Skate and Ray Management in the Northwest Atlantic: An Overview of Current Management and Recommendations for Conservation

By

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The undersigned hereby certify that they have read and recommend to Marine Affairs Program for acceptance a graduate research project titled "*Skate and Ray Management in the Northwest Atlantic: An Overview of Current Management and Recommendations for Conservation*" by Hilary Goodwin in partial fulfillment of the requirements for the degree of Master of Marine Management.

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From birth, man carries the weight of gravity on his shoulders. He is bolted to Earth. But man has only to sink beneath the surface and he is free. Buoyed by water, he can fly in any direction...up, down, sideways. Underwater, man becomes Archangel. – Jacques Cousteau

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ABSTRACT

Skates and rays are among the most vulnerable of exploited marine fish, not only due to target catches, but also because of high bycatch and discard rates in ground fisheries. This thesis reviews existing management measures for skates and rays in the Northwest Atlantic and assesses the need for transboundary management. The US and Canada have developed National Plans of Action for Sharks, which include sections on skate (but not ray) management. Target species are typically assessed and managed in some way, but bycatch species tend to be ignored. The Northwest Atlantic Fisheries Organization (NAFO) set the world's first skate quota by a Regional Fishery Management Organization; however, this quota is not set in line with scientific advice. There are problematic data gaps as skate landings in the US, Canada, and NAFO are not reported by species, which hinders the quality of stock assessments. The US and Canada have both prohibited retention of certain skate species, but rebuilding the stocks will take considerable time and additional protection measures must be implemented, particularly to reduce skate bycatch and discards. Top priorities to help address the conservation of skates and rays include: (1) collect and make public species-specific skate and ray landings and discard data, (2) implement skate quotas based on scientific advice, (3) implement bycatch reduction measures, (4) research the stock structure, life history, growth, and population dynamics of skates to further aid the development of reliable stock assessments, (5) initiate transboundary management between Canada and the US for skate stocks.

KEYWORDS: elasmobranch; skate fisheries; ray fisheries; fisheries management; conservation

GLOSSARY AND ACRONYMS

Terms are from www.fao.org/fi/glossary/default.asp and www.fishbase.org/search.php and http://www.talkingfish.org/fishery-management-glossary

ABC – Acceptable Biological Catch. A level of a stock or stock complex's annual catch that accounts for the scientific uncertainty in the estimate of the overfishing limit and any other scientific uncertainty.

ACL – Annual Catch Limit. The amount of a particular fish stock or stock complex that can be caught in a given year (usually measured by weight). In the US, the reauthorized **MSA** requires that managers implement annual catch limits by 2011 on all managed fish stocks.

ACT – Annual Catch Target. Harvest goal for the fishery under **MSA**, which accounts for management uncertainty.

AM – Accountability Measure. Fishery management rules that prevent annual catch limits from being exceeded (*i.e.* prevent overfishing) and make corrections when fishing foes over the annual catch limit. They are mandated by the 2006 reauthorization of **MSA**.

Bathydemersal – Living and feeding on the bottom below 200 m.

Benthopelagic – Living and feeding near the bottom as well as in mid-waters or near the surface.

BIO – Bedford Institute of Oceanography (part of **DFO**).

Bycatch – Part of a catch of a fishing unit taken incidentally in addition to the target species towards which fishing effort is directed. Some or all of it may be returned to the sea as discards, usually dead or dying.

CFR – Code of Federal Regulations (governs fisheries in the US).

Chondrichthyes – The cartilaginous fishes, which includes the **elasmobranchs** and the holocephalans (chimaeras).

Circumglobal – Distributed worldwide.

Circumtropical – Distributed throughout the tropical regions worldwide.

CHP – Conservation Harvesting Plan (developed by **DFO**).

CITES – Convention on International Trade in Endangered Species of Fauna and Flora.

CMS – The Convention on the Conservation of Migratory Species of Wild Animals (also known as Bonn Convention).

Codend – the end of a fishing net in which the catch collects.

CP – Contracting Parties. Countries or entities that have signed, or otherwise agreed to abide by the terms of, an international agreement.

Continental shelf – The gently sloping, shelf-like part of the seabed adjacent to the coast, extending to a depth of about 200m.

COSEWIC – The Committee on the Status of Endangered Wildlife in Canada.

CSRL – Canadian Shark Research Laboratory.

DAS – Days-at-Sea program (used in the US). A form of fisheries management that regulates catch by limiting the number of days that permitted fishing vessels are allowed to fish and the amount of fish vessels can bring in per day. DAS has been used to manage the groundfish fishery in New England since 1994.

Demersal – Occurring or living near the bottom of the ocean.

DFO – Department of Fisheries and Oceans Canada.

Discards – The component of a catch returned to the sea, either dead or alive.

DMP – Dockside Monitoring Program.

DU – Designable Unit – Subspecies, varieties or geographically or genetically distinct population.

EBSA – Ecologically and Biologically Significant Area

EFH – Essential Fish Habitat (legislated in the **MSA**).

EEZ – Exclusive Economic Zone – A zone under national jurisdiction (up to 200 nautical miles wide) declared in line with the provisions of the UN Law of the Sea.

Elasmobranch – Refers to the class Elasmobranchii: containing the living sharks, skates and rays.

ESA – Endangered Species Act (US legislation).

ESS – Eastern Scotian Shelf.

FAO – United Nation Food and Agriculture Organization.

FMP – Fishery Management Plan (in the US). Rules that regulate the fisheries managed by the federal government under the **NMFS**.

FRCC – Fisheries Resource Conservation Council (advises **DFO**).

FSSI – Fish Stock Sustainability Index (developed by **NOAA**).

HADD – Harmful alteration, disruption or destruction (Subsection 35 of the Fisheries Act in Canada).

HAPC – Habitat of Particular Concern (a subdivision of **EFH**).

HB – House Bill.

High seas – Waters beyond the areas of national jurisdiction, which can be 200 miles or less.

HTS – Harmonized Tariff System.

ICNAF – International Commission for the Northwest Atlantic Fisheries (predecessor to **NAFO**).

IFMP – Integrated Fisheries Management Plan (developed by **DFO**).

IPOA-Sharks – UN **FAO** International Plan of Action for the Conservation and Management of Sharks.

ITC – International Trade Commission (in the US).

IUCN – International Union for Conservation of Nature.

K-selected species – a species typified by slow growth, relatively large size, low natural mortality, and low fecundity.

LOA – Letter of Authorization.

Longline fishing – a fishing method using short lines bearing hooks attached at regular intervals to a longer main line. Longlines can be laid on the bottom (**demersal**) or suspended (**pelagic**).

MAFMC – Mid-Atlantic Fishery Management Council.

MPA – Marine Protected Area.

MSA – Magnuson Stevens Fishery Conservation and Management Act (governs fisheries management in the US).

MSY – Maximum sustainable yield – The largest theoretical average catch or yield that can continuously be taken from a stock under existing environmental conditions without causing the stock to depleted.

NAFO – Northwest Atlantic Fisheries Organization. **RFMO** responsible for the management of fisheries in the Northwest Atlantic.

NCA –NAFO Convention Area (encompasses **EEZ** and high seas).

NEFMC – New England Fishery Management Council. One of the eight regional fishery management councils established by the **MSA** in the US to develop **FMP**s.

NEFSC – New England Fishery Science Center.

NERO – New England Regional Office (**NOAA**).

NESC – Northeast Skate Complex (in the US).

NGO – Non-government organization.

NOAA – National Oceanic and Atmospheric Administration.

NMFS – National Marine Fisheries Service.

NPFMC – North Pacific Fishery Management Council.

NPOA-Sharks – National Plan of Action for the Conservation and Management of Sharks in fulfillment of the **IPOA-Sharks**.

NW – Northwest.

NRA – NAFO Regulatory Area (encompasses area beyond the **EEZ** of **CPs** in the **NCA**).

Oceanic – Living in the open ocean, mainly beyond the edge of the **continental shelf**.

Overfished – A stock is considered "overfished" when exploited beyond an explicit limit beyond which abundance is considered too low to ensure safe reproduction

Overfishing – For long-lived species, "overfishing" (*i.e.* using excessive effort) starts well before the stock becomes overfished.

PDT – Plan Development Team (under the **NEFMC**).

Pelagic – Occurring or living in open waters or near the water's surface with little contact with or dependency on the sea floor.

Precautionary approach – A strategy that acts to ensure the well-being of a species, population, or habitat even when full scientific certainty is lacking.

RAP – Recovery Assessment Potential. Conducted after a **COSEWIC** assessment.

Red List of Threatened Species – Listing of the conservation status of the world's flora and fauna, administered by **IUCN**.

RFMO – Regional Fisheries Management Organization. An intergovernmental body responsible for developing and implementing fishery management and regulations for international waters.

SAFE – Stock Assessment and Fishery Evaluation (developed by **NEFMC**).

SARC – Stock Assessment Review Committee (under the **NEFMC**).

SARA – Species at Risk Act (Canadian endangered species legislation).

SBRM – Standardized Bycatch Reporting Methodology (in the US).

SFA – Sustainable Fisheries Association.

SMU – Skate Management Unit (determined by the **NEFMC**).

SSC – Scientific and Statistical Committee (under the **NEFMC**).

SSG – Shark Specialist Group (part of the **IUCN).**

SSR – Stock Status Report (developed by **DFO**).

Straddling stocks – Stocks occurring within the **EEZ** of two or more coastal States or within the **EEZ** and in international waters.

TAC – Total Allowable Catch. The total catch allowed to be taken from a resource in a specified period (usually a year) as defined in the management plan. The TAC may be allocated to the stakeholders in the form of quotas as specific quantities or proportions.

TAL – Total Allowable Landings.

TMGC – Transboundary Management Guidance Committee (under the **TRAC**).

TRAC – Transboundary Resources Assessment Committee (governs **straddling stocks** between the northeast US and Atlantic Canada).

Trawling – A fishing method utilizing an open net that is dragged behind a boat. Can be used on the bottom (**demersal** trawl) or in mid-water (**pelagic** trawl).

VMRC – Virginia Marine Resources Commission.

VME – Vulnerable Marine Ecosystem.

VMS – Vessel Monitoring System.

WCO – World Customs Organization

ZIFF – Zonal Interchange File Format (**DFO** fisheries database).

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1. INTRODUCTION

1.1. Overview of Skates and Rays and Research Scope

Skates and rays are in the chondrichthyan class of fish which also include sharks and chimaeras, and are characterized by slow growth, late maturity, and low fecundity (Camhi et al., 2009). Due to these life history characteristics, chondrichthyans are vulnerable to being overfished to the point where their populations cannot easily recover. Chondrichthyans are divided into two subclasses: holocephali (chimaeras) and elasmobranchii (sharks, skates, and rays), which are differentiated by their physical characteristics (Collette & Klein-MacPhee, 2002). Skates and rays are part of the batoid superorder, comprised of 574 species, which is more species than the other nine chondrichthyan orders combined (Ebert & Compagno, 2007). Batoids are flat-bodied, cartilaginous fishes (most of them marine-benthic) that tend to inhabit soft substrates (Ebert & Compagno, 2007; Ebert & Sulikowski, 2007). Batoids are known to inhabit continental and insular shelves from the shoreline to depths of 3,000 m (Collette & Klein-MacPhee, 2002). Skates are present at higher latitudes and in deeper waters, and tend to be replaced in shallower, warm temperate to tropical waters by stingrays (Ebert & Compagno, 2007). To reproduce, skates produce egg cases (sometimes known as 'mermaid's purses'), while rays produce live young.

There are 245 recognized species of skates globally, and 16 skate species and 11 ray species are present in the Northwest Atlantic Fisheries Organization (NAFO) Convention Area (Figure 10), which extends from Atlantic Canada and Greenland to the Mid-Atlantic area of the US (Ebert & Compagno, 2007; Collette & Klein-MacPhee, 2002). For the purposes of this research, focus on skate management in the US will be restricted to the

Skate Management Unit which extends from Maine to North Carolina (Figure 1). While directed fisheries are a concern for skates in particular, scientists estimate that half of the global catch of chondrichthyans is due to bycatch (Stevens, Bonfil, Dulvy, & Walker, 2000). Skates have received less focus than other more charismatic elasmobranchs like sharks, even though they are a visible component of bycatch fisheries (Ebert & Sulakowski, 2007). Some scientists argue that skates (Family Rajidae) are the "most vulnerable of exploited marine fishes" (Dulvy et al., 2000, p. 283). Directed fishing pressure has increased since the decline of traditional groundfish species in the Northwest (NW) Atlantic; skates are also frequently caught as bycatch in groundfish trawls and scallop dredges (CSRL & NAFC 2007b; Gavaris et al., 2010). Due to their presence on soft substrates, skates and rays are particularly vulnerable to trawl fisheries (Ebert & Sulikowski, 2007; Collette & Klein-MacPhee, 2002). Rays are more vulnerable to bycatch in tuna and swordfish longline fisheries (Gavaris et al., 2010). Trawl fisheries in the North Atlantic have impacted the "abundance, population structure, and distribution of several skate species, causing several to be given commercially prohibited status" (Ebert & Sulikowski, 2007, p. 108).

Skates are in demand for their meat which is sold as skate wing in Europe and Asia and skate meat is used as lobster bait (Kulka, et al., 2009). While certain species have been determined to be endangered in US waters (*e.g.* Thorny skate) and Canadian waters (*e.g.* Winter skate), no skates or rays are currently listed under the US Endangered Species Act (ESA) or the Canadian Species at Risk Act (SARA). When evaluating if a species should be listed under ESA, ecological considerations are the sole focus, while the SARA considers economic implications, which can result in additional difficulties in achieving adequate conservation status for endangered species.

Commercial fisheries in the NW Atlantic target primarily two skates species – Winter skate (*Leucoraja ocellata*) and Thorny skate (*Amblyraja radiata*) (CSRL & NAFC, 2007a). The Thorny skate is fished by Canada but is prohibited from being landed in the US, while the Winter skate is fished by the US but is prohibited from being landed in Canada (NMFS, 2011c; DFO, 2007b). The International Union for Conservation of Nature (IUCN) assesses Thorny skate as Critically Endangered in US waters and as Vulnerable in Canadian waters (Kulka et al., 2009), while the Winter skate is assessed as Endangered (Kulka, Sulikowski, & Gedamke, 2009). The assumption that Thorny skate is a straddling stock complicates management measures (AES, 2011). Scientists have suggested there is connectivity in skate populations between the US and Canada. For example, Frisk et al. proposed that there is particular connectivity between the Winter skate populations on the Scotian Shelf and Georges Bank (Frisk et al. 2008 as cited in NEFMC, 2008).

In the US, the New England Fishery Management Council (NEFMC) manages the Northeast skate complex which includes seven species. In Canada, the Department of Fisheries and Oceans (DFO) manages skates as part of their groundfish complex, but only Thorny skate is currently commercially targeted (DFO, 2007b). While landings data are available from the National Oceanic and Atmospheric Administration (NOAA) and DFO, the data is not species-specific which hinders advances in management. There is also concern about the mislabeling of species (Kulka et al., 2009; S. Fordham, personal communication, January 22, 2012). If fishermen cannot accurately identify which species are prohibited, such a deficiency is a serious problem for management. Aggregated skate catch data can mask species-specific declines, which highlights why species-specific data is especially critical for skates and other elasmobranchs (Dulvy et al., 2000). Even though Thorny skate is prohibited from being landed in the US, it is still taken as bycatch and there has been no increase in biomass (Kulka et al., 2009; NEFSC, 2012d).

The International Commission for Northwest Atlantic Fisheries (ICNAF) was established in 1950 to manage fisheries outside the territorial waters of coastal states in the NW Atlantic (NAFO, n.d.). In 1979, ICNAF was replaced by the Northwest Atlantic Fisheries Organization (NAFO), a Regional Fishery Management Organization (RFMO), following the extension of the Exclusive Economic Zone (EEZ) to 200 nautical miles (nm) (NAFO, n.d.). NAFO set the first RFMO elasmobranch quota in the world for Thorny skate in 2004, but the Total Allowable Catch (TAC) was not set in line with scientific advice. The scientific advisory committee notes that Thorny skate has a low resilience to fishing mortality (NAFO, 2010a), which indicates the importance of NAFO parties agreeing to manage quotas according to scientific advice.

This research will focus on a critical and comparative analysis of US, Canadian, and NAFO management plans for skates and rays, using indicators such as available landings and discard data, stock status and assessment information, regulations, and scientific research. The purpose of this research will be to examine gaps in skate management within national jurisdiction and international jurisdiction in the NW Atlantic. In order to methodically determine such gaps, a comparative table was created to determine if the countries [Canada and the US] and the RFMO are meeting requirements such as the objectives laid out in the fishery management plans, legal obligations, and whether scientific advice is being followed to set quotas. A case study will examine if transboundary management between Canada and the US could improve stock management of Thorny skate, which is managed differently in Canadian and US waters. Due to the critically endangered nature of Thorny skate in US waters, the importance of adequately managing this species in particular will be studied further. Similarly, Winter skate is managed differently between Canada and the US. International obligations were also reviewed, such as the International Plan of Action (IPOA) for Sharks, which suggests that skates and rays also be included in a country's National Plan of Action (NPOA) for Sharks.

2. OVERVIEW OF SKATE AND RAY SPECIES AND CONSERVATION STATUS IN US, CANADIAN, AND INTERNATIONAL WATERS

2.1. Northwest Atlantic and Arctic Skate and Ray Species

In the Northwest Atlantic and Arctic waters in Canada and the northeastern US, 16 species of skates and 11 species of rays have been observed (Table 1). The majority of the skates are from the family Rajidae (88 percent) and the others are from the family Arhynchobatidae. The only skate species inhabiting Arctic waters are the Arctic skate (*Amblyraja hyperborea*) and Thorny skate *(Amblyraja radiata*). The Shark Specialist Group (SSG) of the IUCN Red List evaluates chondrichthyans periodically. To date, 16 species of skates in the NAFO Convention Area (NCA) have been evaluated and four species are considered endangered or vulnerable, and two species are considered near threatened (Table 1). Of the 11 ray species assessed by the SSG in the NCA, two species have been assessed as vulnerable (*Manta birostris, Gymnura altavela*) and two species have been assessed as near threatened (*Rhinoptera bonasus*, *Aetobatus narinari*). For more detailed information on how the IUCN assesses species, refer to Appendix 1. The IUCN utilizes different quantitative criteria such as population size and generation length (Criteria A-E) to evaluate the threat levels to the species (Appendix 1) (IUCN, 2001).

Table 1 Skate & ray species occurring in NW Atlantic and Arctic Waters (Canada and US) with their global IUCN Red List status and year of assessment. [1]

Family	Species	English common name	Global Red List status[1]	Year
ARHYNCHOBATIDAE	*Bathyraja richardsoni*	Richardson's Skate	LC	2007
ARHYNCHOBATIDAE	*Bathyraja spinicauda*	Spinytail Skate	NT	2009
RAJIDAE	*Amblyraja hyperborea*	Arctic Skate	LC	2007
RAJIDAE	*Amblyraja jenseni*	Shorttail/Jensen's Skate	LC	2009
RAJIDAE	*Amblyraja radiata*	Thorny Skate	VU A2b	2009
RAJIDAE	*Dipturus laevis*	Barndoor Skate	EN	2003

Family	Species	English common name	Global Red List status[1]	Year
RAJIDAE	*Dipturus linteus*	Sailray/White Skate	LC	2009
RAJIDAE	*Leucoraja erinacea*	Little Skate	NT	2009
RAJIDAE	*Leucoraja garmani*	Rosette Skate	LC	2009
RAJIDAE	*Leucoraja ocellata*	Winter Skate	EN A2abd+3b+4abd	2009
RAJIDAE	*Malacoraja senta*	Smooth Skate	EN A2bcd	2009
RAJIDAE	*Malacoraja spinacidermis*	Soft Skate	LC	2007
RAJIDAE	*Raja eglanteria*	Clearnose Skate	LC	2009
RAJIDAE	*Raja bathyphila*	Deepwater/Abyssal Skate	LC	2009
RAJIDAE	*Rajella bigelowi*	Bigelow's Skate	LC	2009
RAJIDAE	*Rajella fyllae*	Round Skate	LC	2009
DASYATIDAE	*Dasyatis americana*	Southern Stingray	DD	2006
DASYATIDAE	*Dasyatis centroura*	Roughtail Stingray	LC	2007
DASYATIDAE	*Dasyatis say*	Bluntnose Stingray	LC	2006
DASYATIDAE	*Pteroplatytrygon violacea*	Pelagic Stingray	LC	2009
GYMNURIDAE	*Gymnura altavela*	Spiny Butterfly Ray	VU A2bd+4bd	2007
GYMNURIDAE	*Gymnura micrura*	Smooth Butterfly Ray	DD	2006
MOBULIDAE	*Manta birostris*	Giant Manta Ray	VU A2abd+3bd+4abd	2011
MYLIOBATIDAE	*Aetobatus narinari*	Spotted Eagle Ray	NT	2006
MYLIOBATIDAE	*Myliobatis freminvillii*	Bullnose Ray	DD	2009
RHINOPTERIDAE	*Rhinoptera bonasus*	Cownose Ray	NT	2006
TORPEDINIDAE	*Torpedo nobiliana*	Atlantic Torpedo Ray	DD	2009

[1] EN: endangered, VU: vulnerable, NT: near threatened, LC: least concern, DD: data deficient

Range of Winter Skate and Thorny Skate

Each species habitat, distribution, and geographical range (in Canada and the US) and known occurrence is summarized in Table 2. Overall, the migratory patterns of skates and rays are poorly understood. Research suggests that skates move in response to water temperature changes, moving offshore in the summer and returning inshore in the winter (NEFMC, 2001). Winter skate are distributed from Georges Bank to Cape Hatteras (Scott & Scott, 1988). Scientists have suggested there is connectivity in skate populations between the US and Canada. For example, Frisk et al. proposed that there is particular connectivity between the Winter skate populations on the Scotian Shelf and Georges Bank (Frisk et al. 2008 as cited in NEFMC, 2008). The New England Fishery Management Council (NEFMC) recognizes that if this connectivity exists, the "increase in Winter Skate on the Georges Bank in the 1980s could have been due to an influx of Winter skates from the Scotian Shelf" (NEFMC, 2008, p.14).

Thorny skate are distributed from the waters off western Greenland to South Carolina (Scott & Scott, 1988). The IUCN Red List assesses population trends of Thorny skate (*Amblyraja radiata*) in three regions (US, Canada, and the Northeast Atlantic) and while there is evidence that supports Thorny skate sub-populations, it is unknown if there is genetic mixing between the sub-populations (Kulka et al., 2009). Overall, Thorny skate is assessed as vulnerable, but within US waters, the IUCN assesses Thorny skate as critically endangered, and within Canadian waters, the IUCN assesses Thorny skate as vulnerable (Kulka et al., 2009). The assumption that Thorny skate is a straddling stock complicates management measures (AES, 2011). A National Marine Fisheries Service (NMFS) fact sheet on Thorny skate as a species of concern highlights that the stock may be transboundary and thus require conservation measures in both the US and Canada (NMFS, 2009). While little genetic work has been completed on Thorny skate, the distribution and lack of barriers on the Grand Banks, suggests a single, reproductive population (Kulka, Simpson, & Miri, 2006). If there is mixing of Thorny skate stocks between the US and Canada, transboundary management could be needed (NMFS, 2009).

Table 2 Summary of demographic information for skate and ray species occurring in NW Atlantic and Arctic waters (Canada and US).

Common name *Scientific name*	Distribution[1]	Habitat[1,2]	Canadian & US geographic range[1,2]	Occurrence/ sightings[1,3]
Richardson's Skate *Bathyraja richardsoni*	circumglobal; temperate and tropical waters	bathydemersal; 1370-2500m	southern Labrador to southwestern Georges Bank	rare
Spinytail Skate *Bathyraja spinicauda*	Northwest and Northeast Atlantic; temperate waters to cool waters	bathydemersal; 140-1463 m; usually 165-255m	east coast of Newfoundland to Georges Bank	infrequent
Arctic Skate *Amblyraja hyperborea*	Atlantic, Indian and Pacific Oceans	bathydemersal; 140-2500m; usually 300-1500m	Davis Strait between southwestern Greenland and Canada	rare
Jensen's Skate *Amblyraja jenseni*	Northwest and Northeast Atlantic; temperate waters	bathydemersal; 366-2295m	Nova Scotia, Canada to southern New England	occasional
Thorny Skate *Amblyraja radiata*	Northwest and Northeast Atlantic; temperate waters	demersal; oceanodromous; 18-1400m; usually 27-439m	Hudson Bay to South Carolina; Grand Banks and Scotian Shelf	common
Barndoor Skate *Dipturus laevis*	Northwest and western Central Atlantic; temperate waters	demersal; oceanodromous; 0-750m, usually >150m	Grand Banks and southern Gulf of St. Lawrence to North Carolina	common
Sailray Skate *Dipturus linteus*	Northwest and Northeast Atlantic; temperate waters to cool waters	bathydemersal; 150-1170m	Grand Banks	rare
Little Skate *Leucoraja erinacea*	Northwest Atlantic; temperate waters	demersal; oceanodromous; 0-329m	Southern Gulf of St. Lawrence and Nova Scotia to North Carolina	common
Rosette Skate *Leucoraja garmani*	Northwest and western Central Atlantic; temperate waters to subtropical waters	benthopelagic; 33-530m; usually 74-274m	Nantucket Shoals, Massachusetts to the Dry Tortugas, Florida	common
Winter Skate *Leucoraja ocellata*	Northwest and western Central Atlantic; temperate waters	demersal; oceanodromous; 0-317m; usually < 150m	Banks off Newfoundland and southern Gulf of St. Lawrence to North Carolina	common
Smooth Skate *Malacoraja senta*	Northwest Atlantic; temperate waters	bathydemersal; 25-1436m; usually 70-480m	Banks off Newfoundland and southern Gulf of St. Lawrence to New Jersey	common

Table 2 (continued)

Common name *Scientific name*	**Distribution**[1]	**Habitat**[1,2]	**Canadian & US geographic range**[1,3]	**Occurrence/ sightings**[1,3]
Soft Skate *Malacoraja spinacidermis*	Atlantic Ocean; Canada; Faroe Islands; Iceland; Namibia; South Africa	bathydemersal; 450-1568m	Offshore Baffin Bay-Davis Strait	infrequent
Clearnose Skate *Raja eglanteria*	Northwest Atlantic and Gulf of Mexico	demersal; oceanodromous; 0-330m; usually <111m	Massachusetts to southern Florida and eastern Gulf of Mexico	common
Deepwater/Abyssal Skate *Raja bathyphila*	Northeast and Northwest Atlantic	bathydemersal; 600-2172 m; usually 1300-1400 m	Northeastern coast of US and Canadian slope, north of 45 degrees and to the Flemish Cap	rare
Bigelow's Skate *Rajella bigelowi*	Atlantic Ocean	bathydemersal; 650-4156m; usually >1500m	Grand Banks off Newfoundland to northeastern Gulf of Mexico	rare
Round Skate *Rajella fyllae*	Northeast and Northwest Atlantic	bathydemersal; 170-2050m; usually 300-800m	Nova Scotia, including the Labrador Shelf, Grand Banks, Gulf of St. Lawrence, and Scotia Shelf	rare
Southern Stingray *Dasyatis americana*	Atlantic Ocean; subtropical waters	reef-associated; 0-53m	New Jersey to northern Gulf of Mexico	occasional
Roughtail Stingray *Dasyatis centroura*	Atlantic Ocean, Mediterranean and Black Sea; subtropical waters	demersal; 3-270m; usually 15-50m	Georges Bank to the eastern Gulf of Mexico	rare
Bluntnose Stingray *Dasyatis say*	Atlantic Ocean; subtropical waters	demersal; 1-10m	New Jersey to the northern Gulf of Mexico	occasional
Pelagic Stingray *Pteroplatytrygon violacea*	Pacific, Atlantic, and Indian Oceans; subtropical to tropical waters	pelagic-oceanic; 1-381m; usually 1-100m	eastern edge of the Grand Bank and from Georges Bank and along the coast of the US	occasional
Spiny Butterfly Ray *Gymnura altavela*	Atlantic Ocean, Mediterranean and Black Sea; warm temperate waters to subtropical to tropical waters	demersal; 5-100m	southern New England	occasional

Table 2 (continued)

Common name *Scientific name*	Distribution[1]	Habitat[1,2]	Canadian & US geographic range[1,3]	Occurrence/ sightings[1,3]
Smooth Butterfly Ray *Gymnura micrura*	Atlantic Ocean	demersal; 0-40m	Chesapeake Bay, Maryland through the Gulf of Mexico	common
Giant Manta Ray *Manta birostris*	circumglobal in temperate and tropical waters	reef-associated; oceanodromous; 0-120m	Delaware to Florida and eastern Gulf of Mexico	rare
Spotted Eagle Ray *Aetobatus narinari*	Atlantic, Pacific, and Indian Oceans; warm temperate waters to subtropical to tropical waters	reef-associated; 1-80m	North Carolina to Florida and throughout the Gulf of Mexico	occasional; summer months off North Carolina
Bullnose Ray *Myliobatis freminvillii*	Northwest Atlantic; subtropical waters	benthopelagic; 0-100m; usually 1-10m	Continental waters from Cape Cod, Massachusetts to southeastern Florida	occasional
Cownose Ray *Rhinoptera bonasus*	Atlantic Ocean; warm temperate and tropical waters	benthopelagic; oceanodromous; 0-22m	southern New England to northern Florida	common
Atlantic Torpedo Ray *Torpedo nobiliana*	Atlantic Ocean and Mediterranean; temperate and subtropical waters	benthopelagic; oceanodromous; 2-800m; usually 10-150m	Nova Scotia to Florida and northern Gulf of Mexico	occasional

[1]IUCN Red List 2012 [2] Froese and Pauly 2012 [3]Canadian Shark Research Laboratory & Northwest Atlantic Science Center 2007d

2.2. Northwest Atlantic Fisheries Organization

The Northwest Atlantic Fisheries Organization (NAFO) Contracting Parties (CPs) have landed skates since 1960, but landings did not reach 10,000 tons until the mid-1980s and the landings peaked at 28,408 tons in 1991 (Figure 12) (NAFO, 2012a). NAFO set the first elasmobranch quota in the world by a RFMO for skate in 2004, based on scientific assessment of Thorny skate, but there are conservation concerns. The Scientific Council has recommended that the Total Allowable Catch (TAC) be set at 5,000 tons in 2011 and 2012, but the CPs have yet to agree to lower the TAC in line with scientific advice (NAFO, 2010b). Skate landings have averaged 4,947 tons between 2004 and 2010, but there is nothing to prevent the CPs from fully fishing their quota (Simpson & Miri, 2012). The dominant method of fishing in the NAFO convention area is bottom trawling, which can result in bycatch of benthic species such as skates and stingrays. The majority of the reported landings (95 percent) in the NAFO Regulatory Area are estimated to be Thorny skate but the landings are not reported by species (Kulka & Miri, 2007).

2.3. Endangered Species Legislation

Partially due to the difficulty in collecting species-specific data in the marine environment, few elasmobranchs have gained domestic or international protection. In the US, the Endangered Species Act (ESA) is the legislation used to protect species that are determined to be endangered. In order to list marine species under the ESA (freshwater and terrestrial species are regulated by the US Fish and Wildlife Service), the National Marine Fisheries Service (NMFS) may initiate a status review of a species or a US citizen or organization may petition NMFS to list a species as threatened or endangered (NMFS, n.d.). If the petition is found to be warranted, then NMFS will undertake a status review;

if the available scientific information indicates a listing is warranted, then NMFS will publish a proposed rule and solicit comments from the public (NMFS, n.d.). A final determination of listing must be made within a year of the proposed rule (NMFS, n.d.). The ESA listing process only takes into consideration the best scientific and commercial information available, but if a species is listed, NMFS is allowed to consider economic implications when designating critical habitat (NMFS, n.d.).

NFMS received two petitions from NGOs in 1999 to list the Barndoor skate (*Dipturus laevis*) under the Endangered Species Act and to designate the Georges Bank and other areas as critical habitat (Endangered and Threatened Wildlife, 2011). NMFS published a finding that a listing might be warranted and initiated a stock assessment of the Barndoor skate, using information provided in the Stock Assessment and Fishery Evaluation (SAFE) Report (Endangered and Threatened Wildlife, 2011). NMFS ultimately found an ESA listing for the Barndoor skate to be unwarranted because survey data indicated an increase in abundance and biomass, but the Barndoor skate was kept on the Species of Concern list until 2009 (Endangered and Threatened Wildlife, 2011).

NMFS received petitions to list the Barndoor skate, Winter skate, Smooth skate, and Thorny skate under the Endangered Species Act in 2011 but rejected the petitions to list each of these species under the ESA (Endangered and Threatened Wildlife, 2011). NMFS suggested that the Thorny skate distribution may be shifting to deeper or more northern waters outside the biomass survey area and noted that rebuilding levels were estimated to take at least 25 years (Endangered and Threatened Wildlife, 2011). NMFS noted that Winter skate should not be listed because the biomass level was above the target threshold biomass level (Endangered and Threatened Wildlife, 2011). While Thorny Skate is not listed under ESA, it has been listed on the NMFS Species of Concern list since 2004 (NMFS, 2009). In addition to drawing attention to this species, the listing allows state agencies to apply for funding through the Proactive Species Conservation Grant Program in order to conduct research on species of concern (NMFS, 2012c). Since 2006, the grant program has received no applications to conduct Thorny skate research (D. Meadows, personal communication, June 26, 2012).

Table 3 Summary of COSEWIC assessments for Atlantic skate species (COSEWIC 2012)

Common name ***Species***	**Status**	**Year**
Winter Skate – S. Gulf St. Lawrence *Leucoraja ocellata*	EN	2005
Winter Skate – N. Gulf St. Lawrence *Leucoraja ocellata*	DD	2005
Winter Skate– Eastern Scotian Shelf *Leucoraja ocellata*	TR	2005
Winter Skate – Georges Bank, Western Scotian Shelf, Bay of Fundy *Leucoraja ocellata*	SC	2005
Barndoor Skate *Dipturus laevis*	NR	2010
Smooth Skate– Funk Island Deep *Malacoraja senta*	EN	2012
Smooth Skate– Laurentian-Scotian Shelf *Malacoraja senta*	SC	2012
Smooth Skate – Hopedale Channel *Malacoraja senta*	DD	2012
Smooth Skate– Nose of Grand Banks *Malacoraja senta*	DD	2012
Thorny Skate *Amblyraja radiata*	SC	2012

In Canada, the Species at Risk Act (SARA) is the legislation used to protect species that are determined to be endangered. Unlike the ESA, SARA has a corresponding advisory body that provides advice on the status of various species. The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) has assessed four species of skates – Winter skate (four sub-populations), Barndoor skate, Smooth skate (four sub-populations), and Thorny skate (Table 3).

Even though a sub-population species of Winter and Smooth skate have been assessed as endangered and threatened, no skate species have been listed under SARA. Scientists estimate that Winter, Thorny, and Smooth skate populations have declined as much as 90 percent off the Eastern Scotian Shelf (ESS) since 1970 (CSRL & NAFC 2007b; McPhie & Campana, 2009). In 2008, DFO gathered input on the potential listing of the three sub-populations of Winter skate under SARA, but in 2010 the Department of Justice released a notice of decision not to list the Winter skate (DFO, 2011; DOJ, 2010). The main argument was that adding these populations to SARA would not address the natural mortality and would result in economic costs (DOJ, 2011). If Winter skate was listed under SARA, DFO would have been required to develop a recovery strategy which may include such methods as designating critical habitat (DFO, 2008a). Allowing economic considerations in the decision whether or not to list a species is problematic for marine species in particular. Even though DFO stopped allowing licenses to commercially fish Winter skate in 2006, the species is still caught as bycatch in bottom trawling and bottom dredging fisheries, particularly in the commercial scallop fishery (Benoit et al., 2010). Winter skate egg cases remain on the sea floor for 18-22 months and are vulnerable to bottom trawling and dredging (DFO, 2005a).

2.4. Species Protection Conventions

The Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) and the Convention on the Conservation of Migratory Species and Wild Animals (CMS) are both international tools that can be utilized to protect threatened species such as certain skates and rays. CITES entered into force in 1973 and CMS in 1983. While some shark protections have advanced under these conventions for species such as the

White shark (*Carcharodon carcharias*), skate and ray protection has fallen short. Ten shark species are protected under CITES and seven sharks species are protected under CMS (Lack & Sant, 2009; Lack & Sant, 2011). None of the skate and ray species in the NAFO Convention Area (NCA) have received protection under CITES, even though six species of skates and rays in the NCA are assessed as threatened by the IUCN, and four species of skates and rays in the NCA are assessed as near threatened. At the CMS 10th Convention of the Parties in 2011, the Giant manta ray (*Manta birostris*) gained protection under Appendix I and II. Appendix I listing require Contracting Parties (CPs) to protect the endangered species by strictly protecting its habitat, mitigating any obstacles to migration, and by controlling any other factors that contribute to the species' endangered status (CMS, 2004). Appendix II listings require CPs to enter into regional or international agreements tailored to protect an endangered species in part or in the entirety of its range (CMS, 2004). Thus, the listing of the manta ray should lead to the development of an international CMS Agreement to manage this species. The US and Canada are both Contracting Parties to CITES, but not to CMS, although both countries are considered participatory members and have agreed to several CMS Memorandums of Understanding and/or CMS Agreements. While the Giant manta ray is only considered to be an occasional visitor to the Gulf of Maine (Collette & Klein-MacPhee, 2002), it would be beneficial if the US and Canada participated in the development of a CMS Agreement for the Giant manta ray.

2.5. National Plan of Action-Sharks

In response to growing concerns about the decline of elasmobranch populations, the United Nations Food and Agriculture Organization (FAO) developed an International

Plan of Action for the Conservation and Management of Sharks (*IPOA-Sharks*) (FAO, 1999). The IPOA-Sharks was created under the FAO *Code of Conduct for Responsible Fisheries* (FAO, 1995), specifically Article 2(d). The *IPOA-Sharks* calls upon all States to develop National Plans of Action (*NPOA-Sharks*) to sustainably fish and conserve Chondrichthyes (sharks, rays, skates, and chimaeras) stocks in their waters. States must consider target Chondrichthyes fisheries, as well as non-target fisheries that catch Chondrichthyes as bycatch (FAO, 1999). Once a *NPOA-Sharks* plan is developed, States must implement and monitor the plan, and the FAO directs States to assess the implementation efforts of the *NPOA-Sharks* at least every four years (FAO, 1999). Of the top 20 shark catching nations, 13 have completed a *NPOA-Sharks* plan (Lack & Sant, 2011). While the content of a State's *NPOA-Shark* plan varies, both Canada's *NPOA-Sharks* and the US *NPOA-Sharks* address skate management but ray management is barely addressed, as further discussed below. As some experts have observed, there is little indication that developing a *NPOA-Sharks* results in better management of the fisheries (Lack & Sant, 2011). While the development of a *NPOA-Sharks* plan is a first step toward conserving

US NPOA-Sharks: Skate Research & Management Needs (NMFS, 2001)

- Species specific landings data
- Size composition data by species
- Increased sea sampling of skates and improved ID
- Age and growth studies
- Maturity and fecundity studies
- Discard mortality rates
- Stock structure studies
- Explore stock recruitment relationships
- Investigate trophic interactions
- Validity of NEFSC trawl survey catchability conversion factors
- Investigate environmental factors on distribution shifts
- Investigate SEAMAP survey data for clearnose and rosette skate
- Investigate historical NEFSC survey data
- Recalculate error distribution of survey indices

and sustainably managing sharks, the implementation of the NPOA is often lacking. Adequate implementation should include the formation of "science-based management measures, species-specific data collection programs, and the means to enforce the regulations" (C. McCarty, personal communication, July 31, 2012).

The US released their *NPOA-Sharks* in 2001 and the plan is divided into commercial skate and ray fisheries, commercial shark fisheries, recreational skate and ray fisheries, and recreational shark fisheries (NMFS, 2001). The plan discusses the seven species of skates occurring in the Northwest Atlantic and notes the demand for skate has increased due to the export market potential and for the use of skates in lobster bait (NMFS, 2001). In 2001, the New England Fishery Science Center (NEFSC) estimated the overall skate complex abundance to be at a medium level of biomass, while delineating that the aggregate skate biomass was at a medium level overall due to an increase in small sized skates (Little, Clearnose, Rosette, and Smooth), rather than large skates (Barndoor, Winter, Thorny) (NMFS, 2001). At the time, the New England Fishery Management Council (NEFMC) had recently been designated as the managing body for skates but a Fishery Management Plan (FMP) had not yet been developed (NMFS, 2001). The plan highlights fourteen research and management needs, many of which still remain priorities. The first two priorities highlight the need to record skate landings by species and to collect size composition data by species, yet this type of data is still not being collected. While rays are briefly mentioned under the Pacific Fisheries skate section, any mention of rays is absent under the Atlantic Fisheries skate section. Recreationally, the fisheries for skate is relatively small compared to commercial skate fisheries (NMFS, 2001). Chimaeras are not included in the US *NPOA-Sharks.*

Canada released their *NPOA-Sharks* in 2007 and divided the plan into regional sections. The plan mentions there are 17 species of skates in Atlantic Canadian waters but only highlights Thorny and Winter skate in more detail. The most common bycatch species are also highlighted – Thorny, Winter, Smooth, Little, Barndoor, Spinytail, and Round skate (DFO, 2007). The plan states that common species are recorded by fishery observer programs (DFO, 2007), yet DFO skate landings data is not reported by species. Identification cards of less common skate species are provided to some observers but it is unclear if any species-specific data is recorded for these less common species. The *NPOA-Sharks* notes that Thorny skates are managed by NAFO and a portion of the TAC is allocated to Canada. The plan also mentions that the biomass of Thorny skate has declined since the 1970s but stabilized around 1994 (DFO, 2007). Winter skate used to be a targeted fishery since 1994, but the fishery was closed in 2006 since the population was not showing signs of recovering (DFO, 2007). The *NPOA-Sharks* plan has a brief section on rays and chimaeras, but only mentions that chimaeras are caught as bycatch and fails to mention any details about rays except for in the Appendix (DFO, 2007). Appendix I in the *NPOA-Sharks* plan states that pelagic stingrays are present in bycatch between 2001 and 2005 at less than one metric ton (DFO, 2007). In the Arctic region, Arctic skate and Thorny skate are present but there are no targeted fisheries; however, the skates may be taken as bycatch (DFO, 2007).

Canada NPOA-Sharks: Skate Research Needs (DFO, 2007)

- Further research on the skate complex (14 species) off Newfoundland and Labrador
  - Age and growth
  - Reproduction
  - Morphometrics & meristics
  - Food & feeding
- Research on the growth and reproduction potential of winter, little, and thorny skates on the Scotian Shelf

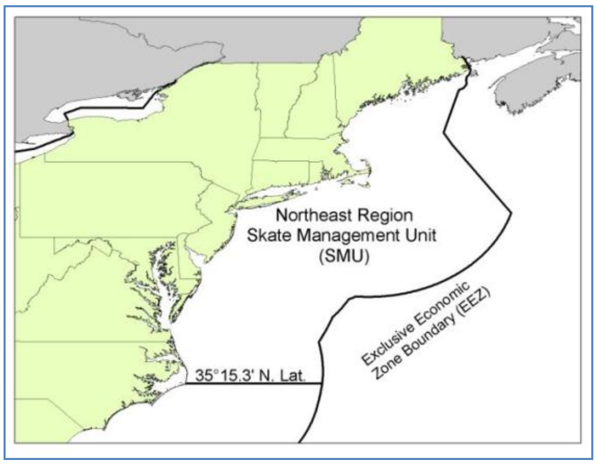
While both the US and Canadian *NPOA-Sharks* plans give an overview of skate management, some sections are outdated or lack detail. In July 2012, DFO released a progress report on the implementation of key actions in the *NPOA-Sharks* plan (DFO, 2012b). On the other hand, the US *NPOA-Sharks* plan is past due for an assessment on the progress of the implementation of the 2001 *NPOA-Sharks* plan, yet the US currently has no plans to update their *NPOA-Sharks* plan (C. McCarty, personal communication, June 26, 2012). Ray management in the Atlantic is not mentioned, which is a recognizable gap. The lack of information on chimaera bycatch and discards is another concern. The subsequent chapters will review skate management in the US and Canada and will note any progress made on the research priorities stated in the respective *NPOA-Sharks* plans.

3. US SKATE FISHERIES AND RAY MANAGEMENT IN THE NORTHWEST ATLANTIC: MANAGEMENT, RESEARCH, AND RECOMMENDATIONS

3.1. US Skate Fisheries Management for Commercial Species

The fisheries of the northeastern (NE) US are regulated by the Code of Federal Regulations (CFR), under the Title of Wildlife and Fisheries (2011), which states under 50 C.F.R. 684.4, Section 14, that vessels targeting skates must have a valid skate vessel permit to possess, transport, sell, or land skates in the Skate Management Unit (SMU).

Figure 1. US Skate Management Unit (NMFS NERO, 2012)



The *Magnuson-Stevens Fishery Conservation and Management Act* of 1976 (MSA) established eight Regional Councils that are responsible for managing fisheries in their regions using management plans and other measures. The National Marine Fisheries Service (NMFS) is responsible for approving and implementing these management measures. The New England Fishery Management Council (NEFMC) manages fisheries stocks in the Exclusive Economic Zone (EEZ) adjacent to its member states (Maine through Connecticut). The Northeast Skate Complex and the Skate Fishery Management Plan (FMP) encompasses skate fisheries from Maine through North Carolina (Figure 1), which was determined to be the best management area for the FMP’s objectives (NEFMC, 2003). The majority of the skate fisheries landings are in New England (Maine, New Hampshire, Massachusetts, Rhode Island, Connecticut), while the Mid-Atlantic (New York, New Jersey, Pennsylvania, Delaware), Chesapeake

(Maryland, Virginia), and North Carolina land lower amounts of skates. Skate landings in New England have dramatically increased since the 1980s from a total of 1,422 tons in 1980 to a peak of 14,432 tons in 2004 (Figure 2) (NMFS, 2012a). Skate landings in the Mid-Atlantic and Chesapeake started noticeably increasing in the 1990s, and peaked at 2,321 tons in 2010 and 393 tons in 2000 respectively (Figures 3, 4) (NMFS, 2012a).

Figure 2. Skate Landings in New England 1950-2010 (NMFS, 2012a)

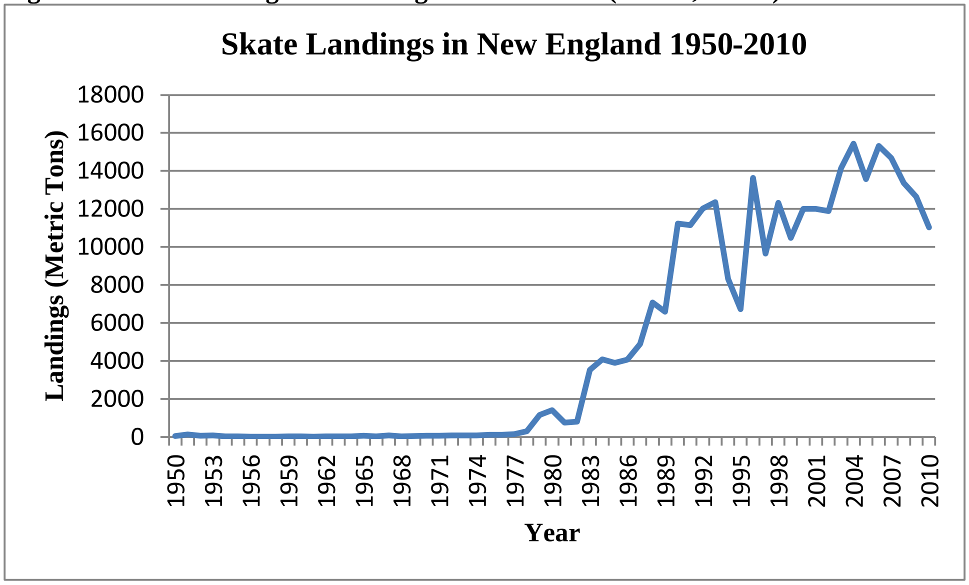


Figure 3. Skate Landings in Mid-Atlantic 1950-2010 (NMFS, 2012a)

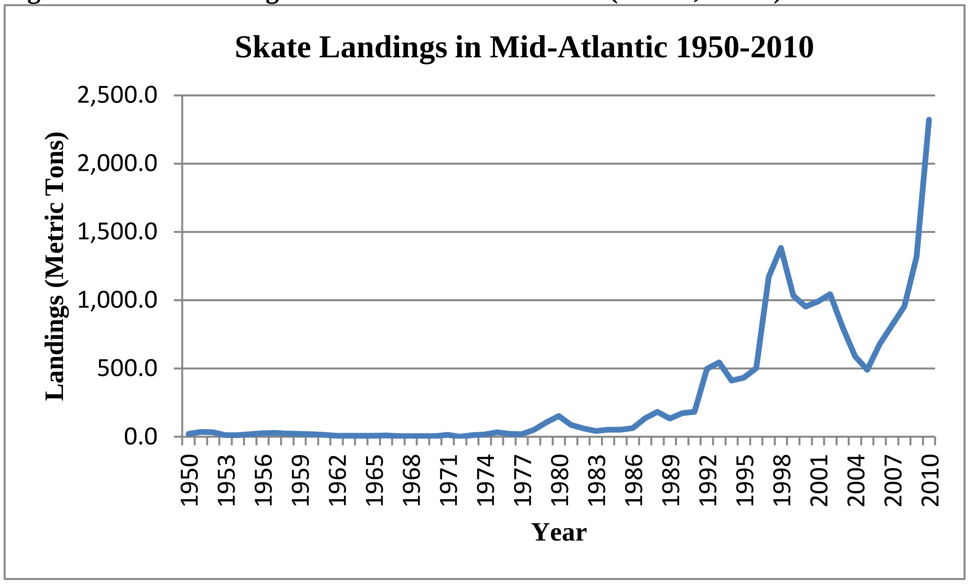
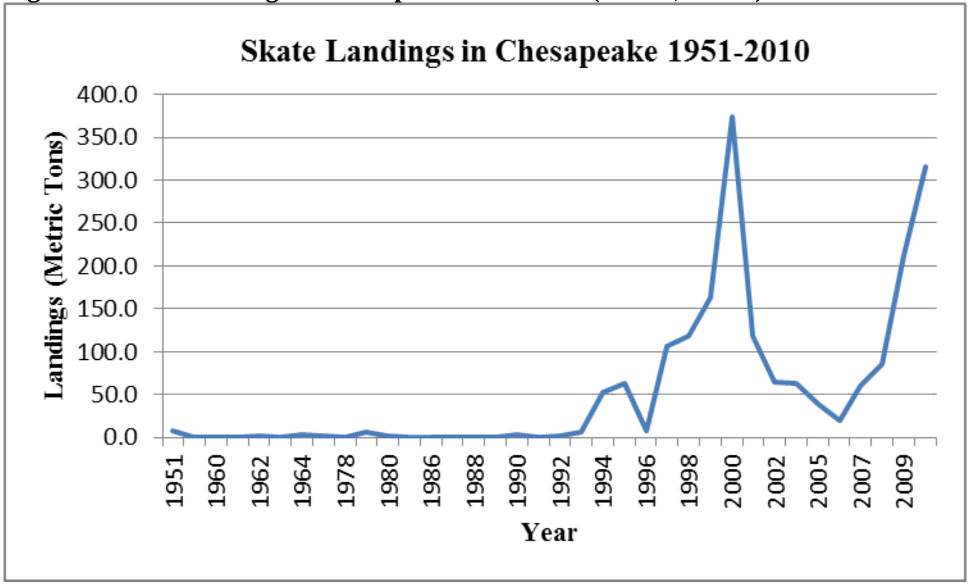


Figure 4. Skate Landings in Chesapeake 1951-2010 (NMFS, 2012a)



Two states, Massachusetts and Rhode Island, account for 85 to 95 percent of skate landings (Sosebee et al. 2008). Landings of skate increased substantially in the mid-1980s, in response to the increased demand for lobster bait and the increased export market for skate wings (Sosebee et al., 2008). In 2010, skate wing landings totaled 8,792 mt and skate bait landings totaled 3,988 mt (NEFMC, 2011b). Export and import data for skates was not tracked until 2012 (see Chapter 5 for further detail). Between 2010 and 2011, skate wing prices varied from $0.15 per pound to $0.95 per pound (NEFMC, 2012). The NEFMC was not directed to manage skate fisheries until 2000 and annual catch limits were not implemented for skates until 2010. There is a directed skate bait fishery but skate wings are caught primarily in mixed-species fisheries (NEFMC, 2008). Since the implementation of the Northeast Skate Complex (NESC) FMP in 2003, skate wing landings have increased, discards have remained stable to a slight increase, and the overall skate biomass has increased for five of the seven skate species (Winter, Little, Barndoor, Smooth, and Clearnose) (NEFMC, 2011a; NEFSC, 2012c). The other two skate species, Smooth and Thorny skate, are under rebuilding timelines.

Initial Management

The Stock Assessment and Fishery Evaluation (SAFE) report was prepared by the NEFMC Skate Plan Development Team (PDT) in 2000 and served as a background document for the first NESC FMP (NEFMC, 2001; NEFMC, 2003). The 2000 SAFE Report acknowledged many data and research needs, and the Stock Assessment Review Committee's (SARC) research recommendations were included in the *NPOA-Sharks* plan. The SAFE Report highlighted that regulations in the NEFMC Groundfish FMP were likely to impact skates due to the overlapping focus on benthic species (NEFMC, 2001). Groundfish closure areas were noted to offer some protection to skates, particularly if the closures were annual rather than seasonal (NEFMC, 2001).

Skate Species in the NE Skate Complex:*

- Barndoor skate * *(Dipturus laevis)*
- Clearnose skate *(Raja eglanteria)*
- Little skate *(Leucoraja erinacea)*
- Rosette skate *(Leucoraja garmanii)*
- Smooth skate * *(Malacoraja senta)*
- Thorny skate * *(Amblyraja radiata)*
- Winter skate *(Leucoraja ocellata)*

=Prohibited

The FMP for the Northeast skate complex was published in 2003 and implemented a number of management measures. There are seven total species in the New England skate complex but three are prohibited species (Barndoor, Thorny, and Smooth skate). Smooth skate is prohibited in the Gulf of Maine Regulated Mesh Area (NEFMC, 2003). Skates have been less studied than other groundfish such as Cod (*Gadus morhua*) and Haddock (*Melanogrammus aeglefinus*) and the NESC FMP acknowledges that the research was not available to determine fecundity or age at maturity for skates in the Northeast skate complex (NEFMC, 2003). Although fisheries-independent data on skate abundance has been available since 1963 from the New England Fishery Science Center (NEFSC), the lack of fisheries-dependent data poses challenges for completing a thorough fishery assessment of the skate complex (NEFMC, 2003; J. Sulikowski, personal communication, July 3, 2012). Without landings and effort data, the NEFMC could not estimate fishing mortality or maximum sustainable yield (MSY) (NEFMC, 2003). A trip limit of 10,000 pounds per day or 20,000 pounds per trip was created for the skate wing fishery and a letter of authorization (LOA) was required for the skate bait fishery (NEFMC, 2003).

FMP for the Northeast Skate Complex: Management Measures (NEFMC, 2003)

- Designated management unit
- Designated fishing year – same as groundfish
- Statements related to MSY & OY
- Overfishing definitions for each of the seven species
- EFH definitions for each of the seven species
- Rebuilding program for overfished skate species
- FMP reviewing and monitoring process
- Framework adjustment process
- Open-access federal permit program
- Requirement to report skate landings by individual species & skate discards by general categories (large/small)
- Prohibited possession of Barndoor and Thorny skates
- Prohibited possession of Smooth skate in the Gulf of Maine
- Designated a 10,000 lb. per day/20,000 lb. per trip possession limit on skate wings
- Required a letter of authorization for bait-only vessels (exempt from skate wing possession limit)
- Created a baseline of management measures in other fisheries that benefit skates & a process to review changes to these baseline management measures

The NEFMC prohibited the retention of Barndoor skate and Thorny skate, as well as Smooth skate in the Gulf of Maine, due to their overfished status (NEFMC, 2003). The three largest species of skate in the New England skate complex are Barndoor, Thorny, and Winter skate. Due to the prohibited status of Barndoor and Thorny skate, Winter skate is the primary source of skate wings (NEFMC, 2003). Little skate is the primary source of bait in the skate fishery (NEFMC, 2003). Skates with a wingspan of more than 18 inches are sold as skate wings, while skates with a wingspan of less than 18 inches are sold as bait (NEFMC, 2003). In order to transfer catches of smaller skates at sea to other fisheries as bait, a LOA is required (NEFMC, 2003). Due to the *k*-selected life history characteristics of skates, the NEFMC acknowledges that the species in the Northeast skate complex are inherently vulnerable to overfishing (NEFMC, 2003). In order to assess skate management measures, the NESC FMP required an annual stock status review (NEFMC, 2003).

The annual fishing season was set up in alignment with the multispecies groundfish fishing year, May 1-April 30 (NEFMC, 2003). The Multispecies Days-at-Sea (DAS) relies on the annual schedule and the majority of skate fishing occurs on the Multispecies DAS (NEFMC, 2003). The DAS program manages fisheries by limiting the number of days that permitted fishing vessels are allowed to fish and the amount fishing vessels can bring in per day. Any reductions in the DAS should result in a reduction of skate fishing activity, since skates are a lower value species compared to groundfish (NEFMC, 2003).

According to the Wildlife and Fisheries 50 C.F.R. 648.8 on *Recordkeeping and Reporting Requirements* (2011), dealers are required to report landings of skates by species and dealers are provided with a skate species identification guide. It is evident from the NMFS Commercial Landings Statistics that dealers are reporting the majority of skate landings as “unclassified skate” (NMFS, 2011a). In 2007, the first species-specific reporting was recorded in the NMFS Commercial Landings Statistics for Little skate

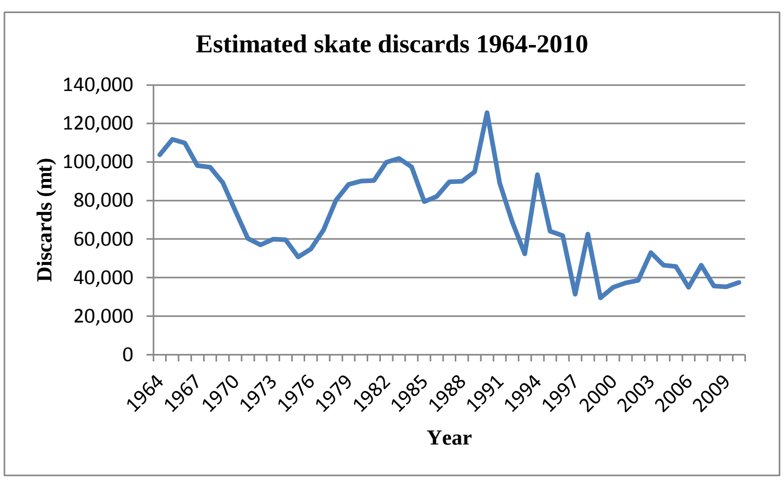
(NMFS, 2011a). While this small amount of species-specific data is a step forward, the NEFMC is still not meeting their requirements of the CFR to report species-specific data. A meeting of the Northeast Data Poor Stocks Working Group in 2008 noted that the skate landing estimates are not reported by species because "identification of skates is uncertain in the Domestic Observer Program" (Sosebee et al., 2008, p. 6). The observers are provided with skate identification guides by the NEFSC, so it is unclear why species-specific data is still not being reported.

Essential Fish Habitat

The MSA was reauthorized and amended by the *Sustainable Fisheries Act* in 1996, which required the regional fishery management councils "to describe and identify essential fish habitat (EFH) in their respective regions, to specify actions to conserve and enhance EFH, and to minimize the adverse effects of fishing on EFH" (Packer, Zetlin, & Vitaliano, 2003, p. iii; NEFMC, 2003). EFH is defined to include "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity" (NEFMC, 2003, p. 37). The 2003 NESC FMP identified EFH for each of the seven skate species in the SMU. Yet, there are issues with the logistics of protecting designated EFH habitats. While federal agencies that "authorize, fund or undertake activities that may adversely affect EFH" are required to consult with NMFS regarding those activities, NMFS and the fishery management councils can only make suggestions on how to minimize or mitigate habitat damage (NEFMC, 2003, p. 38). While the designation of EFH increases awareness of important fisheries habitat, there are legal limitations to actually protecting EFH. If fishery habitat is destroyed, there are no legal consequences from NMFS (Fletcher & O'Shea, 2000). Although the NEFMC evaluated the EFH areas of the seven species of skate in the NESC in 2003, further studies are needed to create a more thorough understanding of the life history and habitat use of skates (J. Sulikowski, personal communication, July 3, 2012). Within EFH, Habitat Areas of Particular Concern (HAPCs) can be established, which are ecologically important, sensitive to disturbance, or rare areas, which may require additional protection from negative fishing impacts (NPFMC, 2012). While areas of egg case concentration of Thorny skate could be designated as HAPCs by the NEFMC, currently only the North Pacific Fishery Management Council (NPFMC) has taken steps to delineate areas of skate egg case concentrations (NPFMC, 2012). Studies of nursery areas of skates in the NW Atlantic should be a priority (J. Sulikowski, personal communication, July 3, 2012). Studies are also needed to research movement patterns, habitat preferences, and long-term discard mortality of skates (J. Sulikowski, personal communication, July 3, 2012). The NEFMC considered closed areas to protect skates under Amendment 3 but failed to adopt any closure areas for skates (T. Curtis, personal communication, July 9, 2012).

Discards

Figure 5. Estimated Skate Discards in the NEFSC Complex 1964-2010 (NMFS NERO, 2011)



Skates are primarily caught through otter trawls and sink gillnets, but can be caught as bycatch in other fisheries (Sosebee et al., 2008). Most skate discards come from the groundfish, monkfish, and scallop fisheries (T. Curtis, personal communication, August 13, 2012). In 2010, estimated skate discards in the NEFSC complex decreased to 37,547 mt from a peak of 125,636 mt in 1990 (Figure 5) (NMFS NERO, 2011). The dead discards were estimated at 18,744 mt in 2010 (NEFMC, 2011b). The dead discard rate declined from an estimated 50 percent to 48 percent, when skate transfers at sea are taken into consideration (NEFMC, 2011b). Observer coverage standards are determined by the Standardized Bycatch Reporting Methodology (SBRM) Omnibus Amendment and the annual Sea Day Analysis and Prioritization documents describe the number of sea days needed for each species group and fleet, how much funding is available for observer coverage, and the sea days allocation when funds are insufficient (NEFMC, MAFMC, & NEFMC, 2007; S. Wigley, personal communication, June 29, 2012). There are three main types of Days-at-Sea (DAS) in the Northeast Region: NE multispecies DAS, monkfish DAS, and scallop DAS, and the skate fishery vessels must fish under one of these types of DAS (T. Ford, personal communication, July 5, 2012). The DAS groundfish and non-DAS groundfish vessels have a monitoring coverage requirement that NMFS has set at 25 percent (8 percent by the Northeast Fishery Observer Program and 17 percent by at-sea monitors) (T. Ford, personal communication, July 5, 2012). Skate discards must be reported according to two size classes: large skates (greater than or equal to 23 inches total length) and small skates (less than 23 inches total length) (NMFS NERO, 2012). The scallop fishery is a major source of skate discards, but there is little research to quantify the amount of dredge-caught skates that do not survive (NEFMC, 2010). The scallop fishery is a primary source of discard mortality for Barndoor skates, while the

Multispecies groundfish fishery is a primary source of discard mortality for Thorny skates (J. Sulikowski, personal communication, July 3, 2012).

A recent study on the immediate and short-term survivability of four of the seven species in the Northeast skate complex (Winter, Smooth, Little, and Thorny skates), following capture by otter-trawl and gillnet vessels, indicated that the discard mortality rate of Winter and Little skate was lower than originally estimated (UNE, 2011; UNE, 2012). Due to this new research, the NEFMC skate plan development team assumes a discard rate of 22 percent with a 50 percent mortality rate, with a variable discard mortality rate for Little and Winter skates (20 percent and 12 percent respectively) (NEFMC, 2011b). Skate species have specific tolerance levels to stress, which highlights the necessity of species-specific discard rates (J. Sulikowski, personal communication, July 3, 2012). A uniform discard rate of 50 percent may be too low for species like Thorny and Smooth skate, which are sensitive to handling stress (J. Sulikowski, personal communication, July 3, 2012). Factors such as tow duration and time of year will impact the discard mortality rate of skates (J. Sulikowski, personal communication, July 3, 2012).

Due to the high value of scallops and the relatively low value of skates, few skates caught as bycatch are kept (NEFMC, 2010). Drs. Mandelman and Sulikowski are working on creating guidelines for fishermen on how to handle skates caught as bycatch in the scallop dredge fishery in order to increase their survival rate (J. Sulikowski, personal communication, July 3, 2012). The discard rate of skates is exceedingly high; for example, between July 2009 and June 2010, only 10 percent of the 3,561,944 kilograms of Little skate that were caught by vessels were actually kept and 100 percent of Rosette skates were discarded due to no market (Table 4). Strangely, there were reported catches of the three prohibited species (Barndoor, Thorny, and Smooth Skate) being kept by vessels (Table 4). The reasons given for keeping the prohibited species were: kept, kept for bait, and kept and consumed by captain and crew (S. Wigley, personal communication, June 29, 2012). The vessels that decided to keep prohibited species seem to be in violation of 50 CFR 648.

Table 4. Total skate catch (kg) landings and discards July 2009-June 2010, Reasons for discarding are given as percentage of total discards (NEFSC, 2012b)

Common Name	Total	Kept	Discard	No Market	Regulation	Poor Quality	Other
Skate, Barndoor	296,198.5	690.8	295,507.7	44.8	55.2	0.0	0.0
Skate, Clearnose	104,577.3	5,876.7	98,700.6	95.7	4.0	0.0	0.3
Skate, Little	1,929,177.9	200,700.8	1,728,477.1	99.0	0.6	0.0	0.4
Skate, NK	565,005.0	201,188.0	363,817.0	97.0	1.5	0.5	1.0
Skate, Rosette	4,508.8	0.0	4,508.8	98.6	1.4	0.0	0.0
Skate, Smooth	42,257.7	52.6	42,205.1	92.6	7.0	0.0	0.0
Skate, Thorny	51,861.9	1465.8	50,395.2	63.5	36.4	0.0	0.1
Skate, Winter	3,561,944.1	1,804,668.3	1,757,275.8	94.1	4.2	0.3	1.4

Amendments to the NESC FMP

In 2007, Amendment 1 was implemented in order to create a Standardized Bycatch Reporting Methodology (SBRM) (NEFMC, MAFMC, & NEFMC, 2007). In order to address the requirements in the MSA, this Omnibus Amendment was implemented; consequently, all of the fishery management plans under the Mid-Atlantic Fishery Management Council (MAFMC) and the NEFMC were amended to create a SBRM in order to track how bycatch is monitored and assessed. The SBRM report is produced annually and has a comprehensive list of discard data for skates (Table 4).

In 2007, the NEFMC started the first phase of Amendment 2, which was an EFH Omnibus Amendment and Supplemental Environmental Impact Statement (Essential Fish

Habitat Components, 2011). Phase two looked at gear considerations and the impacts of fishing on EFH (Essential Fish Habitat Components, 2011). In 2011, the NEFMC expanded the scope of this Amendment to consider potential changes to closed areas (Essential Fish Habitat Components, 2011). The NEFMC voted to consider modifying, and eliminating, existing closed areas, while establishing new habitat closed areas (Essential Fish Habitat Components, 2011). The implementation date of Amendment 2 has been delayed beyond summer 2012, which is a concern given that this Amendment has been discussed for five years (Essential Fish Habitat Components, 2011). Due to the destructive nature of trawling on the benthic habitat of skates and the potential of certain fishing gear to impact the egg cases of skates (NPFMC, 2012), Amendment 2 could result in better research to improve EFH delineation and closure areas to improve protection of skate habitats.

In 2009, the NEFMC finalized Amendment 3, which modified the NESC FMP by addressing management measures for the following issues: overfished stocks (Thorny and Smooth skates), implementation of annual catch limits (ACLs) and accountability measures (AMs), and updating the baseline review process (NEFMC, 2009). ACLs and AMs were required by the Magnuson Stevens Reauthorization Act of 2006. The NEFMC set an Acceptable Biological Catch (ABC) of 41,080 mt, an ACL of 30,643 mt, an annual catch target (ACT) of 22,982 mt, and total allowable landings (TAL) at 9,427 mt (NEFMC, 2009). The ACL must account for discard mortality, as well as retained catch (MSA, 2006). The ACL also cannot exceed the ABC recommended by the Science and Statistical Committee (NMFS, 2011b). There is a 25 percent uncertainty buffer to prevent the ABC from being exceeded (T. Curtis, personal communication, August 14, 2012).

In order to help prevent overfishing, the primary accountability measure under the NESC FMP is the skate possession limit, which was changed to the incidental limit of 500 pounds of whole skates when the skate wing landings reach 80 percent of the TAL (NEFMC, 2009). The landings of the skate bait fishery were limited by a seasonal quota of 4,639 mt, with a LOA (NEFMC, 2009). Possession limits of skate wings were reduced to 5,000 pounds per trip, a significant decrease from the previous possession limits of 20,000 pounds per trip (NEFMC, 2010). An annual monitoring report was required and a SAFE report must be completed biannually, along with skate specifications (ABC, TAL, TAC, *etc.*) (NEFMC, 2010). The TAL amount for skate wing vessels of 9,209 mt for the 2010-2011 fishing year is a 29 percent decrease from landings in 2008 and 2009 (NEFMC, 2011a). The TAL limit did not go into effect until July 2010, yet the NEFMC decided to increase the TAL in March 2011. Because the TAL limit was not applicable until 2.5 months into the skate fishing year, landings were very high early into the year and triggered the 500 pound possession limit for the remaining eight months of the fishing year (NEFMC, 2011a). This dramatic decrease in the possession limit essentially shutdown the skate fishery because it was "no longer economically feasible for many vessels to make fishing trips that depended on skates for a major part of their revenue" (NEFMC, 2011a, p. i). In response, the NEFMC initiated a framework adjustment in November 2010 to change the 2011 trip limit to allow the skate fishery to become economically feasible in 2011 (NEFMC, 2011a). The TAL increased again to 14,277 mt, the TAL trigger was increased to 85 percent from 80 percent, the incidental skate wing possession limit was increased to 1,250 pounds instead of 500 pounds, and vessels would be allowed to process wings at sea and land skate carcasses for the bait market (NEFMC, 2011a).

Recent Rule Changes to the NESC FMP and 2012-2013 Skate Specifications

In April 2011, the fishermen's group, Sustainable Fisheries Association (SFA), sent a letter to the NEFMC Scientific and Statistical Committee (SSC) prior to their April 2011 meeting that raised the following points:

1) "The SSC should consider social and economic data when setting the scientific uncertainty buffer as required by the Magnuson-Stevens Fishery Conservation and Management Act (amended) ("MSA");
2) When setting the Acceptable Biological Catch ("ABC"), the SSC should not take a precautionary approach; and
3) When setting the ABC, the SSC should reduce the percentage of discards" (Sustainable Fisheries Association, 2011).

It is problematic that the SFA suggests the SSC avoid the precautionary approach when setting the ABC because looking at the aggregate trawl survey data does not necessarily acknowledge the overfished status of species such as Thorny skate. At the April 2011 meeting, the SSC analyzed the 2008-2010 NEFSC trawl survey data for skates, and concluded the biomass of Little and Winter skates had increased significantly; the SSC also concluded that the discard mortality of Little and Winter skates was less than originally believed (NEFMC, 2011b; NMFS, 2012b). At the November 2011 NEFMC meeting, Council members decided an emergency increase in quota was needed; NMFS approved the emergency quota increase of 56 percent from 14,277 mt to 21,772 mt, which was effective from November 28, 2011 to April 30, 2012 (UNE, 2011; NMFS, 2012b). NMFS recognized that the TAL increase would "increase revenues for fishing vessels and stabilize markets for seafood dealers" (NMFS, 2012b, p. 3). Due to the increase in overall skate biomass, the ABC increased approximately 23 percent, and due to the decrease in the overall discard mortality rate from 52 percent to 36 percent, the TAL was increased 56 percent (T. Curtis, personal communication, August 14, 2012).

In June 2012, NMFS approved a final rule allowing vessels issued a Federal skate permit and a Skate Bait LOA "to fish for skates in a portion of southern New England from July 1 through October 31 of each year, outside of the NE multispecies days-at-sea (DAS) program" (Fisheries of the Northeastern United States, 2011, p. 38738). Analysis of available data indicated that the bycatch rate of regulated species (primarily Winter and Windowpane flounder) was less than five percent by weight of the total catch in the skate bait fishery (Fisheries of the Northeastern United States, 2011). In theory, exempting certain fisheries with a low percentage of groundfish interactions will allow NMFS to focus observer coverage on other fisheries with a higher percentage of interactions with groundfish (T. Ford, personal communication, July 5, 2012). Exempting the skate bait fishery vessels from the DAS will allow common pool vessels (*e.g.* DAS) more fishing days.

In May 2011, the Skate PDT released their 2012-2013 Skate Complex ACL Recommendations report. The PDT analysis estimates the ABC at 50,435 mt, the ACT at 37,826 mt (75 percent of the ABC to account for management uncertainty), and the TAL at 24,088 mt (NEFMC, 2011b). The increase from the original TAL at 9,427 mt for the 2010-2011 fishing year, to a TAL at 24,088 mt for the 2012-2013 fishing year is substantial. The Skate PDT notes that the biomass for the other five species is above the target value (NEFMC, 2011b), but it is uncertain how the increase in TAL will impact catches of prohibited skate species. In March 2012, the NEFMC released the 2012-2013

NESC Skate Specifications report, which suggests there are “distinct differences in the distribution of the skate wing fishery effort and the distribution of barndoor, smooth, and thorny skates” (NEFMC, 2012, p. 3). The specifications also highlighted that the discard rate was reduced from 52 percent to 36.3 percent, which resulted in the increased TALs as a proportion of the ACT (NEFMC, 2012). The report also considered the following changes: altering the possession limit adjustments to allow the fishery to take 100 percent of TAL, raising the skate possession limit to 25,000 pounds, and counting skate transfers at sea against the skate bait fishery (NEFMC, 2012).

Considering the evolution of skate management by the NEFMC, the catch limits and reductions in trip possession limits are a step forward. However, Thorny skate biomass has not shown signs of improving. Currently, the best way to reduce Thorny skate discards is either to implement time/area closures around document Thorny skate aggregations or preferred habitats or to reduce overall ground fishing effort in the Thorny skate’s range (T. Curtis, personal communication, August 14, 2012). More research is needed on gear modification techniques and discard handling protocols to reduce skate discards in trawl, dredge, and gillnet fisheries.

Rebuilding Prohibited and Overfished Skate Stocks

Under Amendment 3 to the NESC FMP, the NEFMC stated that landings and catch limits should promote biomass growth and achieve rebuilding biomass targets for Smooth and Thorny skates (NEFMC, 2009). The 2012 Fish Stock Sustainability Index (Table 6) indicates which skate species are overfished or experiencing overfishing. Overfishing “occurs whenever the stock or stock complex is subjected to a level of fishing mortality or annual total catch that jeopardizes the capacity of a stock or stock complex to produce

MSY on a continuing basis" (NMFS, 2011b, p. 4). A stock is considered overfished if its "biomass has declined below a level that jeopardizes the capacity of the stock or stock complex to produce MSY on a continuing basis" (NMFS, 2011b, p. 4). Currently, only the Thorny skate is reported to be overfished, while Barndoor skate and Smooth skate stocks are reported to be rebuilding (Table 5). Under MSA, Smooth skate populations must be rebuilt by 2020 and Thorny skate populations must be rebuilt by 2028; if the biomass targets are not met, then implementation of more stringent measures to rebuild those species will be considered (T. Curtis, personal communication, July 9, 2012).

At the time the NESC FMP was developed in 2003, the life history characteristics of skates were poorly understood (NEFMC, 2011a). In 2007, the Skate PDT was able to estimate "maximum rebuilding potential and mean generation times for smooth, thorny, and winter skates" (NEFMC, 2011a, p. 3-13). The SSC advised the NEFMC that this information was not sufficient to forecast rebuilding and set catch limits accordingly and that a MSY-based analytical assessment should be developed (NEFMC, 2011a). Yet, the NEFMC determined that resources and time were not available to conduct such an assessment. Instead, the NEFMC examined changes in "skate biomass in response to historic exploitation rates to estimate probabilities of rebuilding biomass" (NEFMC, 2011a, p. 3-14). This proxy carries high uncertainty as it assumes the current rebuilding potential is the same as historical, and a proper assessment must be a priority. Currently, the trawl survey biomass index is used as a proxy for MSY reference points (T. Curtis, personal communication, July 24, 2012). In order to conduct a proper assessment, species-specific landings and discard data is needed, along with additional information on stock structure, movements, fecundity, growth, natural mortality, and discard mortality (T. Curtis, personal communication, July 24, 2012; NEFSC, 2009).

Typically, a rebuilding plan is "designed to increase stock biomass to the B_{msy} level within no more than ten years (or ten years plus one mean generation period when a stock has been declared overfished" (NEFMC, 2009, p. 7-271). The B_{msy} is defined as an average historic survey biomass and a stock is designated as overfished if the biomass is half of B_{msy} (T. Curtis, personal communication, July 24, 2012).

The original NESC FMP did not adopt a rebuilding plan schedule for Thorny skate due to the lack of critical life history information (NEFMC, 2009). According to the NEFMC, Smooth skate rebuilding and Thorny skate overfishing were addressed in Amendment 3 to the NESC FMP through the introduction of catch limits (NEFMC, 2009). The SARC noted that NEFSC indices of Thorny skate abundance have declined over the last 40 years and indices of Smooth skate abundance have not increased since the 1970s (NEFMC, 2009). The biomass index of Thorny skates has declined from a three year average of 6.17 kg/tow in 1969-1971 to a low of 0.26 kg/tow in 2008-2010 in New England (Endangered and Threatened Wildlife, 2011). A better understanding of the EFH of these species and nursery areas could be helpful to rebuilding their populations. NOAA evaluates the health of fisheries stocks in the US every quarter and assigns each stock a Fish Stock Sustainability Index (FSSI) score. The FSSI score will increase as "stock status becomes known, overfishing is ended, and stocks increase to the level that provides maximum sustainable yield" (NMFS, 2012d).

Table 5. Summary of the skate stock Fish Stock Sustainability (FSSI) Index (NMFS, 2012d)

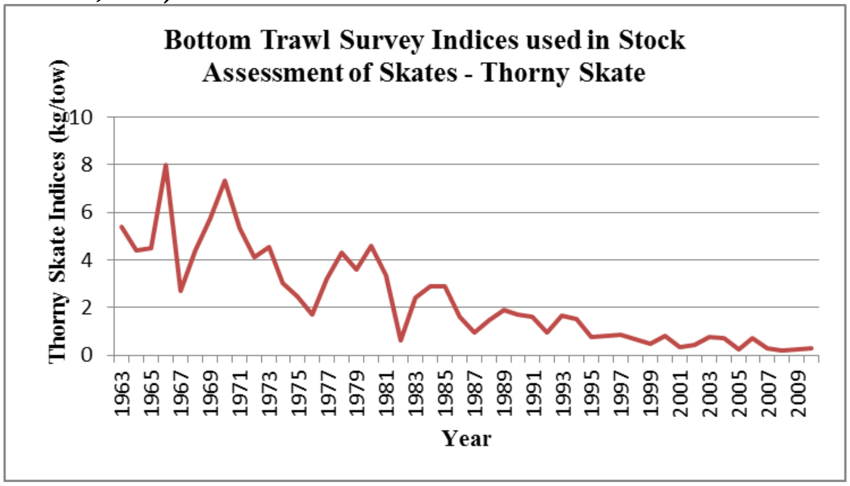
Stock	Overfishing?	Overfished?	Approaching Overfished Condition?	Management Action Required	Rebuilding Program Progress	B/Bmsy or B/Bmsy proxy	Official FSSI Score
Barndoor skate – Georges Bank/ Southern New England	No	No – Rebuilding	No	Continue Rebuilding	Year 9 of plan	0.69	3
Clearnose skate – Southern New England/ Mid-Atlantic	No	No	No	NA	NA	1.43	4
Little skate – Georges Bank/ Southern New England	No	No	No	NA	NA	1.16	4
Rosette skate – Southern New England/ Mid-Atlantic	No	No	No	NA	NA	0.83	4
Smooth skate – Gulf of Maine	No	No – Rebuilding	No	Continue Rebuilding	Year 2 of 10 year plan	0.55	3
Thorny skate – Gulf of Maine	No	Yes	NA	Continue Rebuilding	Year 9 of 25 year plan	0.06	2
Winter skate – Georges Bank/ Southern New England	No	No	No	NA	NA	1.72	4

3.2. NOAA Fisheries Skate and Ray Research

Both the NEFSC and the NMFS Northeast Regional Office (NERO) conduct skate research at the federal level. The NEFSC has conducted bottom trawl surveys to determine skate biomass since 1963. At the state level, agencies such as the Massachusetts Division of Marine Fisheries also conduct trawl surveys. Because skate landings are not reported by species, the biomass estimates from the NEFSC trawl surveys are used as a proxy for MSY and the status of the skate complex (NEFMC, 2003; NEFMC, 2008). A skate identification guide and a fact sheet on regulations in the skate fishery have been created by the NMFS NERO for fishermen (NMFS NERO 2012; NMFS NERO, n.d.). Discussions are in progress between NMFS NERO and NMFS Office of Law Enforcement to develop a new skate identification guide by 2013 with photographs of whole skates and skate wings (T. Curtis, personal communication, July 9, 2012).

The NEFSC is utilizing the HabCam, a towed camera system developed by fishermen and scientists at the Woods Hole Oceanographic Institution, to provide Atlantic sea scallop biomass estimates (NEFSC, 2012a). HabCam collects overlapping digital still images, which are used to estimate abundance (NEFSC, 2012a). This technology is being considered for future utilization in the NE skate complex surveys, and could result in improved understanding of the relationship between skate distribution and habitat, as well as predator-prey interactions (D. Hart, personal communication, June 13, 2012). The most common finfish observed in the Atlantic sea scallop HabCam surveys are skates and hake, and the collected images could be analyzed to determine biomass estimates (D. Hart, personal communication, June 13, 2012).

Figure 6. Bottom Trawl Indices in the Northeast used in Stock Assessment of Skates – Thorny Skate (NEFSC, 2011)

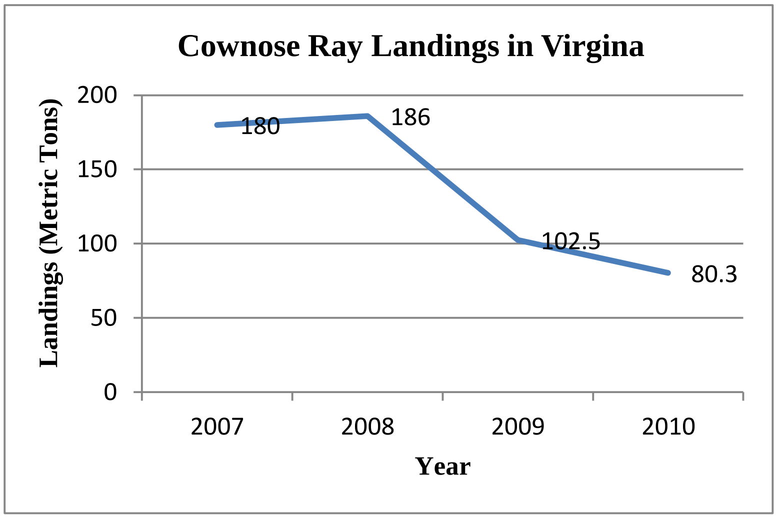


Currently, NMFS is not conducting research on rays in the NW Atlantic and there are no fisheries regulations for rays (T. Curtis, personal communication, June, 28, 2012). According to bottom trawl surveys by the NEFSC between 1963 and 1999, stingrays move north in the autumn and stay inshore and are caught as bycatch in certain fisheries (*e.g.* longline) in the NW Atlantic (Sosebee et al., 2000). The distribution of several ray species in Table 6 has been delineated from the NEFSC trawl survey (Bluntnose stingray, Bullnose stingray, Cownose ray, Roughtail stingray, and Spiny butterfly ray) (Sosebee et al., 2000).

3.3. US Ray Management

There were no targeted ray fisheries in the NW Atlantic until recently. Fishermen have reported that Cownose rays (*Rhinoptera bonasus*) are a nuisance due to their predation on commercial bivalves, which has driven the interest in developing a commercial Cownose ray fishery (Fisher, 2010). The Virginia Marine Resources Commission (VMRC) started a Cownose ray fishery in 2007, even though the IUCN Red List assessed the Cownose ray as near threatened in 2006. The landings of Cownose rays in Virginia between 2007 and 2010 ranged from 180 to 80 metric tons (Figure 7) (VMRC, 2011).

Figure 7. Cownose Ray Landings in Virginia 2007-2010 (VMRC, 2011)



Because the Cownose ray fishery is currently unregulated, the VMRC only requires a general commercial fishing license and any necessary gear permits (J. Grist, personal communication, June 27, 2012). The landings are primarily market driven as there are no quotas in place to restrict landings (J. Grist, personal communication, June 27, 2012). The Virginia Marine Products Board has received funding from the VMRC and the Southern United States Trade Association to develop and expand the market for "Chesapeake" ray (Cownose ray) domestically and overseas (VMPB, 2010). The best international markets for "Chesapeake" ray are in South Korea, China, and Japan (VMPB, 2010).

With the push to expand the market for the Cownose ray, and no regulation thus far, there is a danger of overfishing this species. Cownose rays typically only produce one embryo in a reproductive cycle of 11 to 12 months, but in rare instances, between two and six embryos have been observed (Collette & Klein-MacPhee, 2002; Smith & Merriner, 1986; Fisher, 2010). Studies have indicated that Cownose rays typically give birth in the Chesapeake Bay in mid-June and early July, which has implications for potential seasonal limitations on the commercial fishing of the Cownose ray (Fisher, 2010). The Virginia

Institute of Marine Science sampled 2,255 Cownose rays between May 2006 and September 2009. In this study, bycatch of Cownose rays in the traditional fisheries (commercial haul seine and pound net) was almost completely female from August through October (Fisher, 2010). The indication that females aggregate together post-parturition could easily result in the overexploitation of female Cownose rays (Fisher, 2010). Due to the risk of overfishing the Cownose ray population, a baseline population assessment should be conducted and conservation measures should be created. The MAFMC currently manages other elasmobranchs such as Spiny dogfish, and it is likely the MAFMC would be the responsible body for managing Cownose rays (J. Grist, personal communication, June 27, 2012).

The IUCN Red List recently assessed the Giant manta ray as vulnerable and notes its range in the NW Atlantic beginning around the state of Delaware (Marshall et al., 2011). Although there is currently no commercial fishery for the Giant manta ray in the US, the species is targeted in certain countries such as Indonesia, due to the demand for the gill rakers in international trade markets for use in Asian medicinal products (Marshall et al., 2011; Varkey et al., 2010). Giant manta rays are also caught as bycatch in trawl and gillnet fisheries (Marshall et al., 2011; White et al., 2006). While Giant manta rays are migratory species, they are known to aggregate at cleaning sites and feeding stations, which could lead to localized extinctions if targeted at these aggregation sites (Marshall et al., 2011). There is a dearth of fisheries data and biological data on the Giant manta ray (White et al., 2006), which is a concern for a vulnerable species (Marshall et al., 2011). The discard table of rays in the Northeast fisheries from 2009-2010 (Table 6), lists the Giant manta ray (Atlantic manta ray) discards at 113 kg over a year time period, which seems minimal. However, further research into the distribution and ecology of the Giant manta ray in the NW Atlantic would be useful to assess the health of the population. In 2009, the Hawaiian legislature passed HB 366 which established criminal penalties for the intentional capture or killing of manta rays within state waters (Relating to Manta Rays, 2009).

The largest ray bycatch in the Northeast consisted of the following species: Torpedo ray, Spiny butterfly ray, Bullnose ray, Roughtail ray, and Cownose ray (Table 6). While the Spiny butterfly ray is assessed as vulnerable by the IUCN Red List, the US sub-population is listed as least concern (Vooren et al., 2007). The IUCN Red List assessed the Torpedo ray and Bullnose ray as data deficient which indicates more research on their populations would be beneficial.

Table 6. Total ray catch (live kg) landings and discards July 2009-June 2010, Reasons for discarding are given as percentage of total discards (NEFSC, 2012b)

Common Name	Total	Kept	Discard	No Market	Regulation	Poor Quality	Other
Ray, Bullnose	5,189.3	8.6	5172.1	99.1	0.9	0.0	0.0
Ray, Butterfly, NK	1,297.4	0.0	1,297.4	32.7	0.0	0.0	67.3
Ray, Butterfly, Smooth	355.6	0.0	355.6	98.5	0.7	0.0	0.9
Ray, Butterfly, Spiny	5,756.6	0.0	5,756.6	84.5	14.3	0.0	1.2
Ray, Cownose	2,043.3	2.3	2041.0	99.9	0.0	0.0	0.1
Ray, Eagle, NK	7.6	0.0	7.6	100.0	0.0	0.0	0.0
Ray, NK	116.3	0.0	116.3	100.0	0.0	0.0	0.0
Ray, Torpedo	8,770.2	0.0	8,770.2	86.9	13.1	0.0	0.0
Ray, Manta, Atlantic	113.4	0.0	113.4	100.0	0.0	0.0	0.0
Stingray, Bluntnose	331.3	0.0	331.3	100.0	0.0	0.0	0.0
Stingray, NK	1,121.1	0.0	1,121.1	93.7	6.3	0.0	0.0
Stingray, Roughtail	3,913.0	0.0	3,913.0	87.5	12.5	0.0	0.0
Stingray, Southern	287.6	0.0	287.6	99.2	0.8	0.0	0.0

3.4. Recommendations

FINAL RECOMMENDATIONS

1. The NEFMC should implement a management measure to require commercial fishermen and observers to report skate and ray landings and discards by species.
2. NMFS should invest resources to research nursery areas, movement patterns, habitat preferences, and long-term discard mortality of skates.
3. NMFS should designate Habitat Areas of Particular Concern (HAPC) and closure areas to help rebuild overfished Thorny skate populations. Further studies on critical habitat will be needed to determine HAPCs.
4. The legal consequences of destroying EFH should be strengthened during the MSA reauthorization process in 2016.
5. NMFS should quantify skate discards by fisheries sector and invest in gear modification technology and discard handling protocols to decrease skate bycatch and discards.
6. The MAFMC should develop a FMP for Cownose rays and should cap or suspend any directed Cownose fishing licenses until proper management measures and conservation considerations are implemented.

4. CANADIAN SKATE FISHERIES AND RAY MANAGEMENT IN THE NORTHWEST ATLANTIC: MANAGEMENT, RESEARCH, AND RECOMMENDATIONS

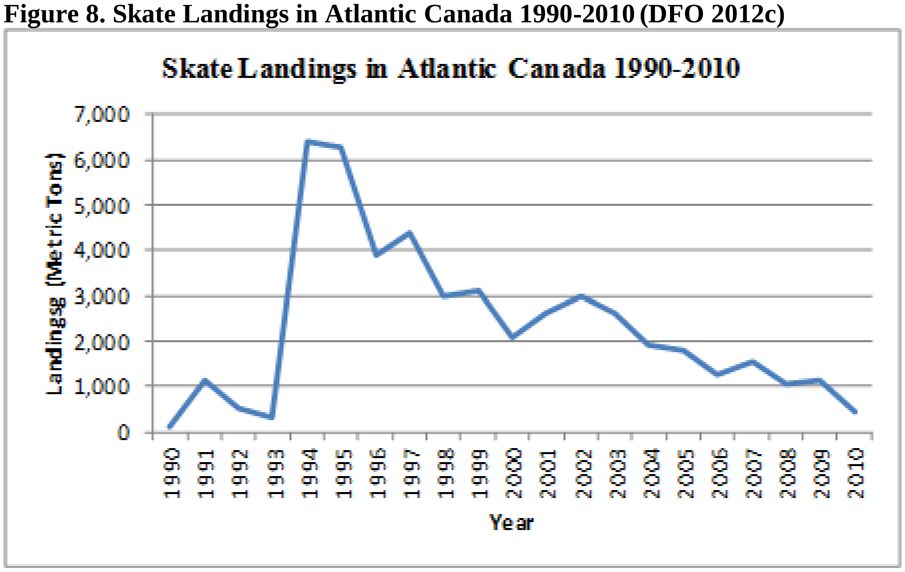
4.1. Canadian Skate Fisheries Management for Commercial Species

The Atlantic Fishery Regulations, under the *Fisheries Act*, provide management measures and denote management areas for fisheries off the Atlantic coast of Canada, including groundfish fisheries. The Department of Fisheries and Oceans (DFO) has regulated groundfish fisheries in the Atlantic since 1977 (DFO, 2000). One important distinction between the US fishery management plans and the Canadian integrated fishery management plans (IFMP) is that the IFMP is not considered to be legally binding (DFO, 2009). Under the *Fisheries Act*, the Fisheries Minister can modify any section of the IFMP for conservation reasons or other valid reasons (DFO, 2009).

Before the mid-1990s, skates were not commercially fished by Canadian vessels (DFO, 2007b). Following the overall decline of groundfish stocks in Atlantic Canada, skates became a targeted fishery (Kulka, Simpson, & Miri, 2006). While the US fishery targets skates for the bait fishery and for skate wings, the Canadian fishery focuses primarily on skate wings (DFO, 2012b). The fishing year is April 1 to March 31 for groundfish on the Eastern Scotian Shelf (ESS) and the fishing season for Northwest Atlantic Fisheries Organization (NAFO) stocks is January 1 through December 31 (DFO, 2000; DFO, 2009). Longline, gillnet, and otter trawl are the primary gears used to fish skates (DFO, 2003). DFO receives advice from the fishing community through a series of regional management committees for the inshore fleets and through three Atlantic-wide committees for fleets greater than 65 feet (DFO, 2000). Scientific information is provided through stock status reports (SSR) by the Regional Advisory Process. The Fisheries

Resource Conservation Council (FRCC) is composed of industry participants and non-government scientists who are appointed by the Fisheries Minister and provide recommendations on TAC and other associated conservation measures (DFO, 2000). The Transboundary Resources Assessment Committee and the Gulf of Maine Advisory Committee also provide advice to the FRCC on the appropriate TAC levels for transboundary stocks on the Georges Bank (DFO, 2000). After the FRCC recommendations are released, DFO fishery managers consult with the regional management committees and further consultations are held after the regulatory measures are approved by the Fisheries Minister (DFO, 2000).

Figure 8. Skate Landings in Atlantic Canada 1990-2010 (DFO 2012c)



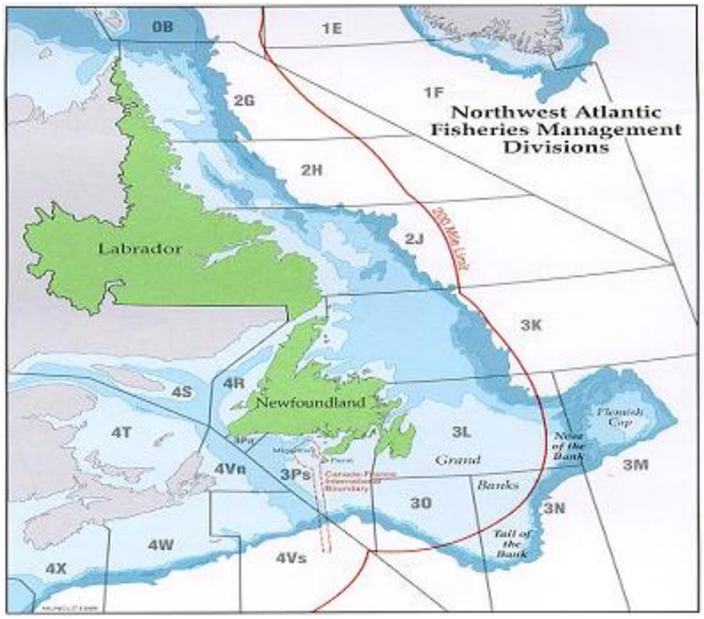
Skate landings in Atlantic Canada peaked at 6,393 tons in 1994 and declined to 431 tons in 2010 (Figure 8). The DFO Commercial Fisheries Landings database does not report skate landings in the Gulf of St. Lawrence after 1995, which is an error (DFO, 2012c). Skate landings are reported in the Gulf up to 2010 in a Canadian Science Advisory Secretariat Report (Swain et al., 2012). The data from this report came from the Zonal Interchange File Format (ZIFF) database which is confidential due to proprietary information (D. Swain, July 25, 2012). This discrepancy would imply that DFO should review the Commercial Fisheries Landings database and include data from the ZIFF database to increase the accuracy of the landings information.

A regulated and directed skate fishery began in Canada in 1995 (DFO, 2003). Conservation Harvesting Plans (CHPs) are negotiated by the fleets with DFO (DFO, 2010b). The skate fishery is also regulated using license conditions (*e.g.* mesh size restrictions), Vessel Monitoring Systems (VMS) on vessels over 35 feet, and through the Dockside Monitoring Program (DMP) which requires 100 percent vessel coverage (DFO, 2010b; DFO 2009). The CHPs require that the mesh size of vessels fishing for skate be a minimum of 300 mm in the codend and 254 mm in the remainder of the trawl (DFO, 2000; DFO, 2009). There are no size restrictions on skate landings.

At-sea observer coverage varies by the fishery and region, but ranges from three to 10 percent in Atlantic Canada for domestic vessels (DFO, 2012b). The Pacific trawl fishery has had 100 percent observer coverage since 1996, and it is unclear why there is such a discrepancy in coverage between the Atlantic and Pacific coasts. Even though a DFO species identification guide for skates in Atlantic Canada is available (Sulak et al., 2009), landings of skates are not reported by species. Although skates represented one of the largest catches on the Grand Banks from the 1990s to the late 2000s, DFO provided limited resources to assess and manage the stock as it was not considered to be a "traditional" species like Cod, Greenland halibut (*Reinhardtius hippoglossoides*), or Redfish (*Sebastes mentella*) (D. Kulka, personal communication, August 14, 2012).

Initial Management

Figure 9. Skate Management Divisions through NAFO (Photo Credit: NAFO/DFO)



The groundfish fishery is regulated using various systems of catch quotas (DFO, 2000). The groundfish stock assessments are conducted using "commercial fishery logbook/purchase slip data, from biological sampling of landings, and from at-sea surveys of the abundance of fished stocks" (DFO, 2000). Reports on the status of all stocks are supposed to be updated annually by DFO Regional Science staff and complete stock reassessments are conducted periodically and reviewed by the Regional Advisory Process and Transboundary Resources Assessment Committee (DFO, 2000).

Thorny skate is currently the only targeted skate fishery in Atlantic Canada, although a targeted fishery for Winter skate existed from 1994 to 2006 (DFO, 2007b; DFO, 2005). The stock is divided into the following areas: Grand Banks, southern coast of Newfoundland, Gulf of St. Lawrence, and the ESS (Figure 9) (FRCC, 2011). The Grand Banks (Divs. 3LNO) stock is managed by NAFO and will be further discussed in Chapter 5. The Canadian skate quota has historically been divided among the DFO regions of the Maritimes (Divs. 4V, 4W), Newfoundland and Labrador (Subdivs. 3Ps), and the Gulf of St. Lawrence (Divs. 4T, 4R) (FRCC, 2011). The majority of skate landings in Atlantic

Canada are caught off Newfoundland and Labrador (DFO, 2012c), and skates landed in the other regions are typically bycatch.

Maritimes

There has been a regulated fishery for skates on the Eastern Scotian Shelf (ESS) since 1994 but landings data exists from 1961 (DFO, 1998). While landings of skates have been low on the ESS (less than 2,600 tons per year), the total removals are likely much higher due to high discard rates (DFO, 1998; DFO, 2012b). In 1998, the TAC was set at 2,000 tons, with 800 tons allocated to conduct joint industry/science surveys (DFO, 1998). Observers of the directed skate fishery in the Maritimes noted that 90 percent of the catch consisted of Winter skate and 10 percent of Thorny skate (DFO, 1998). The overall abundance of Winter skate in NAFO Div. 4VsW has been decreasing since 1991 and there is a greater proportion of smaller skates (less than 40 cm) (DFO, 2002). Even in 1998, DFO expressed concerns that the skate fishery focusing on Winter skate could not be sustainable and suggested that harvest levels not exceed 600 tons (DFO, 1998). While the landings of skate in the Maritimes were 765 tons in 1999, the landings between 2000 and 2005 remained under 600 tons as suggested (DFO, 2012c). In 2001, the TAC was reduced to 400 tons and in 2002, the number of vessels targeted skates on the ESS declined from four to just one (DFO, 2002). From 2002 to 2005, the TAC was 200 tons (DFO, 2005a). In April 2006, Winter skate became a prohibited species due to conservation concerns (DFO, 2012b). DFO-Maritimes has not yet updated the groundfish IFMP since 2002, but is in the process of revising the plan (DFO, 2000; L. Hussey, personal communication, July 24, 2012). At the June 2012 Scotia-Fundy Groundfish Advisory Committee meeting, “industry tabled a proposal which included the development of a skate ID card for distribution to all groundfish fishers, best handling process for live-release, a move-away protocol, mandatory release of thorny skate, and improved reporting of discards" (V. Docherty, personal communication, August 2, 2012). Even though the proposal failed, DFO is already in the process of finalizing a skate identification card, best handling practices, and move away protocols (V. Docherty, personal communication, August 2, 2012). Both the Groundfish Advisory Committee and DFO are working on developing biological reference points and potentially rebuilding targets for skates (V. Docherty, personal communication, August 2, 2012).

Summer research vessel surveys by DFO indicate that since 1990, there has been a significant decrease in the distribution of Thorny skate on the central Scotian Shelf, NAFO subdivision 4V, and the Bay of Fundy (Simon, Rowe, & Cook, 2011). The survey also indicated that Thorny skate is more common in Div. 4X and Divs. 4VW. DFO research surveys on skate biomass indicate that the populations of Winter, Thorny, and Smooth skate have declined over 90 percent since the 1970s (McPhie & Campana, 2009b). Skates can only support low-level fisheries due to their life history characteristics, but it appears "fishing mortality (both directed and undirected) has outstripped the net productivity of the skate populations on the eastern Scotian Shelf" (McPhie & Campana, 2009b, p. 238).

Even though the directed fishery for Winter skate was closed in 2006, skate landings ranging from 36 tons to 254 tons have been reported between 2007 and 2010 (DFO, 2012c). These skate landings are bycatch from other groundfish fisheries (V. Docherty, personal communication, August 2, 2012). However, since Winter skate can no longer be landed, the skate landings are most likely comprised of Thorny and Smooth skate. There are no quotas for these species and the depressed population of Thorny skate on the ESS suggests that bycatch of this species could further harm the population. It would thus be prudent to implement bycatch limits and biomass recovery targets, in particular for Winter skate. In the Maritimes region, DFO and industry are in the process of developing a recovery strategy for all skate species (V. Docherty, personal communication, August 2, 2012).

Newfoundland and Labrador

Thorny skate is the most common skate in Subdivision (Subdiv.) 3Ps and comprise 90 percent of skates caught in DFO research surveys (DFO, 2003). Thorny skate abundance declined in the mid-1990s and has remained stable at low levels (DFO, 2003). Skates are managed through the 3Ps Groundfish Advisory Committee process, which involves the fleets, processors, and the province (DFO, 2010c). In 2009, there were 232 active vessels in the Canadian skate fishery in subdivision 3Ps (DFO, 2010c). A weekly limit of 30,000 pounds of whole skate or 11,111 pounds of skate wings is permitted (DFO, 2009). Canadian catches in the Subdiv. 3Ps averaged 1,115 tons in 1996-2000, 1,409 tons in 2001-2006, and 1,600 tons in 2007-2008 (Simpson & Miri, 2010). Landings in Subdiv. 3P in 2011 were 517 tons (Simpson & Miri, 2012). DFO has expressed concern about other countries exceeding their allocated NAFO quota for skate in Subdiv. 3Ps. For example, the four year average of skate landings by France in 2010 was approximately 400 tons (DFO, 2010c).

In Subdiv. 3Ps, the Thorny skate biomass was estimated at 38,509 tons in 2008 and 27,788 tons in 2009 (Simpson & Miri, 2010). DFO cautions that the gear in the trawl survey has changed three times which creates the impression of an increasing trend for Thorny skate (DFO, 2010c). For the 2012-2013 fishing season, the TAC for skate in the NAFO Subdiv. 3Ps (southern Newfoundland and Labrador) is 1,050 mt, as determined by NAFO (DFO, 2012a). This quota is a decrease from 2003, when 3,000 mt was the TAC (DFO, 2003). As much as 90 percent of the Thorny skate biomass is concentrated (hyper-aggregation) on the southwest area of the Grand Banks and the cause of decline on the northern Grand Banks is unknown (DFO, 2003). DFO conducts assessments of Thorny skate bi-annually for NAFO Divs. 3LNOPs. For further information on the Grand Banks stock of Thorny Skate, refer to Chapter 5.

Gulf of St. Lawrence

Three species of skate commonly occur in the southern Gulf of St. Lawrence: Thorny, Winter, and Smooth skate (Swain et al., 2012). There currently are no targeted fisheries for skates in the Gulf of St. Lawrence, yet skates are caught as bycatch in other fisheries (primarily Winter flounder, Cod, Greenland halibut, and Shrimp) in the Gulf and discarded (NAFO Div. 4T) (Swain et al., 2012; Benoit, 2006). Thorny skate is the most common skate in the southern Gulf of St. Lawrence and is caught as bycatch in the Greenland halibut fishery and previously the Cod fishery (Swain et al., 2012). There was a noticeable contraction in range of Thorny skate between the 1990s and 2000s, and now the Thorny skate distribution is restricted to the slope of the Laurentian Channel and the Magdalen Shallows (Swain et al., 2012). The abundance of Thorny skate has declined by 95 percent since 1971 and scientists suggest that the increase in abundance of grey seals over the past 40 years may "contribute to the high mortality of the adult thorny skate" (Swain et al., 2012, p. ii). Similarly, scientists attribute the decline of Winter skate to unsustainable rates of bycatch in fisheries for other groundfish and to natural mortality from seal predation (Swain et al., 2009). The biomass abundance of mature skates has been declining in the Gulf of St. Lawrence since the 1970s; mature skate declines of 90 percent have occurred in mature Thorny and Winter skate populations and declines of 74 percent have occurred in mature Smooth skate populations (Swain, Hurlbut, & Benoit, 2005). Winter skates are captured in much lower numbers in fisheries in the northeastern and northwestern Gulf of St. Lawrence (NAFO Divs. 4R, 4S) (Benoit, 2006).

Fish Habitat Protection

Section 35(1) of the *Fisheries Act* prohibits harmful alteration, disruption, or destruction (HADD) of fish habitat (DFO, 2007a). However, under Section 35(2), authorization may be obtained for the HADD by applying for a permit through DFO (DFO, 2007a). An authorization cannot be obtained until after DFO has conducted an assessment under the *Canadian Environmental Assessment Act*. If a project results in HADD without prior authorization, penalties could include fines up to $1,000,000 and up to six months in prison (DFO, 2007a).

The *Oceans Act* authorizes DFO to "provide enhanced protection to areas of oceans and coasts which are ecologically or biologically significant" (DFO, 2004). DFO created a comprehensive list of ecological functions (*e.g.* spawning, nursery, feeding, migration, seasonal refuge) and structural features (*e.g.* tidal mixing zones, convergence zones, upwelling zones) which may be considered as ecologically and biologically significant areas (EBSAs). DFO has completed more detailed regional assessments of EBSAs for the

Eastern Scotian Shelf, Gulf of St. Lawrence/Newfoundland, and the Arctic. The identified EBSAs are considered for further protection through methods such as marine protected areas (MPAs). Many of the EBSAs off the ESS were identified due to complex benthic communities and EBSA number 21 on Emerald Bank, Western Bank, and Sable Bank was identified as an area of high larval fish diversity and as a juvenile nursery area for skate (Doherty & Horsman, 2007). The Haddock Box Nursery Area in Div. 4W has been closed to all groundfish fishing since 1993 and could be an indirect source of protection for juvenile skate. There are a number of spawning and stock mixing closures in the subdivision 3Ps and on the Georges Bank which could inadvertently protect skates (DFO, 2009; DFO, 2000). A total of ten EBSAs were identified in the Gulf of St. Lawrence, including the southern fringe of the Laurentian Channel and the entire west coast of Newfoundland (DFO, 2007a). Thorny skate are concentrated in the Laurentian Channel in the Gulf and the identification of the Channel as an EBSA could help protect this species. However, the identification of an EBSA is just a first step, and further protection of these EBSAs should be considered through the development of MPAs or seasonal closures. The COSEWIC report notes that the distribution of Thorny skate overlaps with a number of closed areas and protected areas such as the Gully MPA, the 2J crab box, and the Funk Island deep box (COSEWIC, in press). The report also highlights that Canada is currently considering designating a portion of the Laurentian Channel as a MPA (COSEWIC, in press).

The *Oceans Act* requires that "ecosystem considerations be included in fishery management plans" (DFO, 2000). Protecting nursery habitats of skates is one critical step in considering the ecosystem. For example, a research survey suggests that Thorny skate recruitment in Div. 4X is increasing and there have been observations of skate purses, which indicates that this area may be important to protect (Simon, Rowe, & Cook, 2011). There is also evidence that subdivision 3Ps is an area of Thorny skate recruitment, but Thorny skate reproduce widely throughout their range (Kulka, Simpson, & Miri, 2006; D. Kulka, personal communication, August 3, 2012).

Bycatch and Discards

Discards are estimated by DFO using data collected by fisheries observers, which are present on a subset of commercial fishing trips, typically 5 to 25 percent of all trips (Benoit & Allard, 2009 as cited in Swain et al., 2012). Observer coverage of the scallop fishery in the Maritimes indicated that skate bycatch is 10 percent of total landings, and Thorny skate is estimated to be approximately 10 percent of the total reported skate bycatch (Simon, Rowe, & Cook, 2011). DFO has a bycatch cap on skate that cannot exceed ten percent of landings per trip in the groundfish fishery in the Maritimes (V. Docherty, personal communication, August 2, 2012). Prior to the groundfish fisheries closures in 1994, discards of Winter skate were estimated to be over 1,000 tons (DFO, 2002). Since 1994, estimated discards of Winter skate declined to less than 100 tons (DFO, 2002). A report on discard in NAFO Divs. 4VW, 4X5Y, and 5Z indicates that 13,332 mt of skate discards occurred in these divisions between 2002 and 2006 (Table 7). The groundfish bottom trawl, bottom trawl offshore, and longline, and redfish bottom trawl, and winter skate bottom trawl fisheries resulted in the highest amounts of skate discards (Table 7).

Table 7. Discard estimates (kg) of skates in NAFO Div. 4VW, 4X5Y, and 5Z 2002-2006 (Gavaris et al. 2010)

Species	4VW Discards	4X5Y Discards	5Z Discards	Total Discards in Maritimes
Barndoor skate	21,320	584,096	503,664	1,109,080
Other skates	3,825	612,110	3,864,782	4,480,717
Smooth skate	18,022	145,551	202,532	366,105
Spinytail skate	828	642	23,599	25,069
Thorny skate	169,703	877,480	1,816,214	2,863,397
Winter skate	228,630	560,161	3,699,853	4,488,644
Grand Total 2002-2006	442,328	2,779,474	10,110,644	13,332,446

Bycatch in Newfoundland and Labrador in Subdiv. 3Ps cannot exceed 10 percent of the catch or 200 pounds per trip (whichever is greater) and there is a two percent overall annual cap of each species that has a closed fishery (DFO, 2009). Discard data on skates in Subdiv. 3Ps is not publicly available, but the pre-COSEWIC assessment contains a graph on Thorny skate discards in Subarea 2 and Div. 3KLNOPs (Simpson et al., 2011). For further information on discards in this area, please see Figure 11 in Chapter 5.

Table 8. Estimated discards (in kg with lower and upper 95% CIs) for southern Gulf of St. Lawrence thorny and winter skate 2000-2004 (Swain et al. 2010; Benoit 2006)

Year	Mean Thorny Skate	Thorny Skate LCI	Thorny Skate UCI	Mean Winter Skate	Winter Skate LCI	Winter Skate UCI
2000	166,920	129,690	215,750	64,514	40,286	98,213
2001	91,830	68,960	121,740	49,719	22,001	92,865
2002	55,430	44,100	71,940	9,734	4,269	20,852
2003	55,090	45,620	67,070	6,532	3,669	11,320
2004	98,940	66,150	139,990	10,216	7,914	13,338

Bycatch in the Gulf of St. Lawrence cannot exceed 25 percent of the catch in the fixed gear fisheries and cannot exceed 10 percent in the mobile gear fisheries (D. Swain, personal communication, July 25, 2012). If Winter skate is caught, there is a mandatory live release policy (D. Swain, personal communication, July 25, 2012). Discards of skates in the southern Gulf of St. Lawrence in the 1990s were primarily from the Cod fishery and discards of skates in the 2000s were primarily from the Greenland halibut fishery

(Swain et al., 2012). Further, there is a substantial overlap in the distribution of Winter skate and scallops in the Gulf of St. Lawrence (Benoit et al., 2010). Estimated skate discards were 400-500 tons in the early 1990s and declined to about 40 tons in 2009 and 2010 (Swain et al., 2012). Approximately 96 percent of the total catch of skates in the Gulf of St. Lawrence from 1991-2010 were discarded at sea (Swain et al., 2012). DFO researchers studied the survival rate of Winter skate captured in the scallop dredge fishery and their results indicated that the survival rate was high and most skates were released in excellent or good condition (Benoit et al., 2010). Their results suggest that natural mortality (predation, disease, and unaccounted human-induced mortality) is a bigger concern for rebuilding the population (Benoit et al., 2010). The study estimated that about 14 percent of the juvenile and 7 percent of the adult Winter skate population are killed annually in the southern Gulf of St. Lawrence scallop fishery (Benoit et al., 2010). Further studies could be necessary to determine the post-release survival rates of Winter skate caught in other fisheries. The scallop dredges on the ESS are in deeper waters and Winter skate caught as bycatch may have a different survival rate (Benoit et al., 2010).

While there is no directed fishery for skates in the Arctic, both the Arctic skate and Thorny skate are taken as bycatch in Canada’s Arctic fisheries (DFO, 2012b). More effort should be made to quantify the bycatch of skates in these fisheries. The World Wildlife Fund-Canada has developed a new species identification guide for Chondrichthyes in Atlantic Canada using photographs rather than sketches and is in the process of distributing copies to fisheries observers in conjunction with training sessions (J. Corke, personal communication, July 16, 2012). With these new guides that feature photographic images rather than sketches, it should be easier for fisheries observers to estimate discards by species, in addition to reporting landings by species.

The update on the implementation of the *NPOA-Sharks* mentions bycatch mitigation measures for sharks but fails to mention any comparable measures for skates (DFO, 2012b). DFO recently released a report on *Guidance Related to Bycatch and Discards in Canadian Commercial Fisheries* that states Canada is committed to making their commercial fisheries more sustainable and is in the process of developing a bycatch policy (DFO, 2012d). The bycatch policy will include strategies and measures to manage bycatch and DFO recognizes that the quantification of bycatch and bycatch mortality will require quality data and monitoring programs (DFO, 2012d). While the development of a bycatch policy is an important step forward, there must be periodic evaluations regarding the degree of improvement in reducing bycatch and discards of skate.

Proposed Legislation Changes

The Jobs, Growth and Long-term Prosperity Act of 2012 (Bill C-38), proposes alteration of the text of Section 35(1) of the *Fisheries Act*. The bill passed the House of Commons and is being considered by the Senate. If passed, the changes would weaken the HADD provisions by only protecting fish from “serious harm” and protection is only extended to fish that are part of a commercial, recreational, or Aboriginal fishery. These potential legislative changes could mean that skates and rays that are not commercially fished or listed under SARA could be harmed with little repercussion.

Rebuilding Prohibited and Overfished Stocks

Even though Winter skate is no longer targeted, the species is still taken as bycatch in other fisheries. Some scientists suggest that the increased natural mortality of Winter skate in the southern Gulf of St. Lawerence is due to the increased population of Grey seals, and a seal reduction on the order of 40-70 percent end would be needed to allow Winter skate and other groundfish populations to rebuild (FRCC, 2011; DFO, 2010b; D. Swain, personal communication, July 24, 2012). Grey seal populations have increased over the past five decades in Atlantic Canada while natural mortality of adult fish has been "unusually high in these collapsed and non-recovering fish populations" (DFO, 2010b, p. 2).

The Winter skate population in the southern Gulf of St. Lawrence was designated as endangered by COSEWIC in 2005 (COSEWIC, 2012). Observer reports indicate that Winter skate is most often observed during the months of September and October (Benoit, 2006), which suggests that seasonal closures of high skate bycatch fisheries (*e.g.* bottom trawl and demersal seine) are warranted to increase the chance of rebuilding Winter skate populations in the Gulf of St. Lawrence. The DFO Recovery Assessment Potential (RAP) report emphasized that Winter skate abundance will continue to decline in the Gulf of St. Lawrence even with no skate bycatch in groundfish fisheries, but that bycatch amounts of 50 tons or higher could considerably accelerate Winter skate population decline (DFO, 2005b). The RAP also suggests that "predation by seals may be a cause of the increased adult mortality" of skates (DFO, 2005b, p. 10). The RAP concludes that no recovery is possible unless there is a decrease in the adult natural mortality, which could be related to the increased seal population (DFO, 2005b). One source of uncertainty in the RAP model is due to the lack of information on age at maturity and growth patterns, which indicates further life history studies are needed.

Winter skate on the ESS was also designated as threatened by COSEWIC in 2005 (COSEWIC, 2012). Similar to the Winter skate population in the southern Gulf of St. Lawrence, the population model indicates that the Winter skate population off the ESS have experienced an increase in adult natural mortality (DFO, 2005a). Sources of uncertainty in the population model include ageing information, population dynamics, and the impact of human activities on habitat (DFO, 2005a). The RAP also concludes that there is no chance of Winter skate recovery unless the adult natural mortality is reduced (DFO, 2005a). While both RAP reports mention that the bycatch of Winter skate in the scallop fishery was not quantified, research by Benoit et al. (2010) later indicated that the survival rates of Winter skate discards were high.

Recovery targets for Winter skate populations in the southern Gulf of St. Lawrence and ESS have not been established (DFO, 2005a; DFO, 2005b). DFO should consider setting a recovery target, even though Winter skate was not listed under SARA. Because estimates of virgin (unfished) biomass or MSY cannot be obtained, "potential recovery targets could be the survey catch rates observed in the 1970s or the long term mean" (DFO, 2005a, p. 8). None of the four sub-populations of Winter skate were listed under SARA. The main argument was that adding these populations to SARA would not address the elevated natural mortality and would result in economic costs (DOJ, 2011). Under Section 32 of SARA, listing a species as endangered would "require that any activity that would result in the killing, harassing, capturing or taking the listed species be stopped immediately" (DOJ, 2011). The potential closure of fishing activities in NAFO Divs. 4VW and 4T to eliminate the possibility of taking Winter skate as bycatch would result in millions of dollars in lost revenue (DOJ, 2011). Since Winter skate is not protected under SARA, DFO must try and rebuild the Winter skate population through the closure of the Winter skate fishery, reducing bycatch, and mandating the release of all Winter skate bycatch (DFO, 2011). Additional studies on the survival rate of Winter skate bycatch are needed and seasonal closure areas should be considered to protect Winter skate critical habitat. Discard handling protocols should also be developed, since research indicates that skate mortality can increase substantially due to thermal shock and length of exposure to the air (Cicia et al., 2011).

Thorny skate was designated as special concern by COSEWIC in 2012 (COSEWIC, 2012). The southern population of Thorny skate has experienced population declines and range contractions, while the northern population of Thorny skate has experienced a population increase and is at abundance levels similar to those observed at the beginning of the research surveys in the mid-1970s (COSEWIC, 2012). Thus, the species as a whole does not qualify as threatened (COSEWIC, 2012). Research indicates that "predation on thorny skate by fish predators was negligible although Atlantic halibut, sea raven, American plaice, Atlantic cod and porbeagle sharks have all been observed with thorny skate in their stomach contents" (Simon, Rowe, & Cook, 2011, p. 91). There is concern that a skate bait fishery for Thorny skate could develop in the Gulf of St. Lawrence due to the lack of traditional sources of bait, such as Herring (*Clupea harengus*) (D. Swain, personal communication, July 24, 2012). The update on implementation of the *NPOA-Sharks* acknowledges that DFO completed the last Stock Status Report on Thorny skate in 2004 and indicates that the biomass of the stock has stabilized since 1994 (DFO, 2012b). The decline of Thorny skate on the ESS is not mentioned and the updated report gives the impression that Thorny skate biomass is stable, which is not accurate for certain regions.

Smooth skate off Funk Island Deep was designated as endangered by COSEWIC in 2012 (COSEWIC, 2012). DFO should be in the process of developing a report on the recovery assessment potential of this species. To date, there are no stock status reports on the Smooth skate. The assessments by DFO focus primarily on Winter and Thorny skate, yet COSEWIC has listed the Smooth skate as endangered in certain areas and has listed the Barndoor skate as a species of concern. These recent COSEWIC listings suggest that more comprehensive management of skates as a complex is needed.

4.2. Department of Fisheries and Oceans and Bedford Institute of Oceanography Skate and Ray Research

The Bedford Institute of Oceanography (BIO) is a government sponsored laboratory and the Canadian Shark Research Laboratory (CSRL) is located at BIO. DFO researchers at the CSRL have undertaken studies on skate ageing, reproduction characteristics, and population trajectories. Age and growth information was collected using vertebrae sampling on four skate species: Winter, Little, Thorny, and Smooth skate (CSRL, 2007c). Bomb radiocarbon analysis was also used to conduct studies on the age and growth of Winter and Thorny skate. One of the Thorny skate specimens was estimated to be 28 years old and is the "oldest validated age reported for any species of batoid" (McPhie & Campana, 2009a, p. 546). The *k*-value (growth coefficient) obtained for Thorny skate was similar to *k*-values of large, long-lived shark species like the Great White shark (McPhie

& Campana, 2009a). Due to difficulties associated in validating the age of skate (*e.g*. wild skates must be tagged and recaptured), further studies are needed (CSRL, 2007c).

Further tagging studies of Thorny skate and Winter skate are also needed in the NW Atlantic to study migration patterns and to collect information on growth patterns. The last published study on the migration of Thorny skate in the NW Atlantic is from the 1980s (Tempelman, 1984). DFO tagged a total of 722 Thorny skates off Newfoundland between 1962 and 1965, and over a 20 year period, 19 percent of the coastal tags and 5 percent of the offshore tags were returned (Tempelman, 1984). The majority of the recaptures were from 35 to 60 miles from the original tagging site but several recaptures were as far as 150, 170, and 240 miles away (Tempelman, 1984). Tagging studies are needed in other regions to delineate the migration range of Thorny skates.

The CSRL began a tagging study of Winter skate on the ESS in 2004 (800 skates). The results suggest high rates of bycatch mortality, due to zero tag recaptures (S. Campana, April 29, 2012; CSRL, 2007c). Studies on size, age at maturity, and fecundity have also been conducted at CSRL on Winter, Little, Thorny, and Smooth skate. The results indicate that Winter, Thorny, and Smooth skate are "all slow-growing, late-maturing, long-lived fishes, and are therefore vulnerable to overexploitation" (CSRL, 2007c).

Another study by DFO examined the link between reproductive characteristics and the decline of four skate species off the ESS. Winter skate, Little skate, Thorny skate, and Smooth skate fecundity is estimated to average between 41 and 56 egg cases per year (McPhie & Campana, 2009b). While low reproductive capability is in part cause for the population decline of Winter, Thorny, and Smooth skate, the mortality rates also remain too high to sustain the population levels (McPhie & Campana, 2009b).

The update report on the implementation of the *NPOA-Sharks* highlights new skate research in Newfoundland and the ESS (DFO, 2012b). DFO is close to completing a study on the skate complex off Newfoundland and Labrador to examine data deficient species, along with bycatch and discard mortality studies off the ESS (DFO, 2012b). The report acknowledged that ongoing research is being conducted on skate growth, reproduction, morphometrics and the distribution of the population (DFO, 2012b).

4.3. Canadian Ray Management

The update on the implementation of the *NPOA-Sharks* mentions bycatch mitigation measures for sharks but fails to mention any comparable measures for rays (DFO, 2012b). Research on skates is mentioned but no research on rays is highlighted (DFO, 2012b). A brief section in the update report notes that discard rates and discard mortality rates for rays are unknown (DFO, 2012b). The only published discard data on rays was from the NAFO Divs. 4V, 4W, 4X, 5Y, and 5Z for 2002-2006 (Table 9) (Gavaris et al., 2010). An estimated 55,669 kg of rays were discarded in NAFO Divs. 4VW, 4X5Y, and 5Z between 2002 and 2006 (Gavaris et al., 2010). The highest discard rates were in the swordfish longline fishery.

Table 9. Discard estimates (kg) of rays in NAFO Div. 4VW, 4X5Y, and 5Z 2002-2006 (Gavaris et al. 2010)

Species	4VW Discards	4X5Y Discards	5Z Discards	Total Discards in Maritimes
Atlantic torpedo ray	N/A	3,076	7,238	10,314
Ray	12,141	29,568	3,646	45,355
Grand Total 2002-2006	12,141	32,644	10,884	55,669

4.4. Recommendations

Due to the *k*-selected life history characteristics of skates which make them highly vulnerable to overfishing, DFO should consider creating a separate IFMP for skates, rather than including skate management in the groundfish IFMPs.

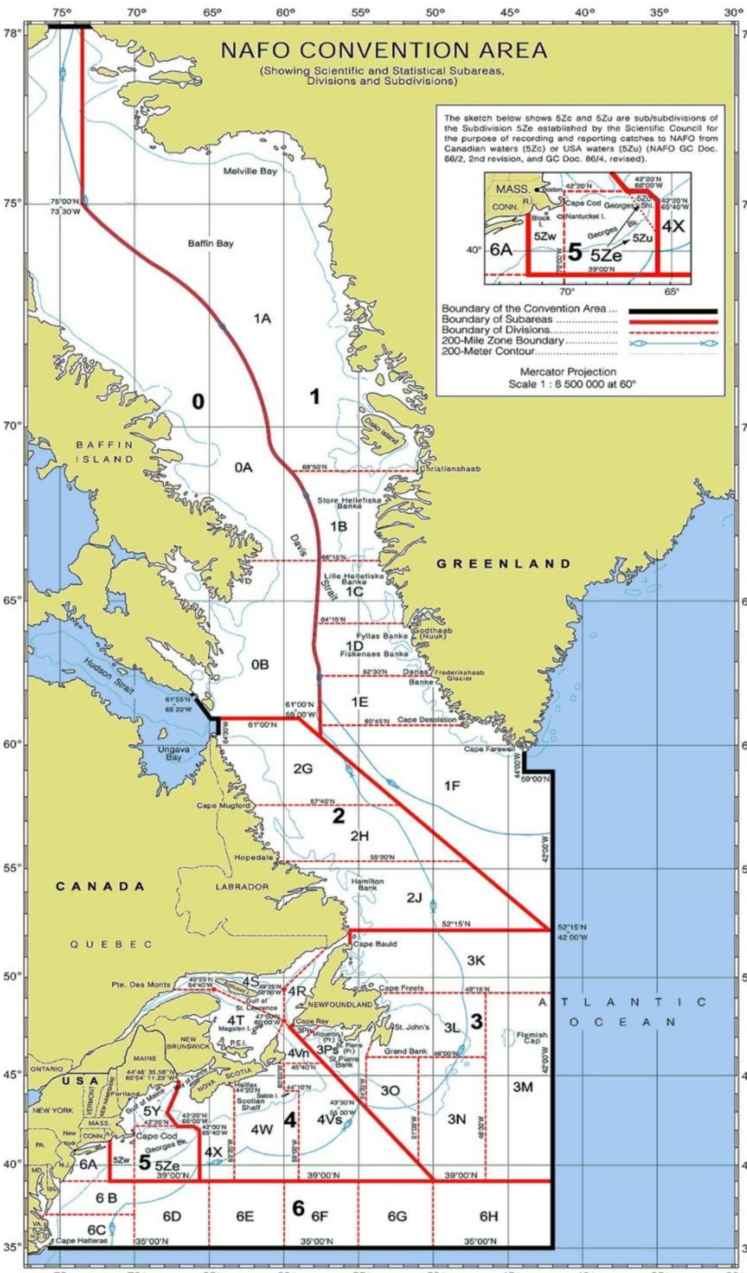
FINAL RECOMMENDATIONS

1. In order to facilitate more effective management of skates, DFO should develop a more comprehensive and streamlined skate management plan for DFO-Maritimes, DFO-Gulf, and DFO-Newfoundland.
2. DFO should require skate and ray landings and discards to be reported by species.
3. In the interest of transparency, DFO should publish discard data online to ensure that these data are publicly accessible.
4. DFO should endeavor to increase efforts to ensure that public fisheries landings statistics are accurate and in line with the ZIFF database.
5. DFO and research institutions should encourage and facilitate studies on skate life history, growth, and population dynamics, particularly for the endangered Winter skate.
6. DFO should initiate comprehensive bycatch reduction strategies and measureable rebuilding targets for skates.

5. INTERNATIONAL MANAGEMENT OF SKATES IN THE NORTHWEST ATLANTIC

5.1. Northwest Atlantic Fisheries Organization

Figure 10. NAFO Convention Area (Photo Credit: NAFO)



The International Commission for Northwest Atlantic Fisheries (ICNAF) was established in 1950 to manage fisheries outside the territorial waters of coastal states in the NW Atlantic (NAFO, n.d.). In 1979, ICNAF was replaced by the Northwest Atlantic Fisheries Organization (NAFO) following the extension of the Exclusive Economic Zone (EEZ) to 200 nm (NAFO, n.d.). The NAFO Contracting Parties (CPs) include Canada, Cuba, Denmark (in respect to the Faroe Islands and Greenland), Estonia, European Union (EU), France (in respect to Saint Pierre et Miquelon), Iceland, Japan, Republic of Korea, Norway, Russian Federation, Ukraine, and the US. Since the mid-1990s, approximately 70 percent of Canadian skate catches were taken outside of their EEZ (Kulka & Miri, 2007). Because the distribution of Thorny skate straddles international boundaries, effective management on the stock depends on international cooperation through organizations such as NAFO. The skate fishery is directed in NAFO Divs. 3LNO and the Subdiv. 3Ps (Canadian jurisdiction) (Figure 10). NAFO requires that all vessels have a Vessel Monitoring System and they must carry at least one independent and impartial observer (NAFO, 2012b).

NAFO set the first elasmobranch quota in the world by a Regional Fishery Management Organization for skate in 2004, based on scientific assessment of Thorny skate (NAFO, 2004), but the TAC is not set in line with scientific advice (Table 10). The NAFO skate quota is allocated among Russia, Canada, and the EU. NAFO CPs set the skate TAC for each year between 2004 and 2009 at 13,500 tons and then lowered it to 12,000 tons between 2010 and 2011. The NAFO Standing Committee on Fisheries Science (STACFIS) has suggested the skate TAC be reduced to 5,000 tons since 2008 (SAI, 2011). In 2012, NAFO Parties agreed to lower the TAC for skate to 8,500 tons and the CPs agreed to consider another reduction at the 2013 NAFO meeting (SAI, 2011). Essentially, the TAC for skate has been twice the level suggested by NAFO scientists until the reduction in quota in 2012. In 2011, the CPs, namely Canada, US, and the EU, put forward proposals for lowering the quota. Canada suggested phasing the reduction over two years to 8,500 tons, the EU suggested adopting the scientific advice for 2012 but in a manner that favored European fishermen, and the US proposed a 5,000 ton quota for 2012 with reductions across-the-board (SAI, 2011). Much of the NAFO annual meeting takes place in a heads of delegation session wherein observers cannot participate, which is a concern because of the lack of transparency. Among the top seven commitments and recommendations from the 2012 UN Rio+20 meeting outcome document, heads of state and governments agreed that RFMO decision-making should be transparent and science-based (United Nations, 2012). This international document is an agreement CPs and observers in NAFO can point to in order to highlight transparency commitments already agreed upon by governments.

Table 10. Recent NAFO catches, advice, and decisions with respect to skates (quotas in tons) (NAFO 2004; NAFO 2011; NAFO 2012a; SAI 2011)

Contracting Party	Skate Quota Share	2004-2009 Quotas	2010-2011 Quotas	Reported 2011 Skate Catches	2012 Quotas	Scientific Advice (t)
Canada	16.67%	2,250	2,000	68	1,417	
EU	62.96%	8,500	7,556	5,269	5,352	
Russia	16.67%	2,250	2,000	7	1,417	
Others	3.70%	500	444	45	315	
Total	**100**	**13,500**	**12,000**	**5,389**	**8,500**	**5,000**

As mentioned in Chapter 4, the Thorny skate stock on the Grand Banks has become hyper-aggregated in a small area on the southern Grand Bank, similar to observations of Northern Cod just prior to its collapse on the Labrador Shelf (Kulka & Miri, 2007; COSEWIC, in press). This type of distribution could make Thorny skate especially vulnerable to overexploitation by international fishing vessels.

The *NAFO Conservation and Enforcement Measures* guide states that each CP must report its monthly catches by species and stock area, yet skate landings are not reported by species (NAFO, 2012b). Species-specific skate codes for skates exist, but landings are still reported SKA, unspecified skate (NAFO, 2012b). The NAFO STACFIS has mentioned the need for species-specific landings data of skates to improve the quality of stock assessments (K. Sosebee, personal communication, May 14, 2012). The majority (95 percent) of the reported landings are Thorny skate on the Grand Banks (Kulka &

Miri, 2007). Skate landings have been reported in NAFO since 1960 and the landings peaked at 28,408 tons in 1991 (Figure 12) (NAFO, 2012a). Skate landings have averaged 4,947 tons between 2004 and 2010 (Simpson & Miri, 2012). Some of the CPs are not fully fishing their skate quotas which may be due limitations regarding bycatch caps of other species (*e.g.* American plaice, Cod). However, there are no measures in place to prevent the CPs from fully fishing their quota. While the 2012 Thorny skate stock assessment for Divs. 3LNOPs notes that the Thorny skate biomass is slowly increasing from low levels, the assessment cautions that the TAC continues to exceed scientific advice when "minimal or no rebuilding of this stock has occurred" (Simpson & Miri, 2012, p. 6). Recruitment levels have slightly improved but skates have a low intrinsic rate of increase (Simpson & Miri, 2012). Data on NAFO discards is not available to the public which is another issue of transparency in a RFMO (B. Marshall, personal communication, July 19, 2012). However, the pre-COSEWIC assessment of Thorny skate contains a figure on estimated discards in Subarea 2 and Divs. 3KLNOPs (Figure 11).

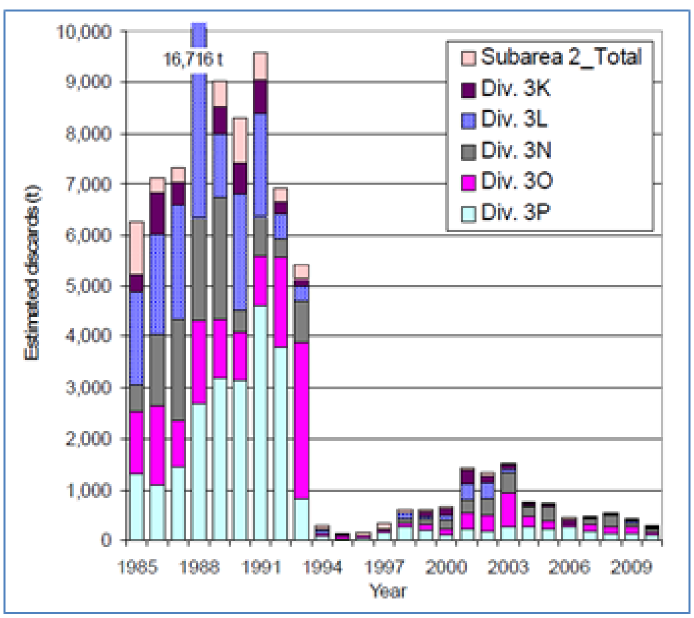
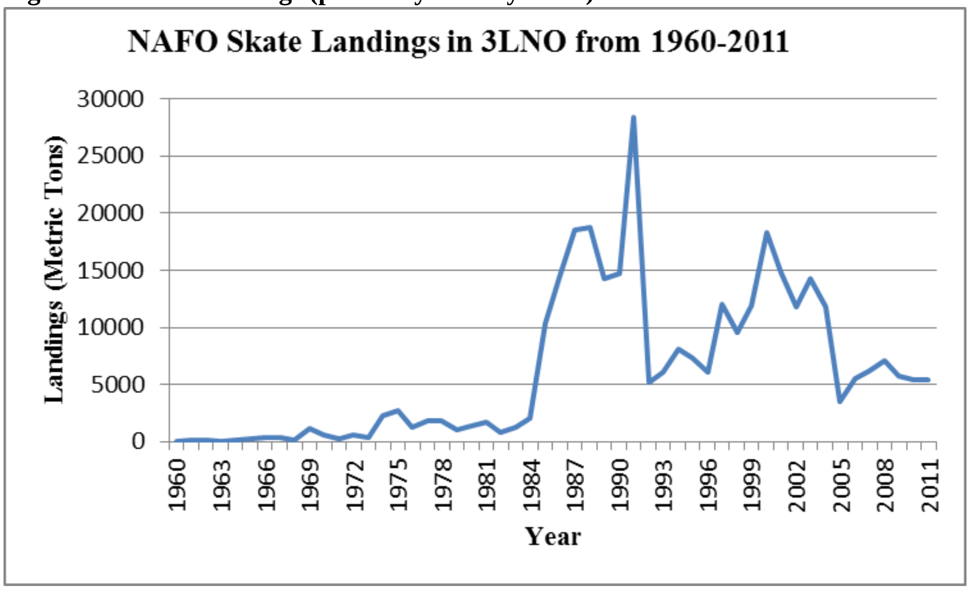


Figure 11. Estimated discards of thorny skate in Subarea 2 and Divs. 3KLNOPs according to the observers' at sea skates discard data pro-rated to total reported groundfish landings 1985-2010 (Photo Credit: Simpson et al. 2011)

NAFO bycatch requirements state that vessels of CPs must limit their bycatch to a maximum of 2,500 kg or 10 percent of the catch (NAFO, 2012b). The Scientific Council could benefit from access to bycatch data but it is up to the CPs if they want to share their data (K. Sosebee, personal communication, May 14, 2012). Currently there is no NAFO elasmobranch species identification guide but there have been discussions by the US representatives to potentially create an elasmobranch identification guide (B. Marshall, personal communication, July 20, 2012; S. Fordham, personal communication, July 25, 2012).

Figure 12. Skate Landings (primarily Thorny skate) in NAFO Divs. 3LNO 1960-2011(NAFO, 2012a)



The STACFIS notes that the Thorny skate has a low resilience to fishing mortality (NAFO, 2010b), which indicates the importance of NAFO CPs agreeing to manage catch quotas according to scientific advice. The IUCN Shark Specialist Group wrote a letter to the Chair of the NAFO Fisheries Commission in 2010 urging the reduction of the skate TAC in line with scientific advice (S. Fuller, personal communication, July 20, 2012). For the past several years, several non-profit organizations such as World Wildlife Fund, Shark Advocates International, Humane Society International, and Project AWARE, sent letters to the US, EU, and Canadian delegations urging the reduction of the skate TAC in line with scientific advice. The pressure on NAFO's CPs to adopt TACs based on scientific advice is increasing, and the EU has been increasingly more willing to adopt skate reductions since the adoption of the 2009 EU Plan of Action for Sharks that includes a commitment heeding scientific advice for elasmobranchs (S. Fordham, personal communication, August 11, 2012). NAFO Parties will again consider reductions in the skate TAC at their September 2012 annual meeting. In the 2011 annual meeting, the NAFO Parties pledged to heed the scientific advice (5,000 tons) and yet a similar commitment in 2010 did not result in a science-based skate TAC reduction in 2011 (S. Fordham, personal communication, August 11, 2012). For now, it is clear that skates are not being managed in line with clear scientific advice or the precautionary approach despite numerous national and international commitments to such practices.

NAFO has implemented some measures to protect vulnerable marine ecosystems (VMEs). The UN Food and Agriculture Organization international guidelines criteria for identifying VMEs are: uniqueness or rarity, functional significance of the habitat, fragility, life history of component species that make recovery difficult, and structural complexity (FAO, 2012a). In 2007, NAFO closed an area to fishing around the southwest Grand Banks (Div. 3O) until 2011, to allow research to be conducted on deep-water corals (Vinnichenko & Skylar, 2007). These protection measures stemmed from the UN General Assembly Resolution 61/105 which encourages RFMOs to address the impacts of bottom fisheries on VMEs (Vinnichenko & Skylar, 2007; NAFO, 2011). NAFO extended this protection until 2014, when it will be reviewed again (NAFO, 2011). NAFO has also designated five seamount areas to be closed to fishing in order to protect corals, sponges, and vulnerable fish (NAFO, 2011). These areas closed to fishing should protect skates as well, but the degree of protection is uncertain.

5.2. Transboundary Resources Assessment Committee

The Transboundary Resources Assessment Committee (TRAC) was established in 1998 to examine "stock assessments and projections necessary to support management activities for shared resources across the USA-Canada boundary in the Gulf of Maine-Georges Bank region" (DFO, 2008b). For example, the TRAC provides advice to the FRCC on the appropriate TAC levels for transboundary stocks on the Georges Bank (DFO, 2000). The Transboundary Management Guidance Committee (TMGC) was established in 2000 to ensure consistent management for species such as Cod, Haddock, Herring, and Yellowtail flounder (*Pleuronectes ferrugineus*) on the eastern Georges Bank (DFO, 2008b). Meetings are scheduled several times a year to discuss transboundary management of these species. The TRAC co-chairs, one appointed by NMFS and one appointed by DFO, could receive guidance from the TMGC to assess Thorny or Winter skate as a transboundary stock. The added level of attention on consistent management of these threatened skate species could help to increase biomass levels and conduct joint research activities.

Scientists have suggested there is connectivity in skate populations between the US and Canada. For example, Frisk et al. proposed that there is particular connectivity between the Winter skate populations on the Scotian Shelf and Georges Bank and indicated the Northeast channel is not a barrier to their movement (Frisk et al. 2008 as cited in NEFMC, 2008). It is possible that the distribution of Thorny skate in the southern Gulf of Maine in the US may be shifting northward and to deeper waters to avoid warming water temperatures (T. Curtis, personal communication, July 9, 2012). This possibility could partially explain the inverse biomass survey rates for Thorny skate in the US and Canada.

The Canadian research surveys also indicate changes in Thorny skate distribution due to temperature, but the shift observed was toward warmer bottom temperatures (Colbourne & Kulka, 2004).

Winter skate populations in Canada are divided into four designable units by DFO, which suggests there is limited range of movement. A genetic study of Winter skate is ongoing at Dalhousie with collaboration by DFO (D. Swain, personal communication, July 24, 2012). Their study on DNA barcoding indicated that genetic tests can be utilized to verify the species in skate catches, which is of particular importance with look-alike species such as Little and Winter skate (Coulson et al., 2011). Winter skate biomass levels vary between Canadian and US waters and age and growth studies indicate that Winter skate along the Northeast coast of the US, Gulf of Maine, and the east coast of Canada have different life history parameters (McPhie & Campana, 2009a). These differences suggest that minimal transboundary management is needed for the Winter skate. However, due to the endangered status of Winter skate on the Eastern Scotian Shelf (ESS), steps to minimize bycatch around the Georges Bank, in addition to the ESS, should be considered as a precautionary measure.

While the age at maturity of Thorny skate populations in the US and Canada can vary, they are thought to be one population (McPhie & Campana, 2009a; Kulka, Simpson, & Miri, 2006). Further genetic studies are necessary to confirm or reject this notion. A recent genetic study on Thorny skate in the North Atlantic indicated that there was little genetic differentiation among the population (Chevolot et al., 2007). However, the varying life history characteristics among northern and southern Thorny skate populations suggest otherwise (COSEWIC, in press). Further studies on the migration of Thorny skate are particularly needed around Georges Bank and the ESS to assess the need for transboundary management in the Gulf of Maine. A recent COSEWIC report on Thorny skate states that the Thorny skate distribution in Canadian waters is continuous with that in US waters, yet "the degree of migration and dispersal between these areas, if any, is unknown" (COSEWIC, in press, p. 59).

5.3. International Trade

In order to understand the demand for skate and ray products, the international trade must be tracked. While the US International Trade Commission is responsible for import codes through the Harmonized Tariff System (HTS), the US Census Bureau is responsible for the Schedule B export codes (US Census Bureau, 2012). The US has their own HTS system for the last 4 digits of the 10 digit codes, while the international Harmonized Commodity Description and Coding System, administered by the World Customs Organization (WCO) under the Harmonized System Convention, has a HTS system of six digit codes to track international trade (US ITC, 2012). Individual countries can utilize the last four digits to specify products more specifically for their own statistical uses.

The US HTS and Schedule B codes for rays and skates (Rajidae) became effective as import codes in February 2012 and as export codes in January 2012 (A. Lowther, personal communication, June 29, 2012). The US HTS codes for whole frozen rays and skates (0303.82.0000) and whole fresh rays and skates (0302.82.0000) are utilized by the NMFS Fisheries Statistics and Economics division by weight in kilos and dollar value (NMFS, 2012a). From February 3, 2012-May 31, 2012, imports of frozen rays and skates were recorded at 414 kilos ($3,196) (NMFS, 2012c). From January 1, 2012-May 31, 2012, exports of frozen rays and skates were 952,905 kilos ($3,407,629) and exports of fresh rays and skates were 554,993 kilos ($2,902,567) (NMFS, 2012a). It is evident that the US exports a significant amount of rays and skates, while the import amount of rays and skates is negligible. Under the *Customs Act*, the Canadian Tariff Schedule has a 10 digit HTS code, 0302.82.0000 (whole fresh) and 0303.82.0000 (whole frozen), rays and skates (Rajidae) (CBSA, 2012). Statistics Canada tracks exports through the Canadian Export Classification (Statistics Canada, 2012). DFO currently has no reported import and export data on skates and rays on the trade section of their website, but the Economics Division is currently processing the import and export data that has been collected since January 2012 (R. Khan, personal communication, July 9, 2012).

The WCO is in the process of updating the codes for the international Harmonized Commodity Description and Coding System by 2017. The UN Food and Agriculture Organization (FAO) submitted a proposal of revised codes, which include six digit codes for “dogfish, other sharks, rays and skates (Rajidae)” (FAO, 2012b). If this change to the international system is made, the US and Canada would have to change their current HTS codes to match the WCO codes. In order to maintain more specific trade data, *i.e.* “rays and skates”, rather than “dogfish, other sharks, rays and skates (Rajidae)”, the countries would have to assign numbers to the last four digits in the codes to keep the specificity of rays and skates.

While the advance in tracking rays and skates should be applauded, it would be beneficial for NMFS and DFO to track rays and skates at the species level, particularly for prohibited species such as Thorny and Smooth skate. The upcoming code changes to the international Harmonized Commodity Description and Coding System in 2017 could be an opportunity for the US and Canada to update their HTS codes to report rays and skates at a species-specific level.

5.4. Recommendations

FINAL RECOMMENDATIONS

1. DFO, NMFS, and/or research institutions should conduct genetic and tagging studies to determine if Thorny skate in the northeastern US and Atlantic Canada are one or several populations.

2. The US and Canada should consider transboundary management to reduce bycatch of Winter and Thorny skates.

3. NAFO's Contracting Parties should follow scientific advice when setting the skate quota.

4. NAFO should phase out the use of the SKA (unspecified skate) code in order to require species-specific landings data. A NAFO skate identification guide should be developed as well.

5. The Transboundary Management Guidance Committee should consider assessing the viability of adding Thorny and Winter skates as transboundary stocks.

6. The US and Canada should utilize the last four digits in the import and export codes to track international skate and ray trade by species.

6. COMPARATIVE SUMMARY OF SKATE AND RAY MANAGEMENT IN THE NORTHWEST ATLANTIC AND SUMMARY OF RECOMMENDATIONS

6.1. Comparative Summary of Skate and Ray Management in the US, Canada, and NAFO

The US, Canada, and the Northwest Atlantic Fisheries Organization (NAFO) all manage skate fisheries through Total Allowable Catches (TAC), but these efforts are not well coordinated. In particular, the NAFO skate TAC, which forms the basis of the Canadian TAC, is not currently in line with scientific advice. As Table 11 indicates, there are sufficient legal mandates to protect skates in the US, Canada, and under NAFO. While the management plans tend to include measures such as catch quotas, other measures like habitat protection, bycatch mitigation, and rebuilding targets and plans should be strengthened. NMFS has designated essential fish habitat for skates and DFO has designated ecologically and biologically sensitive areas, but neither country has explicitly adopted habitat protection for skates in the NW Atlantic. NAFO has implemented protection measures on seamounts and for deep-sea corals, but none of the habitat protection measures are intended to conserve skate habitat or skates within those areas. Further research is needed in order to determine critical skate habitat. Bycatch of skate species is another pressing problem. Bycatch caps that apply to skates exist in Canada and NAFO but not the US. Currently are no discard mortality mitigation measures. Studies on gear modification techniques and discard handling protocols to reduce the bycatch and discard mortality of skates would be beneficial. The *IPOA-Sharks* calls on fishing nations to minimize elasmobranch bycatch and discards. Discards of skates and rays are high in certain fisheries and bycatch mitigation measures should be implemented by NOAA and DFO.

Some large-bodied commercial skate species have been particularly depleted; these include Thorny and Winter skate. As the distribution range of Thorny skate is contracting on the Grand Banks and the Gulf of St. Lawrence, habitat protection may be one important supplementary conservation approach. Winter skate has been assessed by COSEWIC as endangered in the Gulf of St. Lawrence, but no habitat protection measures have been implemented yet. While the US has set biomass rebuilding targets for prohibited skate species, Canada has yet to do so. NAFO recognized in the 2012 Thorny skate assessment that minimal to no rebuilding has occurred, yet the stock is not listed under the NAFO Conservation Plan and Rebuilding Strategy in the *NAFO Conservation and Enforcement Measures*. Rays are essentially unmanaged in the northeast US, Atlantic Canada, and NAFO and collection of species-specific data on discards of rays should be a priority, as well as gear modification techniques to reduce bycatch rates.

Table 11. Legal tools and conservation measures for skates in the US, Canada, and NAFO

Management Tool	**US**	**Canada**	**NAFO**
Legal Mandate			
TALs/TACs	*Magnuson-Stevens Act*	*Fisheries Act*	*NAFO Conservation & Enforcement Measures*
Habitat Protection	*Magnuson-Stevens Act*	*Fisheries Act; Oceans Act*	*UN Fish Stocks Agreement*
Discard Mitigation	*NPOA-Sharks*	*NPOA-Sharks*	*IPOA-Sharks; UN Fish Stocks Agreement; NAFO Convention*
Rebuilding Plan	*Magnuson-Stevens Act*	*Species at Risk Act* (no skates listed)	*NAFO Conservation & Enforcement Measures*
Management Plan	**Northeast Skate Complex FMP**	**DFO Groundfish FMPs**	**NAFO Conservation & Enforcement Measures**
TALs/TACs	Yes	Yes, sometimes unclear (outdated plans)	Yes
Habitat Protection	EFH Designation	EBSAs Designation	Closures to protect bottom fisheries/corals
Discard Mitigation	No	No	No
Rebuilding Plan	Yes (through TACs)	No	No
Scientific Advice	**Scientific & Statistical Committee**	**Canadian Science Advisory Secretariat**	**Scientific Council**
TALs/TACs	Yes	Yes	Yes
Habitat Protection	EFH for skate, but not closures	EBSAs, but only one mentions skate	None for skate
Discard Mitigation	Discard Monitoring	Discard Monitoring	Discard Monitoring
Rebuilding Plan	Biomass target	No biomass targets	TAC reduction suggested

6.2. Conclusion

Similar in their life history to sharks, skates and rays generally grow slowly, mature late, and have low fecundity which makes them especially vulnerable to overfishing. The decline of traditional groundfish (Cod, Haddock) species in the Northwest Atlantic has resulted in increased exploitation of skates, particularly Thorny, Winter, and Little skates. In addition to targeted skate fisheries, the bycatch and discard of many skate and ray species in groundfish and longline fisheries is essentially unmanaged.

Increased use of species identification guides and a requirement to report skate and ray landings by species will facilitate more accurate stock assessments and management. Species-specific discard reporting should be implemented and these data should be made publicly available. Discard handling protocols should be adopted and research in trawl gear modification should be conducted in order to decrease discard mortality. Seasonal or area closures in identified skate nurseries and juvenile habitats should help to promote the rebuilding of skate stocks. Additional studies on life history characteristics are necessary to implement species-specific quotas. In order to improve management of skates in the Northwest Atlantic, the following recommendations are suggested as priorities for NMFS, DFO, and NAFO:

TOP PRIORITIES FOR SKATE AND RAY MANAGEMENT IN THE NW ATLANTIC

1. The New England Fishery Management Council (NEFMC) and the Department of Fisheries and Oceans (DFO) should implement management measures to require commercial fishermen and observers to report skate landings and discards by species.

2. The National Marine Fisheries Service (NMFS) and DFO should initiate comprehensive bycatch reduction strategies. DFO should adopt measureable rebuilding targets for Winter and Thorny skates.

3. NMFS and DFO should invest resources to research nursery areas, movement patterns, habitat preferences, and long-term discard mortality of skates. NMFS, DFO, and research institutions should encourage and facilitate studies on skate life history, growth, and population dynamics, particularly for Winter and Thorny skates.

4. NMFS should designate Habitat Areas of Particular Concern (HAPC) and closure areas to help rebuild overfished Thorny skate populations. Further studies on critical habitat will be needed to determine HAPCs.

5. The Mid-Atlantic Fishery Management Council should develop a Fishery Management Plan for Cownose rays and should cap or suspend any directed Cownose ray fishing licenses until proper management measures and conservation considerations are implemented.

6. NMFS, DFO, and/or research institutions should conduct genetic and tagging studies to determine if Thorny skate stocks in the northeastern US and Atlantic Canada are composed of one or several populations.

7. The US and Canada should consider transboundary management through the Transboundary Resources Assessment Committee to reduce bycatch of Winter and Thorny skates.

8. The Northwest Atlantic Fishery Organization (NAFO) should follow scientific advice when allocating the Thorny skate quota.

9. NAFO should phase out the use of the SKA (unspecified skate) code in order to require species-specific landings data. A NAFO skate identification guide should be developed to aid with this change.

10. In the interest of transparency, DFO and NAFO should publish discard data online to ensure that these data are publicly accessible.

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APPENDIX I: SUMMARY OF THE IUCN'S CRITERIA VERSION 3.1

Criteria A–E	Critically EN	EN	VU
A. Population reduction: Declines measured over the longer of 10 years or 3 generations			
A1	≥ 90%	≥ 70%	≥ 50%
A2, A3 & A4	≥ 80%	≥ 50%	≥ 30%
Al. Population reduction observed, estimated, inferred, or suspected in the past where the causes of the reduction are clearly reversible AND understood AND have ceased, based on and specifying any of the following:			
(a) direct observation			
(b) an index of abundance appropriate to the taxon			
(c) a decline in area of occurrence, extent of occurrence, and/or habitat quality			
(d) actual or potential levels of exploitation			
(e) effects of introduced taxa, hybridisation, pathogens, pollutants, competitors or parasites.			
A2. Population reduction observed, estimated, inferred, or suspected in the past where the causes of reduction may not have ceased OR may not be understood OR may not be reversible, based on (a) to (e) under Al.			
A3. Population reduction projected or suspected to be met in the future (up to a maximum of 100 years) based on (b) to (e) under Al.			
A4. An observed, estimated, inferred, projected or suspected population reduction (up to a maximum of 100 years) where the time period must include both the past and the future, and where the causes of reduction may not have ceased OR may not be understood OR may not be reversible, based on (a) to (e) under Al.			
B. Geographic range in the form of either B1 (extent of occurrence) AND/OR B2 (area of occupancy)			
B1. Extent of occurrence	< 100 km²	< 5,000 km²	< 20,000 km²
B2. Area of occupancy AND at least two of the following:	< 10 km²	< 500 km²	< 2,000 km²
(a) Severely fragmented, OR Number of locations	1	≤ 5	≤ 10
(b) Continuing decline in any of: (i) extent of occurrence; (ii) area of occupancy; (iii) area, extent and/or quality of habitat; (iv) number of locations or subpopulations; (v) number of mature individuals.			
(c) Extreme fluctuations in any of: (i) extent of occurrence; (ii) area of occupancy; (iii) number of locations or subpopulations; (iv) number of mature individuals.			
C. Small population size and decline Number of mature individuals AND either C1 or C2:	< 250	< 2,500	< 10,000
C1. An estimated continuing or decline of at least: (up to a max. of 100 years in future)	25% in 3 years or 1 generation	20% in 5 years or 2 generations	10% in 10 years or 3 generations
C2.A continuing decline AND (a) and/or (b): (a) (i) No. of mature individuals in each subpopulation.	< 50	< 250	< 1,000
(a) (ii) or % individuals in one subpopulation at least.	90%	95%	100%
(b) extreme fluctuations in the number of mature individuals.			
	≤ 50	≤ 250	D1. ≤ 1,000
D. Very small or restricted population Either number of mature individuals	Restricted area of occupancy Area of occurrence	D2.	AND/OR AOO < 20 km² or ≤ 5 locations
E. Quantitative Analysis Indicating the probability of extinction in the wild to be:	≥ 50% in 10 years or 3 generations (100 years max)	≥ 20% in 20 years or 5 generations (100 years max)	≥ 10% in 100 years

From IUCN 2001; Cosandey-Godin 2009

APPENDIX II: BIOLOGICAL PARAMETERS OF SKATE & RAY SPECIES OCCURRING IN CANADIAN & US ATLANTIC WATERS

Common name *Species*	**Population**	**Habitat**	**Sex**	**Size at maturity (TL cm)**	**Age at maturity (years)**	**Longevity (years)**	**Max size (cm)**	**Size at birth (cm)**	**Incubation period (months)**	**Repr. cycle (years)**	**Average clutch size**	**Generation time (years)**	**Source**
Richardon's Skate *Bathyraja richardsoni*	Global	bathydemersal	F	-	-	-	153	18-25	-	-	-	-	Orlov & Cotton 2011; Tempelman 1973
			M	-	-	-	113	-	-	-	-	-	
Spinytail Skate *Bathyraja spinicauda*	NW & NE Atlantic Ocean	bathydemersal	F	-	-	-	172	-	12	-	-	-	Collette & Klein-MacPhee 2002; Stehmann & Burkel 1984 as cited in IUCN 2012
			M	-	-	-	-	-	-	-	-	-	
Arctic Skate *Amblyraja hyperborea*	Atlantic, Indian & Pacific Oceans	bathydemersal	F	-	-	-	-	-	-	-	-	-	Froese & Pauly 2012
			M	94	-	-	106	-	-	-	-	-	
Jensen's Skate *Amblyraja jenseni*	NW & NE Atlantic Ocean	bathydemersal	F	-	-	-	107	-	-	-	-	-	Orlov & Cotton 2011
			M	-	-	-	111	-	-	-	-	-	
Thorny Skate *Amblyraja radiata*	NW & NE Atlantic Ocean	demersal	F	60-94	11-12	22	-	8-12	-	-	10-45	13-17	Swain et al. 2012; Tempelman 1984, Scott & Scott 1988, Walker 1998, Sulikowski et al. 2005 as cited in IUNC 2012
			M	54	12	18	-	-	-	-	-	-	
Barndoor Skate *Dipturus laevis*	NW & Western Central Atlantic Ocean	demersal	F	115	8	8-11	153	18-19	-	-	47	-	Collette & Klein-MacPhee 2002; Frisk et al. 2001; T. Gedamke and Casey & Myers 1998 as cited in IUCN 2012
			M	112	-	-	-	-	-	-	-	-	

APPENDIX II CONTINUED

Common name Species	Population	Habitat	Sex	Size at maturity (TL cm)	Age at maturity (years)	Longevity (years)	Max size (cm)	Size at birth (cm)	Incubation period (months)	Repr. cycle (years)	Average clutch size	Generation time (years)	Source
Sailray Skate *Dipturus linteus*	NW & NE Atlantic Ocean	bathydemersal	F	97	-	-	-	-	-	-	-	-	Froese & Pauly 2012
			M	97	-	-	-	123	-	-	-	-	
Little Skate *Leucoraja erinacea*	NW Atlantic Ocean	demersal	F	43-46	7-7.5	12	53	9-12	6-9	-	28-33	-	Collette & Klein-MacPhee 2002; Frisk & Miller 2009; Scott & Scott 1988; Richards et al. 1963, Johnson 1979 as cited in IUCN 2012
			M	43-46	7-7.5	12	53	-	-	-	-	-	
Rosette Skate *Leucoraja garmani*	NW & Western Central Atlantic Ocean	benthopelagic	F	34-37	-	-	57	-	-	-	-	-	Collette & Klein-MacPhee 2002; McEachran 1977 as cited in IUCN 2012
			M	-	-	-	57	-	-	-	-	-	
Winter Skate *Leucoraja ocellata*	NW & Western Central Atlantic Ocean	demersal	F	76	12.5	20+	-	11-13	18-22	-	18-35	-	Collette & Klein-MacPhee 2002; Frisk & Miller 2009; DFO, 1998; Frisk et al. 2002 as cited in IUCN 2012
			M	76	12.5	20+	-	-	-	-	-	-	
Smooth Skate *Malacoraja senta*	NW Atlantic Ocean	bathydemersal	F	41-54	8-9.5	-	-	-	10	-	<100	10-13	Collette & Klein-MacPhee 2002; Kulka et al. 2006 as cited in IUCN 2012
			M	49-57	8-10	-	-	-	-	-	-	-	
Soft Skate *Malacoraja spinacidermis*	Atlantic Ocean	bathydemersal	F	-	-	-	64	-	-	-	-	-	Hulley 1986 as cited in IUCN 2012
			M	-	-	-	64	-	-	-	-	-	

APPENDIX II CONTINUED

Common name Species	Population	Habitat	Sex	Size at maturity (TL/DW cm)*	Age at maturity (years)	Longevity (years)	Max size (cm)	Size at birth (cm)	Incubation /Gestation period (months)	Repr. cycle (years)	Average clutch /litter size	Generation time (years)	Source
Clearnose Skate *Raja eglanteria*	NW Atlantic & Gulf of Mexico	demersal	F	-	-	-	-	-	3	-	-	-	Collette & Klein-MacPhee 2002
			M	-	-	-	-	-	-	-	-	-	
Deepwater/ Abyssal Skate *Raja bathyphila*	NW & NE Atlantic Ocean	bathydemersal	F	65	-	-	93	11.5	-	-	1-40	-	Stehmann 1978 & Kulka 2006 as cited in IUCN 2012
			M	65	-	-	93	11.5	-	-	-	-	
Bigelow's Skate *Rajella bigelowi*	Atlantic Ocean	bathydemersal	F	-	-	-	45	-	-	-	-	-	Orlov & Cotton 2011
			M	-	-	-	44	-	-	-	-	-	
Round Skate *Rajella fyllae*	NW & NE Atlantic Ocean	bathydemersal	F	49-50	-	-	53	<11	-	-	-	-	Scott & Scott 1988; Kulka 2006 and Dolgov et al. 2005 as cited in IUCN 2012
			M	44-47	-	-	57	<11	-	-	-	-	
Southern Stingray *Dasyatis americana*	Atlantic Ocean	reefs	F	75-80	-	-	150	17-34	4.5-7.5	1	2-10	-	Henningsen 2000, McEachran and de Carvalho 2002, D. Grubbs and J. Musick unpublished data as cited in IUCN 2012
			M	51	-	-	150	17-34	-	-	-	-	
Roughtail Stingray *Dasyatis centroura*	Atlantic Ocean, Mediterranean, Black Sea	demersal	F	150-160	-	-	210-220	34-37	4+	-	2-6	-	Collette & Klein-MacPhee 2002 ; McEachran & de Carvalho 2002, Capape 1993 as cited in IUCN 2012
			M	140	-	-	210-220	34-37	-	-	-	-	
Bluntnose Stingray *Dasyatis say*	Atlantic Ocean	demersal	F	-	-	-	78	-	10-11	-	1-6	-	IUCN 2012
			M	-	-	-	78	-	-	-	-	-	
Pelagic Stingray *Pteroplatytrygon violacea*	Pacific, Atlantic,& Indian Oceans	Pelagic-oceanic	F	39-50	3	10	80	14-24	2-4	-	4-13	-	Mollet et al. 2002, Neer 2008, Wilson & Beckett 1970 as cited in IUCN 2012
			M	37-50	2	10	80	14-24	-	-	-	-	

*Raysare measured in DW (Disc width)

APPENDIX II CONTINUED

Common name Species	Population	Habitat	Sex	Size at maturity (TL/DW cm)*	Age at maturity (years)	Longevity (years)	Max size (cm)	Size at birth (cm)	Gestation period (months)	Repr. cycle (years)	Average litter size	Generation time (years)	Source
Spiny Butterfly Ray *Gymnura altavela*	Atlantic Ocean, Mediterranean, Black Sea	demersal	F	102	-	-	220	38-44	4-9	1	1-8	-	Musick et al. unpub. data., Daiber & Booth 1960, Capape et al. 1992 as cited in IUCN 2012
			M	155	-	-	220	38-44	-	-	-	-	
Smooth Butterfly Ray *Gymnura micrura*	Atlantic Ocean	demersal	F	-	-	-	-	-	-	-	6-8	-	Grubbs unpub. data as cited in IUCN 2012
			M	-	-	-	-	-	-	-	-	-	
Giant Manta Ray *Manta birostris*	Global	reefs	F	400	8-10	40	700-910	-	-	-	-	25	Compagno 1999, Alva et al. 2002, Marshall 2009 as cited in IUCN 2012
			M	400	-	-	700-910	-	-	-	-	-	
Spotted Eagle Ray *Aetobatus narinari*	Atlantic, Pacific, & Indian Oceans	reefs	F	-	4-6	-	330	-	12	-	1-4	-	Last & Stevens 1994, Michael 1993, Compagno & Last 1999 as cited in IUNC 2012
			M	-	4-6	-	330	-	-	-	-	-	
Bullnose Ray *Myliobatis freminvillii*	NW Atlantic Ocean	benthopelagic	F	-	-	-	106	25	-	-	1-6	-	Rafi 1975, McEachran & Carvalho 2002, Bigelow & Schroeder 1953 as cited in IUCN 2012
			M	60-70	-	-	106	25	-	-	-	-	
Cownose Ray *Rhinoptera bonasus*	Atlantic Ocean	benthopelagic	F	85-90	7-8	13	107	25-40	11-12	1-2	2-6	-	Smith & Merriner 1986,1987 as cited in IUCN 2012
			M	75-85	5-6	13	107	25-40	-	-	-	-	
Atlantic Torpedo Ray *Torpedo nobiliana*	Atlantic Ocean & Mediterranean	benthopelagic	F	-	-	-	180	20-25	12	1	1-60	-	Collette & Klein-MacPhee 2002; McEachran & Carvalho 2002, Whitehead et al. 1984 as cited in IUCN 2012
			M	-	-	-	180	-	-	-	-	-	

*Rays are measured in DW (Disc width)