FINAL

Species at Risk Act
Recovery Strategy Series

Recovery Strategy for the Basking Shark (*Cetorhinus maximus*) in Canadian Pacific Waters

Basking Shark (Pacific Population)

July 2011

Fisheries and Oceans Canada
Pêches et Océans Canada
Canada

About the *Species at Risk Act* Recovery Strategy Series

What is the *Species at Risk Act* (SARA)?

SARA is the Act developed by the federal government as a key contribution to the common national effort to protect and conserve species at risk in Canada. SARA came into force in 2003, and one of its purposes is *"to provide for the recovery of wildlife species that are extirpated, endangered or threatened as a result of human activity."*

What is recovery?

In the context of species at risk conservation, **recovery** is the process by which the decline of an endangered, threatened, or extirpated species due to human activity is arrested or reversed, and threats are removed or reduced to improve the likelihood of the species' persistence in the wild. A species will be considered **recovered** when its long-term persistence in the wild has been secured.

What is a recovery strategy?

A recovery strategy is a planning document that identifies what needs to be done to arrest or reverse the decline of a species resulting from human activity. It sets objectives and identifies the broad strategies and approaches to be undertaken. Detailed planning is done at the action plan stage.

Recovery strategy development is a commitment of all provinces and territories and of three federal agencies — Environment Canada, Parks Canada Agency, and Fisheries and Oceans Canada — under the Accord for the Protection of Species at Risk. Sections 37–46 of SARA (www.sararegistry.gc.ca/approach/act/default_e.cfm) outline both the required content and the process for developing recovery strategies published in this series.

A proposed recovery strategy must be posted on the Species at Risk Public Registry within one year after the wildlife species is added to the List of Wildlife Species at Risk for endangered species and within two years for threatened species. A period of three to four years, respectively, was permitted for those species that were automatically listed when SARA came into force.

What's next?

One or more action plans will be developed to identify specific actions to be undertaken, thereby advancing the implementation of the recovery strategy. Directions set in the recovery strategy, however, are sufficient to begin involving land managers and users, communities, and stakeholders in recovery implementation. Cost-effective measures to prevent the reduction or loss of the species should not be postponed for lack of full scientific certainty.

The series

This series presents the recovery strategies prepared or adopted by the federal government under SARA. New documents will be added regularly as species get listed and as strategies are completed and updated.

To learn more

To learn more about the *Species at Risk Act* and recovery initiatives, please consult the Species at Risk (SAR) Public Registry (www.sararegistry.gc.ca).

Final Recovery Strategy for the Basking Shark (*Cetorhinus maximus*) in Canadian Pacific waters

July 2011

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Additional copies can be downloaded from the SAR Public Registry (www.sararegistry.gc.ca).

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PREFACE

The Basking Shark is a marine fish and is under the responsibility of the federal government. The *Species at Risk Act* (SARA, Section 37) requires the competent minister to prepare recovery strategies for listed Extirpated, Endangered and Threatened species. The Pacific population of Basking Shark was listed as Endangered under SARA in February 2010[1]. The development of this recovery strategy was led by Fisheries and Oceans Canada – Pacific Region with the Parks Canada Agency, which is competent with respect to individuals of the species occurring in or on federal waters administered by the Agency, in cooperation and consultation with many individuals, organizations and government agencies, as indicated below. The strategy meets SARA requirements in terms of content and process (Sections 39-41).

Success in the recovery of this species depends on the commitment and cooperation of many different constituencies that will be involved in implementing the directions set out in this strategy and will not be achieved by Fisheries and Oceans Canada and the Parks Canada Agency, or any other party alone. This strategy provides advice to jurisdictions and organizations that may be involved or wish to become involved in the recovery of the species. In the spirit of the National Accord for the Protection of Species at Risk, the Minister of Fisheries and Oceans and the Minister of the Environment responsible for Parks Canada Agency invites all responsible jurisdictions and Canadians to join Fisheries and Oceans Canada and the Parks Canada Agency in supporting and implementing this strategy for the benefit of the Basking Shark and Canadian society as a whole. Fisheries and Oceans Canada and the Parks Canada Agency will support implementation of this strategy to the extent possible, given available resources and their overall responsibility for species at risk conservation.

The goals, objectives and recovery approaches identified in the strategy are based on the best existing knowledge and are subject to modifications resulting from new information. The Minister of Fisheries and Oceans and the Minister of Environment responsible for Parks Canada Agency will report on progress within five years.

This strategy will be complemented by one or more action plans that will provide details on specific recovery measures to be taken to support survival and recovery of the species. The Minister of Fisheries and Oceans and the Minister of Environment responsible for Parks Canada Agency will take steps to ensure that, to the extent possible, Canadians interested in or affected by these measures will be consulted.

RESPONSIBLE JURISDICTIONS

The Minister of Fisheries and Oceans and the Minister of Environment, responsible for the Parks Canada Agency, are the competent ministers for the Pacific population of Basking Shark. The Basking Shark migrates throughout the coast of the Province of British Columbia and within waters administered by the Parks Canada Agency.

[1] The Basking Shark occurs circumglobally in temperate coastal shelf waters, and exists in Canada as two geographically isolated designatable units – Atlantic and Pacific. This recovery strategy was developed specifically for the Pacific population of Basking Shark (COSEWIC 2007).

AUTHORS / CONTRIBUTORS

The 2009-2010 Basking Shark Technical Team developed this recovery strategy for Fisheries and Oceans Canada. Section 12 lists technical team members.

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STRATEGIC ENVIRONMENTAL ASSESSMENT STATEMENT

A strategic environmental assessment (SEA) is conducted on all SARA recovery planning documents, in accordance with the *Cabinet Directive on the Environmental Assessment of Policy, Plan and Program Proposals*. The purpose of a SEA is to incorporate environmental considerations into the development of public policies, plans, and program proposals to support environmentally sound decision-making.

Recovery planning is intended to benefit species at risk and biodiversity in general. However, it is recognized that strategies may also inadvertently lead to environmental effects beyond the intended benefits. The planning process based on national guidelines directly incorporates consideration of all environmental effects, with a particular focus on possible impacts upon non-target species or habitats. The results of the SEA are incorporated directly into the strategy itself, but are also summarized below.

This recovery strategy will clearly benefit the environment by promoting the recovery of the Pacific population of Basking Shark. The potential for the strategy to inadvertently lead to adverse effects on other species was considered. The SEA concluded that this strategy will clearly benefit the environment and will not entail any significant adverse effects. The reader should refer to "Effects on the Environment and other Species and Broad Strategies and Approaches to Recovery" (Appendix A) for specific reference.

RESIDENCE

SARA defines residence as: *a dwelling-place, such as a den, nest or other similar area or place, that is occupied or habitually occupied by one or more individuals during all or part of their life cycles, including breeding, rearing, staging, wintering, feeding or hibernating* **[Subsection 2(1)]**.

Residence descriptions, or the rationale for why the residence concept does not apply to a given species, are posted on the SAR Public Registry: www.sararegistry.gc.ca/sar/recovery/residence_e.cfm.

EXECUTIVE SUMMARY

The Pacific population of Basking Shark (*Cetorhinus maximus*) was assessed as 'endangered' in 2007 by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC). In February 2010 the population was listed as 'endangered' under Canada's *Species at Risk Act* (SARA), affording it legal protection.

The Basking Shark is the world's second largest fish, reaching a maximum recorded length of 12.2 metres. They are filter-feeders, feeding primarily on zooplankton. Basking Sharks are found circumglobally in temperate coastal shelf waters. In Canadian Pacific waters, they are considered to be part of a North American population which migrates into British Columbia waters in spring and summer and winters off California (McFarlane *et al.* 2009). Current abundance in Canadian Pacific waters is unknown, but it is estimated that some proportion up to the full range-wide population (321-535 individuals) utilizes Canadian Pacific waters on a seasonal, annual, and decadal scale (McFarlane *et al.* 2009). Historically, large aggregations of Basking Sharks were seasonally common and widely distributed in Canadian Pacific waters (COSEWIC 2007). At present, Basking Sharks appear infrequently in Canadian Pacific waters with only 13 confirmed sightings since 1996.

The key factors limiting the recovery and survival of Basking Sharks are their long-life (~50 years), slow growth and maturation, and low fecundity which lead to overall low productivity. Even in the absence of human-induced mortality, Basking Shark populations grow very slowly. The Pacific population of Basking Shark is threatened by various anthropogenic sources. Four classes of current threats have been identified in this Recovery Strategy, which are entanglement, collision with vessels, harassment from marine based activities, and prey availability. The decline of the Pacific population of Basking Shark is primarily due to human-caused mortality which occurred between 40 and 70 years ago. Broad strategies and approaches to address the limitations and threats are presented in this recovery strategy.

The following population and distribution objectives will guide recovery efforts for Basking Sharks within Canadian Pacific waters:

1. Maintain the current abundance of Basking Sharks.
2. Attain positive population growth of Basking Sharks within 15-20 years.
3. Attain increase in Basking Shark aggregations (two or more sharks).
4. Maintain distribution of Basking Sharks.

Adequate information does not exist to identify critical habitat at this time. Habitat requirements have not been investigated for Basking Sharks in Canadian Pacific waters, and no specific locations have been identified for reproduction, pupping or rearing. Thus, a schedule of studies has been included in this document, which outlines the research required to gather information that will contribute to the future identification of critical habitat. It is important to note that it may take decades to address the issue of identifying critical habitat, given the long lived nature of the species, a lack of documented recent sightings in Canada, and the associated long-term scope of this recovery strategy. An action plan will be completed within five years of final posting of the Recovery Strategy.

RECOVERY FEASIBILITY SUMMARY

Basking Sharks are particularly vulnerable to any human-induced mortality because of their late age of maturity, low fecundity, long gestation period, long periods between gestations, low productivity, sex segregated populations, use of habitat that supports commercial fisheries, lack of fear of vessels, and current small population size (COSEWIC 2007). It is difficult to accurately assess the feasibility of recovery for the Pacific population of Basking Shark due to the lack of understanding of the factors affecting the survival and productivity of the species. The recovery feasibility is also linked to recovery efforts undertaken in the southern portion of their range (i.e., within the U.S. and Mexico). Nevertheless, based on the best current available information, recovery of the Pacific population of Basking Shark is determined to be feasible.

1. Are individuals capable of reproduction currently available now or in the foreseeable future to sustain the population or improve its abundance?

Answer: Unknown

It is unknown whether individuals capable of reproduction are currently available to improve the population growth rate or population abundance in Canadian waters. Population trajectory models were used by McFarlane *et al.* (2009) to determine the recovery potential of the Pacific population of Basking Shark. If a breeding population exists in Canadian Pacific waters, and no further human-induced mortality and changes to existing habitat occurs, it was estimated that it will take approximately 200 years for the population numbers of Basking Sharks to return to their unexploited state if human induced mortality is zero (McFarlane *et al.* 2009).

2. Is sufficient suitable habitat available to support the species or could it be made available through habitat management or restoration?

Answer: Yes

The current distribution, migration, reproduction, pupping and rearing grounds of the Basking Shark in Canadian Pacific waters is unknown. Some habitat characteristics that attract particular life stages such as high seasonal food availability are known, but these features vary over temporal and spatial scales. For example, Basking Sharks tend to aggregate in the transition zones of coastal shelves where there is enhanced zooplankton abundance (Sims *et al.* 2006). Further, zooplankton abundance (the preferred prey) and community structure have been observed to vary on decadal-scales, as seen in the prolonged period of relative low copepod abundance in some areas of the northeast Pacific from 1989-1997 (King, 2005). There are historical areas that were regularly visited by large numbers of Basking Sharks (e.g., Barkley Sound, Clayoquot Sound, and Rivers Inlet); however, a recovered stock may not return to these areas. Habitat availability for this species is not likely to have changed. Basking Sharks are often associated with both historic and current distribution of the humpback whale (*Megaptera novaeagliae)* (Wallace and Gisborne 2006; Newton pers. comm. 2007). As humpback whale distribution has not changed and abundance has recently increased, it seems reasonable to conclude that suitable habitat is available for Basking Sharks in Canadian Pacific waters

(McFarlane *et al.* 2009).

3. Can the primary threats to the species or its habitat be avoided or mitigated through recovery actions?

Answer: Yes

Threats that could potentially affect Basking Sharks in Canadian Pacific waters have been identified (see section 4 'Threats'). Current threats, listed in order of significance, include entanglement, collision with vessels, harassment and prey availability. The first step in mitigating significant threats is the improvement of knowledge of Basking Shark ecology and biology. Threats could then be managed to minimize impacts. As trends in prey availability (identified as a threat with 'low' level of concern) in the context of Basking Shark recovery have not been thoroughly studied, it is unknown whether or not this threat could be mitigated. Actions in Canada to mitigate known threats include modification of fishing and aquaculture practices and development of a Code of Conduct for public viewing and other public awareness tools (for a full list, see section 6.1 'recovery planning table'). Parallel to these actions, Canadian collaboration with U.S. and Mexico governments will promote recovery throughout the species' range.

4. Do the necessary recovery techniques exist to achieve the population and distribution objectives, or could be developed within a reasonable timeframe?

Answer: Yes

Despite no directed fishery or eradication program for over forty years, it is estimated that the decline from pre-exploitation numbers of Basking Sharks in Canadian Pacific waters still exceeds 90%. This may be in part due to current mortalities from entanglements and incidental catch and/or in part due to the lack of knowledge of the population and distribution of this species (McFarlane et al 2009). As noted above, Basking Sharks are particularly vulnerable to any human-induced mortality because of their late age of maturity, low fecundity, long gestation period, long periods between gestations, low productivity, sex segregated populations, use of habitat that supports commercial fisheries, lack of fear of vessels, and current small population size. The necessary recovery techniques do exist and are assumed to be effective. For example, modification of fishing and aquaculture practices, and Canadian collaboration with U.S. and Mexican governments; however, it is estimated that some 200 years are required before population numbers will return to their unexploited state, assuming human-induced mortality is reduced to zero (McFarlane *et al.* 2009).

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1. COSEWIC SPECIES ASSESSEMENT INFORMATION

Date of Assessment: April 2007

Common Name (population): Basking Shark – Pacific population

Scientific Name: *Cetorhinus maximus*

COSEWIC Status: Endangered

Reason for Designation:
This shark species is the only extant species in the family Cetorhinidae. It occurs circumglobally in temperate coastal shelf waters, and exists in Canada as two geographically isolated designatable units – Atlantic and Pacific. The species is vulnerable to incidental fishing mortality because of its low intrinsic productivity. Females do not mature until 16 to 20 years old, gestate between 2.6 and 3.5 years (the longest known gestation period for any vertebrate), and produce litters of only about 6 "pups". These sharks are especially susceptible to entanglement in fishing gear and collision with boats because of their large size, surface behaviour and fearlessness around boats, and because their coastal distribution overlaps fishing and boating areas. Prior to 1970, large aggregations of these sharks were seasonally common in Pacific Canada, but only 6 sightings have been confirmed since 1996. This dramatic reduction in abundance is attributed to directed fisheries for liver oil (1941-1947) and an eradication program (until 1970) that killed hundreds, perhaps thousands of individuals between 1945 and 1970. The minimum historical population reconstructed from documented kills was at least 750 individuals, whereas the current population is virtually nil, implying a rate of decline exceeding 90% within < 2 generations. The species is believed to migrate seasonally between Canada and California, where regional aggregations were also severely depleted by historic fisheries. Rescue from outside Canada is unlikely.

Canadian Occurrence: Pacific Ocean

COSEWIC Status History:
Designated Endangered in April 2007. Assessment based on a new status report.

2. SPECIES STATUS INFORMATION

Globally, Basking Sharks fall under a variety of status designations. The IUCN Red List assessment has categorized Basking Sharks as Vulnerable globally and Endangered in the north Pacific (Fowler 2005). Basking Shark is listed under Appendix II of CITES (CITES 2009). Basking Sharks are also listed under Appendix I and II of the Convention on the Conservation of Migratory Species (CMS) in 2005 (CMS 2010a). In February 2010, CMS delegates agreed on the content of a Memorandum of Understanding on the conservation of migratory sharks (CMS 2010b). In 2010, the U.S. National Marine Fisheries Service under the National Oceanographic and Atmospheric Administration (NOAA) identified the Pacific population of Basking Shark as a "species of concern" (NOAA, 2010).

The range of the Pacific population of Basking Shark occupies the continental shelf from central British Columbia to southern California (DFO 2009). Approximately 30% of its observed latitudinal range is in Canadian waters. Recent satellite tracking information from the North Atlantic suggests that Basking Sharks may migrate much larger distances and utilize deeper habitats than previously thought (Gore *et al*. 2008; Skomal *et al*. 2009). It is likely that the range of the Pacific population of Basking Shark is different than presently described.

3. DESCRIPTION OF THE SPECIES AND ITS NEEDS

3.1 Species Description

The Basking Shark is the world's second largest fish growing up to 12.2 m. Current understanding of the life history of these sharks suggests they are long lived (~50 years), slow growing, and slow to mature, with a probable low fecundity, and overall low productivity (McFarlane *et al*. 2009). They are thought to feed primarily on zooplankton in the water column by filtering their prey using a specialized adaptation called gill rakers. There is some information to suggest that other prey sources may also be utilized (COSEWIC 2007). The Pacific population of Basking Shark is thought to belong to a single seasonally migrating population. This is based on historical sightings that found that the disappearance of Basking Sharks from California waters in the spring and early summer (Squire 1967, 1990) coincided with the appearance of Basking Sharks in British Columbia waters (Darling and Keogh 1994). Recent satellite tagging information from the north Atlantic has found that Basking Sharks are capable of very large migrations across ocean basins and hemispheres and spend significant periods well below the surface (Gore *et al*., 2008; Skomal *et al*. 2009). Basking Sharks have very low genetic diversity and such little differentiation between ocean basins that it is not possible to designate distinct populations based on genetic differences (Hoelzel *et al*. 2006). To date, no genetic analyses have been completed for the North Pacific population of Basking Shark.

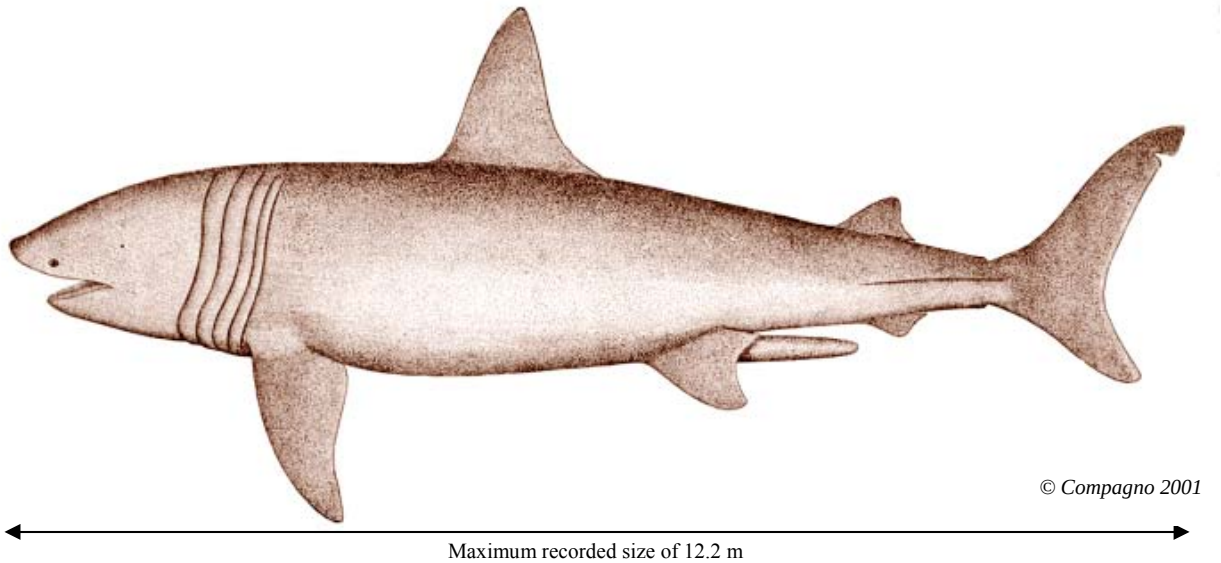

Figure 1. Illustration of the Basking Shark

3.2 Needs of the Basking Shark

Given their large size and their planktivorous feeding strategy, Basking Sharks require oceanographic conditions that concentrate prey. The necessary conditions may change over relatively small spatial and temporal scales (Sims and Quayle 1998). For example, a local area that is suitable feeding habitat one day may not be on the next. Based on experience elsewhere, specific geological structures (i.e., headlands, banks) that concentrate prey are used regularly by Basking Sharks (Sims and Quayle 1998; McFarlane *et al*. 2009; Gore *et al*. 2010). In the northeast Atlantic it was calculated that Basking Sharks require a minimum prey density of between 0.55 and 0.74 $g \cdot m^{-3}$ for net energy gain (Sims 1999).

In Canada's Pacific waters, no specific areas have been identified for reproduction, pupping, or rearing (COSEWIC 2007). Historically there are some areas that were frequented by Basking Sharks on a regular basis (Barkley Sound, Clayoquot Sound, and Rivers Inlet). Some habitat characteristics that attract particular life stages such as high seasonal food availability are known, but these features vary over temporal and spatial scales. For example, Basking Sharks tend to aggregate in the transition zones of coastal shelves where there is enhanced zooplankton abundance (Sims *et al.* 2006). Further, zooplankton abundance (the preferred prey) and community structure have been observed to vary on decadal-scales, as seen in the prolonged period of relative low copepod abundance in some areas of the northeast Pacific from 1989-1997 (King, 2005). Globally, Basking Sharks have been observed in surface waters ranging from 8-24° C with a preference for waters between 9 and 16ºC (Sims et al. 2003).

The key factors limiting Basking Shark recovery and survival are their slow growth and maturation and low fecundity which lead to overall low productivity. Even in the absence of human mortality, Basking Shark populations grow very slowly. Global experience has shown that when Basking Shark populations are exposed to even low levels of human caused mortality, their populations decline (Gore *et al*. 2010). Basking Sharks often utilize surface waters making them particularly susceptible to human caused mortality. There is evidence from other regions that females are more often than males to be on the surface which further adds risk to the populations (COSEWIC 2007). While on the surface Basking Sharks can become entangled in fishing gears, be directly harvested, disturbed, harmed, or can collide with vessels. The Pacific population of Basking Shark is endangered primarily due to human caused mortality that occurred between 40 and 70 years ago. While on the surface, Basking Sharks are primarily engaged in feeding (COSEWIC 2007), however putative mating behaviour has also been recorded (Harvey Clark 1999; Gore *et al*. 2010).

4. THREATS

The Pacific population of Basking Shark is threatened by various anthropogenic sources. Four classes of current threats have been identified in this Recovery Strategy, which are entanglement, collision with vessels, harassment from marine based activities, and prey availability. Historic threats included entanglement, eradication efforts, and directed fisheries. The influence of some or all of these current threats may affect normal behaviour, habitat use, or result in direct mortality. Both past and present threats identified in Canadian waters are also relevant in the U.S. and Mexico component of their range. Basking Sharks elsewhere in the North Pacific, including the coastal regions of Asia, have also experienced decline thought to be primarily due to direct exploitation. Basking Sharks were also vulnerable to entanglement in the North Pacific high seas drift net fisheries; while the squid fishery was banned in 1992, Basking Sharks may continue to be susceptible to other high seas drift fishing (McFarlane *et al*. 2009). It is unknown how much the northeast Pacific population is linked to the mid and northwest Pacific populations. As this population is migratory throughout Canada, U.S. and Mexican Pacific waters, the need for international collaboration is apparent.

4.1 Threat classification

Table 1. Threat Classification Table

The following threats have been identified and ranked in terms of significance, with the greatest threat to the survival of the species appearing at the top of the table. Current and historic threats have been identified under separate headings. It is to be noted that only current threats were ranked. Historical threats are identified due to the impact on the population, but have not been included in the ranking system as they currently have no level of concern to the present population. Threats have been identified based on best available data, such as the COSEWIC Status Report (COSEWIC 2007), the Recovery Potential Assessment (McFarlane *et al.* 2009), as well as new or updated information. A detailed description of each threat is provided following the table. Appendix C provides further explanation of threat attributes.

CURRENT THREATS				
1	**Entanglement**	**Threat Attributes**		
Threat Category	Accidental mortality	**Extent**	Widespread	
			Local	***Range-wide***
General Threat	Fishing activity/aquaculture	**Occurrence**		Current
		Frequency		Recurrent
Specific Threat	Entanglement, bycatch, change in behaviour	**Severity**		High
		Causal Certainty		High
Stress	Reduced population size/viability, local extinctions, small population	**Level of Concern**	High	

2 Collision with vessels		Threat Attributes		
Threat Category	Accidental mortality	**Extent**	Widespread	
			Local	***Range-wide***
General Threat	Marine transportation	**Occurrence**		Current
		Frequency		Recurrent
Specific Threat	Collision with vessels, behavioural or life cycle disruption, damage or injury to individuals	**Severity**		Unknown
		Causal Certainty		Low
Stress	Reduced population size/viability, reduced fitness, injury, mortality	**Level of Concern**	Medium	

3 Harassment		Threat Attributes		
Threat Category	Disturbance or harm	**Extent**	Widespread	
			Local	***Range-wide***
General Threat	Marine based activities	**Occurrence**		Current
		Frequency		Recurrent
Specific Threat	Behavioural or life cycle disruption, damage or injury to individuals	**Severity**		Unknown
		Causal Certainty		Low
Stress	Behavioural changes, reduced productivity, increased natural mortality	**Level of Concern**	Low	

4 Prey availability		Threat Attributes		
Threat Category	Climate and natural disasters	**Extent**	Widespread	
			Local	***Range-wide***
General Threat	Climate and oceanographic change	**Occurrence**		Unknown
		Frequency		Unknown
Specific Threat	Reduced foraging habitat and prey availability	**Severity**		Unknown
		Causal Certainty		Medium
Stress	Reduced productivity, increased natural mortality	**Level of Concern**	Low	

HISTORICAL THREATS

- Entanglement (historical)		Threat Attributes		
Threat Category	Accidental mortality	**Extent**	Widespread	
			Local	***Range-wide***
General Threat	Fishing	**Occurrence**		Historic
		Frequency		Continuous

Specific Threat	Entanglement	**Severity**		High
		Causal Certainty		High
Stress	Reduced population size/viability, local depletion, small population	**Level of Concern**	N/A	

-	**Eradication efforts**	**Threat Attributes**		
Threat Category	Disturbance or harm	**Extent**	Localized	
			Local	***Range-wide***
General Threat	Discriminate killing	**Occurrence**	Historic	
		Frequency	One-time	
Specific Threat	Eradication program	**Severity**	High	
		Causal Certainty	High	
Stress	Reduced population size/viability, local extinctions, small population	**Level of Concern**	N/A	

-	**Directed fishing**	**Threat Attributes**		
Threat Category	Biological resource use	**Extent**	Widespread	
			Local	***Range-wide***
General Threat	Commercial fishery, recreational fishery	**Occurrence**		Historic
		Frequency		Continuous
Specific Threat	Harvesting	**Severity**		High
		Causal Certainty		High
Stress	Reduced population size/viability, local extinctions, small population	**Level of Concern**	N/A	

4.2 Description of threats

Current Threats

Entanglement

Known present day human-induced mortality of the Pacific population of Basking Shark is primarily from continued interactions with fishing gear. Historically, known areas of high occurrence coincided with productive fishing areas which likely holds true today. The overlapping use of productive areas increases the probability for interaction with fishing gear and vessels. Globally, Basking Sharks have been found entangled in gillnets, trawls (bottom, midwater, and shrimp), longlines, trap lines, and seines (Wallace and Gisborne 2006). Basking

Sharks are also likely susceptible to entanglement with fish farming equipment such as nets and lines (COSEWIC 2007). Since 1996 the only recorded mortalities of Basking Sharks in Canadian Pacific waters are from four records observed on groundfish trawl vessels (COSEWIC 2007). These four incidental capture records represent a high proportion of the 13 confirmed[2] sightings in Canadian Pacific waters within this time period. In known areas of historical high occurrence (see Figure 2), entanglement threats are from trap lines, gillnets, trawls, and aquaculture operations. Range-wide there are recent accounts of Basking Sharks caught in gillnets in Baja Mexico (Sandoval-Castillo *et al*., 2005) and California. The Recovery Potential Assessment for this population suggested an annual range-wide mortality rate of 10-17 individuals may be acceptable (McFarlane et al. 2009). Documented mortality in Canadian waters is less than one per year; mortality elsewhere in their range is unknown. Furthermore, Basking Sharks have been observed in close aggregations and are therefore susceptible to a multiple shark entanglement event. Because of their low and uncertain population size, historical susceptibility to entanglement, high mortality rates when entangled, and uncertainty around actual entanglement rates elsewhere in their range, this threat is considered a 'high' level of concern.

Collision with vessels

Basking Sharks often feed by slowly moving along the surface, and therefore altercations between boats (hulls and propellers) and Basking Sharks are probable. Vessel strikes, as reported through photo identification projects, are not uncommon in areas where Basking Sharks are found in greater numbers, such as the Northeast Atlantic (Gore *et al*. 2010). Basking Sharks have an apparent attraction to boat propellers; possibly to the sound they generate (Darling and Keogh 1994). Several Basking Sharks in Clayoquot Sound in the early 1990s had scarring indicative of interactions with boat propellers (Darling and Keogh 1994). There are no recent reported vessel strikes in Canadian Pacific waters or elsewhere in their range. The extent and population consequence of vessel collisions is unknown. This threat is considered to be a 'medium' level of concern.

Harassment

Historically harassment of Basking Sharks was commonplace along the BC coast (e.g., shooting, ramming with small boats) (Wallace and Gisborne 2006). While the extent of this threat is currently unknown along the BC Coast, it is anticipated that if Basking Sharks increase in abundance, harassment in the form of vessel based disturbance by ecotourism operators or individuals may impact normal surface feeding behaviour as has been observed in the northeast Atlantic (Gore *et al*. 2010). The impacts of underwater noise through seismic, explosives, or otherwise on sharks in general has not been well documented. Overall, harassment is considered to be a 'low' level of concern.

Prey availability

Evidence from throughout their global range indicates that Basking Sharks prey primarily on calanoid copepods while feeding in surface waters (Sims 2008); however, diet preference and

[2] Within the context of this recovery strategy, 'confirmed' is based on photo/video identification, or from an experienced source (e.g., on-board observers).

composition for the Pacific population of Basking Shark is unknown. Prey sources in deep waters are poorly understood but may include larger zooplankton. A single stomach sample of a Basking Shark caught in subsurface water (~100 m) off the east coast of Japan was found to contain only the pelagic shrimp, *Sergestes similis*, suggesting that larger prey (e.g., euphausiids) may be an important part of their diet (Sims 2008). The ability of Basking Sharks to switch to alternate prey during periods of low copepod abundance is also not known. Basking Sharks are highly adapted to prey on small (~2mm) zooplankton and have a demonstrated preference for a narrow range of prey in surface waters. At small spatial and temporal scales, Basking Shark distribution and occurrence appears strongly linked to zooplankton abundance (Sims 2008). As well, in the northeast Atlantic, long term trends in surface sightings are correlated with sea surface temperature that may also influence zooplankton abundance and distribution (Sims 2008). A long term downward shift in prey availability from either natural or human causes will certainly influence the behaviour of the Basking Shark and could threaten the population as a whole, considering their low abundance. Trends in prey availability in the context of Basking Shark recovery have not been thoroughly studied. This threat is considered to be a 'low' level of concern.

Historical Threats

Entanglement

Beginning as early as 1901 there are records of Basking Sharks being caught in salmon gillnets in Canadian Pacific waters. The productive salmon fishing areas of Barkley Sound and Rivers Inlet are known areas with several reported interactions (Wallace and Gisborne 2006). It is estimated that between 400 and 1500 Basking Sharks may have been killed by entanglement between 1942 and 1969 (COSEWIC 2007). Entanglement has also been reported in the U.S. component of its range during the 1880s and the 1920s (Thomas 2004). This threat resulted in a reduction in the population and contributed to local depletion.

Eradication efforts

Between 1943 and 1954, Basking Sharks were increasingly being reported ensnarled in salmon gillnets within Canadian Pacific waters (Wallace and Gisborne 2006). To assist fishers, a directed eradication effort was established which operated from 1955-1969. Basking Sharks were killed by the use of a large blade mounted on the bow of a fisheries patrol vessel. Government records reported 413 kills using this method (Wallace and Gisborne 2006). In addition to the blade method, patrol vessels were also under directive to opportunistically ram Basking Sharks (COSEWIC 2007). There was also a small eradication effort in 1943 in Rivers Inlet where six sharks were reported to have been killed (Wallace and Gisborne 2006).

Directed fishing

The historic record suggests that most of the commercial Basking Shark fishery in Canadian Pacific waters occurred between 1941 and 1947 in Barkley Sound with some additional fisheries possibly in the 1920s (Wallace and Gisborne 2006). This fishery was targeting the Basking Shark primarily to extract oil from its massive liver. There is insufficient information to

accurately estimate the number of sharks commercially killed for their oil. In addition to commercial fishing, recreational harpooning of Basking Sharks was widespread between 1940 and the mid-1960s (COSEWIC 2007). In Monterrey Bay, Basking Sharks were the focus of a commercial fishery beginning in the mid 1920s and continued until 1952 (Thomas 2004). During this period, U.S. landings ranged between 25 and 200 sharks per year (McFarlane *et al*. 2009). A recreational harpoon fishery also occurred at this time.

5. POPULATION AND DISTRIBUTION

5.1 Population and Distribution Context

Global Population and Distribution

Basking Sharks are found circumglobally in temperate coastal shelf waters but are characterized by localized occurrences (Froese and Pauly 2010). The IUCN Red List assessment has categorized Basking Sharks as Vulnerable globally and Endangered in the north Pacific (Fowler 2005). In the North Pacific, they are observed in China, Japan, Alaska, and British Columbia down through the United States and Mexico (Compagno 2001). Basking Sharks in Canadian Pacific waters are considered to be part of a North American population which migrates into British Columbia waters in spring and summer and winters off California. The northeast Pacific population of Basking Shark occurs primarily in waters under the jurisdiction of Canada and the United States. There are reported catches in international waters and at least two recent catches within Mexican waters. Information on basking sharks in Mexican waters is poorly understood but sharks in these waters are likely part of the same population being addressed in this Recovery Strategy. Basking Sharks in U.S. Pacific waters have undergone a decline of at least the same magnitude as that seen off the coast of British Columbia. Since 1994, Basking Shark sightings have been extremely rare along the Pacific coast for both the Canadian and U.S. waters. Further, since 1993, Basking Sharks have not been observed in groups of more than two or three individuals within Pacific Canadian and U.S. waters. The best estimate of current abundance of Basking Sharks within this range (Canadian and U.S. Pacific waters) is between 321 to 535 individuals (McFarlane *et al*. 2009). This study estimated the range-wide pre-exploited population (e.g., prior to 1920) to be between 2,790 and 5,116 individuals. It is estimated that the decline from pre-exploited numbers exceeds 90%[3]. Over the time period of three generations (66-99 years), Basking Sharks have all but disappeared from all areas where they were historically abundant.

Canadian Pacific Waters Population and Distribution

The early historic and scientific record for Basking Sharks is limited but consistently describes the Pacific population of Basking Shark as abundant and widely spread, with a minimum historic population of 750 individuals off the coast of British Columbia (COSEWIC 2007, McFarlane *et*

[3] Based on current estimate of 321-535 individuals for the Pacific population of Basking Shark within Canada and the U.S., measured against the catch history ranges from 3,725-5,925 individuals killed between 1920 and 1979 (McFarlane *et al.* 2009).

al. 2009)[4]. At present, Basking Sharks appear infrequently in Canadian Pacific waters with only 13 confirmed sightings since 1996. These sightings are detailed in Table 2 below, and are mapped in Figure 2 on page 11. Current abundance in Canadian Pacific waters is unknown, but all evidence indicates it is much reduced. It is estimated that some proportion up to the full range-wide population (321-535 individuals) utilizes Canadian Pacific waters on a seasonal, annual, and decadal scale (McFarlane *et al*. 2009). Further monitoring and research will assist in closing this knowledge gap. A combination of historic entanglement, eradication, and directed harvest is responsible for the decline in abundance (COSEWIC 2007).

Prior to 1970 large aggregations of Basking Sharks were seasonally common and widely distributed in Canadian Pacific waters (Wallace and Gisborne 2006; COSEWIC 2007). Historical records dating back to the early 1900's have been used to identify three areas with large aggregations of Basking Sharks within the waters off of British Columbia: (1) Rivers Inlet / Queen Charlotte Sound; (2) Clayoquot Sound; and (3) Barkley Sound (see Figure 2) (Wallace and Gisborne 2006). Unconfirmed or smaller groups have been observed historically in numerous other locations in the Strait of Georgia and of the southern banks of Vancouver Island.

It is important to note that sightings of Basking Sharks are only those that are visible at the surface. The percentage of the species' time spent at the surface is varied and unknown. Surface activity is likely influenced by prey distribution, weather conditions, and reproductive behaviours. Abundance estimates based on daytime surface sightings may under or over-estimate shark abundance by at least 10-fold (Sims *et al.* 2005). Decline in abundance of Basking Sharks may also be obscured by historical unpredictability in the occurrence and numbers visiting the coastal areas in which they are seen. Further, effects of climate driven changes such as sea surface temperature may also be a factor (Cotton *et al.* 2005).

Table 2. Recent confirmed sightings of Basking Sharks in Canadian Pacific waters (1996-July 2010).

Year	Location	No. sharks observed
May 1996	Queen Charlotte Sound	1
1999	SW Vancouver Island (Pacific Rim NPR, near mouth of Nitinat)	1
Feb 2000	Queen Charlotte Sound	1
Mar 2000	Queen Charlotte Sound	1
Jul 2002	30 miles SW of Rose Spit (Haida Gwaii)	1
Aug 2004	Rennell Sound, west coast Haida Gwaii	1
May 2008	Between East Pt. and Pt. Roberts	1
Sept 2008	2 mi NW McGinnis Lighthouse (30 mi NW of Bella Bella near Millbanke)	1
Sept 2008	Cape Beale (Pacific Rim NPR, SW of Bamfield)	1
July 2009	Strait of San Juan de Fuca 1 nautical mile S/SW of Salmon Banks, San Juan Island	2
Aug 2009	Mouth of San Juan River, Port Renfrew	1
May 2010	Starling Point near entrance to Sydney Inlet, Clayoquot Sound	1
	Total number of Basking Sharks Observed, 1996-2010	**13**

[4] Reconstructed from the estimated annual removals from 1945-1970 (40 individuals, i.e., 1000/25 years) coupled with the estimate of annual productivity (r=0.023) (COSEWIC 2007; Smith *et al.* 1998). In other words, at a mortality rate of 40 animals per year, it would take 25 years for an initial population of 750 to be diminished to zero assuming r = 0.023. Note that there is no reliable information or trends in abundance to corroborate this inference (McFarlane *et al.* 2009).

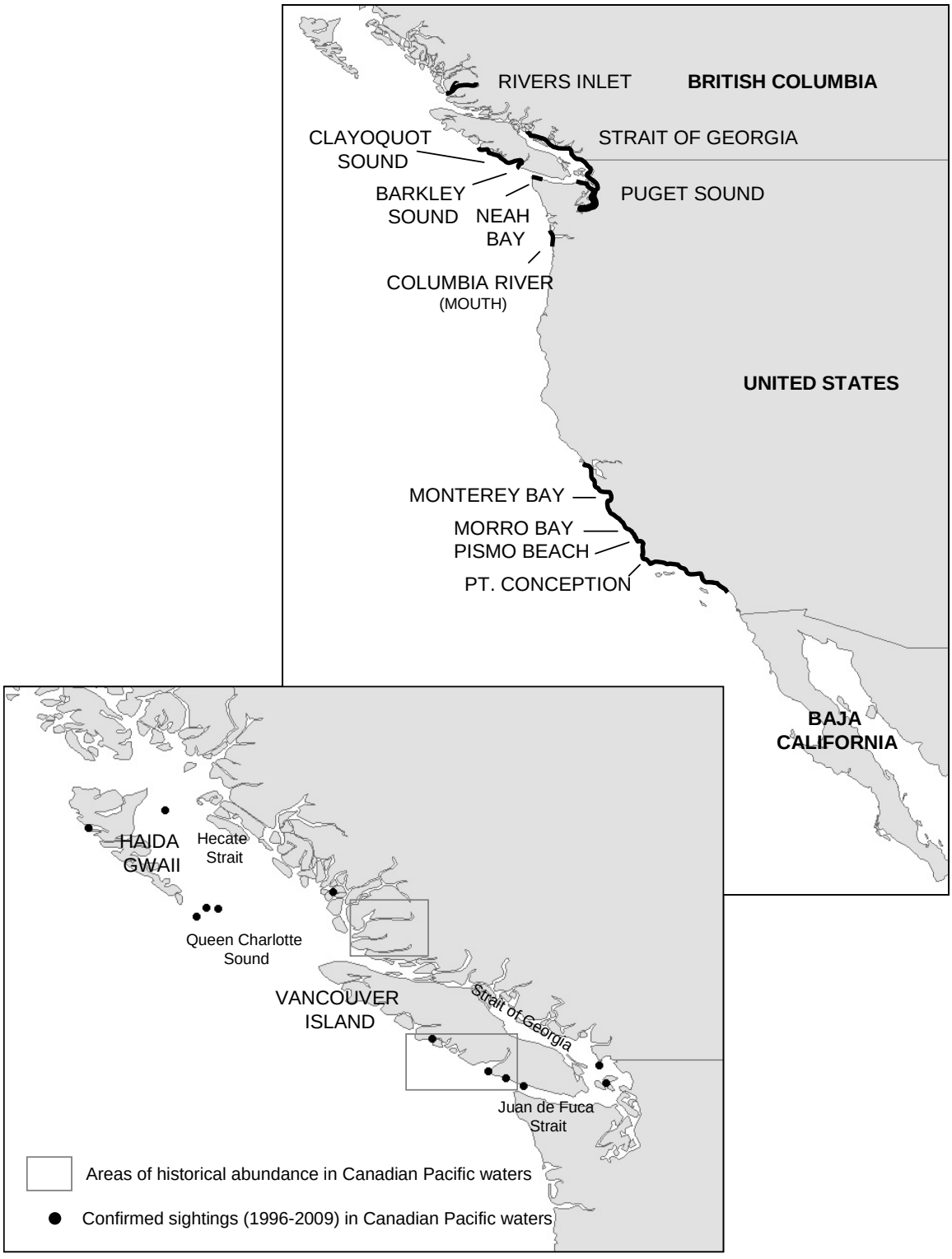

Figure 2: Areas of known historical abundance of Basking Sharks, from the 1900s onwards. Inset shows recent confirmed sightings[5].

[5] Thirteen confirmed sightings as reported to the Basking Shark Sightings Network, from 1996 through July 2010.

5.2 Population and Distribution Objectives

A recovery goal is to see positive growth in the Pacific population of Basking Shark, perhaps reaching the number of observations (average annual kills) recorded for the 1945-1970 period, i.e., 40 per year. A long term recovery goal is to promote the long-term viability of a naturally-producing population. The Basking Shark is a long lived species with a low rate of increase (i.e., generation time of 22-33 years). Using best estimates of current abundance and stock decline, it is assumed that if a breeding population currently exists in the northeast Pacific Ocean, and no further human-induced mortality and changes to existing habitat occurs, that approximately 200 years are needed before population numbers will return to their unexploited rates (McFarlane *et al.* 2009).

The following population and distribution objectives will guide recovery efforts for Basking Sharks within Canadian Pacific waters:

1. Maintain the current abundance of Basking Sharks.
2. Attain positive population growth of Basking Sharks within 15-20 years.
3. Attain increase in Basking Shark aggregations (two or more sharks).
4. Maintain distribution of Basking Sharks.

Recovery potential for the Pacific population of Basking Shark was assessed in 2008 (see McFarlane *et al.* 2009). Three sets of recovery objectives were presented, which include a) rebuild to 1000 breeding pairs, b) attain 30, 40, 50, and 99% of carrying capacity (assumed equal to pre-exploitation numbers), and c) attain 30, 40, 50 and 99% of initial biomass (assumed to be biomass prior to exploitation). Canada's efforts, including the activities outlined in this recovery strategy to meet the above objectives, will contribute towards the survival and recovery of Basking Sharks range-wide; however, coordination of research and management activities with the U.S. and Mexican governments is required to meet these range-wide recovery objectives.

6. BROAD STRATEGIES AND APPROACHES TO RECOVERY

6.1 Actions Already Completed or Currently Underway

Comprehensive survey data does not exist for this population; however, since 2008 there have been intermittent aerial surveys focusing on Basking Sharks within Canadian Pacific waters. There are boat-based and aerial marine mammal surveys, surveillance flights and trained marine mammal observer vessels within historic Basking Shark habitat, none of which have reported Basking Sharks. Further, since 1996, the groundfish bottom trawl fishery has been monitored intensively (100% observer coverage on all trips), with four records of incidental capture of Basking Sharks identified. Since 2006, all commercial groundfish fisheries have 100% at-sea

monitoring[6]. Historical records, including scientific sources, newspapers, and government records have been examined to develop an understanding of past abundance (COSEWIC 2007; Wallace and Gisborne 2006). Recovery Potential for this population was assessed in which a simulation model was used to evaluate scenarios that span the range of plausible human activities that cause mortality (McFarlane *et al.* 2009). Records of Basking Shark sightings were collated in 2007, including the four incidental catches noted above (see McFarlane *et al.* 2009) and a database is being developed in 2010. In 2008, the Basking Shark Sightings Network was launched, with a public awareness campaign ongoing. More details can be found at www.pac.dfo-mpo.gc.ca/SharkSightings.

6.2 Recovery planning

Fisheries and Oceans Canada and Parks Canada Agency encourage other agencies and organizations to participate in the recovery of the Pacific population of Basking Shark where possible, through the implementation of this recovery strategy. Table 3 summarizes the activities that are recommended to support the recovery goal and population and distribution objectives. The activities implemented by Fisheries and Oceans Canada and Parks Canada Agency will be subject to the availability of funding and other required resources.

Table 3. Recovery Planning Table

Priority	Threats addressed	Population & Distribution Objectives targeted	Recommended approaches to recovery
Broad Strategy: Communication & Outreach			
High	▪ Entanglement ▪ Collision with vessels ▪ Harassment	All	▪ Create public education and awareness program to: a) promote reporting of sightings to the Basking Shark Sightings Network; and b) encourage responsible boating and fishing practices (e.g., education program for fishing and aquatic recreation communities, industry, and aquaculture, including a web site, posters, presentations, video, and press releases).
Broad Strategy: Scientific Research			
High	▪ Entanglement ▪ Collision with vessels ▪ Harassment ▪ Prey Availability	All	▪ Further improve understanding of population structure, abundance, and seasonal distribution within Canadian Pacific waters, for example: a) characterize habitat used extensively by Basking Sharks that is essential for providing protection, and document how the areas are used (e.g., seasonal feeding, mating, pupping or rearing); and b) examine Basking Shark feeding ecology and the impacts of fluctuating food-web dynamics.
High	▪ Entanglement ▪ Collision with vessels	2,4	▪ Coordinate opportunistic research and tagging program (e.g., with reported sightings and/or mortalities), providing sex, distribution, migration and

[6] As a condition of licence, all commercial groundfish vessels must have 100% at-sea monitoring. For hook-and-line and trap vessels, this may include either video monitoring or a third-party at-sea observer. For trawl vessels, this includes a third-party at-sea observer.

Priority	Threats addressed	Population & Distribution Objectives targeted	Recommended approaches to recovery
	▪ Harassment ▪ Prey Availability		movement information, stomach contents, vertebrae, and tissue samples for genetics and toxicity work.
Broad Strategy: Management			
High	▪ Entanglement ▪ Collision with vessels	1,2,4	▪ Assess and, where practicable, revise fishing and aquaculture practices to reduce entanglement and incidental catch; where interactions occur, require mandatory reporting of collisions, entanglement and incidental catch.
Low[7]	▪ Entanglement ▪ Collision with vessels ▪ Harassment	All	▪ Implement a Code of Conduct (guidelines for marine users to minimize negative interactions and collisions, i.e., proper boating practices for commercial fisheries, recreational fisheries, and ecotourism).
Low[8]	▪ Entanglement ▪ Collision with vessels	All	▪ Implement spatial and/or temporal fisheries closures in the event of Basking Shark aggregations.
Broad Strategy: Monitoring & Inventory			
High	N/A	All	▪ Conduct aerial surveys for search and enumeration of Basking Sharks in historic areas of abundance, and where possible, identify plankton blooms in real time, for targeted over-flights (May-September).
High	▪ Entanglement ▪ Collision with vessels	1,2,4	▪ Improve species identification and reporting in current observer programs, and expand monitoring programs (e.g., logbook observations) to all fisheries with the potential to entangle Basking Sharks; assess whether the calculated potential removal of 10-17 animals per annum is being exceeded.
High	▪ N/A	All	▪ Creation and maintenance of DFO managed Basking Shark sighting reporting network and database.
Broad Strategy: Coordination of Activities			
High	Collision with vessels, entanglement	All	▪ Collaborate on international efforts (i.e., with the U.S. and Mexico) to research, monitor (including high seas fisheries) and manage activities for the Pacific population of Basking Shark.
Low	N/A	1,2,4	▪ Work with international community to discourage trade and sale of Basking Shark parts.

[7] This approach is deemed a low priority at present; however, should an increased population occur, this would be considered a high priority.
[8] This approach is deemed a low priority at present; however, should an increased population occur, this would be considered a high priority.

6.3 Narrative to support Recovery Planning Table

The approaches listed above (Table 3) are essential to the survival of the Pacific population of the Basking Shark. Some of the approaches in Table 3 address potential threats in Canadian Pacific waters that can be acted upon immediately, while others call for action following the identification and assessment of new threats. It is important to note that for a long-lived species such as the Basking Shark, it may take many decades before increases in population can be documented, and even longer before recovery is achieved. It is therefore imperative that the long-term nature of this strategy is recognized in the evaluation of the objectives and supporting strategies.

7. CRITICAL HABITAT IDENTIFICATION

Under SARA S. 2(1), critical habitat is defined as *"the habitat that is necessary for the survival or recovery of a listed wildlife species and that is identified as the species' critical habitat in the recovery strategy or in an action plan for the species"*. Further, habitat in respect of aquatic species is defined as *"spawning grounds and nursery, rearing, food supply, migration and any other areas on which aquatic species depend directly or indirectly in order to carry out their life processes, or areas where aquatic species formerly occurred and have the potential to be reintroduced"*.

SARA S. 41(1)(c) requires the recovery strategy to include the identification of critical habitat, stating "*an identification of the species' critical habitat is, to the extent possible, based on the best available information, including the information provided by COSEWIC, and examples of activities likely to result in its destruction.*"

7.1 Identification of the species' critical habitat

Adequate information does not exist to identify critical habitat at this time. Habitat requirements have not been investigated for Basking Sharks in Canadian Pacific waters, and no specific locations have been identified for reproduction, pupping or rearing; although other migratory shark species are known to mate in northern areas and pup in southern areas (McFarlane *et al.* 2009). Further, critical habitat has not been defined for this population's southern range (e.g., the U.S. and Mexico). In other areas of the world where dedicated research and science has been ongoing for this species, such as the United Kingdom, habitat features for reproduction have not been identified. There are historical areas in Canadian Pacific waters that were regularly visited by large numbers of Basking Sharks (e.g., Barkley Sound, Clayoquot Sound, and Rivers Inlet); however, the importance of these areas for feeding and mating is unknown. Historical data does not exist to confirm if these areas were the only areas used by Basking Sharks, or if rather these observations were due to human use of these areas and/or natural variability in productivity of these areas. Therefore, it is unknown if a recovered stock will return to these areas. Some habitat characteristics that attract particular life stages such as high seasonal food availability are known, but these features vary over temporal and spatial scales (McFarlane *et al.* 2009). For example, Basking Sharks tend to aggregate in the transition zones of coastal shelves where there is

enhanced zooplankton abundance (Sims *et al.* 2006). Further, zooplankton abundance (the preferred prey) and community structure have been observed to vary on decadal-scales, as seen in the prolonged period of relative low copepod abundance in some areas of the northeast Pacific from 1989-1997 (King, 2005). Studies have not yet been conducted to identify habitat in Canadian waters required by the Pacific population of Basking Shark to achieve and sustain a viable population. It is therefore not possible to identify the habitat currently occupied by the species, the habitat necessary for the survival or recovery of the species, the activities that are likely to result in the destruction of such habitat, or the extent needed to maintain the current population size or support population recovery.

As set out in SARA, if information is inadequate to identify critical habitat within the recovery strategy, a schedule of studies must be prepared. This schedule, once implemented, will yield new information that could contribute to the identification of the species' critical habitat in the future. The schedule of studies identified for the Pacific population of Basking Shark is included below (Table 4). Upon completion of these projects, it is hoped that the results will provide information allowing Fisheries and Oceans Canada and Parks Canada to identify critical habitat for this species. It is important to note that it may take decades to address the issue of critical habitat, given the long lived nature of the species, lack of documented recent sightings in Canada, and the associated long-term scope of the recovery strategy.

7.2 Schedule of studies to identify critical habitat

In order to identify critical habitat and habitat that is important to the recovery of the Pacific population of Basking Shark, research is needed both in Canadian waters and in other parts of the species' range. Table 4 outlines the studies required to identify critical habitat. Because of the long-term nature of this recovery strategy, the timelines represent benchmarks at which evaluations of progress towards the identification of critical habitat will be undertaken.

It is recognized that defining critical habitat will be challenging given the relative scarcity of sightings, and the dynamic nature of the marine environment, potentially leading to shifts in habitat use on inter-annual and inter-decadal time scales. Large aggregations of Basking Sharks have historically been identified in Barkley Sound, Clayoquot Sound, and Rivers Inlet; however, historic and current sightings have also been noted in other regions of Canadian Pacific waters. As Basking Sharks require oceanographic conditions that concentrate prey, and have a preference for surface temperatures between 9 and 16ºC (Sims et al. 2003), the necessary conditions may change over relatively small spatial and temporal scales (Sims and Quayle 1998). Studies will primarily be focused on the areas of historic aggregations noted above, but this focus may be modified as new sightings information is collected. Further, the studies will be carried out to coincide with the timing of the Basking Sharks' seasonal migration into Canadian Pacific waters (May through September).

Table 4. Schedule of Studies to Identify Critical Habitat

Description of Activity	Outcome/Rationale	Timeline
1. Maintain and promote the Basking Shark sightings network.		
Develop the Basking Shark Sightings Database (2010). Maintain and promote the Basking Shark Sightings Network.	Determine extent of species' distribution and potential habitat in Canadian Pacific waters.	2010-2015 Ongoing[9]
2. Basking Shark Tagging Program		
Opportunistic satellite tagging of Basking Sharks in Canadian Pacific waters.	Confirm location(s) of Basking Shark presence in Canadian Pacific waters; determine seasonal distribution, movement, abundance and residency of species.	2010-2015 Ongoing
3. Opportunistic sampling program		
Biological sampling from live sightings and mortalities.	Species distribution, population structure, sex, biophysical features, stomach contents, habitat use by life stage.	2010-2015 Ongoing
4. Overflights		
Use of real time satellite imagery to identify high plankton blooms for targeted overflights (May-September).	Biophysical features and species distribution.	2010-2015 Ongoing
5. Definition of Critical Habitat		
Determine and characterize occupied high-use habitat and define potential critical habitat regions with similar characteristics.	Define high use occupied habitat.	To be determined[10]

8. ADDITIONAL INFORMATION REQUIREMENTS ABOUT THE SPECIES

Knowledge of the Basking Shark globally, and the Pacific population in particular, is not yet adequate to clearly define population and distribution objectives or critical habitat. These knowledge gaps include information related to the distribution, biology, ecology and threats to the Pacific population of Basking Shark, and have been outlined in previous sections of this Recovery Strategy. No further information requirements, other than those previously discussed in this document, are identified at this time.

[9] Activities will be evaluated in 2015. Studies will be adapted and/or recommitted to periodically.

[10] This study is essential to the identification of critical habitat; however, initiation and completion is contingent upon the completion and results of the previously listed studies.

9. MEASURING PROGRESS

Studies to determine current population structure and species distribution are important components necessary to assess future impacts to population growth and recovery. While it is unlikely that these information gaps will be addressed completely prior to action planning, these studies will contribute to an improved understanding of anthropogenic and ecological processes affecting the Pacific population of Basking Shark. Because of the long-term nature of this recovery strategy, and particularly the population and distribution objectives, the timelines in the performance measures listed below represent benchmarks at which evaluations of progress towards meeting the objectives will be undertaken. Performance measures for each population and distribution objective are outlined in Table 5 below.

Table 5. Performance Measures

Population & Distribution Objective	Performance Measures
Objective 1: Maintain the current abundance of Basking Sharks.	▪ Proven maintenance, promotion, and utilization of the Basking Shark Sightings Network and Database. ▪ Within five years, observe, at a minimum, the current annual average number of reliable sightings [11].
Objective 2: Attain positive population growth of Basking Sharks within 15-20 years.	▪ Proven maintenance, promotion, and utilization of the Basking Shark Sightings Network and Database. ▪ Within five years, observe an increase in annual average number of reliable sightings throughout species distribution range. ▪ Within 15-20 years, established Canadian, U.S. and Mexican overflights observe higher numbers of Basking Sharks annually.
Objective 3: Attain increase in Basking Shark aggregations (two or more sharks).	▪ Proven maintenance, promotion, and utilization of the Basking Shark Sightings Network and Database. ▪ Within five years, see an increase in reliable sightings of aggregations of two or more sharks.
Objective 4: Maintain distribution of Basking Sharks.	▪ Proven maintenance, promotion, and utilization of the Basking Shark Sightings Network and Database. ▪ Within five years, observe an increase in annual average number of reliable sightings throughout species distribution range.

10. STATEMENT ON ACTION PLANS

An action plan will be completed within five years of final posting of the Recovery Strategy for the Basking Shark (*Cethorhinus maximus*) in Canadian Pacific waters.

[11] Reliable sightings would include those from aerial surveys as well as confirmed sightings reported to the Basking Shark Sightings Network.

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12. RECOVERY TEAM MEMBERS

Heather Brekke	Fisheries and Oceans Canada, Recovery Lead (Chair)
Carole Eros	Fisheries and Oceans Canada
Adam Keizer	Fisheries and Oceans Canada
Jackie King	Fisheries and Oceans Canada
Romney McPhie	Fisheries and Oceans Canada
Jake Schweigert	Fisheries and Oceans Canada
Jennifer Yakimishyn	Parks Canada Agency

Advisors to the team

Sandy McFarlane	Scientist Emeritus, Fisheries and Oceans Canada
Scott Wallace	Consultant

APPENDIX A: EFFECTS ON THE ENVIRONMENT AND OTHER SPECIES

Measures to protect Basking Sharks and habitat from effect of threats will likely have positive benefits for the protection of other marine species and their habitats. Further, efforts to promote recovery of this species (e.g., the creation of a Basking Shark Sightings Network) and to identify critical habitat will likely result in increased data on other shark and marine mammal species and on oceanographic processes.

APPENDIX B: RECORD OF COOPERATION AND CONSULTATION

The Pacific population of Basking Shark is listed as an endangered species on Schedule 1 of the *Species at Risk Act* (SARA). As an aquatic species, they fall under federal jurisdiction, and are managed by both by Fisheries and Oceans Canada (DFO) and by the Minister of the Environment (as competent Minister for Parks Canada Agency under SARA). DFO established a small internal working group of technical experts to develop the initial draft of this recovery strategy. See section 12 of this document for a list of technical team members.

In December 2007, a technical workshop was held to seek comments and input on the "assessment of information used to develop a Recovery Potential Assessment for Basking Shark Cetorhinus maximus (Pacific population) in Canada" research document. Participants included scientific and technical experts from DFO, academia, an environmental non-governmental organization (ENGO), and the U.S. government. In October 2008, the Pacific Scientific Advice Review Committee (PSARC) held another meeting to seek peer review on this document (see CSAS proceeding series 2009/033 for meeting details). This also provided an opportunity to share knowledge and expertise on Basking Sharks. Participants from DFO Science, Habitat Management and Fisheries and Aquatic Management sectors, the fishing industry, academia, the ENGO community, the Province of British Columbia and the general public including biological consultants were invited to attend.

Letters were sent out to all coastal First Nations soliciting participation in the development of the Recovery Strategy. Given that the population considered in this document migrates through Canadian, U.S., and Mexican Pacific waters, bilateral government and non-government input and collaboration was sought. The draft recovery strategy was sent to Parks Canada Agency, Canadian Coast Guard, Environment Canada, Transport Canada, Department of National Defence, the Province of British Columbia, as well as to the U.S. National Oceanic and Atmospheric Administration for review and comment.

This draft recovery strategy was posted to the DFO Pacific Region Consultation website for a public comment period September 7 to October 12, 2010. The above consultations were web-based, and included mail-outs to all coastal First Nations soliciting input and feedback on the draft recovery strategy. The mail-outs to First Nations were followed up by email and fax; no comments on the document were received. An initial draft of the recovery strategy, along with a discussion guide and feedback form, was available. Notification of this consultation period was also been sent to a distribution list of ENGO's, government agencies and the eco-tourism sector. The document was presented at the Groundfish Forum on September 27, 2010 with members of the Groundfish Integrated Advisory Board, Halibut Advisory Board, Sablefish Advisory Committee, Groundfish Hook and Line Advisory Committee and the Groundfish Trawl Advisory Committee invited to attend and provide comments to the website. A discussion of the Recovery Strategy was held during the Groundfish Forum; however, no comments were received. Responses were received from the U.S.A. National Oceanic and Atmospheric Administration. All feedback received during this consultation period has been incorporated into the final recovery strategy.

APPENDIX C: THREAT ATTRIBUTES TERMINOLOGY

Table 6. Details on terms used for assessment of threats to the Pacific population of Basking Shark. Terms were obtained from Environment Canada's "Guidelines for Identifying and Mitigating Threats to Species at Risk" (Environment Canada, 2008).

Attribute	Level of Effect	Description
Extent	Widespread	Across the species range.
	Localized	
	Unknown	
Occurrence	Historical	Contributed to decline but no longer affecting the species.
	Current	Affecting the species now.
	Imminent	Is expected to affect the species very soon.
	Anticipated	May affect the species in the future.
	Unknown	
Frequency	One-time	
	Seasonal	Due to migration or particular seasons.
	Continuous	Ongoing.
	Recurrent	Reoccurs from time to time, but not on annual/seasonal basis.
	Unknown	
Severity	High	Very large population-level effect.
	Medium	
	Low	
	Unknown	
Causal Certainty	High	Evidence causally links the threat to stresses on population viability.
	Medium	Correlation between the threat and population viability, expert opinion, etc.
	Low	Assumed or plausible threat only.
Level of Concern	High	Overall level of concern for recovery of the species, taking into account all of the above factors.
	Medium	
	Low	