in good condition (i.e., marine mammal stocks whose PBR level have not been exceeded) or poor condition (i.e., marine mammal stocks that have exceeded or are near exceeding their PBR level). For ESA-listed species, any action that results in interactions or take is expected to have negative impacts, including actions that reduce interactions. Actions expected to result in positive impacts on ESA-listed species include only those that contain specific measures to ensure no interactions (i.e., no take). By definition, all ESA-listed species are in poor condition and any take can negatively impact that species' recovery (impacts are negligible for species without interactions and not repeated for every alternative – the focus here is on species where there are interactions). The stock conditions for marine mammals not listed under the ESA varies by species; however, all are in need of protection. For marine mammal stocks that have their PBR level reached or exceeded, negative impacts would be expected from alternatives that result in the potential for interactions between fisheries and those stocks. For species that are at more sustainable levels (i.e., PBR levels have not been exceeded), alternatives not expected to change fishing behavior or effort may have positive impacts by maintaining takes below the PBR level and approaching the zero mortality rate goal.

In addition to taking into account the resource condition of ESA-listed and/or MMPA protected species, factors associated with the risk of an interaction between gear and protected species are also considered in assessing impacts of the alternatives proposed. Specifically, the risk of an interaction is strongly associated with the amount of gear in the water, the time the gear is in the water (e.g., tow time), and the presence of protected species in the same area and time as the gear, with risk of an interaction increasing with increases in of any of these factors.

Negligible changes to overall effort, or the character of that effort, are expected under all alternatives. Therefore the impacts for all alternatives are the same as No-action/status-quo, described below.

No-action: MMPA (Non-ESA Listed) Species Impacts

Aside from several stocks of bottlenose dolphin, the PBR level has not been exceeded for any of the non-ESA listed marine mammal species in the affected environment (section 6.4).

Taking into consideration the above information, and the fact that there are non- ESA listed marine mammal stocks/species whose populations may or may not be at optimum sustainable levels, impacts of no action, i.e. maintaining the current specifications, on non-ESA listed species of marine mammals are likely to range from slight negative to slight positive. As noted above, there are some bottlenose dolphin stocks experiencing levels of interactions that have resulted in exceedance of their PBR levels. These stocks/populations are not at an optimum sustainable level and therefore, are at risk. As a result, any potential for an interaction is a detriment to the species/stocks ability to recover from this condition. As provided above, the risk of an interaction is strongly associated with the amount of gear in the water, the time the gear is in the water (e.g., tow time), and the presence of protected species in the same area and time as the gear, with risk of an interaction increasing with increases in of any of these factors. The No Action Alternative or others are not expected to introduce new or elevated interaction risks to these non-ESA listed marine mammal stocks in poor condition. Specifically, the amount of gear in the water, gear tow duration, and the overlap between protected species and fishing gear (i.e., bottom trawl or mid-water trawl), in space and time, is not expected to change relative to current conditions. Given this information, and the information provided in section 6.4.3, this action is likely to result in slight negative impacts to non-ESA listed marine mammal stocks/species in poor condition (i.e., bottlenose dolphin stocks).

Alternatively, there are also many non-ESA listed marine mammals that, even with continued fishery interactions, are maintaining an optimum sustainable level (i.e., PBR levels have not been exceeded) over the last several years. For these stocks/species, it appears that the fishery management measures that have been in place over this timeframe have resulted in levels of effort that result in interaction levels that are not expected to impair the stocks/species ability to remain at an optimum sustainable level. These fishery management measures, therefore, have resulted in indirect slight positive impacts to these non-ESA listed marine mammal species/stocks. Should future fishery management actions maintain similar operating condition as they have over the past several years, it is expected that these slight positive impacts would remain. Given this, and the fact that the potential risk of interacting with gear types used in the fishery varies between non-ESA listed marine mammal species in good condition (see section 6.4), the impacts of no action or other alternatives on these non-ESA listed species of marine mammals in good condition are expected to be negligible to slight positive (i.e., continuation of current operating conditions is not expected to result in exceedance of any of these stocks/species PBR level).

Based on this information, the No Action Alternative or any others are expected to have slight negative to slight positive impacts on non-ESA listed species of marine mammals.

No-action: ESA Listed Species Impacts

The *Illex* fishery is prosecuted with mostly bottom and some mid-water trawl gear. As provided in section 6.4, reviewing the most recent 10 years (2010-2019) of observer data, Sea Turtle Disentanglement Network and GAR Marine Animal Incident database, and NMFS (2021a), interactions between mid-water trawl gear and ESA-listed species of whales, sea turtles, Atlantic sturgeon, and Atlantic salmon have not been observed or documented; only giant manta rays have been observed/documented in this gear type. In terms of bottom trawl gear, interactions with ESA-listed species of sea turtles, Atlantic sturgeon, Atlantic salmon and giant manta rays have been observed/documented in this gear type.

Based on this information, the *Illex* fishery is likely to result in some level some level of negative impacts to ESA listed species. Taking into consideration fishing behavior/effort under the No Action or other alternatives, as well the fact that interaction risks with protected species are strongly associated with amount, time, and location of gear in the water (with vulnerability of an interaction increasing with increases in of any or all of these factors), we determined the level of negative impacts to ESA listed species to be slight. Under the No Action or other alternatives, the amount of trawl gear, tow times, and area fished are not expected change significantly from current operating conditions. As interactions risks with protected species are strongly associated with amount, time, and location of gear in the water, continuation of "status quo" fishing behavior/effort is not expected to change any of these operating conditions. Based on this, and the fact that the potential risk of interacting with gear types used in fishery varies between ESA listed species (e.g., listed species of large whales have never been documented/observed in bottom or mid-water trawl gear; 6.4) the impacts of the No Action Alternative or other alternatives on ESA-listed species are expected to be negligible to slight negative.

7.4 Socioeconomic Impacts

This action would primarily affect the *Illex* fishery, which is predominantly a commercial fishery. As discussed above, the availability of the targeted species, market conditions, and input costs (especially fuel and labor) may drive effort (and catch and revenues) as much as any regulations.

Illex Fishery Baseline Condition for Socioeconomic Impacts:

Where possible, effects on ex-vessel revenues are described. Although ex-vessel revenues are a useful indicator of relative importance for various fisheries, we note that the true economic importance of these fisheries comes from the overall economic activity, jobs, and community vitality that are supported by the ex-vessel revenues. In fact, when related impact multipliers are considered, the actual economic impact can be several times larger (Jacobsen 2014, Dyck and Sumaila 2010). This concept applies to each alternative, and is not repeated for each alternative. The socioeconomic contributions of *Illex* have been variable over time. Due to the year-to-year variation in catch and effort in the fishery, it is difficult to fully quantify human community impacts but the current fishery supports a number of vessels, as described in Section 6.2, and provides a variety of jobs related directly to fishing and also in associated support services. 33 vessels landed over 10,000 pounds of *Illex* in 2021, with total *Illex* landings valued at $29.7 million. From 2019-2021 *Illex* ex-vessel revenues varied from $25.3-$29.7 million, averaging $28.2 million. Given these contributions to the socioeconomics of fishing communities, the recent impacts are best summarized as moderate positive. While $25.3-$29.7 million annually is a small ex-vessel amount compared to some fisheries like scallops, it is larger than a number of other MAFMC-managed species ex-vessel values (e.g. golden tilefish, blueline tilefish, scup, butterfish, bluefish, mackerel, chub mackerel, and spiny dogfish). Especially considering the multiplier effects within communities from support services, a moderate impact qualifier appears reasonable.

7.4.1 ALTERNATIVE 1: NO ACTION, STATUS QUO

Alternative 1, which maintains the current baselines and permit information requirements, should maintain the current condition whereby relevant communities benefit from sustainable *Illex* fishing in a similar fashion as described above, so similar moderate positive impacts would be expected to continue, like recent years.

7.4.2 ALTERNATIVE 2A: NEW HOLD BASELINE, PERMITS IN CPH CAN USE EXISTING SURVEY

The overall socioeconomic impacts should be very similar to no action since the quota is not impacted. For the 46 permits that do not have mackerel hold documentations already, they would have to get a hold survey/certification. Previous informal contacts by council staff with a few marine surveyors revealed that a fish hold measurement could run approximately $10-$80 per foot of vessel length, which could range from $750 - $6,000 for a 75 foot vessel to $1,500 - $12,000 for a 150 foot vessel, depending on the surveyor, the boat design, and travel expenses. Public comments indicated that such surveys can be found for the lower of the above ranges. To the extent that surveys are already required for insurance purposes these costs may be already part of a vessel's operating costs. The vessel hold baseline upgrade restrictions also limits how vessels may be re-configured or replaced, but it is not possible to determine the nature of that cost for each vessel.

On the other hand, this baseline, just like the other (length and horsepower) baselines in use in most limited access fisheries in the region, could help avoid further overcapitalization of the fleet. The rationale/goal for baselines as described in the 1998 Consistency Amendment developed by NMFS is "capping fishing power." This aligns with issues mentioned in several national standards guidelines, especially #5 Efficiency: "Efficiency. In theory, an efficient fishery would harvest the OY with the minimum use of economic inputs such as labor, capital, interest, and fuel. Efficiency in terms of aggregate costs then becomes a conservation objective, where "conservation" constitutes wise use of all resources involved in the fishery, not just fish stocks." So capping additional vessel fishing power ("capital") to catch Optimum Yield (OY) also becomes a conservation objective because the "wise use of all resources" is being addressed. (50 CFR 648.4(a)(5)(iii))

There will be a tradeoff involved as the flexibility of the fleet is somewhat reduced, but the risks from uncontrolled fishing power in fishing fleets are well documented throughout fisheries literature and negative consequences of "increased fishing pressure" is a principal "finding" of Congress as enshrined in the Magnuson-Stevens Fishery Conservation and Management Act.

It would also be relatively easy to relax baseline upgrade restrictions in the future if warranted, but it is very hard to reduce capacity once it is added to the fleet, so management flexibility may be increased by capping capacity.

Compared to 2B, this Alternative would reduce costs for permits in CPH that already had a survey for the previous vessel, and adds some flexibility to put a permit on a smaller vessel (compared to baselines) next without creating a mismatch between the other larger existing baselines and a smaller hold baseline when a permit is brought out of CPH.

7.4.3 ALTERNATIVE 2B: NEW HOLD BASELINE, PERMITS IN CPH CAN NOT USE EXISTING SURVEY

The overall socioeconomic impacts should be very similar to no action since the quota is not impacted. For the 46 permits that do not have mackerel hold documentations already, they would have to get a hold survey/certification. Previous informal contacts by council staff with a few marine surveyors revealed that a fish hold measurement could run approximately $10-$80 per foot of vessel length, which could range from $750 - $6,000 for a 75 foot vessel to $1,500 - $12,000 for a 150 foot vessel, depending on the surveyor, the boat design, and travel expenses. Public comments indicated that such surveys can be found for the lower of the above ranges. To the extent that surveys are already required for insurance purposes these costs may be already part of a vessel's operating costs. The vessel hold baseline upgrade restrictions also limits how vessels may be re-configured or replaced, but it is not possible to determine the nature of that cost for each vessel.

On the other hand, this baseline, just like the other (length and horsepower) baselines in use in most limited access fisheries in the region, could help avoid further overcapitalization of the fleet. The rationale/goal for baselines as described in the 1998 Consistency Amendment developed by NMFS is "capping fishing power." This aligns with issues mentioned in several national standards guidelines, especially #5 Efficiency: "Efficiency. In theory, an efficient fishery would harvest the OY with the minimum use of economic inputs such as labor, capital, interest, and fuel. Efficiency in terms of aggregate costs then becomes a conservation objective, where "conservation" constitutes wise use of all resources involved in the fishery, not just fish stocks." So capping additional vessel fishing power ("capital") to catch Optimum Yield (OY) also becomes a conservation objective because the "wise use of all resources" is being addressed. (50 CFR 648.4(a)(5)(iii))

There will be a tradeoff involved as the flexibility of the fleet is somewhat reduced, but the risks from uncontrolled fishing power in fishing fleets are well documented throughout fisheries literature and negative consequences of "increased fishing pressure" is a principal "finding" of Congress as enshrined in the Magnuson-Stevens Fishery Conservation and Management Act.

It would also be relatively easy to relax baseline upgrade restrictions in the future if warranted, but it is very hard to reduce capacity once it is added to the fleet, so management flexibility may be increased by capping capacity.

Compared to 2A, this Alternative would not reduce costs for permits in CPH that already had a survey for the previous vessel, and would not add some flexibility to put a permit on a smaller vessel (compared to baselines) next without creating a mismatch between the other larger existing baselines and a smaller hold baseline when a permit is brought out of CPH.

7.4.4 ALTERNATIVES 3/4: INTENDED PROCESSING TYPE DECLARATION

These alternatives would very slightly increase paperwork burden when re-applying for permits.

7.5 Non-Target Fish Species Impacts

Non-Target Fish Species Impacts information will be brought into the document during document finalization but are not expected to differ versus the last specifications Environmental Assessment. See https://mafmc.squarespace.com/s/Illex-specs-2023-06-21.pdf. There are very low non-target catches in the *Illex* fishery.

7.6 Cumulative Effects Assessment (CEA)

7.6.1 Introduction

The purpose of a CEA is to consider the combined effects of many actions on the human environment over time that would be missed if each action were evaluated separately. It is not practical to analyze the cumulative effects of an action from every conceivable perspective. Rather, the focus on those effects that are truly meaningful. A cumulative effects assessment makes effect determinations based on a combination of: 1) impacts from past, present, and reasonably foreseeable future actions; 2) the baseline conditions of the VECs (the combined effects from past, present, and reasonably foreseeable future actions plus the present condition of the VEC); and 3) impacts of the alternatives under consideration for this action.

Depending on what NEPA document is needed for this action, Cumulative Effects will be considered at the appropriate level.

8.0 WHAT OTHER LAWS APPLY TO THE ACTIONS CONSIDERED IN THIS DOCUMENT?

To be added during final NEPA-document development.

9.0 LITERATURE CITED AND SELECTED OTHER BACKGROUND DOCUMENTS

To be added during final NEPA-document development.

10.0 LIST OF AGENCIES AND PERSONS CONSULTED

To be added during final NEPA-document development.

11.0 LIST OF PREPARERS AND POINT OF CONTACT

To be added during final NEPA-document development.

THIS IS THE END OF THIS DOCUMENT