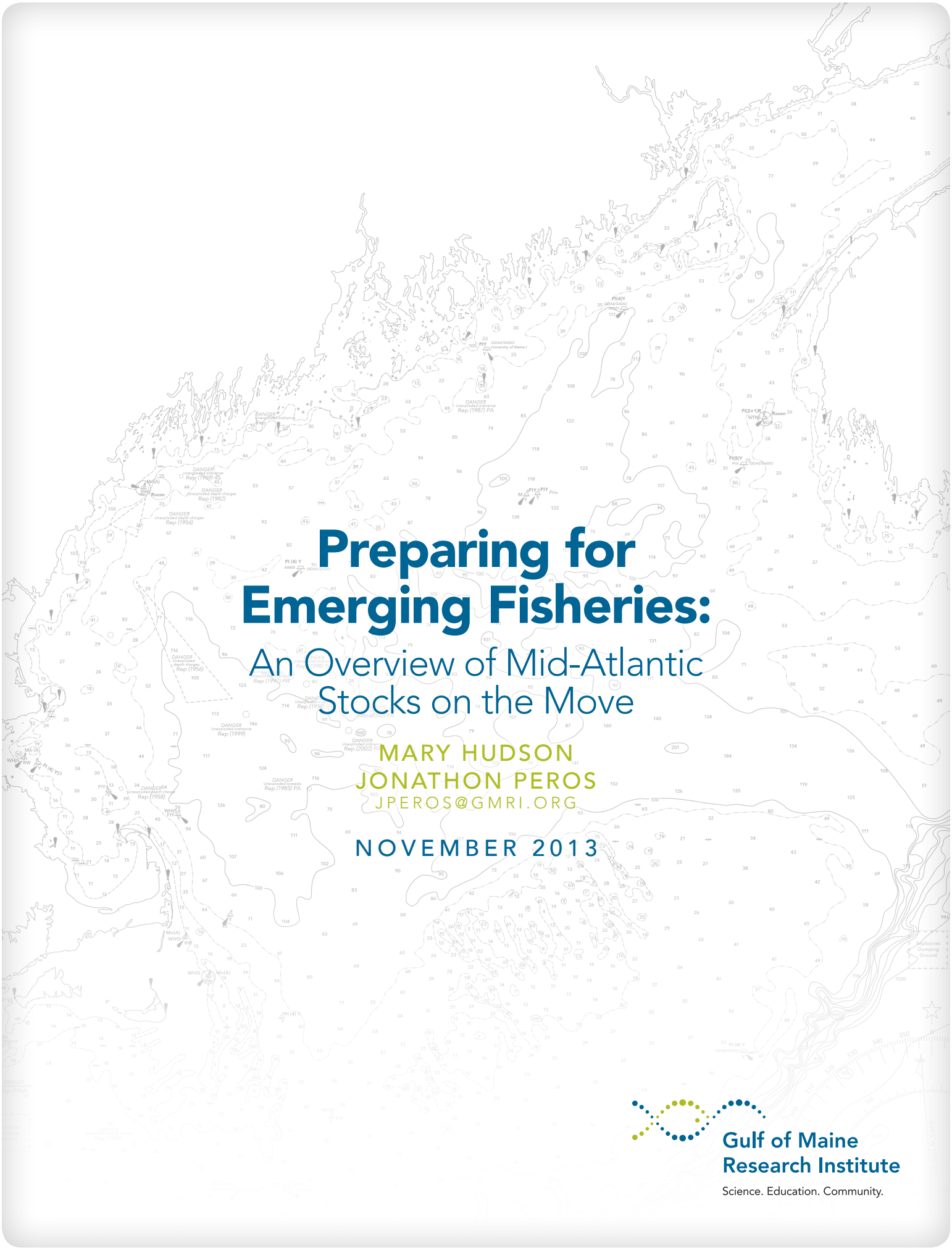

Preparing for Emerging Fisheries:

An Overview of Mid-Atlantic Stocks on the Move

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Introduction

Climate change is affecting marine fish populations in a multitude of ways, including shifts in migration patterns, stock distributions, life histories, and, ultimately, community structures (Cheung et al. 2013). These changes are expected to have significant effects on fisheries worldwide. While research on climate change and fisheries is ongoing, the exact nature of population shifts and subsequent implications for fish and fishermen in the Gulf of Maine are just recently being explored.

The Gulf of Maine is warming. Sea surface temperatures (SST) in the Gulf of Maine have been increasing 0.026°C per year since 1982, and 0.26°C per year since 2004 (Mills et al. 2013). Consistent with SST changes, significant changes in stock structures and distributions have been noted, particularly among groundfish (Lucey and Nye 2010). Cod stocks, for instance, have been shifting into deeper offshore waters in the western Gulf of Maine, and mean body size of the population has declined (Pershing et al. 2013). Also, research predicts reduced cod production and increasing natural mortality rates with increasing water temperatures (Fogarty et al. 2007).

Warming trends in SST are also driving species commonly found in the Mid-Atlantic toward the Gulf of Maine. In particular, centers of population for butterfish, longfin squid, summer flounder, and black sea bass have been steadily moving north since the 1990s *(Figure 1)*. This possible increase of warm water species in the Gulf of Maine is likely to provide opportunity for emerging fisheries.

Management, in particular, is likely to be a significant factor in fisheries development in the Gulf of Maine. Currently, most of the stocks trending north in their distribution are managed by the Mid-Atlantic Fishery Management Council (MAFMC). If these stock move into the Gulf of Maine, fishery managers will be challenged to allow for effective fishery development and management.

The ability of industry to take advantage of such events is highly dependent on a variety of factors, including management, stock status, and market demand. The purpose of this report is to provide an overview of fish stocks managed by the MAFMC and the Atlantic States Marine Fishery Commission (ASMFC) that have shown a northward shift of population center. In doing so, potential opportunities and limitations for emerging fisheries within the Gulf of Maine are highlighted. The following sections discuss the management, permitting, and fishery performance of seven species: summer flounder, scup, black sea bass, longfin and *Illex* squid, Atlantic mackerel, and butterfish.

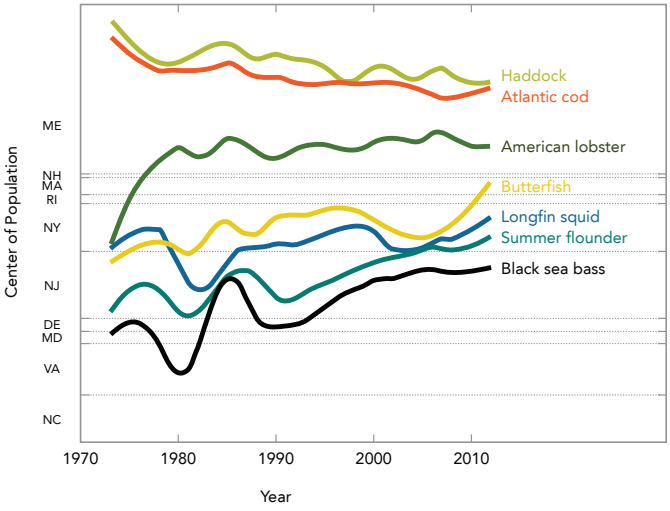

Figure 1: Change of population centers over time (Source: NEFSC 2013).

Management

1. Summer Flounder, Scup, and Black Sea Bass (SFSCBSB)

Summer flounder, scup, and black sea bass are migratory and because of their similar migration patterns, they have all been managed under one Fisheries Management Plan (FMP) since 1996. This FMP encompasses stocks in both state and federal waters from Maine to North Carolina, and is managed jointly by MAFMC and ASMFC.

Along with a commercial fishery, each species within the SFSCBSB FMP has a substantial recreational fishery. While recreational fisheries are managed federally, the majority of the regulations are set on a state-by-state basis. Management measures include size limits, possession limits, and seasons. Additionally, each fishery is regulated by annual catch limits (ACLs). The distribution of ACLs to commercial and recreational fisheries varies for each species. In the summer flounder fishery, commercial fishermen receive 60% of the ACL and recreational fishermen the remaining 40%. Seventy-eight percent of the scup ACL is apportioned to the commercial fishery while 22% is apportioned to the recreational fishery. Lastly, commercial fishermen are allotted 49% of the black sea bass ACL, and recreational fishermen are allotted 51%.

Commercial management measures for summer flounder and black sea bass are set federally and by individual states. Federal regulations include coastwide ACLs, size limits, gear restrictions, and permit moratoriums. The ACLs for summer flounder and black sea bass are distributed state by state based on historical landings *(Table 1, Figure 2)*. Individual states then have the responsibility of implementing harvest controls, often through trip limits and fishery closures.

Table 1: State ACL shares (%)

	BLACK SEA BASS	SUMMER FLOUNDER
Maine	0.5	0.05
New Hampshire	0.5	0.00
Massachusetts	13.0	6.82
Rhode Island	11.0	15.68
Connecticut	1.0	2.26
New York	7.0	7.65
New Jersey	20.0	16.72
Delaware	5.0	0.02
Maryland	11.0	2.04
Virginia	20.0	21.32
North Carolina	11.0	27.45

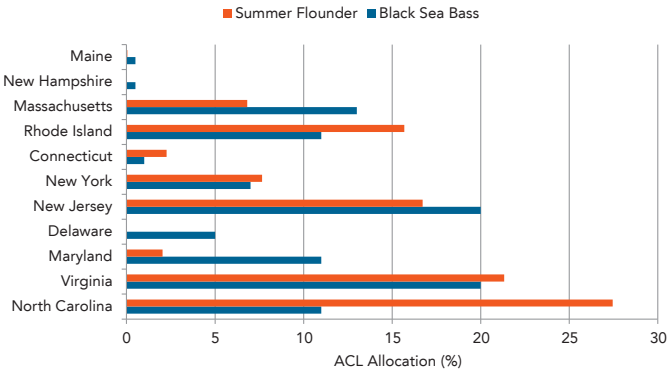

Figure 2: State ACL shares

Scup management differs from summer flounder and black sea bass in that all measures are set federally, including coastwide ACLs, size limits, gear restrictions, permit moratoriums, fishery closures, harvest periods, and trip limits. The scup fishery is managed with three different harvest periods, each with varying trip limits and ACL allocations *(Table 2)*.

Table 2: Scup harvest periods (Source: NOAA 2012)

	TIME OF YEAR	% OF ACL	TRIP LIMIT
Winter I	January-April	45.11	50,000 lbs.
Summer	May-October	38.95	n/a
Winter II	November-December	15.94	2,000 lbs.

2. Squid/Mackerel/Butterfish (SMB)

Longfin and *Illex* squid, Atlantic mackerel, and butterfish have been managed under a single FMP since 1983, and are managed in federal waters from Maine to North Carolina by the MAFMC. With the exception of *Illex* squid, management measures for each species include ACLs, trip limits, restricted areas, fishery closures, and accountability measures.

Longfin squid allocations and corresponding butterfish discard caps are distributed among trimesters (January-April, May-August, and September-December). In 2013, a new three-phase butterfish management scheme was implemented to coincide with the reopening of the direct fishery. Under the three-phase system, trip limits are reduced as catch levels reach

each phase's threshold. Trip limits for each phase vary depending on the permit and mesh sized used. For example, trip limits during Phase 1 are unlimited for fishermen holding a SMB 1 permit and using a mesh size greater than or equal to 3 inches. Once the Phase 1 threshold is reached and Phase 2 is initiated, the trip limit is reduced to 5,000 pounds, and so on.

Permitting

1. Summer Flounder/Scup/Black Sea Bass

Summer flounder, scup, and black sea bass each have federal commercial and recreational permits *(Table 3)*. Commercial permits are limited access and currently closed to new entry.

2. Squid/Mackerel/Butterfish (SMB)

There are a variety of SMB federal permits, each pertaining to different species and associated with varying trip limits *(Table 4)*. Commercial open access permits are available for Atlantic mackerel, incidental squid, and butterfish catch. Limited access permits include squid and butterfish moratorium permits and tiered mackerel permits. Currently, all squid and butterfish moratorium permits (SMB 1 and SMB 5) are closed to new entry.

Tiered mackerel permits (SMB T1, T2, and T3) came into effect in March 2012. These limited access permits allow fishermen significantly higher trip limits, and are given based on past participation in the fishery. Those

Table 3: Summer flounder, scup, and black sea bass permit overview (Source: NOAA 2013) with number of permits homeported in New England (Source: NOAA 2012a).

	PERMIT CATEGORY	TYPE	# OF TOTAL PERMITS (2012)	# OF NEW ENGLAND PERMITS (2012)
Summer Flounder	Category 1	Commercial (Moratorium)	837	433
	Category 2	Recreational	791	299
Scup	Category 1	Commercial (Moratorium)	690	298
	Category 2	Recreational	703	248
Black Sea Bass	Category 1	Commercial (Moratorium)	672	267
	Category 2	Recreational	unknown	270

Table 4: SMB permit overview (Source: NOAA 2013a) with number of permits homeported in New England (Source: NOAA 2012a).

	PERMIT CATEGORY	DESCRIPTION	TRIP LIMITS	# OF TOTAL PERMITS (2012)	# OF NEW ENGLAND PERMITS (2012)
Open Access	SMB 2	Charter Party	None while carrying passengers for hire	741	482
	SMB 3	Squid/Butterfish Incidental	Longfin & butterfish: 2,500 lb Illex squid: 10,000 lb	1,686	1,078
	SMB 4	Atlantic Mackerel	20,000 lb	1,991	1,190
Limited Access	SMB 1	Longfin/Butterfish Moratorium	Unlimited Longfin squid Butterfish: Dependent on phase and mesh size	345	159
	SMB 5	Illex Moratorium	Unlimited Illex	75	28
	SMB T1	Tier 1 Mackerel	Unlimited mackerel	TBD	16
	SMB T2	Tier 2 Mackerel	135,000 lb	TBD	11
	SMB T3	Tier 3 Mackerel	100,000 lb	TBD	31

who do not qualify for a tiered mackerel permit can continue fishing using a SMB 4 permit.

3. Permit Distribution

Open access mackerel permits (SMB 4) are the most common in southern New England, followed by incidental squid and butterfish catch permits (SMB 3) *(Figure 3a)*. Notably, New England fishermen hold 64% of all open access mackerel permits and 60% of all incidental permits *(Table 4)*, with Massachusetts and Maine fishermen holding the majority.

Summer flounder, scup, and black sea bass permits are most common in New England in Massachusetts and Rhode Island, where warmer waters produce a higher abundance of each species *(Figure 3b)*. Massachusetts and Rhode Island also receive a considerably larger proportion of summer flounder and black sea bass quota than other New England states *(Table 1)*.

Squid, mackerel, butterfish limited access permits are least common in New England, with Massachusetts and Rhode Island holding the majority *(Figure 3c)*.

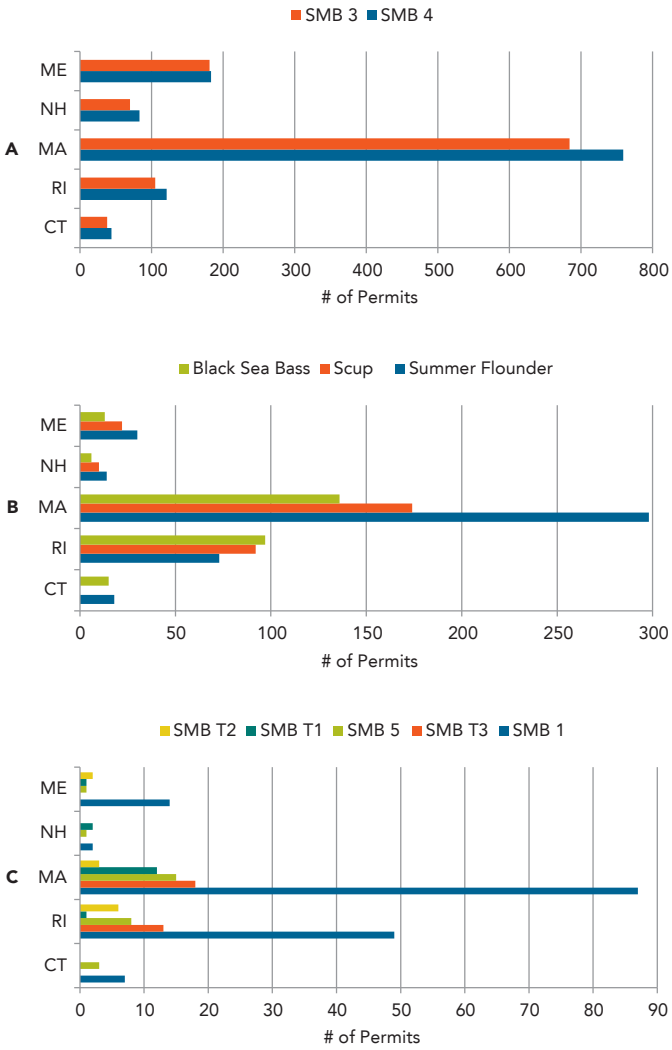

Figure 3: Distribution of 2012 commercial open access SMB permits (a), limited access SFSCBSB permits (b), and limited access SMB permits (c) in New England (Source: NOAA 2012a).

Fishery Synopsis

1. Summer Flounder

1.1 Stock Status and Landing Trends

The Atlantic summer flounder stock ranges from Canada to Florida, with the population concentrated between Massachusetts and North Carolina (FishWatch 2013). Hudson Canyon, off the New Jersey coast, is the approximated center of the population. The stock migrates seasonally, spending winter offshore near the continental shelf break and summer nearshore, along

beaches and estuaries to spawn. Recent observations and assessments depict the stock extending farther north and east (Nye et al. 2009; NEFSC 2013).

The summer flounder stock declined drastically throughout the 1980s due to overfishing, with the spawning stock biomass (SSB) reaching historical lows in 1989 (NEFSC 2006; MAFMC 2012). As a result, management plans for the stock were established, and a significant decrease in allowable catch was implemented in 1993 for both the commercial and recreational fisheries *(Figure 4)*. These measures proved effective, and the stock biomass increased six-fold between 1989 and 2003. Since, the stock size has been slowly increasing, and was declared officially rebuilt in early 2013 (MAFMC 2012).

Despite the recent rebound of the stock, commercial quotas and subsequent landings remain low. Whereas landings once neared 40 million pounds in the 1980s, they are now just below 16 million pounds. Though landings increased considerably from 2008 to 2011, commercial quota has begun to decrease, dropping from 13.08 million pounds in 2012 to 11.4 in 2013.

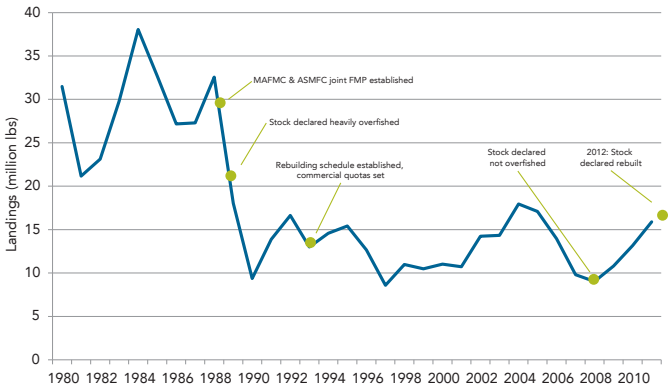

Figure 4: Commercial summer flounder landings along the U.S. Atlantic coast from 1980 to 2011 with corresponding management measures (Source: NOAA 2013b).

1.2 Recent Harvest

Summer flounder is mainly harvested using bottom otter trawls. Distribution of fishing effort throughout the year follows the stock's seasonal migrations; in winter months the fishery operates primarily offshore in the Mid-Atlantic, whereas in summer months the fishery operates primarily nearshore in southern New England. Current commercial harvest is primarily landed in Virginia, North Carolina, and New Jersey *(Figure 5)*, despite being predominantly caught in southern New England waters *(Figure 6)*. Landing of northern-caught fish in southern states is likely a result of quota distribution as 70% is allocated to New Jersey, Virginia, and North Carolina.

Due to the quality of its meat and domestic and foreign demand, summer flounder has a relatively high value market, with average ex-vessel prices ranging from $1.50 to $2.50 per pound over the past decade. In 2011 ex-vessel prices averaged $2.00 per pound and were generally higher in northern states than southern states ($2.27 per pound in Rhode Island vs. $1.46 in Virginia) *(Figure 5)*.

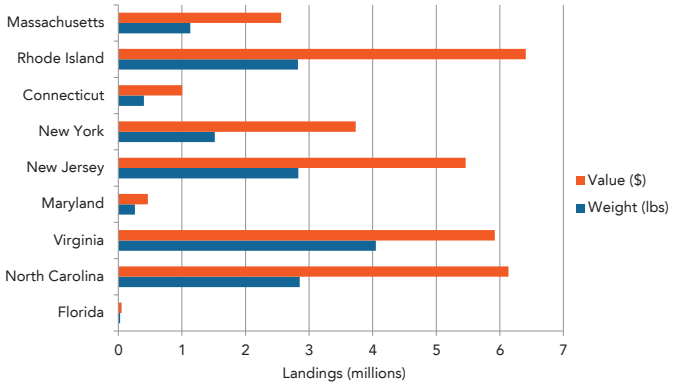

Figure 5: 2011 commercial summer flounder landings distribution by weight and value along the U.S. Atlantic coast (Source: NOAA 2013b).

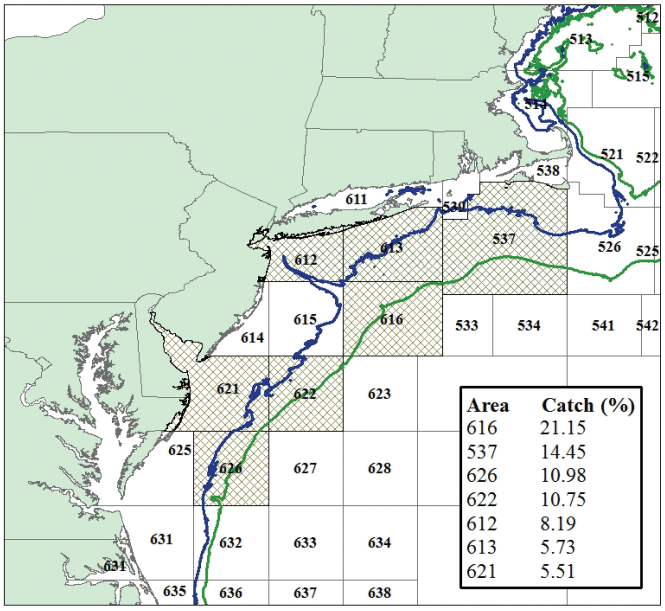

Figure 6: 2011 summer flounder catch distribution by statistical area (Source: MAFMC 2012).

2. Scup

2.1 Stock Status and Landing Trends

The Atlantic scup stock is most abundant between southern New England and North Carolina and in water temperatures ranging from 13°C to 16°C. The stock is migratory, moving inshore and northward during the summer and offshore and southward in the winter. According to MAFMC Advisory Panel members, the scup stock distribution is trending farther north and east, and time spent nearshore has increased (MAFMC 2012a).

Scup SSB reached historically low levels in the 1980s after being heavily fished in previous decades (NEFSC 2010). Subsequent management measures drastically decreased fishing effort to allow the stock to rebound *(Figure 7)*. In 1996 scup was included in the summer flounder FMP, and by 2008 the stock had increased thirty-fold. The stock was declared rebuilt in 2009 and is currently not overfished. Though commercial landings have nearly doubled since 2009, scup harvest still remains low compared to previous decades *(Figure 7)*. Notably, only 14 million pounds of the 27.91 million pound commercial quota were harvested in 2012. The 2013 quota was reduced to 23.5 million pounds.

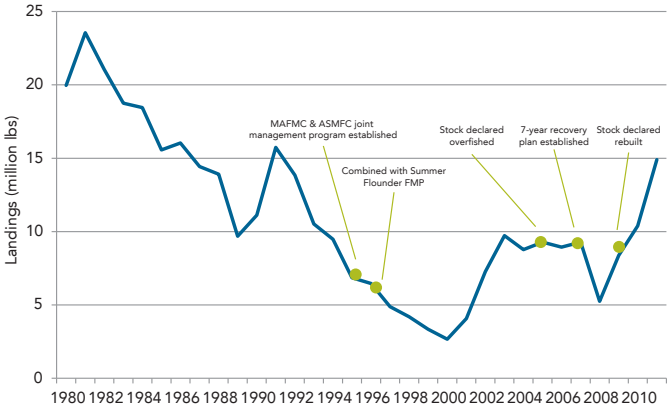

Figure 7: Commercial scup landings along the U.S. Atlantic coast from 1980 to 2011 with corresponding management measures (Source: NOAA 2013b).

2.2 Recent Harvest

Scup is primarily harvested using bottom otter trawls. Scup harvest occurs offshore in the winter and nearshore in the spring. Landings peak in January, February, May, and November when each harvest period begins (NOAA 2013b). In 2011, approximately 80% of the 14.9 million pounds of commercially harvested scup were landed in Rhode Island, New York, and New Jersey *(Figure 8)*. The majority of these landings were caught in adjacent waters *(Figure 9)*.

Recent market demand for scup is low. Ex-vessel prices tend to range from $0.40 to $1.25 per pound (Degener 2013) and averaged $0.56 in 2011. Consistent with landings by weight, Rhode Island, New York, and New Jersey landed the highest values of scup in 2011 *(Figure 8)*.

Demand for scup was significant for the majority of the 1900s until the stock reached historical lows in the 1980s. While it is no longer a popular fish for consumption after its absence from the market over the past three decades, scup's status as a rebuilt stock

provides opportunities for markets to redevelop. Currently, scup is mostly frozen and exported, with some efforts focusing on rebuilding domestic demand.

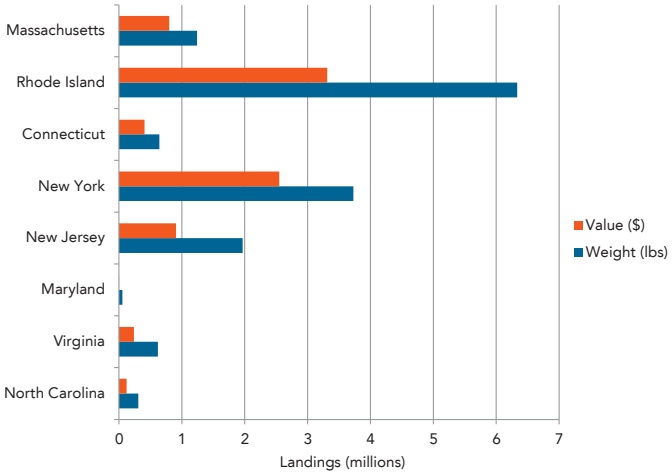

Figure 8: 2011 commercial scup landings distribution by weight and value along the U.S. Atlantic coast (Source: NOAA 2013b).

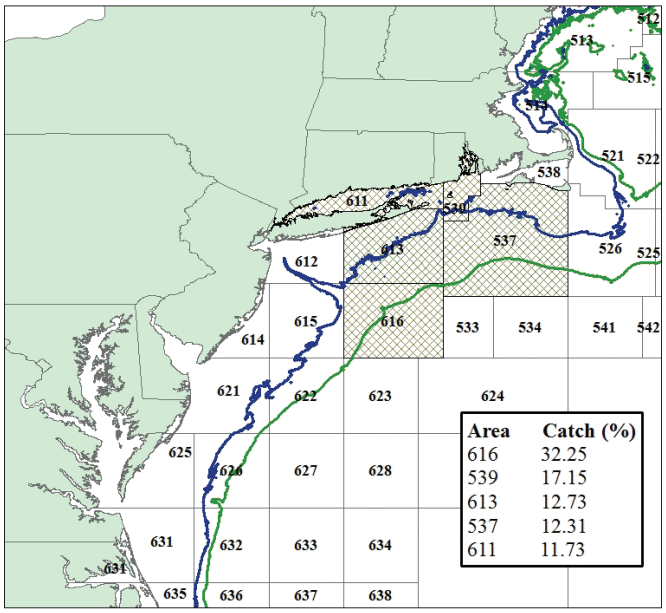

Figure 9: 2011 scup catch distribution by statistical area (Source: MAFMC 2012b).

3. Black Sea Bass

3.1 Stock Status and Landings Trends

Black sea bass is divided into two stocks along the U.S. Atlantic coast: north and south of Cape Hatteras. The Mid-Atlantic black sea bass stock ranges from Maine to North Carolina, and is most abundant from southern New England southward. The stock is migratory, and moves offshore and south in the winter and nearshore and north in the summer, where spawning occurs.

Since the 1970s, commercial landings of black sea bass have been low relative to other fisheries, averaging about 3.66 million pounds a year. Despite low landings, the Mid-Atlantic stock decreased significantly during this time; the spawning stock fell below the biomass target from 1983 until 2002, and dipped beneath the biomass threshold in 1997 (NEFSC 2012). After being declared overfished in 2000, regulations resulted in a significant decline in commercial harvest *(Figure 10)*. The Mid-Atlantic stock was declared rebuilt in 2009. The commercial quota was set at 1.71 million pounds in 2012 (MAFMC 2012c).

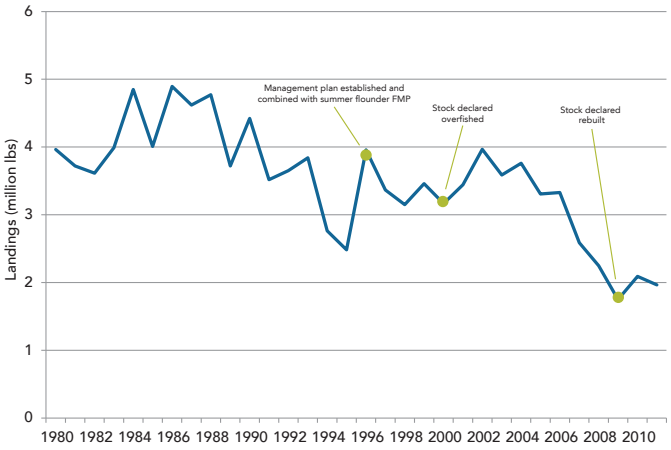

Figure 10: Commercial black sea bass landings along the U.S. Atlantic coast from 1980 to 2011 with corresponding management measures (Source: NOAA 2013b).

3.2 Recent Harvest

Black sea bass is primarily harvested using otter trawls when the stock is offshore and with fish pots and

handlines when nearshore. Distribution of annual fishing effort and subsequent catch varies by season and state. In general, catch is highest during the summer in southern New England, whereas landings are relatively consistent year round in Mid-Atlantic states. Current distribution of commercial landings is relatively uniform from southern New England to North Carolina, with New Jersey, Massachusetts, Virginia, and North Carolina accounting for 57% of the 1.96 million pounds landed in 2011 *(Figure 11)*. Notably, the majority of these landings were caught off the coast of New Jersey *(Figure 12)*.

The quality of meat and exclusivity to the U.S. Atlantic coast creates high market demand for black sea bass, and 2011 ex-vessel prices averaged $2.97 per pound (FishWatch 2013). Prices tend to rise in the winter and drop in the summer, varying greatly by state, and ranging from an average of $3.65 per pound (Virginia) to $1.22 per pound (Florida) in 2011 *(Figure 11)*. Trends over the past decade show ex-vessel prices continually rising (MAFMC 2012c).

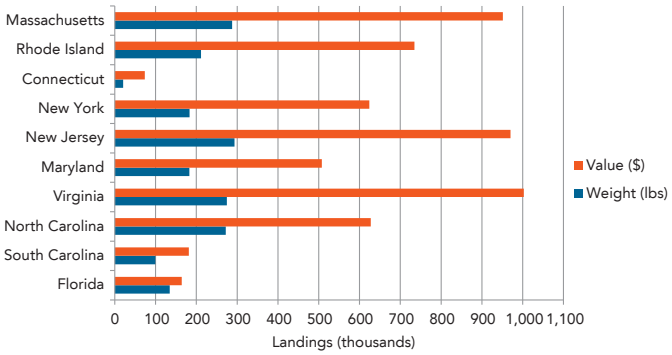

Figure 11: 2011 commercial black sea bass landings distribution by weight and value along the U.S. Atlantic coast (Source: NOAA 2013b).

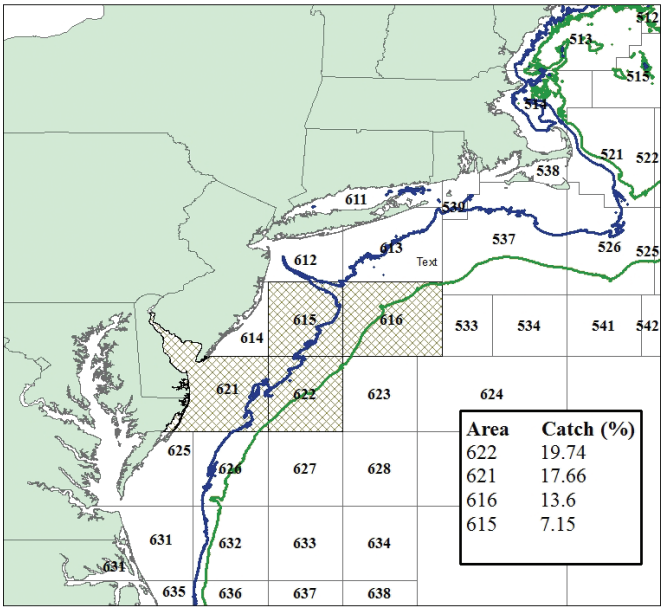

Figure 12: 2011 black sea bass catch distribution by statistical area (MAFMC 2012c).

4. Butterfish

4.1 Stock Status and Landings Trends

The Atlantic butterfish stock ranges from Florida to Newfoundland, with highest concentrations between Cape Hatteras and the Gulf of Maine. The stock migrates seasonally, moving north and nearshore in the summer to spawning and feeding grounds.

Butterfish SSB has varied greatly from year to year since the 1970s, with annual swings of 20 million pounds often occurring. It is possible that these high fluctuations are due to variances in annual predation, as butterfish are an important and highly predated forage fish. Trends show, on average, higher stock sizes in the early 1970s and 1980s, during which fishing efforts peaked with landings reaching 68.6 million pounds and 26 million pounds in 1973 and 1984 respectively (NEFSC 2006). In the late 1980s, both catch and biomass began to steadily decline; the stock was declared overfished in 2005 *(Figure 13)* (NEFSC 2006). Strict regulations over the past decade dramatically decreased commercial quota and trip limits, effectively restricting any directed catch of

butterfish. Subsequently, landings over the past decade have been the result of incidental catch within other fisheries, typically the groundfish and squid fisheries. The current status of the stock is unknown, although recent assessments indicate an increase in abundance over the last few years (MAFMC 2011). As a result, the moratorium on directed catch was lifted in early 2013, although commercial quota remains low at 5.7 million pounds.

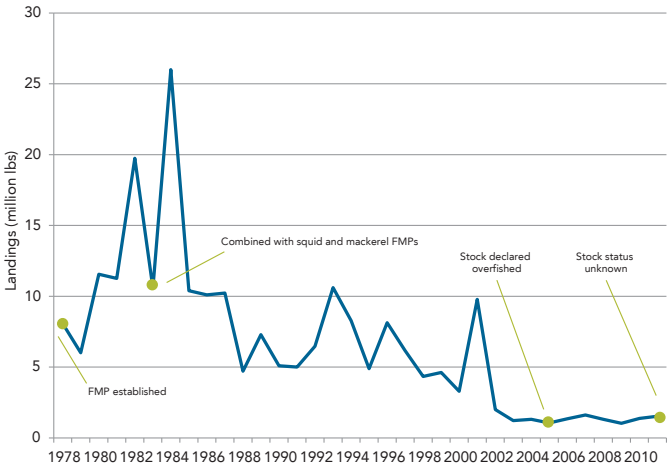

Figure 13: Commercial butterfish landings along the U.S. Atlantic coast from 1978 to 2011 with corresponding management measures (Source: NOAA 2013b).

4.2 Recent Harvest

Butterfish is primarily harvested using bottom otter trawl gear, and landings vary little throughout the year (NOAA 2013b). In 2011, the majority of catch was landed in Rhode Island and New York, accounting for 74% of the total 1.5 million pound annual harvest *(Figure 14)*. Because the 2011 butterfish catch was primarily incidental, the concentration of catch in New York and Rhode Island are likely a result of high squid landings in both state.

Due to minimal landings and low demand, the recent market for butterfish has been poor. Ex-vessel prices averaged just $0.80 per pound in 2011, with little variance of value among states *(Figure 14)*. The majority of harvested butterfish is exported to Japan (NOAA 2013a). Notably, the butterfish market thrived in the 1980s because of high Japanese demand, resulting in prosperous fisheries in Rhode Island, Massachusetts, and New Jersey. However, the 1990 Japanese stock market crash along with declines in biomass, dramatically reduced demand for butterfish (NEFSC 2010a). Currently, with the directed fishery reopening, there is potential to redevelop the once prosperous butterfish market.

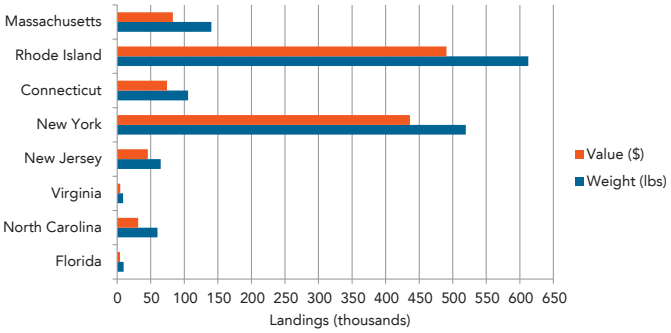

Figure 14: 2011 commercial butterfish landings distribution by weight and value along the U.S. Atlantic coast (Source: NOAA 2013b).

5. Atlantic Mackerel

5.1 Stock Status and Landings Trends

The Atlantic mackerel stock ranges from Labrador to North Carolina, and is highly concentrated from the Gulf of Maine south. The stock is comprised of two separate spawning groups with varying migration patterns. The southern population spawns in the Mid-Atlantic Bight during the spring, and the northern population in the Gulf of St. Lawrence in early summer. During the winter, both populations move to waters warmer than 7°C, ranging anywhere between Nova Scotia and Cape Hatteras.

After being heavily overfished in the 1960s, the Atlantic mackerel stock collapsed in the 1970s. Management measures were implemented in 1978, and fishing effort and subsequent landings remained low through the 1990s *(Figure 15)*. Landings increased rapidly in the early 2000s, peaking in 2004 and 2006 at approximately 124

million pounds. Landings have since plummeted, due to a number of factors including low availability, Atlantic herring fishery closures, and low market demand.

Atlantic mackerel is a data-poor fishery. There is considerable uncertainty surrounding migration patterns and abundance of the stock. Stock assessments conducted by the Northeast Fisheries Science Center (NEFSC) and the Transboundary Resource Assessment Committee (TRAC) are contradictory, one reporting a steady increase in biomass and the other a decrease. Furthermore, landings data varies considerably from source to source. Despite these uncertainties, the National Marine Fisheries Service (NMFS) has listed the stock as not overfished and ACLs remain high. The 2013 commercial quota is set at 74.56 million pounds.

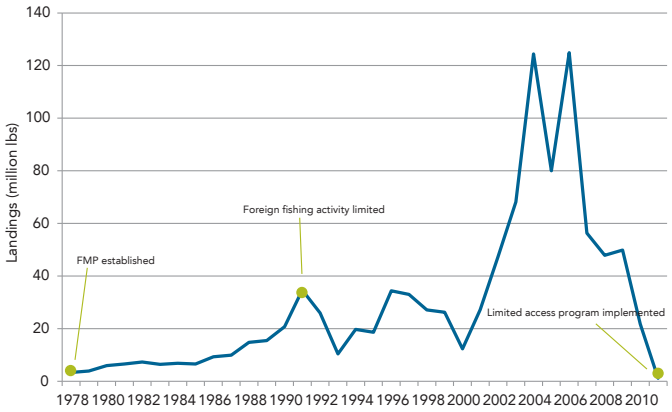

Figure 15: Commercial mackerel landings along the U.S. Atlantic coast from 1978 to 2011 (Source: NOAA 2013b).

5.2 Recent Harvest

Mackerel is harvested primarily using mid-water otter trawls, and is often caught in conjunction with Atlantic herring because of their mixed schooling patterns. Along the entire Atlantic coast, the majority of fishing occurs between February and April when the stock is in shallower waters. Annual distribution of landings varies year to year, though the majority of catch is generally landed in Rhode Island, Massachusetts, and New Jersey. In 2011, Maine and New York yielded substantial landings while Massachusetts accounted for 45% of the 1.14 million pounds landed *(Figure 16)*.

The market demand for Atlantic mackerel is low with ex-vessel prices averaging $0.36 per pound in 2011. Market value varies significantly state to state; in 2011 Rhode Island landings were twice as profitable as Maine landings, despite landing a third less in volume *(Figure 16)*. The U.S. mackerel market in particular is struggling due to the high catch and export rates in the northeast Atlantic (FishChoice 2012). As a result, both landings and prices in the U.S. have decreased dramatically over the past five years.

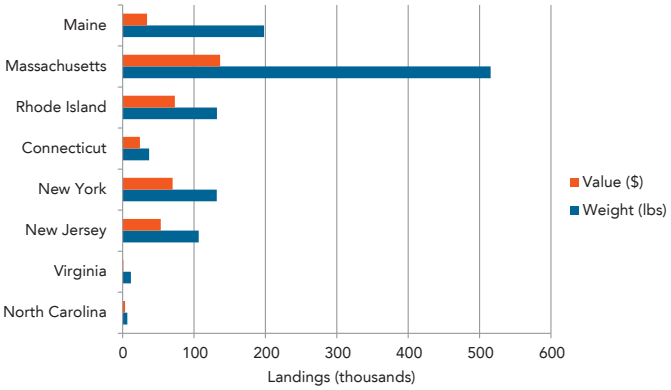

Figure 16: 2011 commercial mackerel landings distribution by weight and value along the U.S. Atlantic coast (Source: NOAA 2013b).

6. Longfin Squid

6.1 Stock Status and Landing Trends

The northwest Atlantic longfin squid stock ranges from the Gulf of Maine to Florida, and is most abundant from Georges Bank to Cape Hatteras. The stock migrates seasonally, moving offshore to the continental shelf edge in the winter and inshore in the summer. Longfin squid also migrate daily through the water column, moving up towards the surface at night and down towards the seabed during the day. Longfin have a short life span, generally ranging 6 to 8 months, and have a high natural spawning stock mortality.

Due to the species' unusual life history and sensitivity to changes in environmental factors, longfin biomass is highly variable from year to year (FishWatch 2013).This renders stock assessments difficult, and there has been

little success accurately determining the status of longfin (MAFMC 2013). Current assessments of the stock estimate its relative abundance at slightly below average but not overfished.

Landings also tend to vary greatly from year to year, and are found to have little correlation with stock biomass estimates (MAFMC 2013). Trends over recent decades show that domestic landings increased significantly from 1982 through the early 1990s, in large part due to the phase out of foreign fishing and seasonal fishery closures *(Figure 17)*. Though increasing since 2010, landings still remain relatively low, and only 56% of the commercial quota was harvested in 2012.

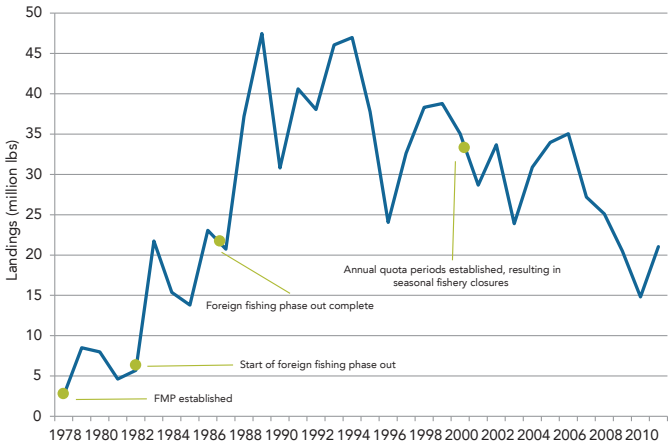

Figure 17: Domestic commercial longfin squid landings along the U.S. Atlantic coast from 1978 to 2011 with corresponding management measures (Source: NOAA 2013b).

6.2 Recent Harvest

Longfin squid is primarily harvested using bottom otter trawl gear. The fishery follows the stocks migration patterns, and moves offshore from October through March and nearshore from April to September. Each year, the seasonal concentration of fishing effort is inconsistent; in 2011 the majority of harvest was landed during the summer months, whereas in previous years the majority was landed during the winter. Similarly, the annual spatial distribution of longfin landings varies though New York, New Jersey, and Rhode Island generally land the highest amounts. In 2011, catch totaled 21 million pounds, 47% of which was landed in Rhode Island *(Figure 18)*.

The northwest Atlantic longfin fishery produces the majority of the world's longfin catch (FishWatch 2013). As such, there is substantial foreign and domestic market demand. Prices have been on the rise since 2000, with the average ex-vessel price peaking in 2011 at $1.18 per pound (MAFMC 2013).

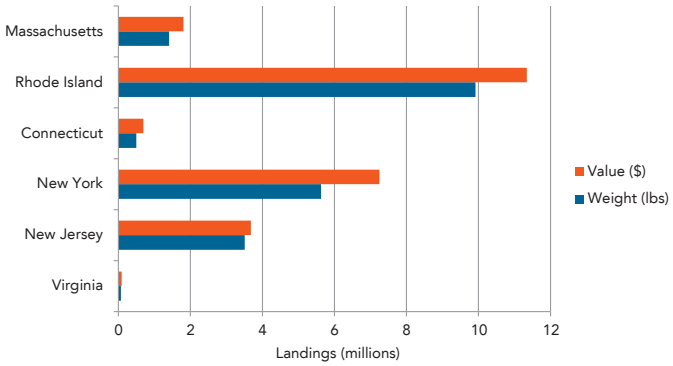

Figure 18: 2011 commercial longfin squid landings distribution by weight and value along the U.S. Atlantic coast (Source: NOAA 2013b).

7. Illex Squid

7.1 Stock Status and Landing Trends

Illex squid in the northeast Atlantic is divided into two stock components: a northern population from Newfoundland to the Scotian Shelf and a southern population from the Gulf of Maine to Florida. Both stocks are migratory, and move off the continental shelf in autumn and winter, and back onto the shelf in the spring and summer. Similar to longfin squid, *Illex* have a short lifespan, living up to just 7 months.

Illex stock abundance is highly variable from year to year because of the species' short lifespan and sensitivity to environmental conditions. For these same reasons, assessing the biomass of the stock is difficult, and estimates are unreliable. As a result, there is a high degree of uncertainty surrounding both the historical and current stock status of *Illex* (MAFMC 2013a).

Historically, a majority of *Illex* was harvested by foreign fleets between the late 1960s and mid-1980s. However, as foreign fishing was phased out in the early 1980s, domestic landings began to increase significantly *(Figure 19)*. Since then, landings have varied tremendously from year to year, largely due to availability and market demand. High catch rates in 1998 and 2004 led to fishery closures followed by low landings in subsequent years *(Figure 19)*. Though on the rise for a few years in the late 2000s, recent landings have dropped from 37.6 million pounds in 2011 to 23.4 million pounds in 2012, utilizing only 51% of the commercial quota.

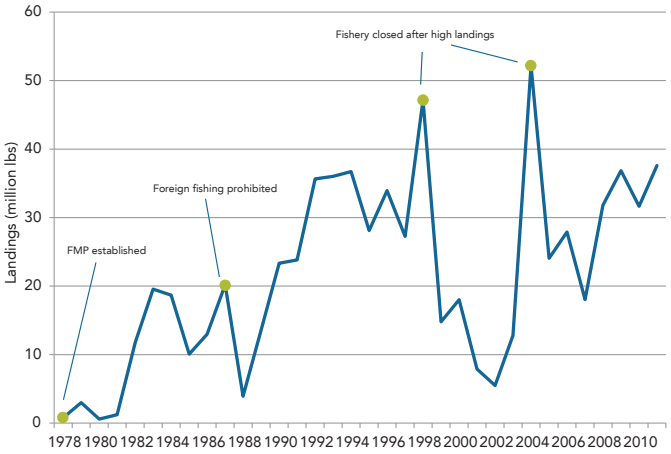

Figure 19: Domestic commercial Illex squid landings along the U.S. Atlantic coast from 1978 to 2011 (Source: NOAA 2013b).

7.2 Recent Harvest

Illex squid is primarily harvested using bottom otter trawls. The fishery follows squid migration patterns and operates principally during the summer months when the stock has migrated onto the continental shelf. The geographic distribution of landings varies annually, though recently Rhode Island (and occasionally New Jersey) has landed the majority of catch. In 2011, 56% of *Illex* catch was landed in New Jersey and 40% in Rhode Island *(Figure 20)*.

Market demand and price for *Illex* are primarily driven by landings in the South Atlantic region. Ex-vessel prices in the U.S. have steadily increased since 2007, averaging $0.46 per pound in 2011. Trends over the past decade indicate that catch landed in New England states fetches better prices than in Mid-Atlantic states (NOAA 2013a). In 2011, ex-vessel prices averaged $0.56 per pound in Rhode Island, $0.40 in New Jersey, and $0.28 in Virginia *(Figure 20)*.

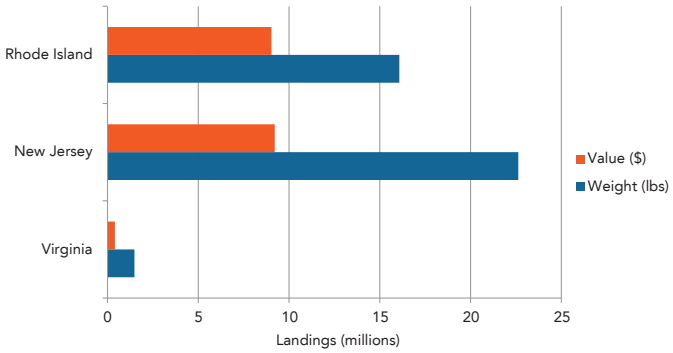

Figure 20: 2011 commercial Illex squid landings distribution by weight and value along the U.S. Atlantic coast (Source: NOAA 2013b).

Conclusion

Understanding the current situation of these fisheries is only the first step in characterizing new fishing opportunities in the Gulf of Maine. As we look forward to the future, a myriad of considerations need to be addressed. Scientists and the fishing industry must work together to construct an accurate assessment of current and future changes by addressing: Which stock distributions are fluctuating, and how? Are stocks splitting, expanding, contracting, or simply shifting? Do stock areas and IDs need to be redefined? In light of these shifts, how accurate are recent stock assessments?

These concerns should also be considered by management. As stocks shift, should management be joint or split between the NEFMC and MAFMC, or not altered at all? How will measures be adjusted to allow for the emergence of new fisheries? What regulations will states need to implement? What are the implications of these shifts for New England's existing FMPs? Industry too must be forward thinking. How will markets for these species emerge? Where, how, and who

will process harvests? These are just a small sample of the many questions that need answering.

Squid and scup have relatively high quotas that, in recent years, have not been fully utilized *(Figure 21)*. Based on this current underutilization, the squid and scup fisheries have the potential to develop in the Gulf of Maine. Furthermore, these fisheries are of higher value when compared to other Mid-Atlantic managed fisheries *(Figure 22)*. Though squid and scup ex-vessel prices are relatively low in comparison to the average ex-vessel price of groundfish *(Figure 22)*, regulations provide the opportunity to catch high volumes per trip, which in turn has the potential to increase revenue for fishermen. Additionally, the possible redevelopment of the scup market could further increase the value of the fishery.

While the best available science indicates forgone yield in these fisheries, access to these resources is limited. Permit availability would present a significant constraint on the emergence of Gulf of Maine squid and scup fisheries. Although there are considerable incidental squid permit holders (SMB 3), trip limits associated with the permit are restricting. Limited access longfin (SMB 1), *Illex* (SMB 5), and scup permits have higher trip limits *(Table 4)*, yet Gulf of Maine-based vessels only account for fourteen SMB 1 permits, one SMB 5 permit, and twenty-two limited access scup permits collectively.

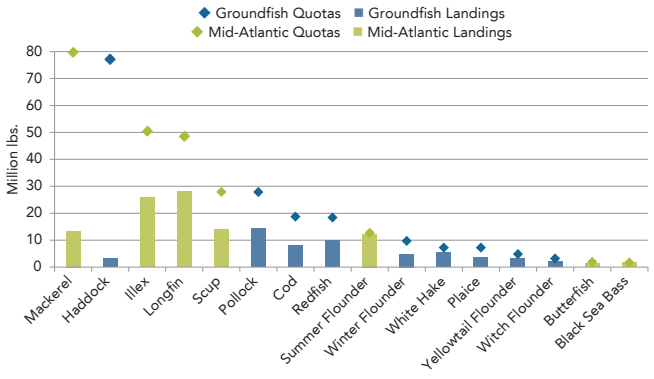

Figure 21: 2012 commercial quota and landings for groundfish (blue) and Mid-Atlantic (green) stocks.

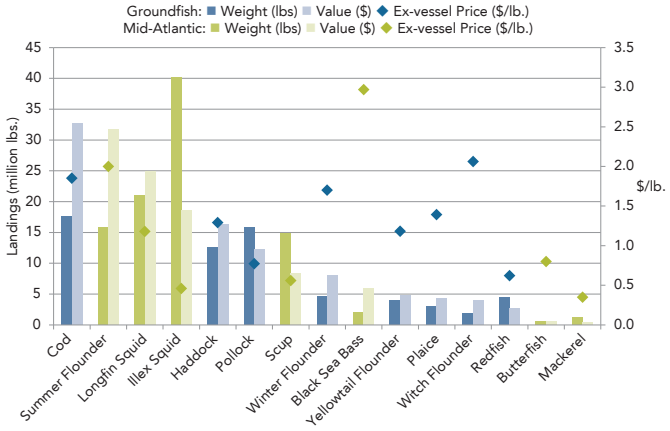

Figure 22: 2011 landings by weight and value (left axis) and 2011 average ex-vessel prices (right axis) of groundfish (blue) and Mid-Atlantic (green) stocks (Source: NOAA 2013b).

Atlantic mackerel is another underutilized species that has potential for further development in the Gulf of Maine. In 2012 just 15% of the 67.64 million pound quota was harvested *(Figure 21)*, an increase from 2011 when landings fulfilled only 3% of commercial quota. Low market demand is the primary reason for these recent low landings, and it will likely similarly impede the development of mackerel fishery in the region. Also, permit availability may constrain the growth of the fishery. Though Gulf of Maine fishermen hold a substantial amount of open access mackerel permits (SMB 4), the 20,000 pound trip limit is potentially limiting for larger vessel classes. Limited access tiered permits with trip limits upwards of 100,000 pounds are available, however permit distribution is based on past participation in the fishery.

Black sea bass and summer flounder are both highly marketable species with consistently strong ex-vessel prices, and have the potential to be valuable fisheries in the Gulf of Maine if their population centers continue to track northward. However, coastwide commercial quota for both species is comparatively low, and each year the quota is met *(Figure 21)*. Though the 2011 summer flounder quota of 17.38 million pounds allowed for significant landings by weight and value *(Figure 22)*, considerably lower quota was implemented in 2012 and

2013 (12.73 and 11.44 million pounds, respectively). Black sea bass commercial quota is set at 1.78 million pounds for 2013 and has not exceeded 4 million pounds in the past decade. The development of summer flounder and black sea bass fisheries in the Gulf of Maine may be hindered by the existing state proportions of the coastwide quota (less than 1% for Maine and New Hampshire). Lastly, commercial harvest permits for both fisheries are currently closed to new entry. For example, just 30 summer flounder and 13 black sea bass commercial permits are collectively associated with vessels homeported in Maine.

Butterfish would likely be a difficult species to develop a fishery for in the Gulf of Maine. While a new management scheme implementing higher commercial quota and trip limits has reopened the fishery for 2013, quota still remains below historic averages. Market demand is also weak and minimal landings coupled with low ex-vessel prices effectively hamper the value of the fishery *(Figure 22)*. Furthermore, there are only 14 federal butterfish permits (SMB 1) issued in Maine, and the fishery is currently closed to new entry. Though the potential for the emergence of a directed butterfish fishery in the Gulf of Maine seems grim, it is important to note the high level of uncertainty surrounding the fishery. Stock abundance is unknown but is estimated to be increasing. Fishing year 2013 will prove to be an experimental year with the implementation of the new three-phase management scheme and the reopening of the fishery. Depending on fishery performance and stock status in coming years, it is possible that butterfish quota may increase substantially. There is also potential for the redevelopment of the butterfish market that, when coupled with higher quota, could result in a much improved fishery.

On the whole, permit moratoriums and state quota allocations based on historical landings are two significant barriers for new fishery development in the Gulf of Maine. Fishing industry members and managers will be challenged to adapt to changing circumstances with low state allocations and few limited access permits for the majority of Mid-Atlantic species. If population centers continue to trend northward, deriving state-by-state quotas based on past participation in a fishery could result in a management dilemma where Mid-Atlantic states possess large amounts of quota but relatively low local stock abundances leaving New England states with low quotas despite high stock abundance.

Upon reviewing the current status of fisheries managed by the MAFMC and ASMFC, it is clear that there are many factors that will influence the opportunity for emerging fisheries in the Gulf of Maine. Management, permitting, stock biomass, landings, and market trends vary dramatically across each fishery that was discussed, suggesting different degrees of potential for each fishery to develop. Ultimately, fisheries managers, scientists, and industry members must become innovative and capable of continual adaptation as ecosystem shifts occur.

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