Fisheries and Oceans Canada / Pêches et Océans Canada
Ecosystems and Oceans Science / Sciences des écosystèmes et des océans

Canadian Science Advisory Secretariat (CSAS)

Research Document 2016/015

Pacific Region

Characterization and Analysis of Fisheries Related Risks to Significant Species, Habitats and Ecosystem/Community Properties within the Proposed Scott Islands marine National Wildlife Area

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March 2016

Canada

Foreword

This series documents the scientific basis for the evaluation of aquatic resources and ecosystems in Canada. As such, it addresses the issues of the day in the time frames required and the documents it contains are not intended as definitive statements on the subjects addressed but rather as progress reports on ongoing investigations.

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Published by:

Fisheries and Oceans Canada
Canadian Science Advisory Secretariat
200 Kent Street
Ottawa ON K1A 0E6

http://www.dfo-mpo.gc.ca/csas-sccs/
csas-sccs@dfo-mpo.gc.ca

ISSN 1919-5044

Correct citation for this publication:

Boutillier, J. 2016. Characterization and Analysis of Fisheries Related Risks to Significant Species, Habitats and Ecosystem/Community Properties within the Proposed Scott Islands marine National Wildlife Area. DFO Can. Sci. Advis. Sec. Res. Doc. 2016/015. viii + 71 p.

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ABSTRACT

This paper was solicited to provide a discussion of the issues and information requirements for the development of an integrated ecosystem management plan for DOE's proposed Scott Islands marine National Wildlife Area (SImNWA). The focus of the paper was to characterize and evaluate the nature and extent of potential impacts posed by commercial fishing activities on examples of Significant Ecosystem Components (SECs) within the SImNWA which included: seabird species; marine habitats of key prey species of seabirds; and ecosystem functioning and community properties. The intended output was to identified high priority information gaps and research needs required to address to fisheries/seabird species, habitat and ecosystem/community property interactions within the SImNWA geographic area, and contribute more broadly to an Integrated Management framework for the Northern Shelf Bioregion Marine Protected Area (MPA) Network in Canada's Pacific marine waters.

The Ecological Risk Assessment Framework (ERAF) used by DFO Pacific was used to scope out the interactions in terms of issues associated with understanding the nature and extent of the interactions and the risks posed to the selected SECs. The key findings of this exercise were: that the pathways of effects of the fishery/SEC interactions are not consistently recognized and addressed in the management of the all fisheries; collection of information on the extent of the interactions is inadequate to be of any use for the management of the interactions; collection of research data in some cases needs to be modified to insure it is adequate to address more complex population, habitat and ecosystem/community property interactions. In most cases there are easily implemented, proven solutions to bring the data up to standard, while in other instances it will require that new research programs be implemented.

Caractérisation et analyse des risques liés aux pêches pour les espèces importantes, les habitats, et les attributs des écosystèmes et des communautés dans le secteur de la réserve nationale marine de faune proposée aux îles Scott

RÉSUMÉ

Le présent document a été demandé pour discuter des enjeux et des exigences en matière d'information en vue de l'élaboration d'un plan de gestion écosystémique intégrée pour la réserve nationale marine de faune proposée aux îles Scott (RNMFIS). Le document était axé sur la caractérisation et l'évaluation de la nature et de la portée des impacts potentiels des activités de la pêche commerciale sur certaines composantes importantes de l'écosystème (CIE) dans la RNMFIS, notamment des espèces d'oiseaux de mer, les habitats marins d'importantes espèces de proies pour les oiseaux de mer, ainsi que le fonctionnement des écosystèmes et les attributs des communautés. On cherchait à déterminer les lacunes les plus importantes dans l'information et les recherches les plus nécessaires pour étudier les interactions entre les espèces d'oiseaux de mer et les pêches, ainsi que les interactions entre l'habitat et les attributs des écosystèmes et des communautés dans la zone géographique de la RNMFIS, et à contribuer, sur un plan plus général, à un cadre de gestion intégrée pour le réseau d'aires marines protégées (AMP) de la biorégion du plateau Nord dans les eaux marines du Pacifique au Canada.

Le Cadre d'évaluation du risque écologique (CERE) utilisé par la Région du Pacifique de Pêches et Océans Canada (MPO) a servi à établir la portée des interactions en ce qui concerne les enjeux associés à la compréhension de la nature et de la portée des interactions et des risques pour les CIE sélectionnées. Les constatations principales de l'exercice sont les suivantes : les séquences des effets des interactions entre les pêches et les CIE ne sont pas uniformément reconnues ni prises en compte dans la gestion de toutes les pêches; les renseignements recueillis sur la portée des interactions sont inadéquats pour gérer les interactions; il faut modifier la collecte de données de recherche dans certains cas pour pouvoir d'étudier des interactions plus complexes entre les populations, l'habitat et les attributs des écosystèmes et des communautés. Dans la majorité des cas, il existe des solutions éprouvées et faciles à mettre en place pour normaliser les données, mais dans d'autres, il faudra mettre en œuvre de nouveaux programmes de recherche.

1. INTRODUCTION

This paper is a result of a joint request for Science Advice by Environment Canada (DOE), Fisheries and Oceans (DFO) Ecosystem Management Branch and DFO Fisheries Management. Within the context of the vision and conservation goals and objectives proposed for DOE's Scott Islands marine National Wildlife Area (SImNWA), this working paper was solicited to provide the basis for discussion and advice which will:

1. characterize and evaluate the nature and extent of potential impacts posed by commercial fishing activities on examples of:
   a. seabird species;
   b. marine habitats used by the sub-set of birds selected above and some of their prey species; and,
   c. ecosystem functioning and community properties;
2. identify information gaps and additional research necessary to quantitatively evaluate the nature and extent of risks and consequences not possible in (1); and
3. And discuss the strengths and challenges of applying the Ecological Risk Assessment Framework (ERAF) in this context.

The information and advice resulting from this request will be used to inform the development of an integrated ecosystem management plan for the SImNWA, aid in planning to address identified high priority information gaps and research needs with respect to fisheries/seabird interactions in the SImNWA geographic area, and contribute more broadly to an Integrated Management framework for the Northern Shelf Bioregion Marine Protected Area (MPA) Network in Canada's Pacific marine waters.

2. DESCRIPTION OF THE SCOTT ISLANDS MARINE NATIONAL WILDLIFE AREA (SIMNWA)

Three federal departments (DOE, DFO, and Parks Canada Agency) have regulatory tools aimed at protecting the marine ecosystems of Canada's marine environment. Under the *Canada Wildlife Act*, DOE can designate and set aside marine National Wildlife Areas (NWAs) that are globally and nationally important to the conservation and protection of migratory birds, endangered species, and the foraging habitat that is essential to support their populations.

The proposed SImNWA supports 40% of breeding seabirds in Canada's Pacific Ocean which includes 90% of all of Canada's Tufted Puffins and ~50% of the world population of Cassin's Auklets (*Ptychoramphus aleuticus*). At present the proposed SImNWA (Figure 1) encompasses approximately 11,546 km^2 of marine area extending from the NW shore of Vancouver Island (Cape Scott) and incorporates the water surrounding the Scott Islands archipelago, which includes Cox, Lanz, Beresford, Sartine and Triangle Islands.

The land areas on northern Vancouver Island adjacent to the proposed SImNWA and the foreshores of the five islands within the proposed SImNWA are protected by the Province of British Columbia as either Provincial Parks or Ecological Reserves. In addition, DFO has designated a Rockfish conservation area (RCA) in the waters around Cox, Lanz, Beresford and Sartine Islands. The northeast boundary of the SImNWA is adjacent to the proposed southern sponge reef in Queen Charlotte Sound (QCS) within the proposed DFO *Oceans Act* MPA for the Hecate Strait/QCS sponge reef complex (Figure 1).

3. SIMNWA VISION, GOALS AND OBJECTIVES

The vision, goals and objectives are taken from Appendix 1 of the Regulatory Strategy for the Designation of the Proposed SImNWA.

3.1. VISION

The vision for the SImNWA is for a marine NWA around the Scott Islands that conserves seabird populations as a vital part of a healthy marine ecosystem that also sustains the socio-economic and cultural values of present and future generations.

3.2. GOALS AND OBJECTIVES

Goal 1: The natural habitats, ecosystem linkages and marine resources that support seabird populations nesting on the Scott Islands are protected and conserved.

A. Marine habitats and ecosystem functions important for seabird foraging are protected from harmful disturbance, damage or destruction.

B. Forage species utilized by seabirds are available, within the limits of natural variation, to support viable populations of seabirds nesting on the Scott Islands.

Goal 2: The risk of adverse effects on the breeding productivity and survival of seabirds resulting from human activities is mitigated in keeping with the conservation and protection objectives.

A. New and existing activities are reviewed based on demonstrated consistency with the management plan, application of effective mitigation measures and best available information.

B. Proactive measures are in place to ensure effective response to catastrophic and chronic spills of oil or any other hazardous materials.

C. Direct mortality of seabirds caused by human activities is minimized through the use of effective mitigation measures.

Goal 3: The marine NWA is managed in a manner that recognizes the authorities for management of human activities in the marine environment and takes into account the socio-economic and cultural values sustained by the marine ecosystem.

A. Breeding habitats on the Scott Islands are maintained, and where feasible restored, in collaboration with the Province of BC, Tlatlasikawala First Nation and Quatsino First Nation.

B. Surveillance, monitoring and enforcement are implemented in collaboration with other agencies, First Nations and marine users.

C. The social and cultural values of First Nations for the Scott Islands and surrounding marine area are respected.

D. In collaboration with other responsible authorities, support the implementation of recovery strategies, action plans and management plans for species listed under Schedule 1 of the *Species at Risk Act*.

E. Management of the marine NWA contributes to the broader marine ecosystem-based management goals for the Pacific North Coast Integrated Management Area (PNCIMA) and the Canada-British Columbia Marine Protected Area Network Strategy.

F. Federal and provincial departments, First Nations, local and regional governments, and marine interest holders are engaged in the ongoing management planning process for the marine NWA.

Goal 4: Understanding of the marine ecosystem and socio-economic and cultural values informs management of the marine NWA.

A. Comprehensive research and monitoring programs are enhanced and developed to improve understanding of marine ecosystems and the influence of human activities.

B. Best available information, including science, traditional knowledge, local knowledge and socio-economic information, is applied for adaptive management of the NWA.

C. Research and monitoring results are shared to contribute to broader understanding and awareness of marine ecosystem values.

4. GENERAL ECOLOGICAL RISK ASSESSMENT FRAMEWORK METHODOLOGY

An ecological risk assessment framework (ERAF) for Ecosystem-based Oceans Management in the Pacific Region was developed and reviewed through a DFO Canadian Science Advisory Pacific meeting in 2012 (O et al. 2015). The methodology outlined in the ERAF document is broken up into two key elements (Figure 2):

- **Scoping**: This is a process to identify the Significant Ecosystem Components (SECs) (DFO 2014) or properties of the system (which in this case is the SImNWA), and the nature of the activities and stressors that have the potential to affect the SECs, or system properties; and
- **Risk Assessment**: This is an analytical approach for estimating the extent of: the exposure of the stressor and the resulting consequences that the SECs or system properties will experience when subjected to one or more identified stressors. There are three types (qualitative, semi-quantitative and quantitative) of risk assessment protocols that can be conducted depending on the availability of the required data.

The focus of this present exercise is to characterize and evaluate the potential effects of the various stressors posed by commercial fishing activities that have historically occurred in the SImNWA using the ERAF elements outlined above (O et al. 2015) as a template to address the following questions: What types SECs or community properties need to be assessed; What information is needed for a quantitative assessment; What information is available; and where do the information gaps occur? The outputs from this exercise can be used to identify and inform issues that need to be addressed within an Integrated Management Framework (IMF) to prioritize gaps in knowledge and suggest potential research directions that will address key knowledge gaps.

4.1. SCOPING

4.1.1. Identification of the SECs

The first step in the scoping phase of the exercise is the identification and selection of examples of ecosystem components at the species, habitat and community/ecosystem properties levels that will used in the evaluation.

Criteria to Identify SECs

The second step is to screen the identified and selected ecosystem components from step 1 (Species, Habitat, and Community/Ecosystem Properties) to determine if they possess or fit criteria so that they can be classified as significant. The ERAF outlines criteria and guidelines to evaluate whether the selected ecosystem component possess or meets the criteria for significance (see Table 1).

Table 1: ERAF criteria for identifying the significance of selected ecosystem components.

Ecosystem Components	Criteria for Significance
Species SEC	Nutrient Importer/Exporter Specialized or keystone role in food web Habitat creating species Rare, Unique, or Endemic Species Sensitive Species Depleted Species
Habitat SEC	Biogenic habitat types; Rare or unique habitats; Sensitive habitats; Habitats critical for sensitive species; Threatened or depleted habitats; Habitats critical for depleted species; Habitats critical for supporting rare, unique or endemic species; Habitats supporting critical life cycle stages; Habitats providing critical ecosystem function(s) or service(s). Many of these criteria are drawn from the DFO process for identification of ecologically and biologically significant areas (EBSAs) (DFO 2004, DFO 2011) and the DFO Policy for Managing the Impact of Fishing on Sensitive Benthic Areas.
Ecosystem/Community Properties SEC	Unique communities; Ecologically significant community properties; Functional groups which play a central role in the functioning and resilience of the ecosystem; Ecological processes critical for ecosystem functioning; Sensitive function groups. (DFO 2006)

Metrics for measuring the Consequence to Significant Ecosystem Components

Consequences will vary depending on the SECs sensitivity to the stressor (acute and chronic) and its resilience as it relates to the ability and time required to recover from these effects (i.e., through processes such as compensatory growth, recruitment, prey switching, etc.). The ERAF recommended a number of sample measures to characterize the consequences of a stressor. The information needs to develop these measures are similar to those required for a comprehensive commercial fishery stock assessment, assessments of Critical Habitat and Recovery Potential for depleted species (DFO 2007a, DFO 2008), and for the identification of DFO and the Convention on Biological Diversity (CBD) defined Ecologically and Biologically

Significant Areas (EBSAs) (DFO 2004, DFO 2011). Needless to say, not all this information is available and this exercise is intended to identify these information gaps and the risks associated with the uncertainty of not having this information. The types of information that have been collected and used to characterize and evaluate the consequences of various stressors on sub-components of the key ecosystem components are shown in Table 2 below.

Table 2: Potential metric used to identify extent and nature of impacts of stressors on SEC components

Ecosystem component	Ecosystem sub-component	Potential Metrics
Species SEC	Population size	number of individuals population density biomass per unit area
	Population condition	organism condition age/size structure genetic diversity and structure spatial distribution of population reproductive capacity behaviour/movement
Habitat SEC	Extent of habitats	the spatial distribution of the habitat as measured by the aerial extent and %cover
	Condition of habitats	habitat structure (patchiness, morphology) substrate quality water quality air quality
Ecosystem/community properties	Ecosystem processes	primary production nutrient cycling oceanographic processes flows of organic and inorganic matter
	Community properties	species diversity species composition species evenness functional group or guild composition spatial distribution of the community trophic diversity

4.1.2. Identification of Human Activities and Stressors

This exercise is limited to commercial fishing activities and the stressors related to the operation of fishing gear. Stressors associated with the fishing vessel (e.g. discharges, noise) are not considered for the purposes of this exercise. The information required to understand the nature of the stressors associated with commercial fishing activities is obtained through a Pathways of Effects (PoE) model of the activities, which include the operation of a variety of commercial fishing gear. A generalized PoE model, outlining the relationships between a specific activity, its associated stressors and their potential impacts on the various SECs is illustrated in Figure 3. Exposure to stressors can arise through direct overlap in space and time, such as direct capture by fisheries, or through more diffuse routes, such as impacts to habitat or impacts on prey or predator species.

An example of the variety of data requirements was compiled in a review of risks associated with silt re-mobilization due to commercial fishing activities on the proposed Hecate Strait and Queen Charlotte Sound Glass Sponge Reef Areas of Interest (AOI) (DFO 2013). For that exercise, two documents were prepared and presented. The risk of Exposure was addressed by

(Boutillier, Masson et al. 2013), who followed a process that identified re-mobilization of sediments as a stressors using a PoE from the literature for fishing activities. The level of exposure was estimated by using all relevant and available data, which informed aspects of the exposure discussion, such as area of overlap between the stressor and the SEC, variations in the stressor related to bottom type, duration of stressor in relation to recovery time of the SEC, intensity of the stressor related to contact with the bottom, and the role of currents in relation to exposure This assessment was then used to start a discussion on mitigation methods and their efficacy in terms of reduction or elimination of exposure and a discussion of the key areas of uncertainty with respect to exposure that required further research. A second document (Leys 2013) described the acute and chronic consequences to the SEC (the sponges that form the reef) from exposure to re-suspended sediments.

4.2. RISK ASSESSMENT

The risk assessment will draw from the terms outlined in the risk analysis framework presented in the CSAS ERAF research document (O et al. 2015). The analytical approach has three Levels of analysis for assessing the nature and extent of the Consequences that a SEC will experience due to exposure to one or more identified Stressors.

4.2.1. Level 1 Qualitative Assessment

The Level 1 assessment is based on qualitative information, scientific literature, and expert opinion to determine the Consequences of activities and stressors that potentially interact with each SEC. Area-specific PoE models are used to ensure that the risks of harm from all potential activities/stressors are considered and thus focus maximum effort on further analysis of those SECs most at risk. It should be noted that the risk to a SEC may be the result of a single stressor or it may be the cumulative risk from a multitude of stressors.

4.2.2. Level 2 Semi-qualitative Assessment

A Level 2 semi-quantitative risk analysis. The ERAF considers two principal terms of the risk assessment (Exposure and Consequence) and provides guidance on the scoring of the subcomponents of these terms.

Level 2 Exposure Assessment

Exposure_{SC} is the estimated magnitude of interaction between the stressor **(S),** the SEC species, SEC Habitat, and SEC ecosystem/community property **(C)** and is calculated using Equation 1 below.

Equation 1: Calculating Exposure

$$\text{Exposure}_{SC} = \text{PExposed}_{SC} \times \text{Intensity}_{SC}$$

where :

$PExposed_{SC}$ is the proportion (%) of the component exposed to the stressor, and $Intensity_{SC}$ is an estimate of intensity of the stressor.

$PExposed_{SC}$ is calculated using Equation 2 below.

Equation 2: Calculating PExposed

$$PExposed_{SC} = \%Areaoverlap \times \%Depth\ overlap \times \%Temporal\ overlap$$

Where $PExposed_{SC}$ is the product of:

1. **$\%Area_{SC}$ overlap**, measured as overlap of the stressor and VEC

2. **%Depth$_{SC}$ overlap,** measured as the vertical overlap of the stressor and VEC; takes into account depth and terrain barriers (e.g. slopes) that may limit interaction of the stressor with VECs.
3. **%Temporal$_{SC}$ overlap**. Is the fraction of the year in which stressor overlaps with the VEC.

All of the terms are scored on a scale of 0.1-10 such that a score of 5 corresponds to 50% overlap in the Area and Depth terms and 6 months in the Temporal term. If there is no quantitative information on the % overlap then a qualitative scoring was recommended in the ERAF paper (O et al. 2015). The qualitative scoring set scores are based on the 75% point of the range for each attribute where:

1. the Low bin represents 0-20% and is scored 15%,
2. the Medium bin 20-50% and is scored as 41%, and
3. the High bin >50% and is scored as 88%.

And :

$Intensity_{SC}$ is a measure of effort/density of an activity or stressor which for this paper is the fishing effort/frequency within the period of temporal overlap. For other stressors the measure Intensity would change to reflect the nature of the stressor such as the estimated density of debris, or quantity or concentration of a pollutant or harmful species.

Scoring for $Intensity_{SC}$ is relative to an estimated **worst-case scenario** for the stressor on a scale of 0.1-10., In the absence of quantitative information about intensity of stressors, the qualitative scoring procedure that reflects the Low, Medium and High bins listed for $PExposed_{SC}$ above can be used. In the absence of any information, evidence, or logical argument to the contrary about $Intensity_{SC}$, the Pacific ERAF recommends a precautionary approach where risk is set as high.

Exposure$_{SC}$ is then calculated using Equation 1 above as the product of PExposed$_{SC}$ and Intensity$_{SC}$ and then rescaled using quartiles based on all outcomes of the exposure equation to values between 1 and 4 where:

1= ***Exposure$_{SC}$*** of 0.0001 to 68.6

2= ***Exposure$_{SC}$*** of 68.7 to 271.8

3= ***Exposure$_{SC}$*** of 271.9 to 827.1

4= ***Exposure$_{SC}$*** of 827.2 to 10000

Level 2 Consequence Assessment

Consequence$_{SC}$ is estimated based on a change in the VEC in response to acute and chronic effects of a stressor, and the VECs' recovery potential. The sub-terms are scored on a scale from 1-3, equating to benchmarks of low, medium, and high risk. The final ***Consequence$_{SC}$*** score is re-scaled to scores of 1-4 using quartiles. Consequence$_{SC}$ is estimated using Equation 3 below. For this exercise, Consequence$_{SC}$ represents the potential for long-term harm to a SEC as a result of interaction with the act of commercial fishing and. is estimated from metrics that represent the capacity of the VEC to resist and/or recover from exposure to the stressor (i.e., resistance and resiliency of the VEC to change).

Equation 3 :

$$Consequence_{SC} = (AcuteChange_{SC} + ChronicChange_{SC}) \times Recovery_{SC}$$

where:

AcuteChange$_{sc}$ is the percent change in population-wide average mortality rate and

ChronicChange$_{SC}$ is the percent change in condition, fitness, and genetic diversity of a population.

AcuteChange$_{SC}$ and ChronicChange$_{SC}$, both represent a % change in the of the VEC in response to a single or multiple stressors. When scoring qualitatively, other factors including resistance to change and duration of effect from the stressor should be considered when estimating the % change. Both terms are scored on a scale of 1-3 where:

1: Low risk = <10% change

2: Medium risk = 10%-30% change, and

3: High risk > 30% change

Recovery$_{SC}$ represents the recovery time for the SEC to return to a pre-stress level once the stressor is removed. This term is scored on attributes that reflect the productivity or sensitivity of the SEC.These attributes for species SECs reflect an indicator of intrinsic population growth rate and would include attributes such as: fecundity, breeding strategy, recruitment pattern, natural mortality rate, age at maturity, life stage, population connectivity, and listing status. The recovery attributes for habitat SECs include the life stage affected for biotic habitats, frequency of natural disturbance, natural mortality of biotic habitats, natural recruitment rate of biotic habitats, age of maturity of biotic habitats, distribution range and fragmentation, and connectivity rating. The attributes of recovery in ecosystem/community property SECs include: species richness, taxonomic distinctness, % of functional groups with total number per group >5 or 10 (more groups equates to less susceptibility), and abundance.

4.2.3. Level 3 Quantitative Assessment

The ERAF does not provide any guidance for Level 3 Quantitative assessments. However, it does provide examples of quantitative assessments that have recently been conducted. Quantitative assessments of risks at the Species SEC level have been conducted using a number of tools including:

1. Single species stock assessments that account for environmental and all **human impacts** (including fishing);
2. The Sustainability Assessment for Fishing Effects (SAFE) model (Zhou and Griffiths 2008, Zhou et al. 2011). The SAFE method has been applied in fisheries assessments in Australia to assess and manage **the impacts of fishing** on multiple species, particularly non-target species, and to establish biological reference points (Zhou and Griffiths 2008, Zhou et al. 2011). This method is similar to formal quantitative stock assessments, but estimates fishing mortality rates from multiple activities and uses life history traits to establish reference points;
3. Quantitative risk assessments of the impacts of fisheries on seabird populations (Tuck et al. 2011); and
4. Other examples include population models or Population Viability Analyses (PVA), which can be used to assess impacts of multiple stressors to SECs (Bolten et al. 2010).

With regard to **habitat and community components:**

1. Encounter-response models can be used to assess specific risks, such as the indirect impacts from re-mobilization of sediment from bottom trawl fisheries (Boutillier et al. 2013);
2. Quantitative benthic species impact models have been developed (Ellis et al. 2008); and

3. Ecopath and Ecosim models could be used to address impacts to community and ecosystem properties (Christensen et al. 2005).

   Ultimately, the appropriate model will have to be chosen based on the SEC and cumulative stressors. A range of methods and approaches from existing processes already exist at this level, but there remain challenges in finding methods that address multiple stressors and different types of ecological components.

5. SIMNWA ECOLOGICAL RISK ASSESSMENT

5.1. STEP 1: SELECTION OF SPECIES, HABITAT AND ECOSYSTEM/COMMUNITY PROPERTIES FOR EVALUATION

The selection process for choosing the Species, Habitat and Ecosystem/community properties (i.e., SECs) was driven by the Goals and Objectives of the proposed SImNWA. Since this document was intended to be exploratory, not all the species, habitat and ecosystem/community properties SECs in the area were addressed. The analysis is restricted to examples of SECs that show a range of interactions and their data requirements to assess the risk of commercial fishing activities against the following proposed SImNWA Goals and Objectives:

- 1 A : Marine habitats and ecosystem functions important for seabird foraging are protected from harmful disturbance, damage or destruction;
- 1 B: Forage species utilized by seabirds are available, within the limits of natural variation, to support viable populations of seabirds nesting on the Scott Islands;
- 2 C: Direct mortality of seabirds caused by human activities is minimized through the use of effective mitigation measures;
- 3 D: In collaboration with other responsible authorities, support the implementation of recovery strategies, action plans and management plans for species listed under Schedule 1 of the Species at Risk Act; and
- 4 A: Comprehensive research and monitoring programs are enhanced and developed to improve understanding of marine ecosystems and the influence of human activities.

5.1.1. Species SECs

The selection process for Species SECs for this exercise was not a full ERAF scoping exercise which evaluated all the seabird species against all the screening criteria noted in Table 1. The SEC species chosen for this exercise were chosen with the screening criteria in mind but also to showcase a range of life history metrics from Table 2 that were employed to understand the complexity of the nature and extent of the risks. This selection process was intended to highlight the information requirements for various susceptibility/interactions with a range of the commercial fisheries stressors, along with the management strategies employed to control direct mortality (Objective 2C). The species SEC were chosen from seabirds that utilize the area for breeding, rearing and/or foraging, with additional emphasis given to those species listed under other federal, provincial or international Acts or ratified agreements (Objective 3D).The bird species chosen as SECs for this review are a sub-set of those species in Appendix 1 that were initially highlighted in the SImNWA ecosystem overview (Fort et al. 2006). The information used in the Species SEC selection was obtained mainly from the reviews in the Atlas of Pelagic Seabirds off the West Coast of Canada and Adjacent Areas (Kenyon 2009); the BirdLife International Species factsheet; the Scott Islands Ecosystem Overview (Fort et al. 2006), where applicable Committee on the Status of Endangered Wildlife in Canada (COSEWIC) Assessment and Status Reports and with some modification, based upon expert opinion (Ken Morgan and Mark Hipfner, Can. Wildlife Serv., Delta, B.C., pers. comm.) to ensure a range of life history characteristics were considered.

Cassin's Auklet (*Ptychoramphus aleuticus*)

The world population of Cassin's Auklet is estimated to be as high as five million birds (Manuwal and Thoresen 1993, BirdLife International 2016a). Although there are indications of regional declines in the number of nesting Cassin's Auklet (<30% over 10 years or 3 generations), they were considered by the International Union for the Conservation of Nature (IUCN) globally as a species of Least Concern until 2008 (BirdLife International 2016a). The BC Ministry of the Environment lists it as Special Concern because BC supports 75% (Kenyon et al. 2009) of the world's breeding population. Fort et al. (2006) reported that the Scott Islands themselves support 55% and 73% of the global and national breeding populations, respectively. Recent declines in population size in BC, suspected to be due to ocean climate and El Niño impacts (Bertram et al. 2005) are such that a report has been prepared for COSEWIC to determine if Cassin's Auklet should be recommended for listing under the *SARA*.

Cassin's Auklet breeds from Buldir Island in Alaska's Aleutian Islands, and along the south and east shoreline of North America to central Baja California. It is considered a single population, but the species exhibits strong natal philopatry (i.e., breeding site fidelity). Philopatry in other species of alcids (diving seabirds or auks) have potentially been one of the factors that have led to identification of genetically unique populations breeding in close proximity (Abbott et al. 2014)

Cassin's Auklet are known to occupy the upwelling regions of the continental slope in the region of Triangle Island where they feed on a variety of zooplankton. The diet of Cassin's Auklet varies geographically, and most of what is known is based on samples of food brought back to their young. In BC, invertebrate prey includes calanoid copepods (e.g., *Neocalanus cristatus, N. plumchrus, Metridia pacifica*), euphausiids (e.g., *Thysanoessa longipes, T. spinifera, Euphausia pacifica*), hyperiid amphipods (e.g., *Parathemisto pacifica, Primno macropa*), caridean and brachyuran larvae, small pandalid shrimp, cirripeds, ctenophores, decapods and immature squid (Vermeer et al. 1985, Burger and Powell 1990). Cassin's Auklet are also known to prey upon juvenile fish (e.g., Irish Lord (*Hemilepidotus hemilepidotus*), Rockfish (*Sebastes*) species, Pacific Sand Lance (PSL), (*Ammodytes hexapterus*), Pacific Sanddab (*Citharichthys sordidus*) (Vermeer et al. 1987, Burger and Powell 1990, Manuwal and Thoresen 1993).

This SImNWA species was chosen as an example of a SEC that meets the following screening criteria: a **Nutrient importer/exporter** that undergoes seasonal migrations into and out of the region for breeding of this global population; **Specialized role in food web** as a planktonic feeder that has changes in food availability (possibly) due to ocean climate and El Niño events, and are **Sensitive** to these changes because of their behavioral philopatry; and **Depleted** status (as suggested by recent documented population declines in BC). It also has **Endemic concerns** because the largest portion of the global and national population has a **Restricted spatial distribution of the breeding population**, in that the SImNWA represents 55% and 74% of the global and national breeding population, respectively, for this species.

Rhinoceros Auklet (*Cerorhinca monocerata*)

Rhinoceros Auklet have an extremely large range in the north Pacific Ocean from California to North Korea. Estimates of population size range from 1.4 (BirdLife International 2016b) to three million birds worldwide (Gaston and Dechesne 1996). The Rhinoceros Auklet is listed as a species of *Least Concern* by the IUCN. The IUCN designation is based on a single large panmictic population and does not take into account recent genetic findings (Abbott et al. 2014) which identified genetically distinct local populations that are closely aligned spatially (the Pine Island and Triangle Island breeding populations).

Rhinoceros Auklet are known to nest at 35 sites within BC, but only six colonies account for >85% of the provincial breeding population (Pine Island, Storm Islet, Triangle Island, Moore Island, Byers Island, and Lucy Island, (Rodway 1991). The Triangle Island nesting population accounts for about 7% and 12% of the global and national populations, respectively. Rhinoceros Auklets are monogamous and have high nest site fidelity.

Rhinoceros Auklet are generally found within <60 km of land, over the continental shelf (Gaston and Dechesne 1996), or seaward of the shelf-break in upwelling areas (Briggs et al. 1987), where they tend to associate with steep sea surface temperature gradients (O'Hara et al. 2006). They are also known to occupy near-shore areas that have high concentrations of food.

The prey of Rhinoceros Auklet includes small squid, a wide variety of fish (e.g., Capelin (*Mallotus villosus*), Eulachon (*Thaleichthys pacificus*), Lingcod (*Ophiodon elongatus*), myctophids, Northern Anchovy (*Engraulis mordax*), Pacific Ocean Perch (*Sebastes alutus*), Pacific Cod (*Gadus macrocephalus*), Pacific Herring (*Clupea pallasii*), PSL, Pacific Saury (*Cololabis saira*), Salmon (*Oncorhynchus* spp.)), copepods and euphausiids (Vermeer and Westrheim 1984, DeGange and Sanger 1986, Vermeer et al. 1987, Bertram and Kaiser 1988, Hatch and Sanger 1992, Vermeer 1992, Gaston et al. 1998). Studies on chick growth, fledgling size and fledgling success show that these attributes appear to be highly correlated with the % of PSL in their diets (Hedd, Bertram et al. 2006, Borstad, Crawford et al. 2011).

Rhinoceros Auklet and Common Murre (*Uria aalge*) are estimated to make up 80% of the seabird bycatch in salmon net fisheries (Smith and Morgan 2005).

This SImNWA species SEC met the following screening criteria: **Uniqueness** because of the recent findings with respect to genetically distinct populations, and **Vulnerability** because of its' propensity for brooding site fidelity; indications of high correlations between chick growth, fledgling size and fledgling success with the % of PSL in their diets; and it's interaction with the salmon net fisheries. Rhinoceros Auklet are reasonable surrogates to provide examples of challenges facing other seabird species such as Tufted Puffins (*Fratercula cirrhata*).

Common Murre (Uria aaige)

The global population of Common Murre is estimated to be 21 million individuals which is one of the largest seabird populations in the northern hemisphere (Hipfner and Greenwood 2008, Kenyon et al. 2009). Globally the Atlantic and Pacific populations of Common Murre diverged during the Pleistocene and are genetically distinct populations that do not exchange migrants (Morris-Pocock et al. 2008). There are two geographically disjoint subspecies of Common Murre within the Pacific Ocean basin: *U. a. inornata* which is common in the Gulf of Alaska; and, *U. a. californica* which is located off California and Oregon. These two subspecies were designated based on morphological differences in the colour of the mantel, the extent of streaking on the sides, and morphometric differences in the bills and wings; but this designation has not been substantiated by genetic evidence (Morris-Pocock et al. 2008).

There are only about 40,000 individual nesting Common Murre from Washington State through British Columbia to S.E. Alaska. Common Murre in British Columbia are morphometrically more closely aligned with the Gulf of Alaska subspecies.

The two main breeding sites in British Columbia are located on the Kerouard Islands at the southern end of the Haida Gwaii archipelago, and on Puffin Rock, Triangle Island. The Common Murre shares its breeding colonies with Pelagic Cormorant (*Phalacrocorax pelagicus)*, which like the Murre are open ground nesters. Breeding success of the Common Murre on the Puffin

Rock rookery was very high from 2003 to 2006 relative to other northern Pacific colonies. In contrast, Murre breeding success was significantly reduced in 2007, 2008, and 2009. The reduced success appeared to be correlated with predation on eggs and chicks by Glaucous-winged Gulls (*Larus glaucescens)* and Ravens (*Corvus corax).* Murre predation occurs when the adults are flushed from their nests by Bald Eagles (*Haliaeetus leucocephalus*). Increased activity by Bald Eagles preying on the adult Murres on their breeding rookery in 2007-2009 appears to have been correlated with the absence of nesting Peregrine Falcons *(Falco peregrinus pealei)* in vicinity of the Common Murre nesting site. The Falcons, when present in the area, aggressively defended the air space around their nests from other raptors (Hipfner et al. 2011).

The results of stable isotope analyses show that the more northern subspecies of Common Murre feed more heavily on fish than the southern subspecies. On Triangle Island, about 80% of the chick diet normally consists of a combination of PSL and unidentified Rockfish (*Sebastes spp*.). It has been noted however, that adult diets may be somewhat different than the diet they provide their chicks (Hodum and Hobson 2000).

As with the Rhinoceros Auklet, the Common Murre is one of the most commonly caught seabirds in west coast Canadian salmon net fisheries (Smith and Morgan 2005).

This species was chosen as it met the following SEC screening criteria: **Depleted** because of the recent declines in its breeding success, **Sensitivity** because of its reliance on key pelagic fish prey species in the area, its exposure to predation of eggs and juveniles because of its ground-nesting behaviors and its unique relationship with Peregrine Falcons for protection provides an example of a fragile ecosystem structure; and it’s **Rarity/Uniqueness** as the relative isolation of these small BC breeding populations at the southern extent of the Gulf of Alaska populations.

Black-footed Albatross (*Phoebastria nigripes*)

The IUCN classification of the global population of Black-footed Albatross has recently been down-listed to Vulnerable and a reassessment may find that Near Threatened is warranted (BirdLife International 2016c). Under the *SARA*, Canada lists this albatross as a species of Special Concern (COSEWIC 2006); and it was added to SARA Schedule 1 in 2009. The global population of Black-footed Albatross is estimated to be between 200,000 and 300,000 individuals. The main breeding colonies are in the Northwestern Hawaiian Islands, but they are also known to nest on three or four outlying Islands off Japan (Kenyon et al. 2009). Approximately 2500 Black-footed Albatross are estimated to occur within Canada in the offshore waters of British Columbia each summer to forage for food. The long-term population trends for this species are unclear with population estimates ranging from stable to 60% declines over three generations. No models showing trends in abundance of this species within Canadian waters have been developed. There is great deal of uncertainty as to the by-catch associated with longline fisheries in Canada, which confounds any population assessment.

The birds are monogamous and pairs remain intact until death or disappearance of a mate. Adults breed at age 7 or 8. Only a single egg is laid each year with both adults incubating the egg. Birds primarily feed by seizing prey from the surface of the water or by scavenging discarded fish from fishing vessels. Lifespan estimates vary from 12 to 40 years. Juveniles are known to be preyed upon by Tiger Sharks in the Hawaiian Islands.

Black-footed Albatross was selected as an example SEC for this exercise because its **Role in the food web** makes it an excellent example of problems facing a variety of other surface feeding, scavenging seabirds (e.g., other species of Albatross, Shearwaters, Fulmars, Gulls) that use Canadian water as feeding areas and are attracted to fishing vessels to scavenge on baits and discarded fish and offal, and its **Depleted** status and population structure. Life history **Sensitivities** with respect to breeding characteristics, longevity and feeding habits are similar to other *SARA*-listed species such as the Short-tailed Albatross (*Phoebastria albatrus*) and the Pink-footed Shearwater (*Ardenna creatopus*), both of which have been listed in Schedule 1 as Threatened.

5.1.2. Habitat SECs

Examples of habitat SECs were selected to meet goals and objectives for the SImNWA and include identifiable areas that provide the Habitat SEC selection criteria noted in Table 1.

There are three functional descriptions of **Habitat SECs** included in the SImNWA goals and objectives which meet the ERAF Habitat Screening Criteria; they include:

1. Areas of feeding aggregations meet ERAF Habitat SEC screening criteria for:
    - o Habitats critical for depleted species;
    - o Habitats supporting critical life cycle stages;

    Areas of feeding aggregations are defined within the DFO EBSA process (DFO 2004). as identifiable areas with pelagic oceanographic conditions (temperature fronts, upwelling, gyres, etc.) that are favorable for ready access to key prey for adult survival and juvenile rearing.

2. Areas modified by fishing activities that attract species that scavenge food from fishing vessels which meet the ERAF Habitat SEC screening criteria for:
    - o Habitats supporting rare and unique species;
    - o Habitats providing ecosystem functions or services such as the trophodynamics of the system.

    These are areas of fishing activities that attract SEC species that scavenge food from vessels carrying out active fishing activities.

3. Spawning or resting areas within the SImNWA for key prey species which meet the ERAF Habitat SEC screening criteria for:
    - o Sensitive habitats for prey species that utilize biogenic structure like corals, sponges, bryozoans;
    - o Habitats critical supporting critical life stages like spawning and resting areas.

    Land based Habitat SECs are not within the scope of this project as they have already been addressed in the assessment and establishment of the BC Parks and Ecological Reserves; and, because they fall out of the Scoping part of the exercise. Mapping marine area Habitat SECs within the SImNWA, will require identification of the spatial extent of the areas utilized that are likely to have the necessary properties mentioned above It should be noted that many of the species that utilize the SImNWA are known to carry out foraging excursions well beyond the proposed SImNWA boundaries (Smith and Morgan 2005).

    For the purposes of this exercise Habitat SECs will be chosen from those habitats that support species which have crucial trophodynamic roles and definable benthic habitat requirements. Juvenile Rockfish and PSL are known prey species in diving birds' diets (Bertram and Kaiser 1988, Hedd et al. 2006) and potentially have biogenic or unique benthic habitat requirements. PSL in particular, are a forage species that is crucial to the success of fledgling survival of some of the seabird SEC populations that nest and raise their young in the area.

5.1.3. Ecosystem/Community Property SECs

Selection of an example of an Ecosystem/Community Property SEC is taken from the literature for European Atlantic fisheries, which examines the discard practice of unwanted fish, offal and bait of a commercial fishing activity, and how changes in the management of this fishing practice can impact ecosystem function/community properties. This Ecosystem/Community Property SEC is used by analogy and meets the SImNWA Goals and Objectives outlined in 4A3.2. The intent is to identify hypotheses concerning impacts on ecosystem function/community properties (not hypotheses specific to SImNWA) to inform future planning and decision-making.

The impacts of these fishing practices and management actions affect the population dynamics of “sensitive functional groups” and “functional groups” which play a critical role in functioning (trophodynamics) and resilience of the ecosystem. A number of studies have demonstrated direct linkages between increases in fisheries discard availability and population growth of seabird populations that scavenge these discards (Oro 1996, Furness 2003, Votier et al. 2004). Examinations of the effects of reduction of fisheries discards resulting from reduced fishing activities due to target species overfishing and/or implementation of management provisions designed to eliminate fisheries discards found both direct and indirect effects on seabird populations. Direct negative effects occurred on seabird populations that depend on discards as a food source. Indirect effects occurred on non-scavenging seabird populations that were subsequently preyed upon due to prey switching by the large scavenger seabird populations. Fishery discards represent a significant proportion of the diet of certain seabird species; for example, it was found to represent as much as 70% of the adult and 82% of the chick diets of Great Skuas (*Catharacta skua*). Opportunistic generalist feeders, including Skuas and Gulls, have been documented to switching prey species to forage fish and smaller seabird species when fishery discard food supplies were reduced or eliminated (Garthe, Camphuysen et al. 1996). The consequences of this prey switching may in turn be mitigated somewhat by increases in forage fish populations through reduced predation and increased survival if the overfishing occurred on large predatory fish populations (Furness 2003). In the case where reduced availability occurs on both forage fish and the fisheries discards food sources is has been shown that the impact will occur mainly on the marine sea bird populations (Votier et al. 2004). Predation by Skuas is known to have reduced one large population of Black-legged Kittiwakes (*Rissa tridactyla)* in Shetland by 54-85% between 1981 and 1995. Even a 5% increase in seabirds being consumed by Skuas can result in very large number of mortalities, relative to the populations in certain areas (Votier et al. 2004). The changes to fishery discard practices have also resulted in changes in behavior, distribution and foraging patterns of seabird scavengers out to as much as 11km away from fishing events (Bodey et al. 2014).

The example Ecosystem/Community Property SEC for SImNWA are species or species groups which might play a similar role in the SImNWA is the Glaucous-winged Gull which have strong population levels and are known to scavenge on discards from fishing vessels and to prey on eggs and juveniles of other seabirds (Hipfner et al. 2011). There is no evidence at present supporting the hypothesis of community property/ecosystem impacts as described above within the SImNWA.

5.2. STEP 2: IDENTIFYING THE FISHING ACTIVITIES IN THE AREA AND THE NATURE OF THE POTENTIAL PATHWAYS OF EFFECTS THAT MAY ACT AS STRESSORS

5.2.1. Fishing PoEs

PoEs for fishing activities were reviewed in two national CSAS advisory processes. The first process dealt with the impacts of trawl gears and Scallop dredges on benthic habitat, populations, and communities (DFO 2006); and the second process addressed impacts of all other fishing gears that potentially have bycatch issues or impact marine habitats and communities (DFO 2010). PoEs that result in direct mortality of SEC species, and those PoEs that affect SEC populations indirectly by modifying benthic habitats and/or Ecosystem/Community Property SECs are considered in the present paper.

To address issues of data collection consistency and quality, the focus of this paper is on fishing activities that have been operating in the region from 2007 to present. Some fishing activities outside the SImNWA will also be discussed if they are known to potentially impact populations and are within the range of some of the SImNWA SEC species (i.e., some seabird species nesting in the Scott Islands travel distances in excess of 80 km or more on daily foraging excursions). The CSAS reviews (DFO 2006, DFO 2010) of the PoEs of fishing gears concluded that fishing gears do impact biodiversity, habitats and ecosystem/community properties; however, the extent and nature of the effects are not uniform and depend on:

- the species present;
- the specific features of the seafloor habitats, including the natural disturbance regime;
- the configuration of the type of gear used, the methods and timing of gear deployment, and the frequency with which a site is impacted by specific gears; and,
- the history of human activities, especially past fishing, in the area of concern.

The nature of the effects that could be experienced include:

- reduced biodiversity through direct mortality of species that are not targeted in a regulated fishery through bycatch and entanglement;
- damaged or reduced structural biota;
- damaged or reduced benthic habitat complexity;
- alteration of seafloor structure and large habitat features;
- changes in the relative abundance of benthic species (possibly resulting in alterations to the composition of benthic communities);
- decreased abundance of long-lived species with low turnover rates;
- increased abundance of short-lived species with high turnover rates;
- sub-lethal effects (i.e. injury, exposure) on individuals of benthic populations (these may result in increased vulnerability to other sources of mortality or reductions in their fitness);
- increased presence of scavengers in the community;
- temporary increases in sedimentation rates; and,
- altered rates of nutrient cycling.

5.2.2. Fishing Activities

The proposed SImNWA occurs within parts of Groundfish Management Areas 4 and 5 and DFO Fisheries Statistical Areas 12-14, 111, 127-2, 127-3, 127-4 and 130. Commercial fisheries targeted catch, fishing gear used and their present status within the proposed SImNWA are listed in Table 3 below. A more detailed summary of the effort, management and potential impacts are summarized by major fisheries grouping and gear type below.

Table 3: Commercial fisheries that have historically taken place with the proposed boundary of the SImNWA.

TARGETED CATCH	GEAR	STATUS
Demersal Groundfish	Bottom Trawl	On-going
Pelagic Groundfish	Mid-water Trawl	On-going
Demersal Groundfish	Longline	On-going
Demersal Groundfish	Troll gear	On-going
Demersal Groundfish	Hand-line	On-going
Demersal Groundfish	Traps	On-going
Geoduck	Diving with stingers	Last fished in 2001
Red Sea Urchins	Diving and hand picking	Last fished in 2001
Prawn	Traps	Sporadic
Shrimp	Small mesh bottom trawls	Last fished in 2001
Salmon Trolling	Troll gear	On-going
Tuna Trolling	Troll gear	On-going

Groundfish fisheries

The groundfish fisheries that operate within the SImNWA utilize a variety of gear types including bottom trawls, mid-water trawls, hook and line long-lines, hook and line hand-lines, hook and line traps, and hook and line troll gear. The extent of annual effort that was documented in the log-books for 2007 to 2013 by each groundfish gear type (excluding hook and line hand-lined and troll gear).is shown in Table 4 below.

Table 4: The number of sets per year within the proposed SImNWA by Groundfish major gear types.

Year	GF Longline	Mid-water Trawl	Bottom Trawl	Groundfish Trap
2007	1622	153	826	245
2008	1841	301	608	164
2009	1414	215	876	183
2010	1385	162	984	71
2011	1564	357	578	70
2012	1879	488	502	116
2013	1445	441	649	64
Totals	11150	2117	5023	913

Groundfish Bottom Trawl Fishery

Groundfish bottom trawling is a mobile fishing operation, and is open year-round, other than for area or species specific seasonal closures noted in the Integrated Fisheries Management Plan (IFMP).

The main target species for the bottom trawl fishery in the proposed SImNWA are Pacific Hake (*Merluccius productus*) followed by a variety of rockfish species (Widow (*Sebastes entomelas)*, Yellowmouth (*S. reedi)*, Pacific Ocean Perch and Yellowtail (*S. flavidus*)); Lingcod ; several Cods (principally Pacific Cod (*Gadus macrocephalus)* and Walleye Pollock (*Theragra chalcogramma*)); and flatfish species (Arrowtooth Flounder (*Reinhardtius stomias)*, Rock Sole (*Lepidopsetta bilineata)*, Dover Sole (*Microstomus pacificus)* and Petrale Sole (*Eopsetta jordani*)). Over the seven year period analyzed, approximately 28,040 tonnes of fish was retained and 2,879 (10.2%) tonnes of fish and invertebrates were released in unknown condition. The mean recorded bottom depth fished was 220 m with a Standard Deviation (SD) of 123 m. The minimum recorded depth was 51 m and the maximum recorded depth was 640 m.

In 2012, the Canadian Groundfish Research and Conservation Society on behalf of the BC groundfish trawl industry agreed to freeze benthic habitat impacted by the Option-A bottom trawl fishery (those vessels permitted to fish with bottom trawl gear in all areas, except management Area 4B and Fisheries Management Areas 12 to 20 and 29) to the areas that had been fished between 1996 and 2011(Figure 4). This agreement however does not preclude or infringe on:

1. First Nations rights to access, or initiatives pertaining to First Nations rights to access;
2. Requirements of the Pacific Region IFMP for Groundfish, including those related to the Policy for Managing the Impacts of Fishing on Sensitive Benthic Areas;
3. Marine planning processes (e.g., Province of British Columbia and First Nations Marine Plan Partnership (MaPP), Pacific North Coast Integrated Management Area (PNCIMA), MPAs, Parks Canada National Marine Conservation Areas (NMCAs)); and
4. Issues pertaining to Total Allowable Catch (TAC) limits, bycatch, releases, and other possible conservation matters.

The Option A bottom-trawl fisheries catches are monitored with at-sea observers, and as part of their license conditions, they are required to report all birds caught by **species** and, if alive, birds must be released in the least harmful manner possible.

Groundfish Mid-water Trawl Fishery

The Groundfish mid-water trawl is a mobile fishing operation. The main difference between bottom trawling and mid-water trawling is that mid-water trawling is typically operated in a manner to avoid contact with the bottom. However, bottom contact during fishing operations can and does occur, depending on the spatial distribution of the target species and the bottom type (Rogers et al. 2008). The Option- A Groundfish mid-water trawl fisheries are open year-round, other than during area or species specific seasonal closures noted in the IFMP.

The main target species for the mid-water trawl fishery in the SImNWA tows analyzed was Pacific Hake, which comprised 96.4% of the 9,329.7 tonnes of fish retained from 2007 to 2013. Nine species of shelf and slope Rockfish made up 3.5% and the remaining 0.1% consisted of seven other species of fish. The mid-water trawl fishery is monitored using a log-book, electronic monitoring validation, dock-side monitoring and occasional observers. The average depth fished within the proposed SImNWA boundaries was 337 m with a SD of 242 m and minimum and maximum recorded depths of 67 and 1,691 m, respectively. The depths in this case reflect the depth of the net's headrope rather than the footrope depth. As part of the license conditions for this fishery, all birds caught must be reported by species and, if alive, they must be released in the least harmful manner possible.

Groundfish Hook and Line Longline Fishery

Hook and line longline gear accounted for landings of 4,232 tonnes of fish between 2007 and 2013 from the SImNWA (Figure 5). Longline gear is considered a bottom-tending, stationary fixed gear, which in the SImNWA is targeting Pacific Halibut *(Hippoglossus stenolepis).* Pacific Halibut makes up 41.7% of the retained catch by weight*,* while the remaining landings (by weight) consist of Sablefish (*Anoplopoma fimbria)* (19.1%)*;* Lingcod (*Ophiodon elongates)* (10.1%)*;* 26 species of inshore, shelf and slope Rockfish (~21.7%); Spiny Dogfish (*Squalus acanthias)* (1.7%); three species of Skate (5.7%); and a number of other species of demersal groundfish. A total of 788,303 fish were reported retained, while 409,571 other fish, invertebrates and birds were reported released over the same period of time. Hook and line longline fishing within the SImNWA boundaries occurred at an average depth of 234 m with a SD of 163 m and minimum and maximum reported depths of 11 and 3,158 m, respectively.

Bycatch considerations are incorporated into Integrated Fisheries Management Plan (IFMP) for this fishery (Figure 6). As part of the IFMP, this fishery is monitored through a log-book program and the bycatch is validated using a minimum of 10% electronic video monitoring. The directed Pacific Halibut fishery is open from mid-March to early November while a Groundfish hook and line longline fishery for other species is open year round, with a spawning season closure for the retention of Lingcod from November 15th to March 31st in all areas. The license conditions for these fisheries require the reporting of all birds caught by species, the release of all live birds in the least harmful manner, the use of bird avoidance streamers and or buoys the use of baited hooks that sink to the bottom as soon as they are put in the water (e.g. use sinking groundlines, thawed bait, and/or additional weight on the groundline), the discharge of old bait and offal so as not to attract seabirds to the longline gear, and the use of bait fish that do not retain air in their swim bladders or fish in which the air bladder is punctured .

Groundfish Trap Fishery

The groundfish trap fishery is considered a stationary fixed gear and is used in the SImNWA to target Sablefish, which comprised 98.1% of the 457 tonnes of the retained catch from the area between 2007 and 2013. The remainder of the landings consisted of two slope Rockfish species (1.3% of the catch) and a number of other incidental commercial fish species. A total of 48,148 incidental species were reported released. The fishery is mainly a deep water fishery with approximately 97% of the trap sets fished between 200-500 m along the continental slope. The fishery is monitored through a log-book program, electronic monitoring and dock-side validation. As part of the license conditions for this fishery, all birds caught must be reported by species and they must be released in the least harmful manner.

Other Groundfish Hook and Line fisheries

There are three small fisheries that fall within this grouping which include trolling, hand-line and rod and reel gear types. The groundfish troll fishery catch is composed of over 91% Lingcod. The hand-line fishery is 63 % Lingcod and most of the remainder is a variety of inshore Rockfish species. The rod and reel fishery catch is composed of >50% inshore rockfish species and most of the remainder is Lingcod. The hand-line and the rod and reel fishing events are mainly located in near-shore areas with average depths of 64 and 47 m, respectively. The average depth fished for all trolling events is 195 m. The license conditions for these fisheries requires the reporting of all birds caught by species and the release of all live birds in the least harmful manner. The fishery is monitored through a log-book program.

Invertebrate Fisheries

Prawn Trap Fishery

Prawn trap gear is a stationary fixed string of gear in which traps are attached to a longline that is anchored at each end of the string. Prawn traps have a number of small tunnel openings that do not have any triggers on the entrances so that ingress and egress are not impeded for animals that would fit through a tunnel opening (approximately 7 cm in diameter). The main target species is British Columbia's largest shrimp species, B.C. Spot Prawn (*Pandalus platyceros*). The first recorded commercial fishing in the SImNWA was occurred in 1984, and since that time all DFO statistical area/sub-areas in the SImNWA have been fished on occasion. In the years spanning 2007 and 2013, 6 vessels have fished within the SImNWA, deploying a total of 14,668 traps and catching ~10 tonnes of Spot prawn. The average fishing depth was 100 m with a minimum of 10 m and a maximum of 120 m. At sea-observer coverage is use to estimate an in season spawner index (female Prawns/standardized trap) by area and sub-area to determine the fishery closing times, and to record Rockfish bycatch data. Within the SImNWA, observer coverage has only been reported in statistical area 27-2 in all years that were fished. The average coast-wide sample rate for commercial Prawn trap-strings increased from 0.74% in 2002 to 3.48% in 2008 (Rutherford et al. 2010). There are no requirements within the conditions of license for reporting of any birds caught or for any interactions with species-at-risk, with the exception of Basking Shark (*Cetorhinus maximus*). The likelihood of bird interactions with this fishery is probably negligible; the only potential interaction with species-at-risk might be entanglement of marine mammals in the buoy lines, which has been reported in the Crab fishery.

Shrimp Trawl Fishery

A shrimp trawl is a mobile bottom-tending gear. A shrimp trawl fishery operated in the SImNWA from 1991 to 2000 targeting Smooth Pink Shrimp (*Pandalus jordani*). Two types of trawl are utilized in BC: beam trawls, which are held to a constant opening with a fixed beam, and otter trawls, which are held open using trawl doors. A total of 13 vessels operated in the SImNWA during the 1991-2000 period and reported catching ~175 tonnes of Pink Shrimp in the area. There is potential in this fishery for the capture of surface feeding seabirds, as in the groundfish trawl fisheries. The Shrimp trawl fishery in Queen Charlotte Sound was closed in 1999 due to concerns about the incidental catch of Eulachon. Use of bycatch reduction devices was introduced to the fishery in 2002. The fishery has been monitored using a partial observer program which varies in coverage by year, area, and trawl type. Reported coast-wide observer coverage (Rutherford et al. 2013) by year and trawl type ranged from 0.05% to 2.6% for beam trawls and 0.3% to 3.4% for otter trawls. There are no requirements within the conditions of license for the reporting of any birds caught or for modifying fishing activities to avoid any interactions with birds or species-at-risk, with the exception of Basking Shark.

Dive Fisheries

Both the Geoduck (*Panopea generosa*) and the Red Sea Urchin (*Strongylocentrotus franciscanus*) have been targeted in dive fisheries that have operated in the SImNWA. The Geoduck landings were recorded in one bed within the SImNWA, but the area has not been fished since 1999 and the dive fishery for Red Sea Urchin has not occurred since 2001. There is no bycatch in either of these fisheries.

Salmon Fisheries

Salmon Net Fisheries

There are no commercial Salmon surface net (gillnet/seine) fisheries in the SImNWA. However, Salmon net fisheries do occur in Johnstone Strait; an area used by Species SECs, most likely during migration after the breeding season. The conditions of license for the various Salmon net fisheries require reporting of any bird catches by “species or type” in their logbooks; recommend avoiding fishing among seabirds; and request collection of any bird mortalities for processing by DOE for subsequent identification.

Salmon Troll Fisheries

Salmon trolling occurs in the portions of Area 127 that overlap with the SImNWA. Area 127 ranks 4^{th} in terms of coast-wide troll effort for the years 2007-2013 During that time frame, Area 127 had an average of 8.5% of the coast-wide effort. The conditions of license for the Salmon troll fisheries require reporting of any bird catches by “species or type” in their logbooks; recommend avoiding fishing among seabirds; and request collection of any bird mortalities for processing by DOE for subsequent identification. There have been no reported bird bycatch in the Salmon troll fishery although it is known that some trolling practices catch birds especially if the bait is being trolled behind the vessel near the surface during deployment.

Pelagic Fisheries

Sardine Seine Fisheries

There are no reported commercial Sardine Seine Fisheries landings from within the proposed SImNWA since 2001. On the inside waters, the fishery has occurred in subarea 12-15 adjacent to subarea 12-14, which is partially included within the SImNWA. In the outside waters, the closest activities occurred in Area 126. There are no requirements within the conditions of license for reporting of any birds caught or for modifying fishing activities to avoid any interactions with birds or any species-at-risk with the exception of Basking Shark.

Herring Net Fisheries

There are no Pacific Herring fisheries within the proposed boundaries of the SImNWA. With the exception of terms and conditions for licensing of the special use ZY fishery and the ZM food fish fishery, there are no requirements for the reporting of any birds caught or for modifying fishing activities to avoid any interactions with birds or any species-at-risk. The ZY fishery license does provide details on the use of bird netting on holding ponds and the ZM fishery does provide guidance on interactions with Basking Shark.

Albacore Tuna Fisheries

The hook and line fishing gear licensed for fishing of Albacore Tuna (*Thunnus alalunga)* is specified as being either longline or troll gear. The only licence requirement with respect to bird interactions for this fishery is the utilization of avoidance devices when using longline gear; however, there is no Albacore Tuna fishery using longline gear. There are no requirements for the troll gear component of this fishery to report any birds caught or to modify fishing activities to avoid any interactions with birds or any species-at-risk with the exception of Basking Shark.

5.3. STEP 3: DEVELOP METRICS THAT MEASURE THE RISKS

The goal of this exercise is to determine the information requirements and data availability for undertaking a Level 2 assessment (Figure 2) as outlined in Section 4.2.2. To do this, the examples of species, habitats and ecosystem/community property SECs (identified in Section 5.1) will be assessed for overlap with commercial fishing activities and the known PoEs (identified under header 5.2). Where there is an overlap between the activity with a known stressor and the identified SEC, the data requirements to carry out a Level 2 Risk Assessment, focusing mainly on the most quantitative assessment protocols, will be considered and any issues identified.

5.3.1. Species SEC

Based on the scoping phase of this exercise, the stressor PoE from commercial fishing activities that will be considered in the risk assessment of **Species SECs** is the "*reduction in biodiversity through direct mortality of species that are not targeted in a regulated fishery through catch and entanglement*". This exercise will use a three step process to identify the information needed and available to undertake a Level 2 risk assessment of the identified stressor on the identified SEC.

The **first step** is to define the conservation unit or population with significant divergence of allele frequencies, that will be managed to ensure that evolutionary heritage is recognized and protected (Moritz 1994). Defining the population provides a base-line from which to measure consequence in terms of population size and productivity and to assess potential genetic loss and to evaluate the capacity for the SEC population to recover from the effects of the stressor.

The **second step** is to develop measurements of the exposure and consequences terms outlined in the Section 4.2 The exposure terms include measurements of the % overlap (area, time, depth) of the stressor and the SEC, and the intensity of the stressor in terms of amount and frequency of the stressor. The consequence terms include measurements of resilience and recovery potential. Resilience is a combination of the total loss as a measure of the acute change from direct mortality from the fisheries being assessed on the SEC population, and % change of fitness consequences is a measurement of chronic change.

The **third step** is to compare the population status to defined areas of risk. In a Level 2 risk assessment, there areas of risk are pre-defined exposure and consequence attributes based on scientific understanding of how stressors and populations respond, depending on a broad ranking of resilience and recovery attributes of various life history strategies of the species SECs. A fully quantitative Level 3 Risk Assessment measures the population level against upper and limit reference points which delineate the level of population risk into 3 zones: Critical is the zone below a lower limit reference point; Cautious is the zone between the lower limit and upper stock reference point and Healthy is the zone above the upper stock reference point. These zones are now part of DFO's Decision-Making Framework Incorporating the Precautionary Approach.

Step 1: Defining the population

Cassin's Auklet

Population genetic studies, on Cassin's Auklet, have identified two sub-species: a northern sub-species, (*P. a. aleuticus*), from the Aleutian Islands to Southeast Farallon Islands; and a southern sub-species (*P. a. austral*) from the Channel Islands of California to San Benito Island off Baja California (Wallace 2012). Cassin's Auklets nesting in BC are part of the northern sub-species complex.

Rhinoceros Auklet

A recent publication on the genetic structure of Rhinoceros Auklet (Abbott et al. 2014) identified a minimum of four distinct genetic groups from samples taken on breeding colonies in BC, Alaska and Japan. One of the most interesting findings was that the Pine Island and Triangle Island breeding populations were genetically distinct local populations despite their close spatial proximity. The Pine Island population is aligned with populations in S.E. Alaska, while the Triangle Island population is unique.

Black-footed Albatross

There is sufficient evidence of strong genetic differentiation between breeding populations of Black-footed Albatross in Hawaii and Japan to support treating them as separate populations for conservation management purposes (Walsh and Edwards 2005). The differentiation between the Hawaiian and Japanese populations was assessed to be insufficient to support further taxonomic separation, even at the subspecies level, according to the Taxonomic Working Group of the Agreement on the Conservation of Albatrosses and Petrels. It has also been suggested (Ando et al. 2011) that the Bonin Islands population be treated as a single genetic management unit separate from the other Japanese populations. The Japanese breeding populations make up ~ 5% of the global breeding population of Black-footed Albatross. The Bonin Islands population consists of 400 breeding pairs. According to the COSEWIC Assessment and Status Report, birds from both the Hawaiian and Japanese populations forage in Canadian waters (COSEWIC 2006).

Common Murre

The Pacific northern sub-species of Common Murre has a disjointed breeding distribution with hundreds of thousand of birds breeding on colonies between Oregon and northern California, greater then a million birds breeding on colonies from the Gulf of Alaska to the north and west and only 40,000 birds breeding on colonies from Washington state north to S.E. Alaska (Hipfner and Greenwood 2008). The estimated breeding population within BC is considered to be less than 10,00 individuals (Campbell et al. 1990, Hipfner 2005) and they occur in two major breeding colonies on Triangle and Kerouard Islands. These birds are part of the northern sub-species breeding population and are morphologically more similar to Gulf of Alaska populations than the more southerly breeding populations of this sub-species (Hipfner and Greenwood 2008).

Step 2: Measuring the Exposure and Consequence of the PoE on Species SECs

Quantifying the *"reduction in biodiversity through direct mortality of species that are not targeted in a regulated fishery through catch and entanglement"* against a species SECs resulting from an identified PoE stressor will require an assessment of bycatch associated with various types of fisheries. Fisheries deploying hook and line longline and gillnet gear were identified as having the highest levels of seabird bycatch although trawl, troll and seine fisheries were also identified as having seabird bycatch (Smith and Morgan 2005). The hook and line longline, trawl and troll fisheries are known to interact with surface feeding seabirds (such as Albatrosses, Shearwaters, Fulmars and Gulls), when the birds attempt to feed on bait, discards or offal while the fishing gear is being actively deployed or retreived whereas, gillnet and seine fisheries interact with diving birds (such as alcids, Loons, Grebes, and Cormorants) while the seabirds are actively feeding on forage fish in the same area as the fishing activity (Smith and Morgan 2005). There has been an anecdotal report of a Cormorant caught in a Sablefish trap fishery (Kate Rutherford, Groundfish Data Unit, DFO, pers. comm.)

Seabird bycatch information will examined for the Salmon net fisheries that occur outside the SImNWA as these types of fisheries do not presently occur within the SImNWA and for the Groundfish hook and line and bottom trawl fisheries that occur within and outside the SImNWA for this exercise. Seabird bycatch for all other fisheries that occur within the SImNWA were not evaluated as there is no information on the extent or nature of the bycatch that occurs in these fisheries. This lack of information results from the fact that these fisheries are not required at this time to provide this information on any bycatch species as a condition of licence, even species-at-risk, with the exception of Basking Shark.

Salmon net fisheries

There are no Salmon net fisheries in the proposed SImNWA boundaries; however, a review of information on the distribution of seabirds that breed in the SImNWA area shows that there is some overlap in space and time with Salmon net fisheries during non-breeding periods of feeding and migration. A summary of dead and released bird bycatch data from commercial Salmon net fisheries' seabird bycatch phone-ins, logbook and at-sea sampling programs found that between 2007 and 2013, Area 12 was one of the areas that tended to report the highest seabird bycatch. Area 12 is the statistical area just east and south of the SImNWA. For the diving bird SECs examples used in this exercise, seasonal distributional data (Kenyon et al. 2009) indicated that portions of Area 12 are utilized by Common Murre in the spring, summer and fall seasons; and by Rhinoceros Auklet and Cassin's Auklet, in the spring and summer.

Area 12 Salmon fisheries occur in in July, August and September targeting Fraser River Sockeye and Pink Salmon; and in October, on the Johnston Strait Chum Salmon stocks. Of the reported birds caught in these Area 12 fisheries between 2007 and 2013, 16% were taken in the Sockeye and Pink fishery, with a total effort of 6,375 boat days and 84% of the birds were reported caught in the October Chum fishery with 3,694 boat days of fishing.

The Area 12 seine fishery accounted for 78 (47%) of the birds reported, with only 1,905 (19%) of the boat days fished in the area while the gillnet fishery account for 87 (53%) of the birds and 8,164 (81%) of the total boat days fished in the area. The average reported seabird bycatch is 1.1 seabirds per 100 boat days for the Salmon gillnet fishery and 4.1 seabirds per 100 boat days for the Salmon seine fishery in Area 12.

The at-sea observer program was designed to collect and identify seabird carcasses in response to uncertainty in the identification of the seabirds reported in the logbook and telephone hot-line programs. The misidentification of the seabirds by industry caught in these fisheries is such that any formal assessment of bycatch impacts on seabird species or populations is impossible. In addition, the logbook reporting system is such that seabird bycatch can reported as being released, but there is no information as to condition (alive, dead, healthy, injured, etc.) at the time of release (Laurie Wilson, DOE pers. comm.). Reporting of bird bycatch is a condition of license in many fisheries, but there are only limited ways of validating the accuracy of the information at this time. A Chum salmon fishery opening in Area 12 on Oct 7-9, 2013, provides an example of the extent of the reporting problem. During the opening, only one vessel reported catching birds and retained the 5 birds it caught for DOE to conduct subsequent identification and maturity sampling. During an on-water sampling cruise of this fishery opening, DOE recovered 32 additional bird corpses caused by the fishery floating in the area which were not reported (Laurie Wilson, DOE, pers. comm.). If this example is representative of compliance by Salmon fisheries and assuming that DOE collected all other non-reported mortalities, then only 13.5% of the total mortality was captured through the gillnet logbook and voluntary reporting program.

Table 5: Seabird bycatch and effort data collected from Area 12 salmon net fisheries.

Area	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**
Central Coast							
12	**Gillnet**						
Count of Vessels	90	112	128	250	179	103	100
Effort (boat days)	498	691	681	4244	1448	602	708
Bird reported	26	2	20	5	11	0	23
CPUE (birds per 100 boat day)	5.2	0,3	2.9	0.2	0.8	0	3.2
12	**Seine**						
Count of Vessels	56	45	72	84	99	40	68
Effort (boat days)	77	81	241.44	371	815	60	259
Bird reported	14	22	0	1	24	2	15
CPUE (birds per 100 boat day)	18.2	27.2	0	0.3	2.9	3.3	5.8

Groundfish fisheries

Hook and line longline fishery

Within the 2007-2013 timeframe, bycatch of seabirds within the SImNWA was reportedly made exclusively in the groundfish hook and line longline fisheries. A total of 36 birds were reported in logbooks which included:16 Albatrosses (three of which were identified to species), eight Gulls and 12 unknown birds.

The Hook and line longline fleet collects data on their entire catch using both logbook and electronic monitoring programs. The logbook is the official catch as reported by the captain while the electronic monitoring program provides an audit of the accuracy of the reported catch. The electronic monitoring program captures a video record of the haul-back of every set and 10% of the video sets (with a minimum of at least one per trip) are randomly chosen for review to determine the relative accuracy of the logbook records for catch management purposes (Stanley et al. 2011). If there are discrepancies between the video and logbook information on location, date, time and catches of key species or species groups that are identified as having management concerns, then more of the video is reviewed. A pilot program was initiated in 2013-14 which included other species of interest in the audit program such as seabirds, Sharks (other than Spiny Dogfish), marine mammals and some Skates, to also evaluate the accuracy of the logbook catch reports with respect to these species groups.

The accuracy of Hook and line longline logbook records from the entire BC coast was evaluated using the video audit program to estimate the accuracy of the reported logbook catch of seabirds. The results of this evaluation for all records from the 2007-2013 period are as follows:

1. 251 video audited longline sets recorded 360 seabirds caught;
2. 365 longline logbook sets reported 521 seabirds caught;
3. 38 video and logbook longline records, with matching TripID and sets numbers, were found in which both sets of records reported seabird bycatch. Both sets of data reported 62 seabirds caught;
4. 213 (84.9%) additional video records recorded catches of 298 seabirds. None of these seabird catches were recorded in the equivalent(matching TripID and set numbers) logbook records.
5. an additional 459 birds were reported from sets in the longline logbook records that were not validated within the 10% video audit.

One conclusion based on this evaluation of compliance is that longline logbook records are underestimating seabird bycatch by as much as ~ 85%, which if extrapolated to the total logbook reported catch of 521 birds, would produce an estimate of 3,450 birds captured in the longline groundfish fishery coast-wide, and 238 in the SImNWA, during the 2007-2013 period. This coast-wide number is fairly close to the 3,600 birds that could be extrapolated solely from the video analysis, assuming that only 10% of the video has been analyzed and 360 birds were identified in that 10% coverage.

Trawl fisheries

The Option A (offshore) bottom trawl fishery is monitored with observers and the mid-water trawl fishery is monitored with a combination of logbook/electronic video compliance monitoring and observers on every vessel. There were no reported bycatches of seabirds in the SImNWA and only six seabird records reported in logbook records for the entire coast for the 2007-2013 period.

The absence of logbook reports of seabird bycatch from the trawl fishery in the SImNWA is assumed to be correct; however, it should be noted that even though there is an observer on the vessel, it is not always possible for the observer to track every tow especially when a vessel fishes continuously throughout the trip. Seabird bycatch has been reported in the trawl fishery on a coast-wide basis between 2007 and 2013. Five fishing events from these logbook records reported seabird bycatch. Three of these events reported catching unidentified birds (with a combined total weight of 3.63 kg, which equates to 4 birds at an average weight of 0.91 kg per bird). One event reported an unidentified Shearwater species for total catch weight of 0.91 kg, and one record reported a Northern Fulmar (*Fulmarus glacialis)* for 1.36 kg. When estimating seabird bycatch, the National Oceanic and Atmospheric Administration (NOAA) extrapolates the observer catch by the proportion of actual tows observed (Shannon Fitzgerald, NOAA/NMFS, pers. comm.). A quick review of the Option A Bottom trawl catch data found that ~5.6% of the reported fishing events had both the location information and the species composition from the logbooks only; which means that the remaining 94.4% of the reported catch records had observer validation.

Step 3: Setting the Reference Points

Reference points, as the term is understood by fisheries managers, are not used for seabird management. However, population reference points for seabirds in the SImNWA can be set based on criteria used nationally by COSEWIC to determine the status of birds under the

Species at Risk Act (SARA). At this time, of the 40+ species of seabirds (see APPENDIX 1) that are found in the SImNWA and fall under the protection of the *Migratory Birds Convention Act*, *SARA* and the BC *Wildlife Act*, three species have been identified as threatened and two species identified as special concern**.** For the species listed as threatened, there are recovery strategies in place for the Short-tailed Albatross, Pink-footed Shearwater and the Marbled Murrelet (*Brachyramphus marmoratus)*.

Once an animal is listed under *SARA* as Extirpated, Endangered or Threatened, there are three main prohibitions within the legislation that have relevance to aquatic species-at-risk (including seabirds). These prohibitions include: a prohibition against killing, harming, harassing, capturing or taking species-at-risk (Section 32); a prohibition against damage or destruction of residence (Section 33); and a prohibition against destruction of critical habitat (Section 58).

Allowable harm may be permitted through an authorization for SARA-listed species under *SARA* Subsections 73 and 74. A *SARA* compliant Authorization may not be required if an activity is determined to be exempt. For an activity to be exempt from the *SARA* prohibitions, two requirements must be met:

1. The proponent must be authorized under a federal Act of Parliament, (e.g., the proponent must have a valid Section 32 or S.s.35(2) *Fisheries Act* Authorization) with any conditions governing the activity that the Minister of Fisheries and Oceans considers necessary for protecting the species-at-risk, minimizing the impact of the authorized activity on the species or providing for its recovery so that it has the same effect as a SARA permit. Under exceptional circumstances, the issuance of a *Fisheries Act* authorization that contravenes the SARA general prohibitions can occur as long as the preconditions in section 73 of SARA can be met; and
2. The recovery strategy or action plan clearly states that the activity is allowed to occur.

It should be noted that DOE and DFO have established the National Seabird Bycatch Working Group to coordinate actions to reduce the incidental catch of seabirds in fisheries. This collaborative approach recognizes DOE's responsibilities for seabirds and the tools that DFO has to mitigate the impacts of fisheries on seabirds. Although DOE does not issue allowable harm authorizations for seabirds, it is recognized that some seabird bycatch by fisheries may occur as long as the nature and extent of seabird bycatch and the use of mitigation measures to reduce seabird bycatch can be demonstrated by DFO and the fisheries that it manages.

The use of Sections 73 and 74 for exemptions under *Fisheries Act* Authorizations requires that the preconditions in 73(2) to 73(6) are met. These **preconditions for exemptions** are:

- Under Section 73(2) of *SARA*, the agreement may be entered into, or the permit issued, only if the Minister is of the opinion that:
    1. the activity is scientific research relating to the conservation of the species and conducted by qualified persons;
    2. the activity benefits the species or is required to enhance its chance of survival in the wild; or
    3. affecting the species is incidental to the carrying out of the activity.
- Section 73(3) establishes that the agreement may be entered into, or the permit issued, only if the Minister is of the opinion that all three of the following pre-conditions are met:
    1. all reasonable alternatives to the activity that would reduce the impact on the species have been considered and the best solution has been adopted;

2. all feasible measures will be taken to minimize the impact of the activity on the species or its critical habitat or the residences of its individuals; and
3. the activity will not jeopardize the survival or recovery of the species.

- Section 73(3.1) states that if an agreement is entered into or a permit is issued, the competent Minister must include in the public registry an explanation of why it was entered into or issued, taking into account the matters referred to in paragraphs section 73 (3)(a), (b) and (c) above.
- Section 73(4) notes that if the species is found in an area in respect of which a wildlife management board is authorized by a land claims agreement to perform functions in respect of wildlife species, the competent Minister must consult the wildlife management board before entering into an agreement or issuing a permit concerning that species in that area.
- Section 73(5) notes that if the species is found in a reserve or any other lands that are set apart for the use and benefit of a band under the *Indian Act*, the competent Minister must consult the band before entering into an agreement or issuing a permit concerning that species in that reserve or those other lands.
- Section 73(6) states that the agreement or permit must contain any terms and conditions governing the activity that the competent Minister considers necessary for protecting the species, minimizing the impact of the authorized activity on the species or providing for its recovery.
- Section 73(6.1) states that the agreement or permit must set out the date of expiry of the agreement or permit.

After the agreement or permit is issued, Section 73(7) requires that the competent minister must review the agreement or permit if an emergency order is made with respect to the species.

Other international jurisdictions have set actual actionable reference points for some of these same seabird species. For example, NOAA has set an action-level consisting of a catch ceiling of two birds per year for Short-tailed albatross in the Alaskan longline fisheries, based on historical catches of the species in the fishery. If this level is met or exceeded, then a review of the fishery is required (Shannon Fitzgerald, NMFS, pers. comm.).

5.3.2. Habitat SEC

Fishing stressors that effect affect Habitat SECs in a manner and to a degree that they no longer have the physical characteristics necessary to function as feeding, spawning or resting areas were considered in evaluating the extent and consequence of commercial fishing activities in the SImNWA.

These effects could include damage or reduction of benthic biogenic structural biota, damage or reduced benthic habitat complexity, altered seafloor structure and large habitat features, or modification of sediment suspension rates. To understand the extent and nature of the consequences to the **Habitat SEC** requires knowledge of the ecological value of the habitat which includes information outlined in following steps described below.

The first step in a Risk Assessment of habitat SECs is to functionally describe the habitat properties of a species for successful completion of all life history stages. Defining the habitat gives a base-line from which to measure consequence in terms of the resilience and recovery of the Habitat SEC from the effects of a stressor.

The second step is to develop measurements of the exposure and consequences terms outlined in the Risk Assessment (Section 4.2). The exposure terms include measurements of the % overlap in area of the stressor and the habitat SEC, and the intensity of the stressor in terms of amount and frequency of occurrence. The consequence terms include measurements of resilience and recovery potential. Resilience is a combination of metrics measuring acute changes or % changes to the areal extent of a habitat when exposed to a given stressor, and of chronic changes that measure the structural integrity, condition, or loss of productive capacity. These chronic changes may be reflected as changes in density of biotic habitats, such as the density of kelp stipes, or changes in the amount of structural habitat sustained by abiotic habitats. Recovery is dependent on whether the habitat is biotic or abiotic; the metrics are similar to those used for Species SECs for biotic habitats, while the metrics for recovery of abiotic habitats are those that would reflect frequency of natural disturbance and the extent of occurrence and the fragmentation or number of locations.

The third step is to compare habitat status to defined levels of risk. DFO has adopted a Sensitive Benthic Area Policy that outlines the required steps to manage ongoing fishing activities and expansion of fishing activities into frontier areas. The Level 2 Risk Assessment in the ERAF (Figure 2) provides a pre-defined set of exposure and consequence attributes from current scientific understanding of how stressors and populations respond, depending on a broad rank of resilience and recovery attributes of various life history strategies of the biogenic habitat SECs. In a fully quantitative Level 3 assessment, the habitat upper and lower limit reference points would be used to delineate the level of risk to various abiotic and biotic habitat types. Providing baseline quantitative information on the types, location, size and condition of various habitat types for use in a Level 3 assessment is a work in progress under DFO projects related to the Pacific Marine Ecological Classification System (PMECS) (Robinson et al. 2015). The three Habitat SECs identified from the Habitat SEC selection process are discussed in relation to the outline presented above.

Areas of feeding aggregations

Defining the Habitat SEC

The functional description of SImNWA feeding aggregation Habitat SECs is an identifiable area that consistently includes bathymetric, geological and oceanographic conditions that provide access to diving seabirds targeting key zooplankton and/or forage fish species. Identification of feeding aggregation Habitat SECs is mainly informed by at-sea seabird surveys, documenting bird presence and abundance of birds by species, along transects (Kenyon et al. 2009), remote telemetry of key seabird species to follow individual movements and to identify areas of feeding as was documented for Cassin’s and Rhinoceros Auklets (Boyd et al. 2000, Ryder et al. 2001), and bathymetric, geological and oceanographic data that can be used to characterize areas of aggregation. This work is ongoing, and the results from telemetry work on additional species of seabird species is expected within the next year.

Developing metrics of exposure and consequences

In the scoping phase of this assessment of fishing activities identified within the SImNWA, there were no PoEs identified that would affect the pelagic feeding aggregation Habitat SECs for SImNWA seabirds. Other stressors such as changing climatic conditions have been implicated in changing the properties of these pelagic habitats (Bertram et al. 2001, Bertram et al. 2005) in a manner that has changed survival and production characteristics of Species SECs. Evaluating the consequences of these kinds of stressors is beyond the scope of this present Risk Assessment. Exposure to fishing activity stressors could be calculated but this is unnecessary since there are no known PoEs and no known acute or chronic changes which suggests no known consequences to the pelagic feeding habitat. Thus, based on the information currently available, the risk to the pelagic habitat SEC areas of feeding aggregations is likely neglible.

Areas of fishing that attract species that scavenge food

Defining the Habitat SEC

Commercial fisheries attraction Habitat SECs are associated with pelagic habitats that are utilized by commercial fisheries with fishing practices that discard overboard bycatch or offal or set baited gear that is accessible to birds at or near the surface of the water. These fishing practices attract surface feeding seabird species that scavenge these products as food. Within the SImNWA these fishing practices may occur in the Groundfish and Shrimp trawl fisheries, Groundfish hook and line (longline, troll, hand-line and rod and reel) fisheries, Albacore troll fishery and the Sablefish and Prawn trap fisheries.

Developing metrics of exposure and consequences

The abiotic characterization of the areas utilized by these fisheries varies as it is driven by the needs of the targeted fish species. Information on the areas fished is available through mandatory reporting requirements for these fisheries. However, the scoping phase of fishing practices identified within the SImNWA did not identify any PoE that would affect pelagic habitats. As such the exposure to fishing activity stressors could be calculated but this is unnecessary since there are no known PoEs and therefore no known acute and chronic changes which suggests no known consequences to the pelagic habitats SEC from fishing activity stressors. Thus, based on the information currently available, the risk to the areas of fishing that attract species that scavenge food is likely neglible.

Spawning and resting areas for key forage species within the SImNWA

Defining the Habitat SEC

The selection of spawning and resting habitat SECs for key forage species is based on forage species that depend on defined benthic habitats to provide key life history functions. The functional description of the properties of these Habitat SECs that allow successful completion of all life history stages was obtained from the literature. The data sources used to gather information to characterize or quantify definable habitat types, which are then correlated with species use patterns (Greene et al. 2007, Robinson et al. 2013) include directed photometric ROV surveys, visual dive-surveys, targeted benthic grab surveys, and modelling of abiotic bathymetric, oceanographic and geological characteristics.

Developing metric of exposure and consequences

The commercial fishery stressors that need to be assessed for the forage species habitat SECs are those associated with bottom-tending gear that damage or reduce structural biota, damage or reduce habitat complexity, alter seafloor structure and large habitat features, or modify sedimentation rates. These stressors may lead to alterations in the habitat characteristics that impede their functioning in a manner that allows for successful completion of the species life history requirements. These effects always occur on benthic habitats (DFO 2010) and as such only forage species that utilize benthic habitats during key life history stages will be considered for use in this exercise.

Juvenile rockfish *(Sebastes spp.)* and juvenile and adult PSL (Hedd et al. 2006, Hipfner and Greenwood 2008) are known to rely on specific benthic habitats for critical periods of their life histories and are also known to be important forage species for SImNWA diving bird SECs.

In the examples given below, only the groundfish bottom trawl and groundfish bottom-tending longline fisheries were analyzed as they consistently fished in the SImNWA area and had information on non-retained catch. The estimation of extent of the overlap between the stressor and the Habitat SEC depends on the nature of the interaction and the needs of the particular forage species chosen.

Juvenile Rockfish

Defining the Habitat SEC for juvenile Rockfish

Juvenile Rockfish have been identified as forage fish for a number of seabirds (Gillespie and Westrheim 1997, Kenyon et al. 2009), but the level of taxonomic identification in these studies was at the level of Family (*Scorpaenidae*). There are over 32 species of Rockfish that are caught in the SImNWA including representatives from inshore, slope and shelf populations. Some juvenile Rockfish are known to utilize habitats dominated by biogenic structures such as Glass Sponges, Corals and Hydrozoans as rearing areas (Rooper, Boldt et al. 2007). As noted above biogenic structures are prone to damage and/or removal by bottom-tending fishing activities. The locations of the habitat utilized by the juvenile stages of Rockfish varies considerably between species from near-shore benthic habitats (Love et al. 1991) to offshore benthic habitats (Rooper et al. 2007).

Developing metrics of exposure and consequence

The area of impact of a bottom trawl can be calculated in a number of ways, depending on the information available. In this example, the area of impact of the trawl was calculated by multiplying the door spread of the gear by the length of tow, i.e., by estimating the "area swept" by the trawl. The length of tow was calculated from the geo-referenced locations of the start and end points of the tow using the “haversine” formula (see Equation 4:) to calculate the great-circle distance between two points over the earth’s surfaces.

Equation 4:

$$\boldsymbol{Distance}\ (\boldsymbol{km}) = \boldsymbol{ACOS}(\boldsymbol{SIN}(\boldsymbol{lat1}) * \boldsymbol{SIN}(\boldsymbol{lat2}) + \boldsymbol{COS}(\boldsymbol{lat1}) * \boldsymbol{COS}(\boldsymbol{lat2}) * \boldsymbol{COS}(\boldsymbol{lon2} - \boldsymbol{lon1})) * \mathbf{6371}$$

The average “haversine” distance towed for hard and soft bottom groundfish trawl gear was 7.45 km. The average door spread of 51.18 metres was estimated from logbook information when available for hard and soft bottom trawl. The average estimated area swept per trawl tow over the period 2007-2013 was 0.38 km^2. There were 5,023 reported groundfish bottom trawl tows (see Table 1) in the SImNWA over the 2007-2013 time-frame, so the area swept over that time was ~ 1,915 km^2. This estimate has both low and high biases. The low bias occurs because the estimated length of the tow is based on the shortest distance between the beginning and end points of the tow and does not take into account the actual shape of the tow which can loop back onto the starting point. The high bias occurs because the calculation does not take into account any overlap in bottom areas between different tows. The total area that is presently open to the bottom trawling within the SImNWA is 2,315 km^2 (see Figure 4). The estimated area swept is equivalent to 83% of the total allowable trawling area.

There were 11,150 sets deployed within the SImNWA by the hook and line longline fisheries over the period 2007-2013. The actual area of contact is difficult to estimate because it would be based on the amount of movement that the gear had while in contact with the bottom. Movement may occur during deployment and retrieval of the gear, as well as by fish struggling while the gear is fishing. To assess the potential area of impact the SImNWA was gridded into 5 x 5 km blocks and the number of sets was compiled for each block. Within the SImNWA there were 403 blocks or 83% of the area that was identified as being fished using hook and line longline gear. The minimum number of sets in a block was 1 and the maximum was 1,715 with an average of 200 and a SD of 269.

The extent and nature of the impact on stressors that damage or reduce habitat SECs can in part be determined by analyzing the bycatch in the commercial groundfish fisheries within the

SImNWA for structural biota. As part of this project, a review of the logbook information from groundfish fisheries in SImNWA was completed. It found that structural biotic species were reported including unknown Sponges, Calcareous Sponges, Glass Sponges, Demosponges, unknown Anthozoans, Stony Coral, Anemones, Soft Corals, Gorgonian Corals, *Paragorgia sp., Primnoa sp.,* unknown Sea Pens/Sea Whips and *Ptilosarcus gurneyi.* All the reported bycatch of these biogenic species was taken in groundfish trawl fisheries. It is possible to assign the removal of structural habitat types to individual tows; however, since the tows are on average 7.45 km long, the precise location of the habitat would be more difficult to determine without further analysis to assess catches from overlapping or closely aligned tows. Furthermore, if most of the damage to these biogenic structures occurs on the first pass of the gear over the bottom, then this type of analysis may be inconclusive.

It is known that hook and line and trap fisheries can also damage or reduce structural biota (DFO 2010), but since the structural biotic species are not usually retained by hook and line longline, hand-line, rod and reel or trap gear, it is impossible to assess the nature or location of the impact without some additional information such as video assessment of the seabed in areas of fishing activities. The Sablefish trap fishery is working with DFO using video cameras that are motion activated, to assess the area and nature of potential impact of this trap gear on the seabed and its community (R. Kronlund, DFO, pers. comm.).

The first step in defining the consequences of interaction between the fishing activities stressors and juvenile Rockfish habitats is getting information on which species of juvenile rockfish are being utilized as forage species. Knowing the forage species of Rockfish is necessary to identify their species specific habitat requirements for the habitat SEC selection.

The second step after the habitat SEC is selected is to estimate the extent of exposure of the habitat to the footprint of the various fishing stressors, and to estimate the potential consequences (resilience and recovery potential) for the various species-specific biogenic structure and the resulting impact on the successful completion of all life histories of the forage Rockfish species.

The third step in the process is to understand the location and size of the impacted habitat in relation to the total habitat available to the forage species. One of the key pieces of information for assessing the quantity and location of various habitats types is a bottom classification analysis based on multi-beam echo-sounding data. Multi-beam echo sounding surveys were conducted between 2006 and 2013 in and near the SImNWA RCA to classify backscatter to bottom type and relate it to various inshore Rockfish habitats; this type of work will be discussed below in relation to the spatial extent of PSL habitat.

Adult and juvenile Pacific Sand Lance

Defining the Habitat SEC for PSL

PSL is a key forage fish for a variety of the diving seabirds that utilize foraging areas in the SImNWA. PSL are targeted from their larval stages (e.g., Cassin’s Auklet) through to adult stages (e.g., Rhinoceros Auklet and Common Murre) (Gillespie and Westrheim 1997, Ostrand et al. 2005, Hedd et al. 2006, Thayer et al. 2008, Kenyon et al. 2009, Therriault et al. 2009, Borstad et al. 2011). The presence of PSL in the diets of many seabirds has been shown to be key in the success of fledgling growth and survival (Bertram et al. 2001, Hedd et al. 2006). Robinson and Jones (2013) summarized published and unpublished information and studies on PSL, and their congenerics in Japan and the North Sea, and identified four key habitats utilized by different life history stages of PSL. Of the identified habitats utilized by PSL, the spawning habitats and the resting and overwintering habitats are both benthic habitats.

Spawning habitats for PSL are mainly intertidal and potentially subtidal, and characterized by fine to course (0.2-0.4 mm) sand with little to no silt (Robards et al. 1999, Penttila 2007). Silt is thought to affect habitat suitability as it may lead to anoxic conditions in the benthic substrate where spawning occurs (Robinson and Jones 2013).

PSL utilize resting and overwintering habitats to bury themselves when they are not able to feed visually during period of low and no light conditions, as an energy conservation strategy because they do not have a swim bladder and must swim constantly while in the water column, and as refugia from predators (Robinson and Jones 2013). Predictive modelling has been carried out to locate burying resting/overwintering habitats in the Strait of Georgia, BC (Robinson et al. 2013). The habitat characteristics used in this modelling were coarse sand substrate (0.25 -2.0 mm), shallow <80 m depth, and high (25-63 cm sec^{-1}) bottom currents. Based upon other studies on the BC coast (Haynes and Robinson 2011, Robinson et al. 2013), resting habitat is considered to be critical for management actions, because they are patchy and limited in distribution, they need to be in close proximity to PSL pelagic feeding areas, and PSL have high specificity and site fidelity to such areas.

Categorization of the benthic habitats in the SImNWA area is derived from the analysis of bathymetric and acoustic bottom backscatter data collected by a Multibeam Echosounder (MBES). The Canadian Hydrographic Service (CHS) conducted five MBES surveys between 2006 and 2011, covering 780 km^2 of seabed, and one MBES survey (in 2013) that covered an additional 130 km^2, within the SImNWA (Figure 7). The 2006-2011 data were analyzed and reported on by Stephen Finnis and the 2013 data were analyzed and reported on by Cassie Bosma[1]. This analysis was intended to be a semi-automated seafloor classification technique that used the sediment composition (i.e., sand, bedrock, slightly gravel sand, gravelly sand) and broad scale topographic features (i.e., crests, slopes, flats, depressions) to develop a zonal classification of the SImNWA. The grain size composition of the sand, slightly gravel sand and gravelly sand sediments were classified with ArcGIS™ software using only backscatter intensity, while the bedrock information was derived from the bathymetric information on slope, neighborhood statistics and rugosity (Figure 8). The topographic features were derived from a Bathymetric Position Index (BPI) which uses multibeam bathymetry data to provide fine and broad scale quantitative descriptors of the seabed terrain which in turn are used as predictor variables for species distribution models. The BPI used was part of the Benthic Terrain Modeller (BTM) toolbox developed by NOAA and Oregon State University.

Estimating the location and abundance of PSL resting/overwintering benthic habitats within the SImNWA required the use of finer scale BPI structural characteristics that are nested within the broad scale Zonal classification of the area as noted above. Finer scale BPI structural characteristics include features such as sand waves, pinnacles and current scoured depressions. Seabed sand waves can be visually detected from multibeam bathymetry and hillshaded relief models. Sand waves at depths < 80 m are considered indicative of areas containing the modelled habitat preferences for PSL resting and overwintering habitats (Robinson et al. 2013, Robinson and Jones 2013). Three and five sand waves were identified in the 2006-2011 and 2013 data, respectively, at depths of <100 m within the survey areas. These sand waves were mainly associated with a “sand” sediment composition and broad scale “flats” topographic features. The total area for the seven sand wave areas identified was 3.9 km^2 while the total area surveyed <100 m was 847 km^2. This techniques likely underestimates of the area of the sand waves as the BPI calculations are binned at 25 m^2 into a single classification so if

[1] Both Finnis and Bosma were employed as coop student terms jointly working with CHS (Dave Jackson) and DOE (Greg Jones)

there is a boulder in the area the whole area would be defined as a non-sand wave (Cassie Bosma, DFO, pers. comm.).

Developing metrics of exposure and consequence

Coast-wide, there have been a number of activities identified as potential threats to PSL habitat, including sewage outfalls from coastal development, electrical and communication cable seabed corridors, and dredge disposal/dumping (Robinson et al. 2013), These activities are all known to modify benthic habitats through direct contact, or through changes in sedimentation regimes by covering the area with sewage, dumped material, mud or silt. A recent CSAS meeting addressed the re-mobilization of sediment caused by fishing activities (Boutillier et al. 2013). The key factors that characterize the sediment impacts of fishing activities include the bottom sediment composition where fishing occurs, the force of the gear on the bottom, which affects the height to which the material is re-suspended, and the current direction and strength (Boutillier et al. 2013). The commercial groundfish bottom trawl fishery is operating within the SImNWA next to the proposed southern Queen Charlotte Sound Sponge Reef Area of Interest (AOI) (Figure 1). In the development of the boundaries around this AOI, it was determined that the sediment types that the fishery was working on included postglacial sand, a foraminifera-rich Holocene sand often with ripples or sand waves on the surface, low stand sublittoral sand and silt with grey to olive grey silty sand to sandy silt, glaciomarine ice-distal sediments of grey or dark grey silty clay with minor interbeds of sand and matrix-supported sand and gravel, and Ice-contact tills (which is a massive sandy, gravelly mud with a surface that is hummocky, iceberg scoured and pitted) (Figure 9). The majority of the trawling occurs on a low stand sublittoral sand and silt (Conway et al. 2008) (the Light brown unit on Figure 9). It is well-sorted sandy silt to silty sand that was eroded from bank margins during a post glacial sea level. This unit contains 5-20 % sand and 40-60% silt with smaller amounts of clay (Conway and Luternauer 1985, Conway et al. 2005).

In the Risk Assessment of remobilization of sediments from trawling (Boutillier et al. 2013), a resettlement model was constructed and run on the remobilization characteristics of a composite mud sediment type based on the average characteristics of the mud sediment types in the area. The resettlement model estimated the potential distance of dispersion under steady flow conditions in relation to the height off bottom attained by the remobilized bottom sediment. For the purposes of the framework presented for that Risk Assessment, the sediment settlement and transport modeling was based on a sediment composed of 55% silt (3.9 to 63um), 30% clay (0 to 3.9um) and 15% sand (63um+) with a calculated average grain size = 20um.

The resettlement model predicted that:

- The majority of large silt to sand-sized particles will settle to the bottom within one tidal cycle;
- The majority of cohesive-sized particles (small silt and clay), which is the most common particle size, are likely to be flocculated and due to their cohesive nature, they will not be easily eroded again; and
- There will be unflocculated grains that will not settle as quickly but material eroded from a stable cohesive bed is likely to be highly aggregated. Furthermore, the high concentration of remobilized material, as well as the turbulent nature of the trawl, is likely to bring particles in contact so that they flocculate and settle at high rates as compared to individual particles.

Resettlement rates are affected by the clay content. If the clay content is reduced to <30%, the resettlement time will increase and the area of impact will expand. This low clay content is indicative of the low stand sublittoral sand and silt sediment found on the seaward edge of the southern Sponge reef AOI complex, adjacent to the SImNWA. This sediment is found in depths between 100-200 m, as is the most heavily trawled area within the region of interest. However, it is important to note that the remobilized sediment will largely remain at the depth horizon of remobilization due to the trawl impact, which may be ~10 m off the bottom (Boutillier et al. 2013). It is highly unlikely that this material would move up onto the shallower, subtidal and intertidal areas identified as spawning habitats and resting and overwintering habitats for PSL, unless there were strong currents moving the silt upwards.

The key factor in assessing the consequences to abiotic habitats is the frequency of natural disturbance similar to the stressor identified from the commercial fishery. The sea bottom on Cook Bank in the SImNWA is naturally modified by storm-related wave disturbances, which can be seen to depths of 80-105 m as ripples on seabeds composed of coarse sand and shell (Yorath et al. 1979) and as sorting of mineral-enriched sands to depths of 80-160 m. If the remobilized materials from bottom trawling initially settled on PSL burying habitats in depths of <80 m, then the material could be remobilized in the next storm event. Fine sand transport will occur at least 10% of the time in depths shallower than 100 m in the SImNWA (Barrie 1991), assuming a critical threshold velocity of 0.25 m s^{-1} for a 0.125 sediment particle size.

5.3.3. Ecosystem/Community Properties SEC

The ecosystem/community property SEC (see 5.1.3) chosen for this section will assess the potential risk of the fishery stressor of discarding bycatch, offal and bait, impacting the trophodynamic relationships within the SImNWA. This complex problem requires an understanding of the nature and extent of a number of interrelated stressor/response relationships, a discussion of the kinds of data required to evaluate the exposure and consequences of the various scenarios, and a discussion of the types of management actions and the risks associated with their implementation.

The first step in the Risk Assessment of an Ecosystem/community property SEC is identifying the trophic community properties (Rice 2006), by identifying the species assemblage and assessing their roles, needs and interaction strengths in the community food web. Where species with large interaction strengths cannot be directly identified, the best science practice for trophic relationships is to focus on key trophic roles that are essential to ecosystem structure and function, including forage species, highly influential predators, nutrient importing (and exporting) species, primary production, and decomposition. This approach will provide a base-line from which to measure consequence in terms of the resilience and recovery factors of the ecosystem/community property SEC.

The second step is to develop measurements of the exposure and consequences terms outlined in the Risk Assessment (Section 4.2). The exposure terms include measurements of the % overlap in area, timing and depth of the stressor and the various ecosystem/community property SECs, and the intensity of the stressor in terms of amount and frequency of the stressor. The consequence terms include measurements of resilience and recovery potential. Resilience is a combination of metrics measuring the % of species impacted;, % of functional groups impacted, % decrease in total abundance per functional group, and % decrease in taxonomic distinctness. Recovery factors include attributes concerning species richness; taxonomic distinctness, % of functional groups with total number of members per group >5 or 10, and, abundance of functional groups. High rankings of these recovery factors are consistent with low consequences.

The third step is to understand if, where and how the myriad of interactions could be managed and if the resulting consequences of the management action are producing the expected and desired results.

Step 1: Understanding the nature and extent of stressor/response relationship

Species or species groups, which might play a top-predator role in the trophodynamics in the SImNWA include Bald Eagles and large Gulls (*Larus* spp.). These predators are known to scavenge and benefit from fishing vessel discards (Gillespie and Westrheim 1997) and to prey on the eggs, juveniles and adults of seabirds. Diet studies in the North Sea and Mediterranean Sea have found that populations of top seabird predators can increase as a result of ready access to food resulting from discard practices in the commercial fishing industry (Furness 2003, Furness et al. 2007).

Within the SImNWA an interesting dynamic has been documented between Peregrine Falcon, Bald Eagle, Glaucous-winged Gull, Common Murre and Pelagic Cormorant at Triangle Island (Hipfner et al. 2011). In this case breeding success of two ground nesting bird species on Triangle Island (Common Murre and Pelagic Cormorant) was high during a four year period (2003-2006) in which a pair of Peregrine Falcons nested in a near-by falcon eyrie. In the following three years, the falcon eyrie was inactive and the adult Common Murre were heavily preyed upon by Bald Eagles. Also, once the Murres were flushed from the incubating areas by Bald Eagles, Glaucous-winged Gulls fed on the eggs. As a result of the lack of protection provided by the Peregrine Falcons, breeding success for both of the ground-nesting species on Triangle Island was poor in 2007 and was zero for Common Murre in 2008 and 2009 and the Pelagic Cormorants no longer nested in the area. In this scenario there are three functional groups: the guardian (Peregrine Falcon); the predators; and the ground-nesting prey.

What is understood in this scenario is that the populations of Bald Eagle and Glaucous-winged Gull are sufficiently large to have severe effects on the ground nesting species in the SImNWA, and that if the Peregrine Falcons are occupying the eyrie, that these predation rates are curtailed. What is not known is the extent to which fishery discards play a role in the population abundance of these top predators, the drivers of Peregrine Falcon presence/absence in the eyrie, and the effect on prey species and their role in the ecosystem in the long term.

Step 2: Data required to understand effects of community property trophodynamics

In trying to understand the more complex trophodynamic interactions, there is a need to distinguish between natural and anthropogenic stressors (e.g., fisheries discards) and their relative effects on ecosystem and community properties. Gaining this understanding requires spatial and temporal quantification of the natural and anthropogenic stressors that contribute to population dynamics of the three functional groups noted in step 1. This means understanding and documenting the extent and nature of effects from climatic events such as El Niño and La Niña on the trophodynamics in the region and understanding the amount, composition and how the fisheries discards are processed temporally and spatially (Furness et al. 2007). It also means being able to understand the extent and nature of the response within the community such as changes in the availability of prey species (Bertram et al. 2001, Bertram et al. 2005, Hedd et al. 2006), seasonal overlap between the stressor and the community (Ryder et al. 2001, Kenyon et al. 2009), nutritional value of the forage species (Österblom et al. 2008), the nutritional requirements of the community species consumers (Hedd et al. 2006, Thayer et al. 2008, Borstad et al. 2011), and the responses of prey species behaviorally and their population dynamics as well as functional role in the ecosystem.

Step 3: Ecosystem/community property Management actions and the risk associated with implementation

There is evidence that not managing issues such as fisheries discards may have led to elevated populations of seabird scavengers/predators in the North Sea and Mediterranean Sea (Furness et al. 2007). It has been shown that with the implementation of management actions aimed at reducing the availability of discards such as varying the timing of fisheries, establishing a moratorium on certain fisheries in certain areas (Oro 1996), or eliminating or reducing discards (Votier et al. 2004) that there will be a variety of responses from the predatory/scavenger birds including reduced reproductive output, poor fledgling survival, changing feeding locations into novel land-based habitats (Oro et al. 2004) and prey switching (Duffy and Schneider 1994).

Pacific Fisheries management measures have been implemented by DFO to reduce discards in a number of fisheries in Pacific Region. According to fishing and processing industry these actions appear to be effective in meeting their intended goals of cleaner and better condition catches in the Shrimp fishery, and better utilization of commercial species in the groundfish fisheries), however there has been no documented review on the complete extent and nature of the consequences of these changes to the ecosystem as a whole.

As noted in Step 1 above, there have been issues documented within the SImNWA ecosystem in the Pacific where predatory birds impacted populations of some ground-nesting seabird populations (Hipfner et al. 2011). At this time there is no work proposed by either DOE or DFO to evaluate the linkages between commercial fishery discard rates and population size, feeding behavior, or nutritional requirements of these predatory seabird populations.

6. DISCUSSION

The goals of this paper are to discuss examples of the risks of fishing activities impacting the conservation goals and objectives of key species, habitats and ecosystem/community properties within DOE’s proposed SImNWA. The intended results of this analysis are to identify and inform issues associated with fisheries that impact the SImNWA conservation goals and objectives, prioritize gaps in knowledge, and, suggest potential research directions that will address the knowledge gaps. To be effective, an IMF should include measures that:

- monitor the nature and extent of the interactions between SECSs and anthropogenic stressors, against a background of variations within natural environmental stressors;
- implement where possible mitigation measures that modify practices to reduce or eliminate the interactions; and
- assess mitigation measure to evaluate their relative effectiveness against their intended objectives.

6.1. KEY SPECIES

The types of fishing gear that potentially expose seabirds to the risk of incidental capture include trawl; hook and line longline, troll, hand-line, and rod and reel gear; gillnet; and seine gears (Smith and Morgan 2005). Reporting of seabird bycatch in DFO-managed fisheries is the responsibility of the Minister licensing or authorizing the activity. The reporting of these impacts is in accordance with Canada’s federal legislative framework under the *Species At Risk Act* (SARA), as well as ratified international agreements such as the 1995 Conduct of Responsible Fisheries (FAO 1995, FAO 2010). These legislative and ratified agreements provide the *raison d’etre* for the development of DFO’s “Strategic Framework for Fishery Monitoring and Catch Reporting in the Pacific Fisheries”, as part of the 2009 Sustainable Fisheries Framework suite of policies and tools for the implementation of an ecosystem approach to management. The objectives of this framework are applicable to all fisheries (commercial, First Nations, and recreational)l, and are designed to ensure that Canadian fisheries are managed in a manner that supports the sustainable harvesting of aquatic species while minimizing the risk of causing serious or irreversible harm to bycatch species, and to account for total catch, including retained and non-retained bycatch. The implementation of this strategic framework is guided by the document "Guidance on Implementation of the Policy on Managing Bycatch". Within this guidance document are sections that outline strategies to achieve the policy objectives, including:

1. Develop data collection and monitoring systems that will support timely, reliable, and aggregated reporting on retained and non-retained bycatch species;
2. Evaluate the impact of fishing on bycatch species, whether they are retained or returned to the water;
3. Minimize the capture of bycatch species and specimens that will not be retained, to the extent practicable;.
4. Where capture of bycatch species and specimens that will not be retained is unavoidable, maximize the potential for live release and post-release survival;.
5. Manage the catch of retained bycatch so as not to exceed established harvest levels for the species; and
6. Develop appropriate measures to manage bycatch and regularly evaluate their effectiveness.

More specific requirements are included under the Canadian *SARA* legislation for activities that negatively affect plants and animals that are listed as Threatened, Endangered or Extirpated. *SARA* legislation outlines the responsibilities for licensing of fishery activities that expose *SARA*-listed species to the risk of harm. These responsibilities for licensing need to recognize that prohibitions are in place against killing, harming, harassing, capturing or taking any birds listed as Threatened, Endangered or Extirpated under *SARA*, unless authorized or permitted under Section 73 or 74 of *SARA*. Under these sections of the *SARA*, any license, order or other similar document authorizing a person or organization to engage in an activity affecting listed species must include an explanation of why this was entered into or issued in the Public Registry.

6.1.1. Recognition of the Issue

DOE and DFO recognize seabird bycatch as a conservation issue. The two Departments created the Pacific Region Seabird Bycatch Working Group in 2000 and began sharing data on seabird bycatch within numerous fisheries, reviewing and analyzing bycatch data, exploring options for mitigating seabird bycatch and providing advice. As well, the Departments established a Memorandum of Understanding for the sharing of data related to commercial and test fisheries, seabirds and the incidental bycatch of seabirds while fulfilling their respective mandates.

Shortly thereafter, DFO and DOE established the National Seabird Bycatch Working Group to coordinate the preparation of a 2003 Status Report (DFO and CWS 2003) and later, published Canada's National Plan of Action (NPOA) for Reducing the Incidental Catch of Seabirds in Longline Fisheries(DFO 2007b). The collaborative approach recognizes DOE's responsibilities for seabirds, and the tools DFO has to mitigate the impacts of fisheries on seabirds. In 2012, the National Seabird Bycatch Working Group released a 5-year review of Canada's NPOA - Seabirds .

Management of some fisheries, that utilize gear known to catch seabirds, has recognized the issue and included conditions within the license that require or encourage relevant actions to address seabird bycatch. In the Pacific Region, these types of statements are present in license conditions for the Groundfish trawl and hook and line fisheries, the Salmon gillnet, seine and troll fisheries, the Albacore longline fishery (for which there are no active Canadian participants) and the Herring special use ZN fisheries.

However, this management response is not consistently applied to all fisheries in the Pacific Region that authorize the use of trawls, hook and line gear, gillnets and seines. Management of fisheries including the Shrimp by trawl; Herring pond spawn on kelp; Herring gillnet; Herring seine; Herring communal roe; Albacore troll and Sardine seine, do not have any conditions of license that specifically address seabird bycatch issues.

6.1.2. Utilization of known mitigation methods

Mitigation methods to reduce or eliminate seabird bycatch have been studied, evaluated, and reported upon internationally for trawling and longline hook and line fisheries under the Agreement on the Conservation of Albatrosses and Petrels (ACAP). Some of the recommended ACAP mitigation measures have been incorporated into the Groundfish hook and line longline, and the Albacore longline conditions of licenses in Pacific Region. These mitigation measures include release of all live birds in the least harmful manner, use of bird avoidance streamers and or buoys, use baited hooks that sink to the bottom as soon as they are put in the water, e.g. use sinking groundlines, thawed bait, and additional weight on the groundline, and use of bait fish that do not retain air in their swim bladders or have a punctured swim bladder, and proper care and management of discarded bait and offal. There are no compliance measures in place to ensure the use of these mitigation measures during fishing operations.

The ACAP Seabird Bycatch Working Group are working on measures to reduce entanglements in trawl nets during setting and hauling procedures and measures to reduce interactions with warps and third wires. To date some of the best practices recommended by the working group include:

- Discard and offal discharge management so that it does not occur prior to or during setting and hauling. The goal is to minimize the number of birds associated with the fishing vessel;
- A combination of net cleaning (Hooper et al. 2003) prior to the shooting of the net, and increasing the sinking rate of the net through net binding (Sullivan et al. 2004, Roe 2005);
- Minimizing the time the net is on the surface, and avoiding slack/lofting by maintaining tension on the net; and
- Care is needed to remove birds without causing injury, which may include keeping waterlogged birds on board in a quiet dry place until they can recover prior to release.

Although these trawl mitigation best practices recommended by the ACAP Agreement are not presently incorporated into the conditions of license for any of the Pacific coast trawl fisheries, some of the industry may be carrying out these practices voluntarily.

DFO does not currently have conditions of license to mitigate bird catch interactions with diving birds and the salmon net fisheries. At best fishers are requested to avoid fishing in areas of high bird concentrations in the salmon net fisheries and to take care when releasing entangled birds. The use of gear modifications, such as weed-lines, is voluntary in most areas, and where they are implemented in the fishing notices, it is in response to bycatch issues of other salmonid species. There has been work conducted as part of the Selective Fisheries Policy that included bird-bycatch information which could be analyzed to determine if management measures, such as weed-lines or varying the timing and areas of fishing, help to reduce diving-bird bycatch (Jeff Grout, DFO Fisheries Management, pers. comm.). No such analysis has been completed at this time (Jim Thomas, consultant, pers. comm.); however, there are unpublished summary notes from the Salmon Selective Fishery Program (1995-1999) Nitinat gillnet test fishery bycatch study which indicated that the bycatch of seabirds appeared to be reduced with the use of weedlines (Wilf Leudke, DFO Science, pers. comm.).

6.1.3. Monitoring programs

For those fisheries that require reporting of seabird catches as part of their conditions of license, only those that incorporate an effective compliance monitoring program are capable of providing reliable estimates of the associated direct mortalities for Species s. Only the Groundfish fisheries in Pacific Region meet this standard.

Defining the conservation unit

DFO's management actions, under the Strategic Framework for Fishery Monitoring and Catch Reporting in the Pacific Fisheries, or under *SARA*, deal with seabirds only at the species level. There is no management recognition of any seabirds at a population level resolution, in part because there is a lack of scientific research on population ID for many of these bird species.

Estimating the Exposure of the Impact

Estimates of the total seabird bycatch can in part be calculated from the groundfish bottom trawl observer program, and the electronically-monitored groundfish hook and line longline and trap fisheries. These monitoring programs were designed to check for errors in logbook reporting as the timing, location and total catches are used to manage coast-wide quotas. The program is designed with checks and balances to ensure accuracy such that normally 10% of the video is used to validate the logbook records for select groups of animals. However, if the error rate or the difference between logbook and video estimates, is deemed to exceed an allowable error rate, then the fisher has to pay to have 100% of the video analyzed. In the bottom trawl fishery, for which coverage is high, the error checking is based on extrapolation of observed to non-observed hauls, similar to practices used by NOAA in the Gulf of Alaska trawl fishery. The observer program for the Pacific bottom trawl fishery is designed so that this extrapolation can be made. One potential uncertainty in this system is that an observer may not record incidental bird catches because they are not the main target species required for reporting against quotas.

Estimates of total bycatch of seabirds from the salmon net fisheries logbook and hail reporting programs are suspected to be inaccurate (see Section 5.3.). These self-reporting monitoring programs have no systematic quality assurance procedures that can be used to validate catch and the reporting of location and timing data are imprecise, as they are aggregated by Fisheries Statistical Sub-Areas and day.

For the other trawl, and hook and line, gillnet and seine fisheries that do not require bycatch reporting, there are no estimates of bird bycatch. Consequently it is impossible to estimate any interactions in these commercial fisheries.

Even with the extensive coverage and compliance monitoring systems in some fisheries that recognize the issue with seabird bycatch, there are few data from commercial vessels for which there is any certainty as to the identification of the seabird bycatch at the species level and there are no data for identification of seabirds at the population levels. There is an at-sea program, run by DOE, that was established to collect bird mortalities from the salmon fishing fleet for a limited number of fisheries and vessels. The dead birds are identified to species level, then sexed and aged. This kind of program can be effective when the fleet is concentrated temporally and spatially, for example during a gillnet fishery opening, or operating in a specific area for a short duration. It is, however, impractical for other fisheries like the groundfish longline fisheries, which are spread-out over the coast and operate for months at a time. Additionally, there appears to be a reluctance to retain dead seabirds on fishing vessels for later collection and analysis.

It is not possible to assess the risk of direct harm to seabird populations in the SImNWA because there is little information on the identification of seabird bycatch to species in DFO-managed fisheries at present. Stock ID programs based on genetic analysis and identification are being used for salmon management. Tissue samples are collected by at-sea sampler or by stakeholder groups, following an established collection protocol. This type of program could be adapted to address fisheries related mortalities of seabirds at the species or population level.

Estimating the Consequences of the Impact

There is no program that is being undertaken by DOE/DFO designed to evaluate the Resilience or Recovery of seabirds taken as bycatch in Canada's Pacific commercial fisheries. This is type of program would be useful but it may run into the same problems with species identification that plague the estimate of exposure.

6.2. HABITAT SECS

Three Habitat SECs may have interactions with the SImNWA goals and objectives:

1. Areas of seabird feeding aggregations;
2. Areas of fishing activities that attract seabird species that attempt to steal bait from hooks and/or scavenge food such as offal, discharged from fishing vessels; and
3. Spawning or resting areas within the SImNWA for identified key prey species.

There were no identified PoEs caused by fisheries that would present any risk to the first two habitat SECs listed above.

The examples chosen for the third habitat SEC were associated key prey species that utilized benthic habitats for spawning or resting. The impacts from fishing were found to be either unlikely or unknown for juvenile Rockfish and PSL in the SImNWA.

In the case of PSL, the PoE of remobilized sediment, ascribed to the fisheries in the area, would not likely have any effect on the type of habitat (sediment-free, sandy substrate, <100 m depth) required for spawning or resting of this critical prey species. However, it still is important to know the locations of these habitats and their relative abundance, as there are activities and stressors, other than fisheries, that could potentially impact them.

In the case of juvenile Rockfish, there are PoE from a number of bottom-tending fisheries known to have effects on biogenic habitats utilized by some Rockfish species. However, without information on which species of Rockfish are utilized by seabirds, it is not possible to draw the linkage and overlap between the extent of the various fishery impacts and the amount and location of the key prey Rockfish species habitat requirements. Recognizing the difficulty with identification of juvenile Rockfish, one way to address this information shortfall is to utilize a genetic species ID program to confirm the identification of key prey species.

6.3. ECOSYSTEM/COMMUNITY PROPERTY SECS

The work in the North Sea on Great Skuas, and in the Mediterranean on large Gulls, showed that the abundance of these birds reached and was maintained at artificially high levels, because of access to fishery discards. Trophodynamic changes in community properties of those species occurred after fisheries management actions were implemented to reduce and ultimately, eliminate fisheries discards. The consequences of the fisheries management actions triggered prey switching by the Skuas and Gulls, which resulted in impacts to other biota, including other seabirds. There was no management response to this switching, even though the prey switching ultimately may lead to some scavenging and population declines in some prey seabird populations to a level where they might be considered threatened or endangered. The general conclusion in the literature is that there is a belief/hope that the predators and prey will come to some sort of equilibrium within the ecosystem, although there is no information on the magnitude of these historic equilibrium levels.

There also have been a number of fish discard reduction measures used in the Pacific region by industry and management to address a number of different issues. These discard reduction measures include: the integrated groundfish management plan which accounts for and provides a mechanism to all groundfish sectors to land all commercial species; establishment of bycatch quotas on Coral and Sponge catches for the Option A groundfish trawl fisheries; Eulachon catch quotas for the Shrimp trawl fisheries off the West Coast of Vancouver Island; and the use of bycatch reduction grates in the Shrimp trawl fishery to eliminate the retention of large fish.

There are still discards resulting from these fisheries and as such outcome has been a reduction in bycatch rather than a complete elimination. Unfortunately there has been no evaluation of the overall effectiveness of these programs in terms of changes in the species composition, changes in the nutritional values of the discards or changes in the total discard weights because in many fishery sectors (excluding the Option A bottom trawl fisheries) the historic and present discards are not well documented . Without these data it is impossible to determine if there is a relationship between varying discards rates from fisheries and changes in the trophodynamics in the region or the population dynamics of various seabird populations utilizing these discards. There is evidence in the Pacific region that Glaucous-wing Gulls and Bald Eagles can utilize fisheries discards and that they have been documented to have impacts on breeding success of Common Murre and Pelagic Cormorants on Triangle Island under certain conditions.

7. RESEARCH NEEDS

The evaluation of research and monitoring needs within the SImNWA is based on the data needs to carry out Risk Assessments for the examples of SEC species, habitats and ecosystem properties. This Risk Assessment requires information on the ***overlap*** and ***intensity*** elements of the **Exposure** of the stressors on the SECs and the **Consequence** attributes related to the SEC in terms of ***resilience*** (acute and chronic change) and ***recovery.***

7.1. SPECIES SECS

The objectives proposed for the SImNWA that focused on Species SECs were:

- 2 C: Direct mortality of seabirds caused by human activities is minimized through the use of effective mitigation measures:
- 3 D: In collaboration with other responsible authorities, support the implementation of recovery strategies, action plans and management plans for species listed under Schedule 1 of the *Species at Risk Act*.

7.1.1. Exposure information for Commercial Fishing Activities

To understand the exposure components of the Risk Assessment, it is necessary to understand the nature (PoE) of the effect that would cause direct mortality on seabirds (2C) and that would ensure implementation of the recovery strategies for listed species (3D). The information requirements include estimates of total direct mortalities by species attributed to commercial fisheries, and estimates of the extent of overlap and intensity of the various commercial fishing stressors to which the SECs are exposed. Such information is needed to manage these activities within the rebuilding strategy for species SEC's.

Estimation of Overlap (Location, timing, depth)

Current Context:

There are ongoing programs in all commercial fisheries that require reporting of the **timing, location and effort** of all fishing activities. In estimating the overlap of the Exposure term there were a few issues that were evident in terms of the quality of the information from the commercial fishing activities reviewed.

Gaps in quality of information:

- Location information is imprecise in salmon net fisheries, i.e., location is reported by Statistical Area rather than by latitude and longitude of the fishing event. This lack of precision on fishing effort and seabird bycatch locations, precludes understanding the potential linkages between areas of high fishing effort and high seabird numbers and bycatch.
- The information on the time of overlap is poor in the commercial salmon net fisheries because fishing activities are reported only by the date of the fishing event, rather than by the date and the start and finish times of each fishing event. Knowing the time of day birds are caught relative to when fishing occurs could assist with efforts to minimize or eliminate seabird bycatch if the catch of seabirds in these fisheries is related to the day or night conditions.
- There are potentially some issues with determining the overlap in depth fished by mid-water trawls and their potential impacts on benthic habitats. The depth of a mid-water trawl set is often reported as depth of the headline rather than the footrope of the net opening, which can differ by > 10 m.

Estimation of the intensity of the impact of the stressor

Current Context:

- When assessing the quantitative extent of the bycatch stressor on Species SECs, the quality of information available from fisheries that potentially have seabird bycatch varies from good to non-existent. There are reporting requirements for seabird bycatch in the license conditions for active groundfish and salmon net fisheries while none of the other active commercial fisheries for invertebrates or pelagic fish that utilize trawls, gillnets, seines, or hook and line (troll or trap) gear, have license conditions that require the reporting of seabird bycatch.
- The information available from the Groundfish Option A trawl fisheries and the hook and line longline and trap fisheries, can be validated as the data collection programs have either observers and electronic monitoring quality assurance components in their design which make it possible to estimate the total seabird bycatch with a degree of confidence. However, the information generated by these programs is not useful in it’s present state because the system does not have sufficient resolution to provide estimates at either the seabird species or population levels.
- Some salmon net fisheries have an at-sea monitoring program designed to validate the identification of seabirds species reported in as bycatch. Anecdotal observations of floating dead birds in areas of fisheries that are not reported indicate that the total reported bycatch in the voluntary system underestimates the total number of birds killed, assuming the anecdotal data are representative of seabird mortality in the fishery. There is no quality assurance program in place for the Salmon fisheries from which to reliably estimate total seabird catch.

- There are a number of mitigation measures that have been implemented in the License Conditions for the groundfish fisheries. Testing of various seabird bycatch mitigation measures for trawl and hook and line longline fisheries, have been carried out by many international bodies (governments, NGOs and industries) around the world.
- Mitigation measures have not been implemented to reduce seabird bycatch in the Salmon net fisheries. Some mitigation research studies have been conducted on gillnets as part of the Salmon Selective Fishing policy. Unfortunately, the analysis was restricted to bycatch of certain non-target Salmonids even though information on seabird bycatch was collected.
- Salmon net fisheries do not occur in the SImNWA. However, salmon net fisheries do take place in Johnson Strait, which is used at various times throughout the year by seabirds that nest on the Scott Islands.

Gaps:

- The lack of seabird bycatch reporting from other fisheries that utilize gear known to catch and kill seabirds makes it impossible to measure the total impact of fishing on seabird populations.
- None of the fisheries examined provide sufficiently detailed information on the identification of the species or populations of seabirds that are being impacted. Without this information it is not possible to estimate the impact of fisheries on seabirds species or population of seabirds.
- Although well-studied elsewhere, the efficacy of the mandatory mitigation measures listed in the conditions of licensing of some fisheries (e.g., Groundfish hook and line) have never been tested in the Pacific Region. As well, the level of compliance in using the mandatory mitigation measures has never been assessed.
- The lack of quality assurance programs on bycatch reporting in the Salmon net fisheries makes it impossible to estimate total fishing related seabird mortality with any degree of confidence.
- There is no inventory of feasible measures to minimize/mitigate the impacts of commercial fishing activities to reduce or eliminate the threats to species or their habitats. For example, the Salmon selective fishing mitigation research has not been analyzed to incorporate non-Salmonid bycatch species, even though these data were collected.

Assessment and research needs to estimate the Overlap and Intensity components necessary to estimate the Exposure terms of Commercial Fisheries impacts on Species SECs:

- A review of seabird bycatch monitoring requirements needs to take place under the implementation guidelines of the DFO Pacific Strategic Framework for Fishery Monitoring and Catch Reporting in Pacific Fisheries for all hook and line (longline, troll, hand-line, rod and reel and trap), trawl, gillnet, and seine fisheries.
- There is a need for an effective genetic sampling program to provide essential information on the species of seabirds impacted by fishing. The Barcode of Life (BOL) program has collected base-line genetic ID data for all the seabird species identified within the proposed SImNWA (Appendix 1) and can distinguish between all species except for Flesh-footed Shearwater (*Ardenna carneipes*) and Pink-footed Shearwater (*A. creatopus*) (Paul Hebert, Barcode of Life, pers. comm.). On-board vessel genetic sampling procedures and protocols have been used with sectors of the Salmon fishing industry for a variety of purposes and can be easily be adapted to address this issue.

- Quality assurance and compliance monitoring programs need to be developed to understand the degree of uncertainty associated with the data provided by the various fishing sectors. Designing these programs could be part of the review of the implementation guidelines of the DFO Pacific Strategic Framework for Fishery Monitoring and Catch Reporting. Most practical solutions arise through collaboration with industry.
- The Salmon selective fishing mitigation research needs to be expanded to include analysis of other bycatch issues. A summary document of these Salmon selective fishing studies needs to be prepared and the results made available to managers responsible for bycatch issues in these fisheries.
- Recovery action plans have been completed for *SARA*-listed seabird species and include proposed biological reference points for delisting the species

7.1.2. Consequence Information for Species SECs

To understand the consequence side of the Risk Assessment equation, the example stressor chosen for this exercise is limited to bycatch of seabird Species SECs attributed to the commercial fishing activities. To evaluate the consequence side of the risk assessment equation, the information requirements measure changes related to the species SECs of two factors: Resilience and Recovery.

7.1.3. Resilience Factors

1. Acute Change is a measure of the change in population-wide mortality rate when exposed to the stressor. This metric requires an evaluation of the present SEC status in terms of abundance, range and number of populations.

   Current Context:

   - There is an ongoing program to estimate reproduction and population trends of the seabird species at breeding sites within the SImNWA.
   - Assessment of non-breeding populations of seabirds that utilize the SImNWA is normally done at their breeding sites, however measurement of the total impacts from fisheries is an international effort. If the newly established North Pacific Regional Management Organization follows the lead of the South Pacific, Antarctic and the Atlantic RFMOs, then it will be requesting national estimates of seabird bycatch as part of a commitment to global assessments of highly migratory endangered species.
   - Much of the spatial/temporal marine distribution and abundance information on the seabird community is collected by placing observers on ships-of-opportunity. There are some very effective programs using telemetry which allows tracking of breeding birds during foraging trips from their nest sites, or of post-breeding season movements (of adults or young) away from the colonies.

   Gaps:

   - Seabird assessment and management programs are carried out at the species level, but there is evidence in the literature that it would be more appropriate to do so at the population level for some species of seabirds. Many species of seabirds, including those that nest in the proposed SImNWA, exhibit behavioral patterns, such as mating for life and site fidelity with respect to the natal breeding location, which could easily lead to unique population structures.

- o Having an understanding of the at-sea distribution and abundance of seabirds is essential to identify potential areas (and the extent of) overlap with a variety of stressors. However, this kind of information is limited spatially and temporally.

2. Chronic Change is a measure of change at the population level of condition fitness, and genetic diversity.

   Current Context:

   - o For the stressor/species SEC interaction chosen, the focus was on the Acute Changes (increased mortality) caused by bycatch in commercial fisheries. The major gap identified in assessing Acute Change in terms of the identification of the species or populations being impacted would need to be addressed first before trying to understand Chronic Change.
   - o There is ongoing work investigating the diet of the breeding seabirds in the SImNWA and information is collected on the general condition of adults, clutch sizes and fledgling survival. This information is essential for understanding variations in condition, fitness, and some of the factors that may contribute to this variability.

Recovery factors

Recovery factors are those attributes of a species biology and behavior that affect the time for the SEC to return to a pre-stress level once the stressor is removed. These attributes include fecundity, breeding strategies, recruitment patterns, natural mortality rates; age at maturity, life history stage affected, population connectivity, and population status.

Current Context:

Time series of most information listed above are collected annually through international assessments of seabirds during breeding season aggregations. This information is essential for the assessment and management of these seabirds.

Gap:

At present there is no international consensus on the appropriate level of genetic conservation, i.e., should some seabirds be managed at the species level or at a population level? The lack of consensus affects estimation of recovery attributes including connectivity, population status ranking under IUCN standards and national COSEWIC/SARA standards, assessment of the probability that the recovery targets can be achieved with current population dynamics parameters, and how that probability varies with changing mortality (especially lower) and productivity (especially higher) parameters.

Assessment and research needs to estimate the Resilience and Recovery factors necessary to estimate the Consequence terms of Species SECs exposed to bycatch in commercial fisheries:

- An effective population genetic sampling program needs to be developed to determine the appropriate genetic level at which to assess, monitor and manage seabird species/populations in Canada's Pacific marine waters in general and the SImNWA in particular.
- There is potential to expand the at-sea observer program that provides information on the spatial and temporal range of seabirds utilizing the SImNWA by better coordination of ships-of-opportunity utilized by other federal departments for enforcement or science, academic researchers and industry. The first step is to evaluate data availability and information gaps.

7.2. HABITAT SEC

Assessment and research needs for habitat SECs are restricted to the risks posed by commercial fisheries in meeting the three SImNWA objectives:

1. Areas of feeding aggregations;
2. Areas modified by fishing activities that attract species that scavenge food from fishing vessels; and
3. Spawning or resting areas within the SImNWA for identified key prey species.

The PoE for commercial fishing activities did not identify any effects on pelagic habitats. Commercial fisheries impacts that were analyzed in this exercise were those that could affect benthic habitats associated with spawning and resting areas of the key prey species examples for seabirds in SImNWA (i.e., PSL and juvenile Rockfish).

7.2.1. Exposure information on Habitat SECs from Commercial Fishing Activities

To evaluate the exposure components of the Risk Assessment, it is necessary to understand the nature of the impact on benthic spawning and resting areas for the identified key prey species. The basic information needs are identification of the key prey species, the characteristics of the resting and spawning habitats for those identified key prey, the nature of the impact, the location and quantity of the habitats and the overlap with the fishing event impacts.

Estimation of Overlap (Location, timing, depth)

Current status for estimating exposure overlap with juvenile Rockfish habitat data

- Juvenile Rockfish are known to be common in a number of seabird diets.
- The juveniles of several Rockfish species utilize benthic habitats that are complex, particularly those with large biogenic structures.
- The PoE from commercial fishing activities that impact habitat SECs for Rockfish will be those that damage or reduce the benthic biogenic structural biota, damage or reduce benthic habitat complexity, or alter seafloor structure and large habitat features.
- The main commercial fishery impacting benthic biogenic structures is associated with the use of mobile bottom-tending gear; although, stationary bottom-tending gear may also impact biogenic structures.
- The largest fishery operating in the SImNWA using mobile bottom-tending gear is the Groundfish Option A bottom trawl fishery. There are ongoing programs in the major commercial groundfish fisheries that require reporting of the timing, location, effort, and all catch.
- Large biogenic structures, such as Sponges, Corals and Hydrozoans, occur in catches of bottom trawls.
- The Sablefish trap fishery is experimenting with trap cameras to assess their impacts on biogenic structures.
- Gaps in estimating exposure overlap for juvenile rockfish habitat data*:*
- Whether or not juvenile Rockfish are key prey species in the diet of some seabird species that occur in the SImNWA is unknown at present.

- There are over 32 species of inshore, shelf, and slope Rockfish known to occur in SImNWA. The Rockfish that are showing up as prey in the seabird diets have not been identified to species.
- The location of habitat essential to the prey Rockfish species cannot be determined until the Rockfish are identified to species.
- Non-mobile bottom-tending gear like Groundfish hook and line longline and trap fisheries, do not normally retain biogenic structures they impact, so it is difficult to assess the potential level of harm attributable to these gears.
- Current Context: for estimating exposure overlap for PSL habitats
- The PSL is an essential prey element associated with fledgling success in a number of seabirds that occur in the SImNWA.
- PSL benthic habitats are associated with benthic resting and spawning areas.
- PSL resting habitats are subtidal, course sandy areas associated with strong bottom currents. The maximum depth for these resting habitats is thought to be <80 m.
- PSL spawning areas are thought to be intertidal and composed of fine to course sand with little or no silt.
- The identified stressor from commercial fishing activities that potentially impact these habitats is remobilized bottom sediments which could silt over existing habitats, resulting in those habitats becoming anoxic.
- Sub-tidal PSL resting habitat is believed to be associated with sand-waves, and can and has to a limited extent, been identified and quantified within the proposed SImNWA, using multi-beam hydroacoustic back-scatter data.
- The quantity and mobility of sediment remobilization depends on the type of benthic habitat being fished; with the greatest remobilization occurring on bottoms with very small sized, non-flocculating, silt type materials.
- Areas of high mobility sediments have been identified by Natural Resources Canada (NRCan) through a combination of analysis of multi-beam backscatter data and validation with bottom grabs, in waters >120 m deep, that are impacted by bottom trawling.
- Other information that is required to quantify the distribution of remobilized material is the force of the gear on the bottom, the height in the water column to which remobilized material ascends, and bottom currents.
- There does not appear to be any overlap between remobilized material from known deep-water (>120 m) silty bottoms, and either the resting or spawning areas of PSL. Remobilized sediment will likely be limited to at the depth horizon to which it was re-suspended. For deep-water tows, it is assumed the plume will ascend as high as 10 m above the bottom, which is still in waters much deeper than the resting or spawning areas of PSL.
- Gaps for estimating exposure overlaps with juvenile and adult PSL habitat data*:*
- The inventory of the benthic habitats in the SImNWA is incomplete.
- There is no information as to the actual height of the sediment plumes from various configurations of bottom-tending fishing gears.
- The information on the possibility of sub-tidal PSL spawning areas is sparse.

Estimation of the intensity (effort/density) of impact of the stressor

Current status for estimating intensity of impact on juvenile Rockfish habitats

It is not possible to quantify the intensity of the stressors on juvenile Rockfish habitats since the habitat characteristic and distribution may vary depending on the species of Rockfish and species identification is lacking at present.

Current Context: for estimating intensity of the impact on PSL habitats

There is no known overlap between the remobilization of sediment stressor from bottom trawling and the PSL benthic habitat SEC so the intensity of the impact was not estimable for PSL benthic habitats.

Assessment and research needs to estimate the Overlap and Intensity factors necessary to estimate Exposure terms of Commercial Fisheries impacts on Habitat SECs:

It should be noted that even though some of the stressors from commercial fishing activities do not impact the examples of habitat SECs chosen in this exercise, there are potentially other activity stressors (such as pollution) that could impact both pelagic and benthic habitat SECs within the SImNWA.

For the impact/habitat examples analyzed, the recommended research and analysis required to quantify exposure include:

- Appropriate identification of the Rockfish prey species. Identification can be accomplished by collecting tissue samples from prey species and having the BOL analyse them to species. The BOL has a fairly good genetic ID inventory of Pacific marine fishes.
- There needs to be better information on the nature and extent of impact by bottom-tending, non-trawl fishing gear to understand impacts modifying the biogenic and non-biogenic habitats.
- There needs to be better information on the height off bottom of remobilized sediments to better understand the spatial extent of the impacts remobilized of sediments.
- There needs to be a complete benthic classification inventory of the location and areal extent of the various qualities/properties of the benthic habitats in the SImNWA.

7.2.2. Consequence Information for Habitat SECs

The attributes that are used to assess potential risks to habitat SECs are resilience factors (Acute and Chronic Change) and recovery factors, which include risk elements for biotic habitats (life stage affected, natural mortality rate, recruitment rate, age at maturity, connectivity rating) and for both abiotic and biotic habitats (frequency of natural disturbance and distribution range/fragmentation).

Resilience Factors

Current context for measuring resilience factors for habitat SECs

Acute and Chronic change to Habitat SECs

Acute change is measured as the % change in areal extent of a habitat when exposed to a given stressor. Chronic change is measured as the % change of structural integrity, condition, or loss of productive capacity.

- It is not possible to measure the acute or chronic change of juvenile Rockfish prey habitats until the species identification issue outlined above is resolved.
- Since there is no known exposure overlap between the stressor (remobilized sediment) and PSL resting and spawning habitat SECs, there is no measurable acute or chronic change.

Recovery Factors

Current Context for measuring consequence recovery attributes for habitats SECs

Biogenic structures

- There is very little information in the literature on the biology and population characteristics for many cold-water Corals, Sponges, Bryozoans, and Hydrozoans from which to estimate the recovery attributes of these biogenic structures. This issue is recognized internationally and is central to the commitments of Convention on Biological Diversity (CBD 2008) and highlighted in FAO work on vulnerable marine ecosystems (Rogers et al. 2008).
- DFO Pacific Region released a Cold water Coral and Sponge conservation strategy in 2011 that identifies objectives, strategies and actions for cold-water Coral and Sponge conservation, management and research.

Abiotic seabed classification

- There are a number of collaborations within DFO, as well as with other federal government departments, to share hydroacoustic multi-beam backscatter and oceanographic data, to develop a better understanding of the abiotic features of the pelagic and benthic marine habitats.
- There is a program within DFO Marine Ecosystem and Aquaculture Division (MEAD) and OSD to use a modelling approach to develop a Pacific Marine Ecological Classification System (DFO 2013, Robinson et al. 2015).

Assessment and research needs to estimate the Resilience and Recovery factors necessary to estimate the Consequence terms of Commercial Fisheries impacts on the biotic and abiotic elements of Habitat SECs:

The recommended research and analysis required to quantify consequences to the habitat examples analyzed will require research on:

- the critical habitat needs of the key prey species;
- what constitutes a key prey species of seabirds. This would require information to answer questions on:
    - o The nutritional requirements of various life stages of the seabird Species SECs;
    - o The nutritional value of various life stages of the prey species; and
    - o The fitness condition of SECs as a result of feeding on various prey species;

  There have been some excellent examples in the literature from the SImNWA, documenting changes in the pelagic environment affecting food supplies and ultimately seabird fledgling survival. The key aspect to this work is the continued collection and access to the relevant oceanographic data, bottom classification and biological information that is collected in cooperation with a number of agencies;
- the presence and extent of habitat spatial configuration constraints, if any, such as connectivity, barriers to access, etc. This information is essential for quantifying consequences to Habitat SECs and would mean support for continued access to high level

oceanographic information delivered by DFO to understand how water properties change over time, and how these changes affect distributions of pelagic prey species or biogenic habitat;

- benthic habitats utilized by essential prey species. Understanding where, how much and the properties of these habitats is an ongoing process that has historically involved the efforts of the CHS and NRCan; while working on issues common to DOE, DFO and Parks Canada. This information must continue to be collected as it is a key piece in understanding the risks to SImNWA and it is critical to managing issues over the entire region;
- the development of the Pacific Marine Ecological Classification System (DFO 2013, Robinson et al. 2015). The development of a full scale PMECS will take a number of years and as such needs a long term commitment. The products from the final PMECS program will provide quantitative information on the consequence recovery factors associated with distribution range/fragmentation;
- the feasibility of restoring habitat to higher values; and
- cumulative effects from all activities and stressors which can alter the quality and/or quantity of habitat that is available. This requires a Risk Assessment on a broader more encompassing range of anthropogenic activities within the SImNWA. This type of exercise is presently underway for DFO MPAs, and could be applied to SImNWA.

7.3. ECOSYSTEM /COMMUNITY PROPERTIES SECS

For this exercise, the commercial fishery stressor considered was the practice of discarding unwanted fish, offal and bait. The hypothesized ecosystem/community property alteration was associated with the trophodynamics of the system. The discussion that followed was related to the mechanisms by which anthropogenic derived food supply could affect the trophodynamics of the ecosystem, and what information would be required to assess the validity of this hypothesized interactions. As with the other categories of SECs, risk to ecosystem/community properties is a function of exposure and consequences.

The example stressor chosen to understand the information needs for the consequence side of the Risk Assessment equation, is limited to hypothesized impacts on the trophodynamics of the ecosystem, as a result of discards attributed to the commercial fishing activities.

7.3.1. Consequence Information for ecosystem/community

The information required to assess consequences includes measures of a suite of attributes related to Resilience and Recovery factors.

Resilience factors:

- % of species impacted,
- % of functional groups impacted,
- % decrease in total abundance per functional group, and
- % decrease in taxonomic distinctness.

Recovery factors:

- Species richness,
- Taxonomic distinctness,

- % of functional groups with total number of member per group >5 or 10, and
- Abundance per functional group.

These consequence attributes provide measures of potential areas of change within the ecosystem.

Exposure Information for ecosystem/community

On the exposure side of the equation includes attributes of overlap and intensity, the types of information that are required address questions such as:

- Which birds utilize commercial fisheries discards as a food source?
- Where, when and how much discarded material is available within the SImNWA seabird foraging arenas?
- How much of a species' diet is obtained from commercial fishery discards over time?
- What is the nutritional value of the discarded material?
- How have the populations of birds utilizing this discard resource changed over time?

Current Context for consequences and exposure:

- The ecosystem/community property SEC changes are direct and tractable cases of species-based assessments of ecological significance, where a species has a crucial role in the structure and function of the trophodynamics of the system;
- The crucial roles identified were: vulnerable seabird SEC species which function as prey species (in this example these are ground-nesting Common Murre and Pelagic Cormorant); highly influential predators on these seabird SECs (Bald Eagle, Glaucous-wing Gull and Raven); and raptors that provide positive non-consumptive facilitations in the form of refuge for the seabird SECs prey species (Peregrine Falcon through aggressive territorial defense around their nests provide refuge for ground-nesting pelagic seabirds);
- Assessments of Common Murres which have high breeding site fidelity provide good information on consequences to one of the major prey species;
- Pelagic Cormorants are believed to abandon breeding sites in areas when faced with high levels of predation. Population declines for Pelagic Cormorants populations across western North America are thought to be associated with an increasing populations of Bald Eagle;
- Presence or absence data around SImNWA pelagic seabird nesting sites is available for Peregrine Falcon and Bald Eagle;
- Assessments of Glaucous-wing Gulls are available;
- Breeding failed completely for the breeding populations of Common Murre and Pelagic Cormorant in the years that the Falcon eyrie was unoccupied;
- There is information associated with how abiotic factors such as El Niño and La Niña events affect seabird populations;
- For the exposure side of the equation, there is information available on the location, and timing of fishing activities for all fisheries;
- There is information available, from many of the groundfish fisheries within SImNWA, on the amount and composition of the non-retained species;

- Work on diets for SImNWA diving birds has proven indispensable for understanding some of the factors related to the health and well-being of seabird populations utilizing the area; and
- There was work historically carried out on in the area on the marine food-web dynamics.

Gaps in the consequence and exposure information:

- Lack of information on what drives the occupancy of the Peregrine Falcon eyrie;
- Lack of a historical perspective on quantity and quality of discards and how they varied over time;
- Lack of a historical perspective on any correlations between availability of discards and population response in scavenging seabird populations;
- Lack of a historical and ongoing perspective of food-web dynamics in the area; and
- Lack of a historical perspective on changes in diets of predatory birds.

Assessment and research needs to estimate the Consequence and Exposure factors of Commercial Fisheries discard impacts on the trophodynamics of the SImNWA Ecosystem:

To understand the trophodynamic interaction example presented here, to the extent that it can provide information to inform managers on the implications of management actions affecting the quality and quantity of discards, the types of assessment and research needs include:

- A better understanding of the factors affecting the population dynamics and behavior of bird species that provide key functions in the ecosystem (i.e., Peregrine Falcon);
- Routine monitoring of the resilience and recovery factors of the consequence elements identified in the Risk Assessment framework, for the ecosystem/community properties from bycatch, seabird diets and marine fisheries assessment programs;
- Expand bycatch monitoring to all fisheries;
- Understand the nutritional requirements of seabird SEC life stages;
- Routinely monitor the nutritional value of diets; and
- Explore relationships between diets and abiotic environmental factors.

The federal and provincial natural resource departments responsible for management of natural resources have a strong history of working together. Continuing to find mechanisms to foster this working relationship will be the only way that these issues can be addressed.

8. ACKNOWLEDGEMENTS

I greatly appreciate the efforts of Greg Jones and Ian Parnell from Canadian Wildlife Service (CWS) of DOE for believing in this project and providing the resources necessary for it's completion. Without the insights and work of many of DOE staff this work could not have been completed in particular I would like to express my gratitude to Ken Morgan, Mark Hipfner, Doug Bertram and Laurie Wilson for taking time to talk with me and answer my questions and share their insights. Data from DFO Science was provided by Shelee Hamilton, Kate Rutherford, Lisa Lacko and Leslie Barton, while information and experiences were shared with retired DFO Fish Management and Science staff including Brent Hargreaves and Don Lawset as well as a multitude of current DFO Groundfish, Salmon, Herring and Invertebrate fisheries managers, SARA managers and Oceans managers. A special thanks to the Regional CSAS office and the

CSAS chair for supporting this review of this work that addresses issues that are relevant to both DOE and DFO.

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10.FIGURES

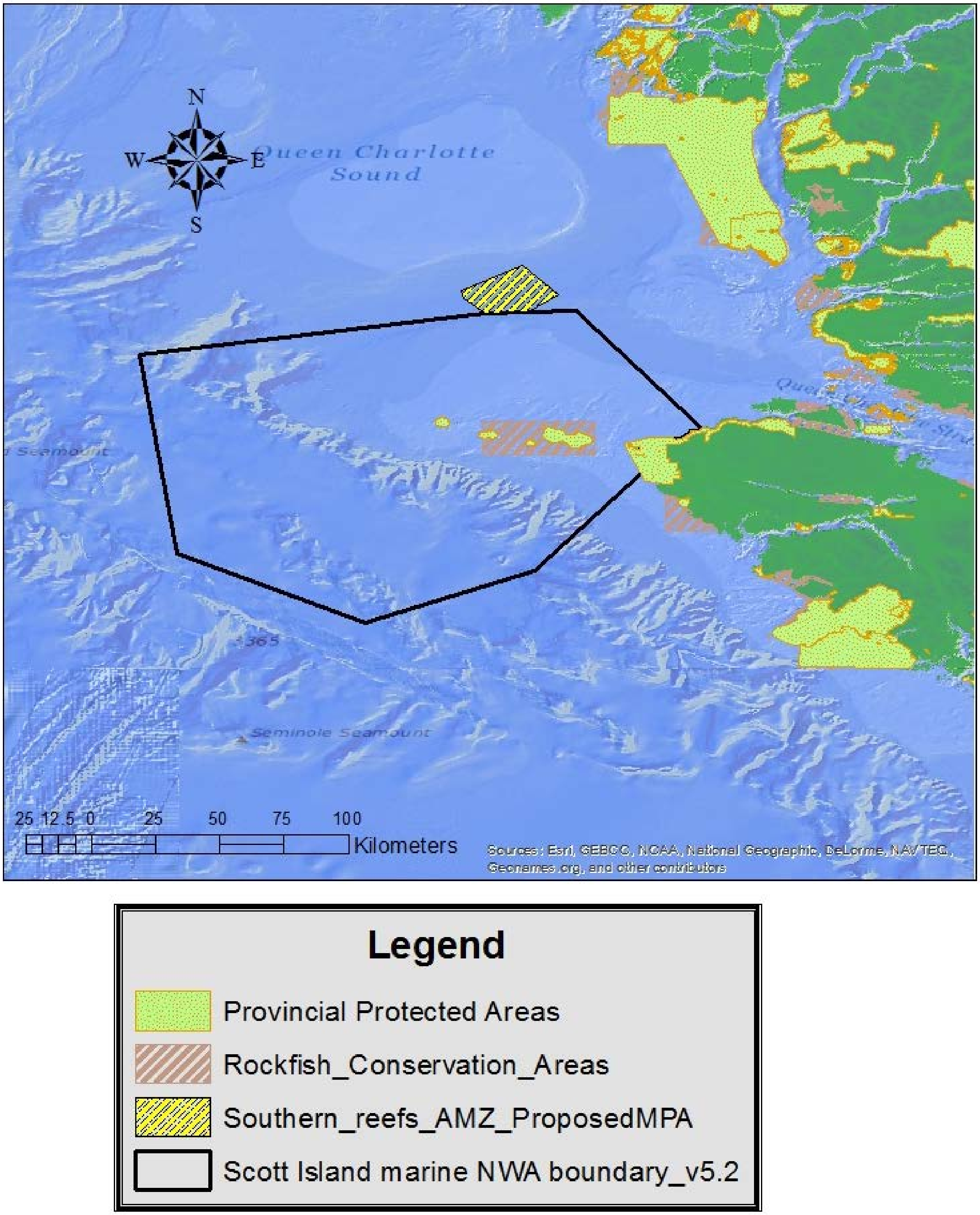


Figure 1: Environment Canada proposed Scott Islands Marine National Wildlife Area (SImNWA) with other areas protected by Fisheries and Oceans Canada and the Province of British Columbia within the region.

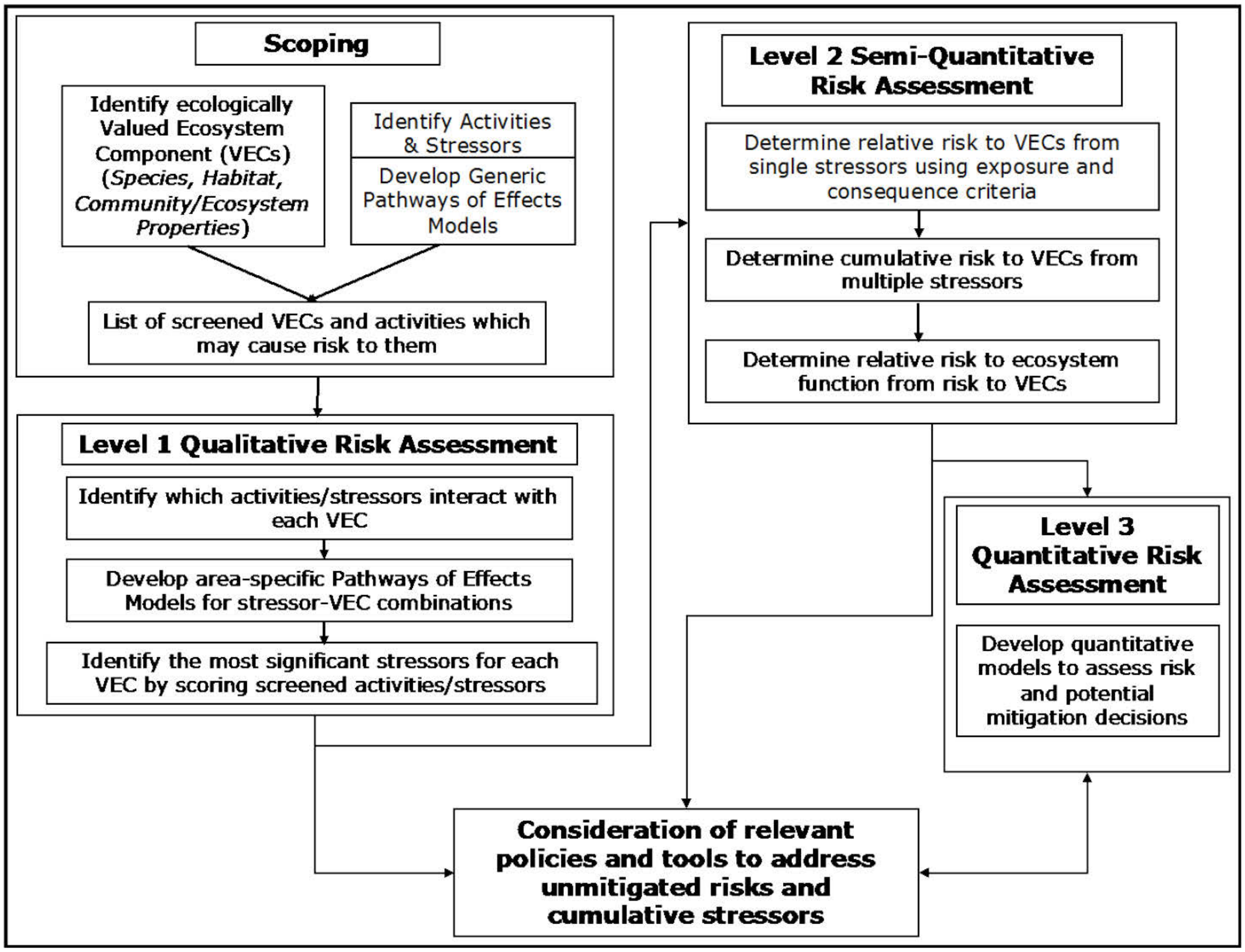


Figure 2: Key elements of the ecological risk assessment framework (ERAF) developed by O et al. (2015).

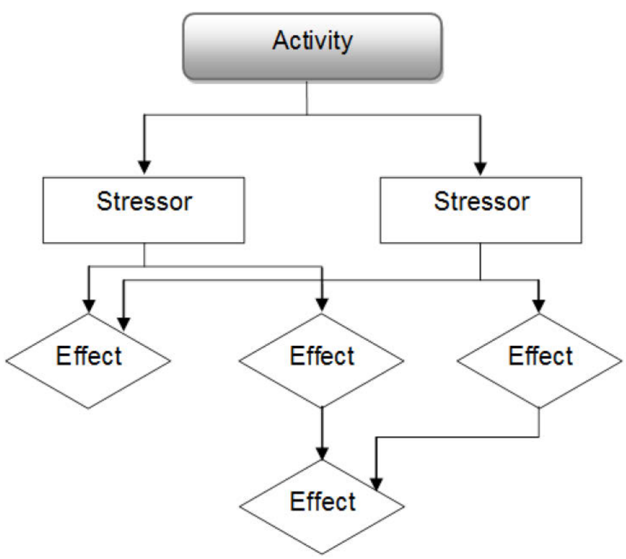


Figure 3: General template for an activity-based Pathway of Effects (O et al. 2015).

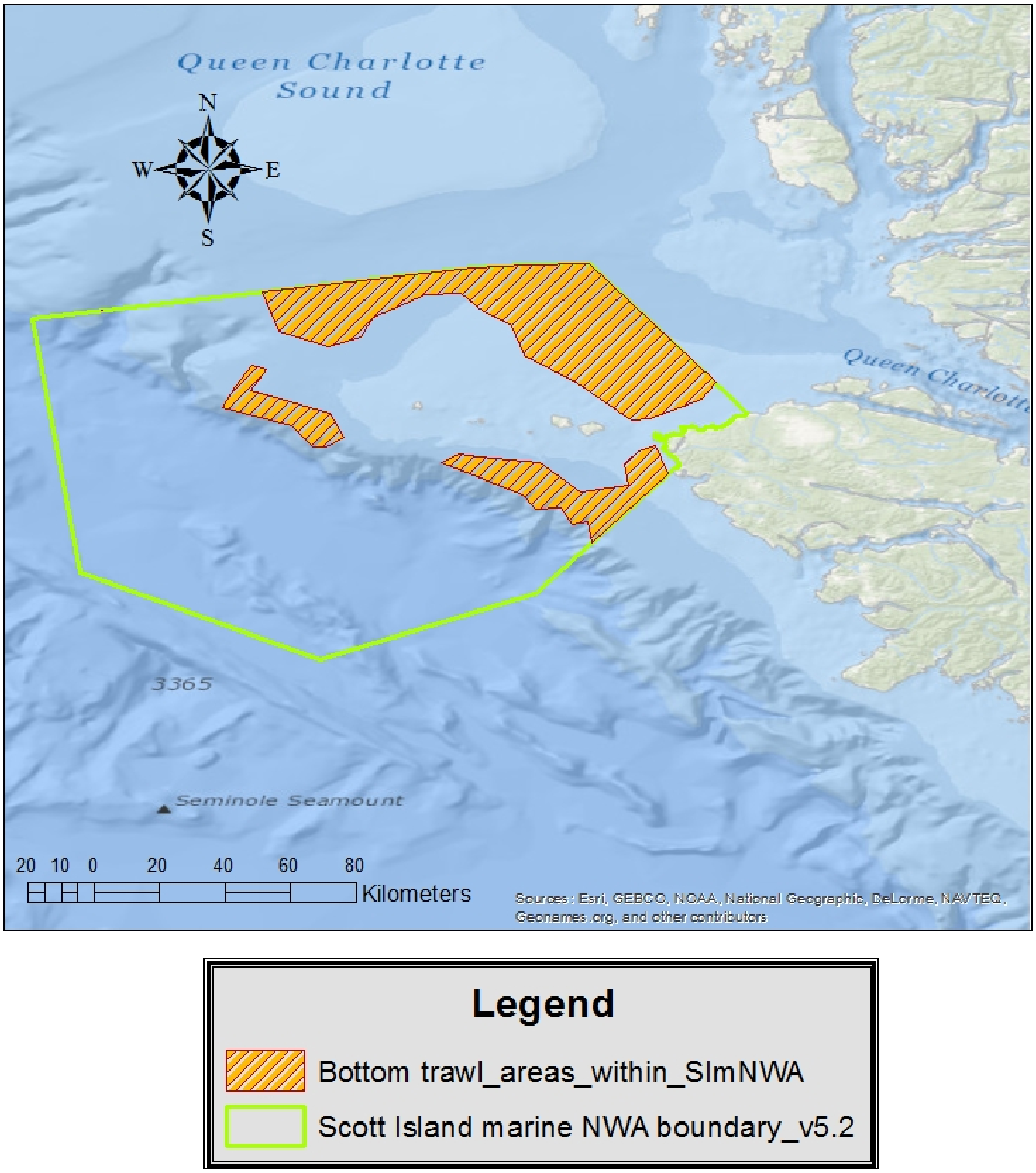


Figure 4: Groundfish bottom trawl fishing areas within the proposed SImNWA.

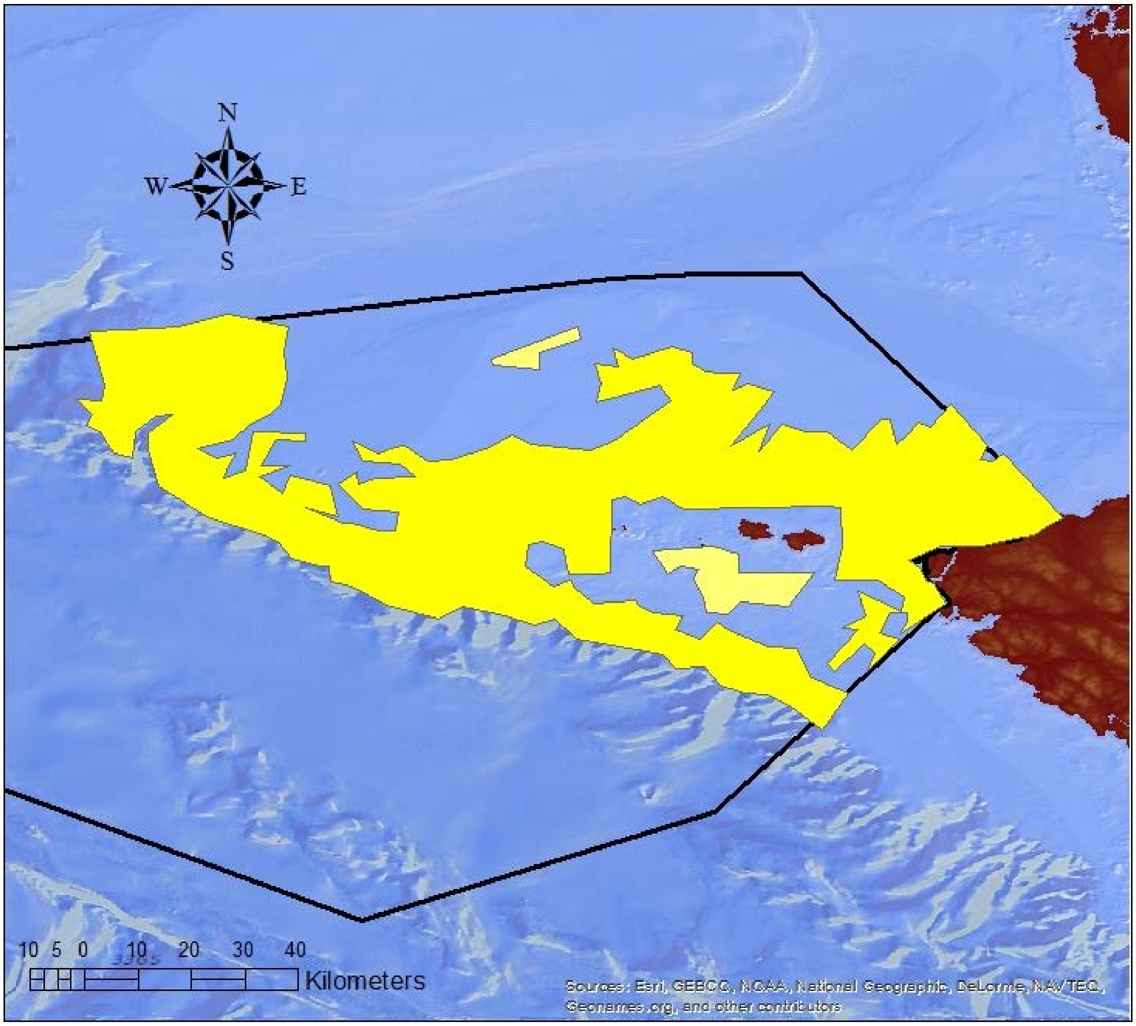


Figure 5: Groundfish hook and line longline fishing areas within the SImNWA.

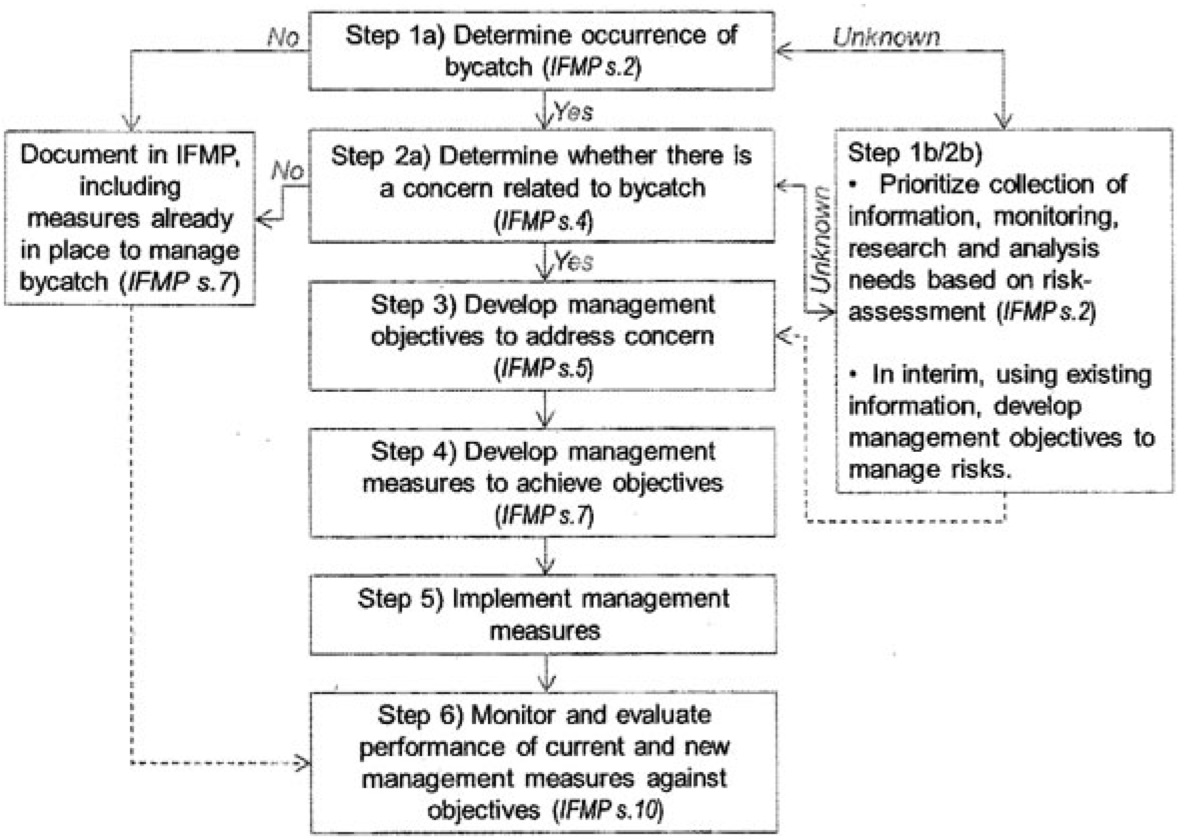


Figure 6: Summary of the analytical steps for addressing bycatch within the Integrated Fisheries Management Plan (IFMP) process.

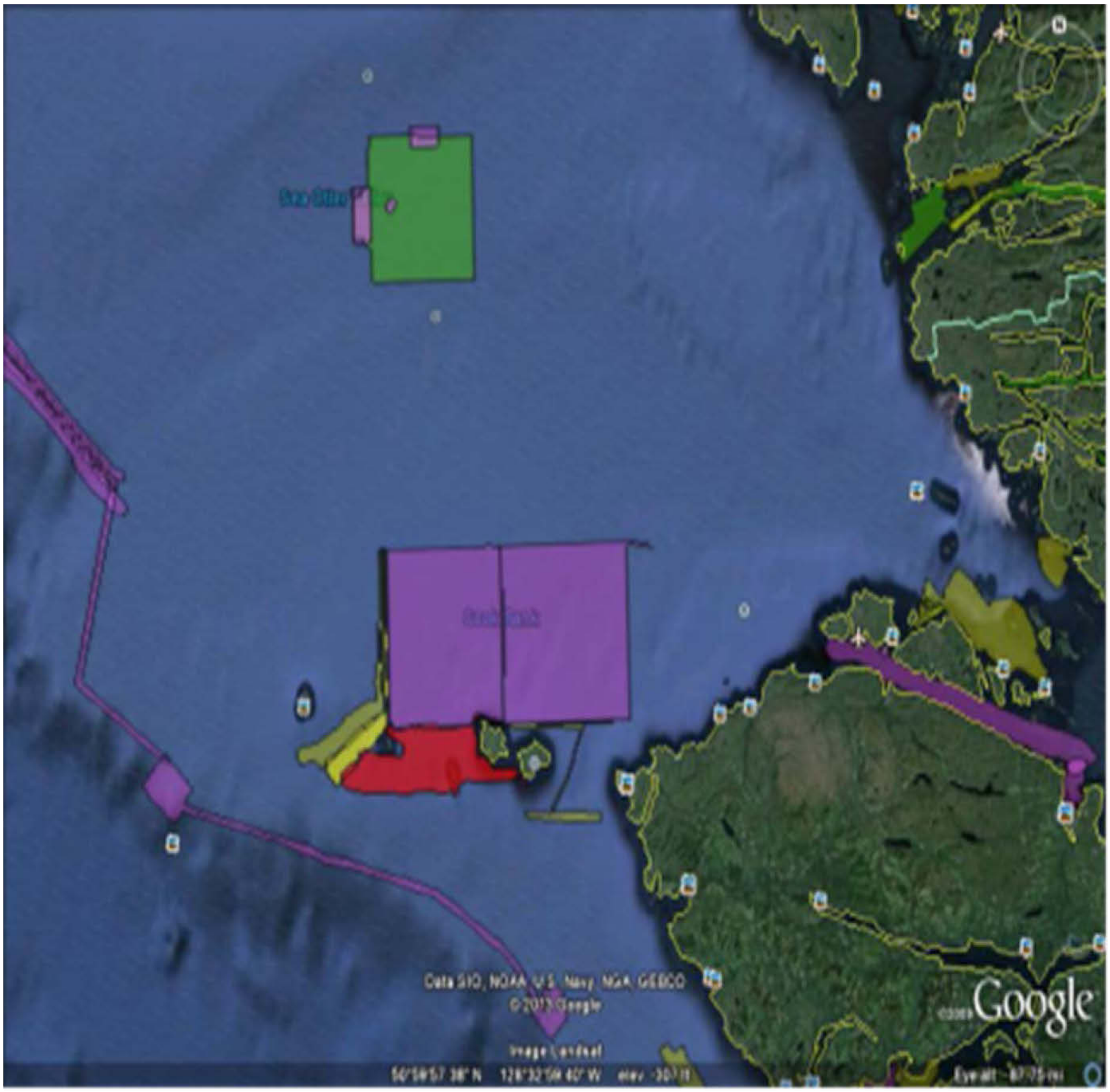


Figure 7: Locations of muli-beam echo sounding locations within the proposed SImNWA. Colours correspond to areas surveyed by year.

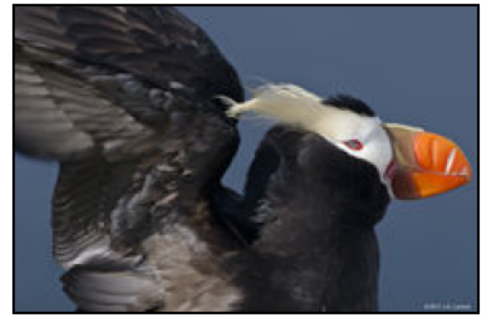
Proposed Scott Islands Marine National Wildlife Area

Draft Seafloor Classification: Morphology

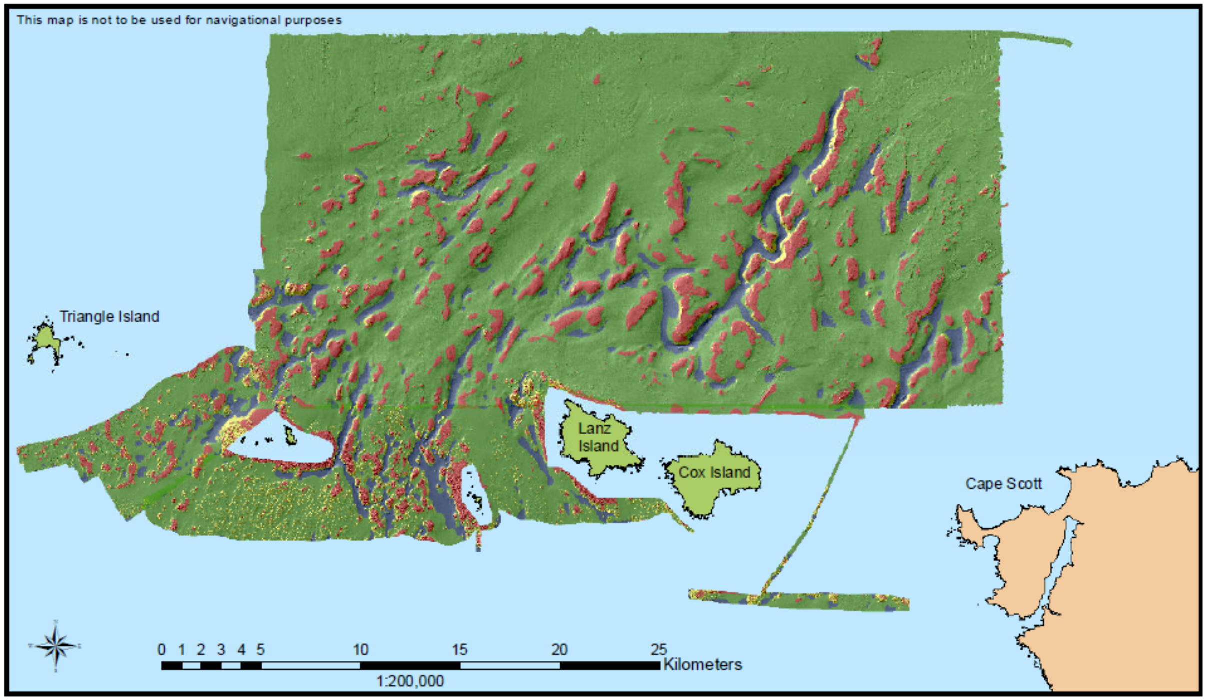
The Scott Islands support the highest concentration of breeding seabirds in Canada's Pacific ocean. About 40% of the seabirds that breed in British Columbia nest there. Five islands make up the Scott Islands archipelago. The land area and the foreshore of all five islands are protected by the Province of British Columbia. The seabirds that nest on the Scott Islands need a healthy ocean, rich in their primary food sources of fish and zooplankton. Birds may travel distances of up to 85 to 120 kilometres from the Scott Islands to feed in the open ocean waters. The Scott Islands marine National Wildlife Area will protect the marine areas the seabirds require to get food for themselves and their young. The region is the ancestral home of the Tlatlasikwala First Nation and the Quatsino First Nation, and holds important cultural and spiritual significance for these First Nations.

This chart illustrates benthic morphology within the surveyed zone of the proposed Scott Islands NWA north of Vancouver Island, British Columbia. Other classification data compiled includes slope and depth ranges, and potential substrate. Fields of potential sand waves that may be habitat for Pacific Sand Lance have also been identified throughout the surveyed area.

Multibeam and backscatter data was collected between 2006 - 2013 by the Canadian Hydrographic Service, Pacific Region. Morphology classification was completed in ArcMap using a Benthic Terrain Modelling (BTM) tool developed by the National Oceanic and Atmospheric Administration (NOAA).The north section classification was completed in 2012 by Stephen Finnis and the south was completed in 2014 by Cassandra Bosma.



Tufted Puffin, Scott Islands, British Columbia
Jim Lamont, 2011



Legend

Morphology

- Slope
- Depression
- Flat
- Crest
- Scott Islands
- Vancouver Island

Datum: WGS 84

Projection: UTM Zone 9N

Data Source(s): Canadian Wildlife Service (CWS); Candadian Hydrographic Service (CHS); Natural Resources Canada (NRCan)

Author: Cassandra Bosma Environment Canada (CWS)
Date: February 17 2014

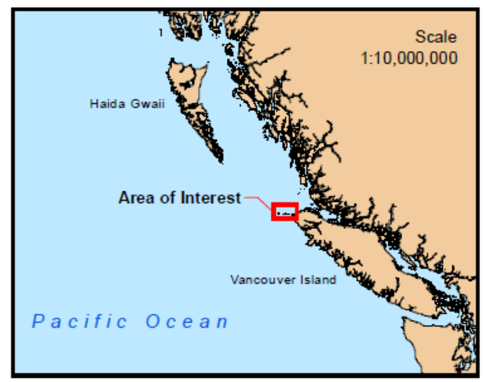


Figure 8: Seafloor Morphology Classification of the proposed SImNWA.

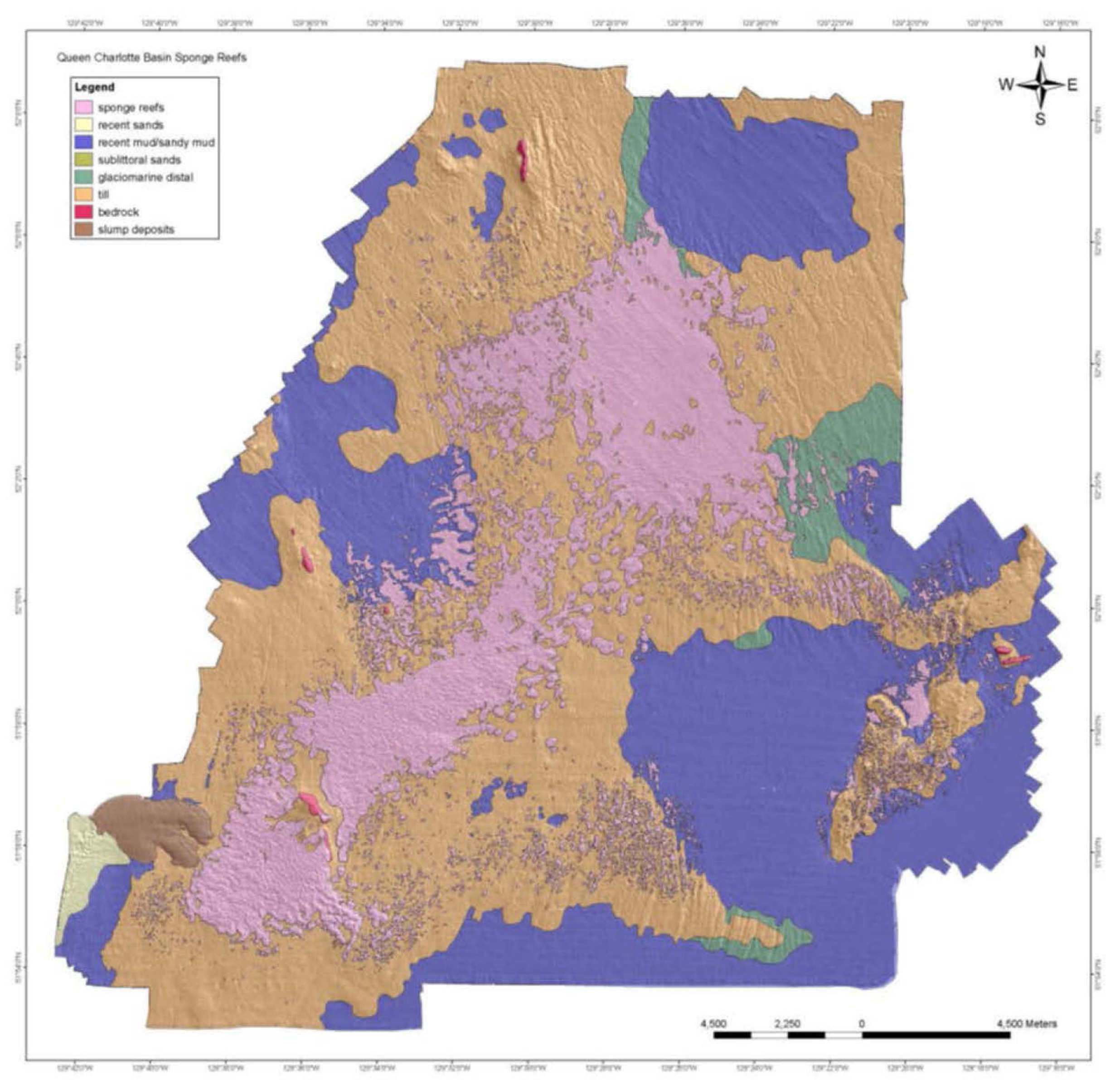


Figure 9: NRCan Bottom sediment maps around the Southern Queen Charlotte Sound Sponge Reef AOI.

APPENDIX 1

Table A1. Species of marine-associated birds found within the proposed Scott Islands marine NWA, their Canadian and Global threat rankings, and global population estimates.

IUCN categories: LC = Least Concern, NT = Near Threatened, V = Vulnerable, E = Endangered.
IUCN trend: ↓ decreasing, ↑ = increasing, ⇔ = stable, ? = unknown.

Species	**SARA listing / COSEWIC**	**IUCN listing / global trend** **[source = reference 1]**	**Global population estimate (1000's of birds)**
Red-throated Loon (*Gavia stellata*)	None / Not assessed	LC↓	200 - 590 [2 1]
Pacific Loon (*G. pacifica*)	None / Not assessed	LC↑	930 - 1,600 [1]
Common Loon (*G. immer*)	None/ Not at Risk	LC↓	615 (Evers, Paruk et al. 2010)
Laysan Albatross (*Phoebastria immutabilis*)	None / Not assessed	NT⇔	1,700 [1]
Black-footed Albatross (*P. nigripes*)	Schedule 1 / Special Concern	NT↑	130 [1]
Short-tailed Albatross (*P. albatrus*)	Schedule 1 / Threatened	V↑	3.4 - 3.5 [3]
Northern Fulmar (*Fulmarus glacialis*)	None / Not assessed	LC↑	15,000 - 30,000 [1]
Pink-footed Shearwater (*Ardenna creatopus*)	Schedule 1 / Threatened	V**?**	100 [1]
Flesh-footed Shearwater (*A.carneipes*)	None / Not assessed	LC⇔	650 [1]
Buller's Shearwater (*A. bulleri*)	None / Not assessed	V⇔	2,500 [1]
Sooty Shearwater (*A. griseus*)	None / Not assessed	NT↓	20,000 [1]
Short-tailed Shearwater (*A.*	None / Not	LC↓	23,000 [1]

2 [1] The IUCN Red List of Threatened Species. Version 2014.3.

Species	SARA listing / COSEWIC	IUCN listing / global trend [source = reference 1]	Global population estimate (1000's of birds)
tenuirostris)	assessed		
Manx Shearwater (*Puffinus puffinus*)	None / Not assessed	LC ↓	1,050 - 1,170 [1]
Fork-tailed Storm-Petrel (*Hydrobates furcatus*)	None / Not assessed	LC↑	6,000 [1]
Leach's Storm-Petrel (*H. leucorhous*)	None / Not assessed	LC⇔	20,000 [1]
Brandt's Cormorant (*Phalacrocorax penicillatus*)	None / Not assessed	LC↓	?
Double-crested Cormorant (*P. auritus*)	None / Not at risk	LC↑	?
Pelagic Cormorant (*P. pelagicus*)	None / Not assessed	LC↓	?
Bald Eagle (*Haliaeetus leucocephalus*)	None/ Not at Risk	LC↑	?
Peregrine Falcon (pealei subspecies) (*Falco peregrinus pealei*)	Schedule 1 / Special Concern	LC⇔	1,200 [1]
Red-necked Phalarope (*Phalaropus lobatus*)	None / Special Concern (COSEWIC 2014)	LC↓	3,600 - 4,500 [1]
Red Phalarope (*P. fulicarius*)	None / Not assessed	LC↓	1,100 - 2,000 [1]
South Polar Skua (*Catharacta maccormicki*)	None / Not assessed	LC⇔	10 - 20 [1]
Pomarine Jaeger (*Stercorarius pomarinus*)	None / Not assessed	LC⇔	250 - 3,000 [1]
Parasitic Jaeger (*S. parasiticus*)	None / Not assessed	not assessed	?

Species	**SARA listing / COSEWIC**	**IUCN listing / global trend** **[source = reference 1]**	**Global population estimate (1000's of birds)**
Long-tailed Jaeger (*S. longicaudus*)	None / Not assessed	LC⇔	150 - 5,000 [1]
Mew Gull (*Larus canus*)	None / Not assessed	LC**?**	2,500 - 3,700 [1]
California Gull (*L. californicus*)	None / Not assessed	LC↓	?
American Herring Gull (*L. smithsonianus*)	None / Not assessed	LC↓	430 - 520 [1]
Thayer's Gull (*L. thayeri*)	None / Not assessed	LC↑	?
Western Gull (*L. occidentalis*)	None / Not assessed	LC↑	?
Glaucous-winged Gull (*L. glaucescens*)	None / Not assessed	LC↑	570 [1]
Sabine's Gull (*Xema sabini*)	None / Not assessed	LC⇔	330 - 700 [1]
Black-legged Kittiwake (*Rissa tridactyla*)	None / Not assessed	LC↓	17,000 - 18,000 [1]
Arctic Tern (*Sterna paradisaea*)	None / Not assessed	LC↓	2,000 [1]
Common Murre (*Uria aalge*)	None / Not assessed	LC↑	18,000 [1]
Thick-billed Murre (*U. lomvia*)	None / Not assessed	LC↑	22,000 [1]
Pigeon Guillemot (*Cepphus carbo*)	None / Not assessed	LC⇔	470 [1]
Marbled Murrelet (*Brachyramphus marmoratus*)	Schedule 1 / Threatened	E↓	350 - 420 [1]
Xantus's Murrelet * [Scripps's Murrelet	None / Not assessed	V↓	15 - 30 [1]

Species	**SARA listing / COSEWIC**	**IUCN listing / global trend [source = reference 1]**	**Global population estimate (1000's of birds)**
(*Synthliboramphus scrippsi*)]			
Xantus's Murrelet * [Guadalupe Murrelet (*S. hypoleucus*)	None / Not assessed	E↓	7.5 [1]
Ancient Murrelet (*S. antiquus*)]	Schedule 1 / Special Concern	LC↓	1,000 - 2,000 [1]
Cassin's Auklet (*Ptychoramphus aleuticus*)	None / Special Concern (COSEWIC 2014)	LC↓	3,570 (Ainley, Manuwal et al. 2011)
Rhinoceros Auklet (*Cerorhinca monocerata*)	None / Not assessed	LC↓	1,300 [1]
Horned Puffin (*Fratercula corniculata*)	None / Not assessed	LC↓	1,200 [1]
Tufted Puffin (*F. cirrhata*)	None / Not assessed	LC↓	3,500 [1]

* Xantus's Murrelet recently split into two species: Scripps's Murrelet and Guadalupe Murrelet. Both species have been recorded in BC waters, but none of the birds observed within the (proposed) SImNWA boundaries were identified, at the time of observation, to the (sub)species level.