

Review of Management of Selected North Temperate Shrimp and Prawn Fisheries

John A. Holmes and Ken H. Fong

Fisheries and Oceans Canada
Pacific Biological Station
3190 Hammond Bay Road
Nanaimo, BC V9T 6N7
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ABSTRACT

Holmes, J.A., and Fong, K.H. 2026. Review of Management of Selected North Temperate Shrimp and Prawn Fisheries. Can. Manuscr. Rep. Fish. Aquat. Sci. 3344: xi + 170 p.

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The commercial Shrimp trawl fishery in the Pacific Region of Canada has collapsed economically in recent years with very little fishing effort despite advice from Fisheries and Oceans Canada (DFO) Science Branch that Shrimp stocks are generally in a healthy status in British Columbia (BC) coastal waters. In recent years, the available quota has been far higher than the quota removed by commercial harvest.

DFO management of the Pacific Shrimp trawl fishery follows DFO's National Sustainable Fisheries Framework (SFF) policy to achieve conservation, economic and governance goals. The commercial Shrimp trawl sector do not believe that the current management and assessment framework provides stable long-term/year-round fishing opportunities and market planning, leading to the poor economic performance of this fishery. The objectives of this report are to: (1) review and summarize the management approach as well as management and science considerations of other domestic and international shrimp trawl fisheries; (2) identify alternative management options/tools for the Pacific Shrimp trawl fishery; and (3) evaluate the benefits and limitations of these options/tools in the relevant jurisdiction as well as Pacific Region, including a determination of their alignment with National DFO SFF policy requirements.

The assessment and management frameworks of eight northern temperate water Shrimp trawl fisheries were reviewed to identify alternative management options for the BC Shrimp trawl fishery. The BC Prawn and Shrimp trap fishery and the Australian Northern Prawn fishery were also reviewed to provide contrasting management systems to those employed in the northern temperate water fisheries. The management approach including management and science considerations in each fishery was summarized to identify the key features for consideration in the Canadian context. There are no quick fixes or changes that can be implemented. Tools/approaches identified represent incremental rather than transformational change but are intended to address vocal concerns expressed by Industry.

RÉSUMÉ

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La pêche commerciale de la crevette au chalut dans la région du Pacifique du Canada a connu un effondrement économique ces dernières années, caractérisé par un effort de pêche très faible, et ce, malgré les avis de la Direction des sciences de Pêches et Océans Canada (MPO) indiquant que les stocks de crevettes sont généralement en bonne santé dans les eaux côtières de la Colombie-Britannique. Ces dernières années, le quota disponible a largement dépassé les quantités effectivement prélevées lors de la pêche commerciale.

La gestion de la pêche commerciale de la crevette au chalut dans le Pacifique par le MPO s'inscrit dans le cadre de la politique nationale du MPO sur le Cadre pour la pêche durable (CPD), visant à atteindre des objectifs en matière de conservation, d'économie et de gouvernance. Le secteur de la pêche commerciale de la crevette au chalut estime que le cadre actuel de gestion et d'évaluation ne permet pas d'assurer des possibilités de pêche stables (à l'année et à long terme) ni une planification commerciale adéquate, ce qui explique les piètres résultats économiques de cette pêcherie. Les objectifs de ce rapport sont les suivants : (1) examiner et résumer l'approche de gestion ainsi que les considérations scientifiques et de gestion propres à d'autres pêcheries de crevettes au chalut, tant nationales qu'internationales ; (2) recenser des options ou outils de gestion alternatifs pour la pêche de la crevette au chalut dans le Pacifique ; et (3) évaluer les avantages et les limites de ces options ou outils dans leurs juridictions respectives ainsi que dans la région du Pacifique, tout en déterminant leur conformité avec les exigences de la politique nationale du MPO sur le CPD.

Les cadres d'évaluation et de gestion de huit pêcheries de crevettes au chalut des eaux tempérées du Nord ont été examinés afin d'identifier des options de gestion alternatives pour la pêcherie de la Colombie-Britannique. La pêche aux crevettes et aux crevettes tachetées au casier en Colombie-Britannique ainsi que la pêche à la crevette du Nord en Australie ont également été étudiées afin d'offrir des modèles de gestion contrastant avec ceux utilisés dans les pêcheries des eaux tempérées du Nord. L'approche de gestion, incluant les aspects scientifiques et opérationnels de chaque pêcherie, a été résumée pour mettre en évidence les éléments clés à prendre en compte dans le contexte canadien. Il n'existe pas de solution miracle ni de changement immédiat pouvant être mis en œuvre. Les outils et approches identifiés représentent une évolution progressive plutôt qu'une transformation radicale, mais ils visent à répondre aux préoccupations exprimées avec insistance par l'industrie.

Introduction

The commercial Shrimp trawl fishery in the Pacific Region of Canada has collapsed economically in recent years with very little fishing effort (Figure 1) despite advice from Fisheries and Oceans Canada (DFO) Science Branch in 2024 that Shrimp stocks are generally in a healthy status coastwide. The biomass available for harvesting from 36 Shrimp Management Areas (SMAs) during the 2024/25 season was estimated to be ~3,175 t (7 million lbs), but only ~103 t (227,000 lbs) was landed (approximately 3%) even though few SMAs were closed due to low Shrimp abundance during this season.

DFO management of the Pacific Shrimp trawl fishery uses a variable harvest rate strategy to establish catch ceilings in SMAs in which reference points have been established based on annual survey results to achieve conservation, economic and governance goals (DFO 2026a). Conservation objectives for the fishery include sustainability of the target stocks, and sustainable exploitation of these stocks and minimizing bycatch of Eulachon (*Thaleichthys pacificus*), which was assessed as Endangered by the Committee on the Status of Wildlife in Canada (COSEWIC) and migrates through offshore areas in Prince Rupert District, Queen Charlotte Sound, and along the west coast of Vancouver Island (WCVI); the latter area is considered the most productive Shrimp fishing grounds at present. Economic goals include managing the fishery to provide opportunities for economic prosperity and the Governance goals include providing stability, transparency, and predictability in fisheries management and improved practices.

Much of the DFO management focus for the Shrimp trawl fishery is on achieving conservation and sustainability goals. These goals for harvested shrimp stocks are realized through the implementation of the policy requirements in the [Decision-Making Framework Incorporating the Precautionary Approach](#). The Precautionary Approach management framework ('PA Framework') is based on the use of biological reference points to categorize stock status into three zones (Critical, Cautious, Healthy) and provide guardrails for the sustainability of stocks in terms of variable exploitation rates depending on the status of the stock. The Eulachon conservation objective is addressed through the use of net-based measures (biological reduction devices, BRD, and LED lights on the footrope), a hard 4 t cap on Eulachon bycatch (Eulachon Action Level, EAL) in the WCVI offshore SMAs, and 100% observer coverage on vessels fishing in the offshore SMAs. The observer coverage requirement was scaled back to 25% beginning with the 2026-27 fishing season (DFO 2026a).

Implementation of the PA Framework to the Shrimp Trawl fishery occurred in 2010 and combines biomass abundance estimates of three target species of Shrimp with a variable commercial harvest rate between 0% – 35% to establish catch ceilings depending on an evaluation stock status at the SMA level relative to the limit and target

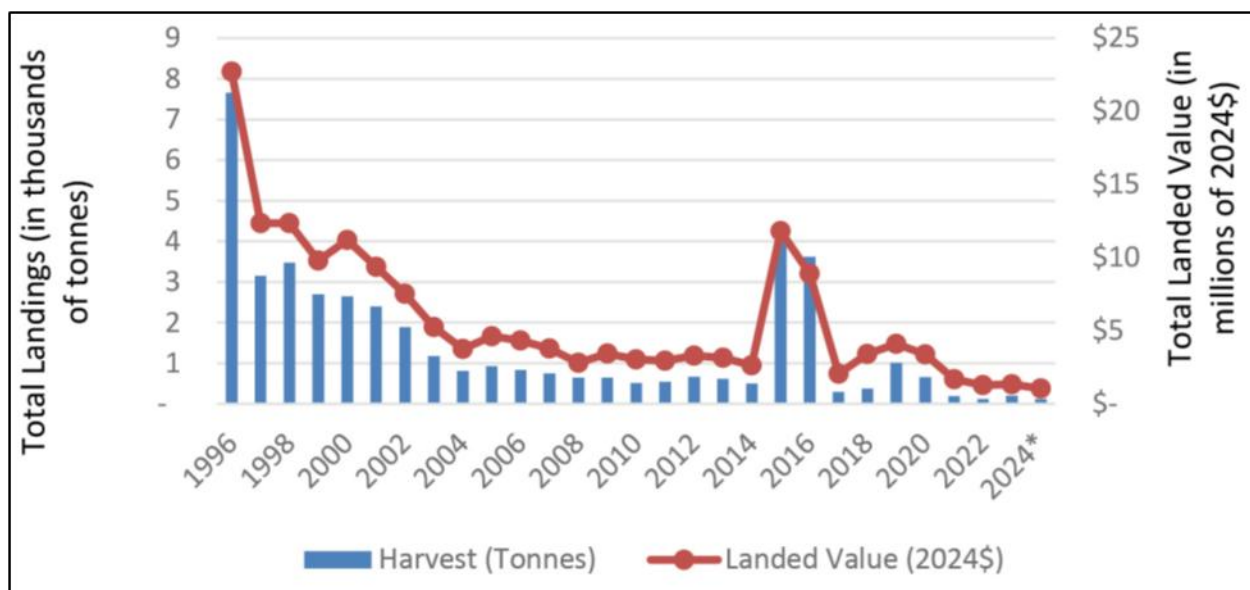


Figure 1. Annual landings and landed value (in 2024 CAD) of the Pacific Shrimp Trawl fishery in British Columbia, 1996-2024. Taken from DFO (2026b).

reference points for each species. Biomass surveys are conducted at rotating mix of index sites in 13 of 36 SMAs annually and small commercial catch ceilings are allocated to SMAs that are not surveyed. The fishing season extends from April 1 to March 31 the following year. Currently, annual stock assessment advice often arrives later in the season, delaying fishing opportunities for the fleet, and creating market uncertainty regarding SMA openings for harvesters, processors, and markets.

Representatives of commercial licence holders ('Industry') have raised several concerns regarding DFO's assessment and management and the resulting impacts on the long-term economic viability of the Shrimp trawl fishery (Figure 1). These concerns include: (1) high monitoring standards and costs (especially the 100% observer requirement for the WCVI offshore component of the fishery, although it has been reduced to 25% beginning in 2026-27); (2) the hard 4 t EAL cap which can quickly constrain fishing opportunities in the productive offshore waters of the WCVI component of the fishery; (the Shrimp trawl fishery in Queen Charlotte Sound, which was a productive fishing area, was closed in 2000 owing to concerns about bycatch of Eulachon in the Central Coast DU, which also was assessed as Endangered by COSEWIC); (3) the implementation of the PA Framework in Shrimp Trawl fishery management and the impacts of this approach on fishing opportunities, harvesters and markets; and (4) the delivery of Science information and advice ranging from the logistics of conducting surveys, the accuracy of biomass estimates, and the timeliness of those estimates for management needs. Industry does not believe that the current management and assessment framework provides stable long-term / year round fishing opportunities for the fleet or processors.

Given the recent economic performance of the Shrimp Trawl fishery (Figure 1) and the concerns raised by Industry regarding some of the causes of this poor economic performance, it is clear that the balance between achieving conservation, economic and governance objectives has been altered over the last two decades. Substantial TAC has been left in the water by the Shrimp trawl fishery in recent years because of perceived constraints in the management framework and this has led industry to push loudly for changes that support an economically viable fishery. The long-term goal seems to be a fishery that fills the domestic market and is able to compete in international markets. Whether or not Industry has the economic resources and ability to persist in restructuring the Shrimp Trawl fishery, even if the economic prospects and governance are improved, are open questions at present.

Although several options to revise the management framework have been discussed operationally by DFO and Industry, both DFO and Industry would benefit from an outside perspective on alternative options that may offer more long-term stability and market planning for Industry and processors. The goals of this document are to:

1. Review and summarize the management approach as well as management and science considerations of other domestic and international shrimp trawl fisheries;
2. Identify potential alternative management options/tools for the Pacific Shrimp trawl fishery; and
3. Evaluate the benefits and limitations of new options/tools in the relevant jurisdiction as well as Pacific Region, including a determination of whether or not these alternatives align, or can be adjusted to align, with National DFO Sustainable Fisheries Framework Policy requirements.

This document does not directly address the concerns raised by Industry regarding the delivery of Science assessments, particularly surveys. Those concerns require interaction amongst DFO and Industry experts and gear experiments to resolve standard procedures and processes and are out of scope for this report.

Work is underway by DFO to revise the assessment and management framework to restructure the Shrimp Trawl fishery and a document has been developed mapping out key milestones in this process beginning in 2025-26 and concluding in 2028-29 (Appendix 11). DFO (2025) recently reported that there is no evidence of stock structure in the three target species of the Shrimp Trawl fishery and concluded that coastwide stock definitions should be adopted. When implemented, these new definitions will supersede the current practice of assuming separate stocks of each species in each SMA. DFO (2025) also recommended changes to the survey and model approach for biomass estimation to support the implementation and use of coastwide stock definitions. Finally, the DFO (2025) conclusions also highlighted the need to re-estimate reference points using the new biomass index estimation methods to ensure that in-season biomass estimates and reference points are on the same scale. While these new framework pieces envisage status determination occurring at the coastwide level, there will be a need to provide harvest advice at a sub-regional scale and address

uncertainty regarding local depletions from harvesting and migration or movement dynamics within a shrimp stock given the patchy nature of Shrimp stock biomass.

A large number of species are identified in the text using common names and following the practice of the American Fisheries Society to capitalize common names. Common and scientific names of species in the text are shown in Table 1. Similarly, symbols and acronyms used throughout the text are explained in Table 2.

Table 1. Common and scientific names of species cited in the text of this document.

Common Name	Scientific Name
Atlantic Cod	<i>Gadus morhua</i>
Atlantic Haddock	<i>Melanogrammus aeglefinus</i>
Arctic Cod	<i>Boreogadus saida</i>
Blue Endeavour Prawn	<i>Metapenaeus endeavouri</i>
Brown Tiger Prawn	<i>Penaeus esculentus</i>
Coonstripe Shrimp	<i>Pandalus danae</i>
Dungeness Crab	<i>Metacarcinus magister</i>
Eulachon	<i>Thaleichthys pacificus</i>
Euphausiid	<i>Euphausia pacifica</i>
Euphausiid	<i>Thysanoessa spinifera</i>
Greenland Halibut	<i>Reinhardtius hippoglossoides</i>
Grooved Tiger Prawn	<i>Penaeus semisulcatus</i>
Humboldt Squid	<i>Dosidicus gigas</i>
Humpback Shrimp	<i>Pandalus hypsinotus</i>
Northern Shrimp	<i>Pandalus eous</i> (Pacific only)
Northern Shrimp	<i>Pandalus borealis</i> (Atlantic, Arctic)
Ocean Shrimp, Smooth Pink Shrimp	<i>Pandalus jordani</i> (US West Coast)
Pacific Hake	<i>Merluccius productus</i>
Red Endeavour Prawn	<i>Metapenaeus ensis</i>
Redfish	<i>Sebastes</i> spp.
Redleg Banana Prawn	<i>Penaeus indicus</i>
Sablefish	<i>Anoplopoma fimbria</i>
Saithe, Pollock	<i>Pollachius virens</i>
Sidestripe Shrimp	<i>Pandalopsis dispar</i>
Silver Hake	<i>Merluccius bilinearis</i>
Slender Sole	<i>Lyopsetta exilis</i>
Spiny Pink Shrimp	<i>Pandalus borealis</i> (Pacific only)
Smooth Pink Shrimp	<i>Pandalus jordani</i> (British Columbia)
Spot Prawn	<i>Pandalus platyceros</i>
Striped Shrimp	<i>Pandalus montagui</i>
White Banana Prawn	<i>Penaeus merguensis</i>

Table 2. Glossary of symbols and acronyms used in the text of this document.

Symbol or Acronym	Explanation
ASMFC	Atlantic States Marine Fishery Commission
ASO	At-Sea Observer – independent third party scientific personnel place on vessels to record catch and bycatch composition, size, maturity, sex, and sample for more detailed biological information
B ₀	Unfished biomass, "virgin biomass" - The estimated total weight of a fish stock that would exist if no fishing had ever occurred. It represents the natural carrying capacity of the ecosystem for that stock.
BRD	Bycatch reduction device – usually a rigid Nordmøre grid with bar spacing that can be altered depending on sizes expected
CL	Carapace length
CMO	Crew-member Observer – in Australian Northern Prawn Fishery
COSEWIC	Committee on the Status of Endangered Wildlife in Canada
DFO	Fisheries and Oceans Canada acronym
EAL	Eulachon Action Level – a hard cap on Eulachon bycatch which, if exceeded results in closure of the fishery in offshore SMAs
EAZ	Eastern Assessment Zone – NL Shrimp fishery
EEZ	Exclusive Economic Zone, i.e., waters claimed by a country out to 200 miles from the coast
ESS	Eastern Scotian Shelf
EGSL	Estuary and Gulf of St. Lawrence
GOM	Gulf of Maine Shrimp Trawl fishery
HCR	Harvest control rule
ITQ	Individual Transferable Quota
LRP	Limit Reference Point
MEY	Maximum Economic Yield
MSE	Management strategy evaluation
MSY	Maximum Sustainable Yield
mt	Alternative symbol denoting metric tonnes (1,000 kg)

Symbol or Acronym	Explanation
PA Framework	Precautionary Approach Framework applied by Fisheries and Oceans Canada to manage fish stocks
PFMA	Pacific Fishery Management Area
Redfish	Common name on the Atlantic coast of Canada for species in the genus <i>Sebastes</i> spp. (= Rockfish on the Pacific coast)
SFA	Shrimp Fishing Area – used in Quebec, Maritimes and Newfoundland-Labrador Regions of Canada
SKND	Skagerrak and Norwegian Deep Trawl Fishery
SMA	Shrimp Management Area – used in Pacific Region
SMA GTSE	Shrimp Management Area Georgia Strait – East side
SMA FR	Shrimp Management Area Fraser River
SSB	Spawning Stock Biomass - The combined total weight of all sexually mature fish in a stock that are capable of reproducing. It is a critical metric in monitoring a stock's reproductive capacity and assessing fishery sustainability over time.
SST	Sea Surface Temperature (°C)
t	Symbol denoting a metric unit of mass – tonnes (1,000 kg)
TAC	Total Allowable Catch
TRP	Target Reference Point
USR	Upper Stock Reference -
WAZ	Western Assessment Zone – NL Shrimp fishery
WCVI	West Coast of Vancouver Island

Methods

The review focused on Shrimp Trawl fisheries in temperate waters of the northern hemisphere. This choice means that the species targeted by the Shrimp trawl fisheries review are primarily species in the genus *Pandalus*, especially Northern Shrimp, *P. borealis* in the Atlantic and Arctic basins. Northern shrimp in the Pacific basin, *P. eous*, is largely confined to the Alaska coast and management of this species was not reviewed because there is no commercial fishery and few information sources are readily available in the literature. The Shrimp trawl fisheries reviewed for this report include the Barents Sea Coldwater Prawn fishery, the Estuary-Gulf of St. Lawrence Northern Shrimp fishery, the Eastern Scotian Shelf Northern Shrimp fishery, the Newfoundland-Labrador Northern Shrimp fishery, the Skagerrak-Norwegian Deep Northern Shrimp fishery, the Shrimp Trawl fishery in Pacific Region, the Gulf of Maine Northern Shrimp fishery within the United States exclusive economic zone (EEZ), and the Washington-Oregon-California Ocean Shrimp fishery within the United States EEZ.

The Pacific Prawn and Shrimp by Trap fishery, and the Australian Northern Prawn fishery (NPF) were also reviewed because they both employ effort-based management systems, in contrast to the largely catch-based management systems employed in the temperate water fisheries listed above. Industry has proposed an effort-based CPUE management approach as used in the Prawn and Shrimp by Trap fishery as a model for the reform of the Shrimp by Trawl fishery management approach. Management of the Australian NPF uses effort controls to achieve the explicit goal of maximizing net economic returns (NER) in the fishery, an approach that is the direct opposite in execution to temperate water Shrimp fisheries where catch is maximized.

Management documents, scientific assessment and research documents, and sustainability certification authority audit documents were reviewed to extract key information for each fishery. The key information identified and extracted was categorized into five groups: (1) Overview (containing tombstone information such as target species, stock structure, fleet and gear characteristics, history of the fishery, economic impact); (2) Stock Status and Science, which includes a description of the assessment framework and stock dynamics, biomass indices and reference points and current stock status and catch data; (3) Management and Governance, which includes the Management framework describing how decisions are made, the monitoring program supporting the management framework, harvest control rules (HCR) and total allowable catch decisions; (4) Ecosystem and Environmental Impacts, which includes a description of the bycatch management system and key species of bycatch, Ecosystem impacts of the target species, habitat impacts of fishing activity and mitigation measures and the impact of environmental factors on stock dynamics; and (5) Performance and Sustainability, which includes information on fishery certification for sustainability by independent third parties and economic viability of the fishery. Summaries of the information extracted for each fishery reviewed are captured in

Appendices 1-10. These fishery summaries are organized geographically, starting with Canada, followed by Europe-Scandinavia, the United States and finishing with the British Columbia Prawn trap fishery and the Australian Northern Prawn fishery.

After the key information was extracted from the literature, the fisheries summaries were evaluated for commonalities and differences. The goal of the commonality review was to identify patterns in the delivery of assessment and management for shrimp trawl fisheries that reinforce or weaken support for elements of the current management framework for the Pacific Shrimp trawl fishery. Differences could be variations in process or procedures to accomplish the same objective or they could be unique approaches shared by one or a few fisheries to address specific risks or functions in those fisheries. The latter differences are the focus of this report and were subjected to an evaluation of strengths and weaknesses and for potential policy compliance in the Canadian context.

The remainder of this report is structured into a Results section and a Discussion section. The Results section consists of short executive summaries describing the key features of each fishery reviewed. These summaries are followed by the results of the commonalities and differences evaluations. The benefits and limitations of new options/tools in the Pacific Region context and whether or not they are or can be made to align with the Canadian policy context are considered in the Discussion section. Finally, a concluding section is presented containing some observations for decision-makers to consider when moving forward with changes to the Shrimp Trawl management system.

Results

The following sections are intended to be short summaries of the more detailed information extracted for each fishery reviewed in this report. The fishery summaries are ordered beginning with the BC Shrimp trawl fishery followed by other Canadian Shrimp trawl fisheries (Estuary-Gulf of St. Lawrence, Eastern Scotian Shelf, Newfoundland-Labrador) and other Shrimp Trawl fisheries in the North Atlantic (Barents Sea, Skaggerak-Norwegian Deep, United States Gulf of Maine), the United States West Coast Shrimp trawl fishery and for contrast, the BC Prawn and Shrimp by Trap fishery and the Australian Northern Prawn trawl fishery. The detailed information extracted for these fisheries is included in Appendices 1-10 at the end of this report.

British Columbia Shrimp Trawl Fishery

The British Columbia (BC) Shrimp Trawl fishery is a commercially active but historically downscaled sector managed across 36 SMAs along the Pacific coast of Canada. Seven Shrimp species are harvested in this fishery, but the main target species are Smooth Pink Shrimp, Spiny Pink Shrimp (Northern Shrimp in Atlantic Ocean shrimp trawl fisheries) and the larger Sideshripe Shrimp. The fishery operates in soft mud or sandy bottom habitats at depths of 100 to 150 m, and spans protected inshore waters such as the Strait of Georgia to open ocean ecosystems off the west coast of Vancouver Island (WCVI). Major shrimp fishing grounds are located in Barkley Sound, offshore WCVI in Pacific Fishery Management Areas (PFMA) 124 and 125, the Strait of Georgia, Central Coast adjacent to Rivers Inlet-Fitz-Hugh Sound and Goose Islands in Queen Charlotte Sound (which are closed), and waters around Prince Rupert (Figure 2).

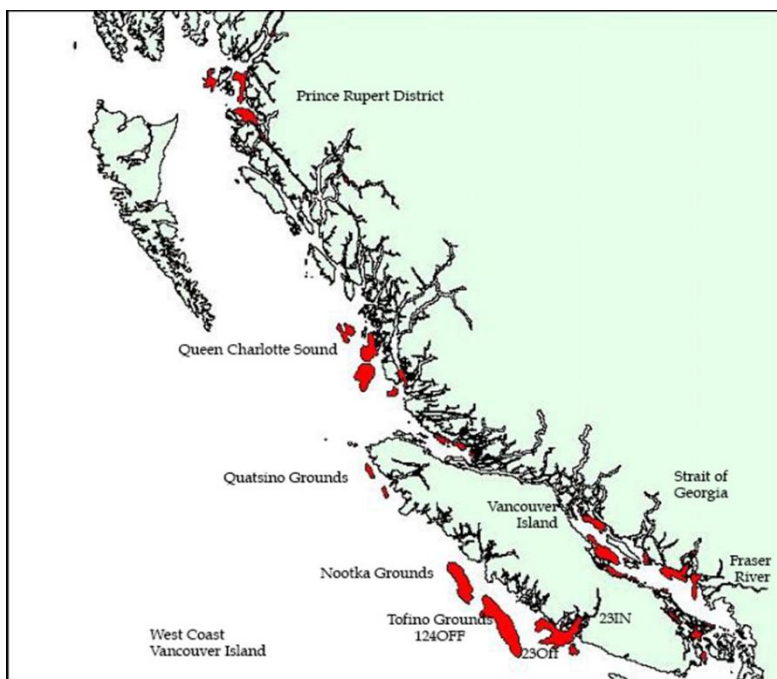


Figure 2. Major Shrimp production areas along the coast of British Columbia (areas highlighted in red). Taken from DFO (2024b).

The majority of vessels in the fishery are small coastal trawlers utilizing either single beam or otter trawls to fish. Beam trawls are used in inshore channels and consist of a rigid horizontal beam that holds the mouth of the net open as it is towed, keeping the gear slightly off the seafloor. Otter trawls are used in larger waters and offshore locations along WCVI (Figure 2) and consist of doors on either side that hold the mouth of the net open. While there are roughly 229 vessel-based licences (including 26 communal commercial licences for First Nations), annual participation is heavily scaled down (DFO 2026j). Over the last decade, active participants averaged 45–60 vessels, but has dropped as low as 15 active vessels in recent cycles. Only 19 vessels participated in the 2024 fishery, a 5% decrease since 2023 (DFO 2026j).

The British Columbia Shrimp trawl fishery began in the 1930s and developed rapidly in the 1960s when a downturn in the Salmon and Halibut fisheries occurred and continued to expand through the 1980s and 1990s (DFO 2026j). Landings and landed value peaked at 7,657 t and \$22.7 M (2024 CAD), respectively, in 1996 and have declined since this time except for a brief revival in 2015 and 2016 (Figure 1) when Pink Shrimp abundance was high in fishing grounds offshore of WCVI. By the 2023-24 season, 201 t were landed, which was a 73% increase relative to 2022-23 and in 2024-25 only 115 t were landed, which was only 3.6% of the maximum available catch (total of all estimated catch ceilings) of 3,175.2 t (DFO 2026j). Landed value for the 2024-25 fishery was \$1.0 M (2024 CAD) and is the lowest landed value to date (Figure 1). The majority of shrimp landings have historically come from the offshore areas of the West Coast of Vancouver Island on the Barkley Sound, Tofino and Nootka grounds (Figure 22).

The British Columbia coast was divided into 36 SMAs in 1997 to distribute fishing effort on Shrimp stocks, which were treated as distinct stocks in each SMA, and to improve the effectiveness of management actions (Boutillier et al. 1999). A fixed harvest rate management strategy is used to estimate catch ceilings for each species in a SMA based on fishery-independent survey results (DFO 2012, 2025e, 2026a). Initial catch ceilings are established annually for each species in each SMA using provisional reference points, harvest rates based on stock status in each SMA and stock biomass forecasts in the SMA estimated by the surveys (DFO 2012). These initial catch ceilings are defined before the season and are adjusted when new in-season biomass estimates from the survey are available, which can result in a patchwork of openings and closures of SMAs due to one of three species being below the LRP. The surveys conducted by DFO off the WCVI, in the Strait of Georgia and Prince Rupert District typically occur in 13-14 of the SMAs. In SMAs for which there are no survey data, catch ceilings are based on the 10th or 25th percentile of the pre-1997 catch history – generally 10 t in inshore areas and 25 t for offshore areas (DFO 2026a).

Provisional MSY-based reference points compliant with the Precautionary Framework are based on expert workshop recommendations (DFO 2009). Since MSY is a model estimated quantity and there is no model for these Shrimp stocks, a proxy is used to

estimate MSY ($B_{\text{MSY-proxy}}$), and for BC Shrimp stocks the proxy is defined as the natural logarithm of the average biomass from 1997 to 2007, which is considered a stable productive 10-yr period for Pink and Sidesripe Shrimp (DFO 2012). The provisional reference points used in managing this stock are 0.4 $B_{\text{MSY-proxy}}$ and 0.8 $B_{\text{MSY-proxy}}$ for the LRP and USR, respectively (DFO 2009, 2012, 2026a).

Shrimp stock size in British Columbia shows high inter-annual variation, which in turn results in high inter-annual variability in catch ceilings and economic performance of the Shrimp trawl fishery under the current management system (DFO 2025e). Recruitment of the main Shrimp species is believed to be more strongly influenced by environmental conditions, especially conditions impacting pelagic larval dispersal, than spawning stock size (DFO 2026a). Fishing is believed to have little influence on stock productivity and abundance so conventional fishery models have not been applied in the assessment of these shrimp stocks (DFO 2026a).

Martell et al. (2000) reconstructed Smooth Pink Shrimp stock abundance off the WCVI and found that survey biomass estimates in the offshore areas are good predictors of pre-season vulnerable biomass. These authors also reported that in years of low SSB, recruitment in these offshore areas was through immigration. Relatively little is known about the movement dynamics of shrimp stocks in British Columbia waters either through larval dispersal or movements within the exploitable portion of the biomass within season. Information on larval dispersal formed part of the basis for stock separation in the NL Shrimp trawl fishery, reducing six stocks to two stocks for assessment (DFO 2025b). Information on in-season movements such as from low to high density areas or vice versa, may be important for mitigating concerns related to local depletions of Shrimp stocks when the new coastwide stock definitions are implemented.

A recent review of the science framework for BC Shrimp stocks (DFO 2025f) recommended managing Smooth Pink, Spiny Pink, and Sidesripe as single coastwide stocks rather than separate stocks in each SMA due to a lack of evidence for multiple sub-stock structure within each species. This review also evaluated the survey design and recommended switching to a systematic sampling station design to improve accuracy and precision of biomass estimates and using a survey area of 70,421 km² to support the single coastwide stock definition for each species. Implementation of a spatiotemporal model (i.e., sdmTMB) also was recommended to improve accuracy and bias in biomass estimates in support of the single coastwide stock definition. This modeling approach requires a minimum of 10 survey tows that are positive for Shrimp within the survey area in each year surveyed; 200 tows (not all will be positive for shrimp) are expected to be achievable annually in future surveys (DFO 2025f). These recommendations will be implemented and a workplan has been developed but full implementation will take time (Appendix 11). One concern for managers is the need for advice on catch ceilings at a smaller scale (e.g., SMA) than stock status determination

(coastwide). The NL Shrimp trawl fishery recently went through a similar transition so it can be done successfully.

One of the key issues for the BC Shrimp trawl fishery is Eulachon bycatch management. Eulachon is a small anadromous pelagic smelt-like fish that spawns in coastal rivers of BC from the Skeena-Nass watershed to the Fraser River. COSEWIC assessed the Central Coast and Fraser Designatable Units (DU) of Eulachon as Endangered and the Nass/Skeena stock as Threatened in 2011. A Recovery Potential Assessment (RPA) for Eulachon (Fraser River and Central Pacific Coast DUs) was undertaken by Schweigert et al. (2012) which identified Eulachon bycatch in the Shrimp trawl fishery occurring in offshore WCVI areas as a key threat to Eulachon recovery. Eulachon bycatch is managed in Canada using a hard 4t bycatch limit (Eulachon Action Level – EAL) applied to offshore WCVI fishing areas, where Eulachon are migrating, and the requirement for vessels fishing in these areas to have 100% observer coverage (reduced to 25% in 2026-27) to verify and record bycatch. When Eulachon bycatch approaches the EAL, the fishery is closed in these offshore areas, resulting in substantial economic impact as the offshore areas are the most productive Shrimp grounds along the BC coast. No fishing has occurred and thus no Eulachon bycatch in the offshore WCVI fishery areas since at least the 2023-24 season because it is not economically viable to incur the time and cost to train observers coupled with lack of an established market for the product and the potential for quick closure due to EAL being exceeded. In-season Eulachon bycatch estimate for WCVI was ~ 1 t in 2023-24 and ~0.5 t in 2024-25 (DFO 2026a). Modifications to the current EAL will require new Science advice that the risk to the Fraser River Eulachon stock from Shrimp trawl bycatch is not as great as assumed and/or advice that whatever risks are estimated can be mitigated effectively.

Several causative factors are cited for the slow decline in this fishery biologically and economically. High costs of the monitoring program paid by Industry (e.g., at-sea observer requirements in offshore areas), low market demand, and high regulatory oversight as a result of precautionary management including selective fishing, multiple openings and closures of SMAs in-season related to one of three species below the LRP, catch ceilings and bycatch management of Eulachon. Lack of predictable fishing opportunities is considered by Industry to be a key limiting factor that affects marketing within the BC Shrimp trawl fishery. Industry has proposed the implementation of a minimum fixed annual catch rather than the current maximum catch ceilings and alternative management frameworks that would promote conservation but allow for long-term stable fishing plans to address their concerns.

More detailed information on this fishery is found in Appendix 1.

Estuary-Gulf of St. Lawrence Northern Shrimp Trawl Fishery

The Estuary-Gulf of St. Lawrence (EGSL) Northern Shrimp fishery is an important inshore industry in eastern Canada operating at depths of 200–300 m in four stock

areas: Estuary, Sept-Îles, Anticosti, and Esquiman delineated by Bourdages et al. (2023) (Figure 3). These fisheries target a single species, Northern Shrimp.

The EGSL Shrimp fishery began in 1965 and landings gradually increased from nearly 1,000 t in the 1970s to more than 35,000 t in the late 2000s (Figure 4). A collapse of Atlantic Cod and Redfish stocks in the mid-1970s and the low prices paid for these species led to increased demand for fishing licences for Northern Shrimp, which were limited in 1980 to 111 licences so as to not further increase fishing capacity on groundfish species since all the Northern Shrimp fishing licence holders were also holders of groundfish fishing licence (LRQA 2023a). Landings have subsequently declined, reaching 2,570 t in 2024 and 3,381 t in 2025 (preliminary data as of January 5, 2026), out of overall total allowable catches (TAC) of 3,060 t and 3,809 t, respectively (DFO 2026d). The 2024 and 2025 landings are the lowest recorded since 1974 for the Sept-Îles, Anticosti and Esquiman stocks (Figure 4).

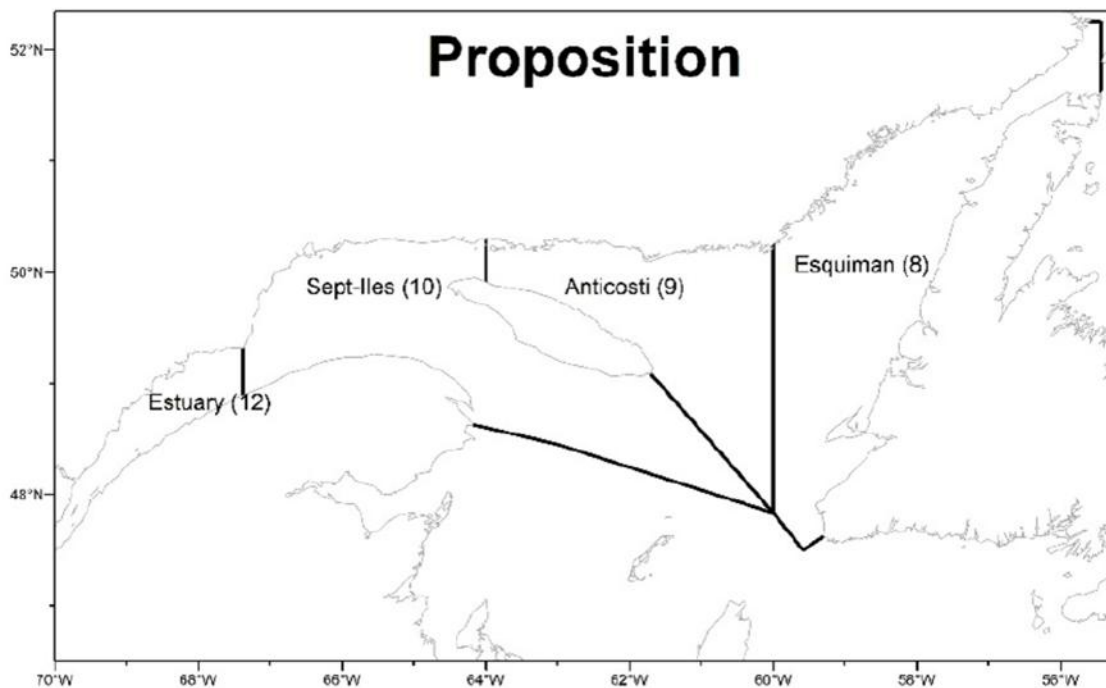
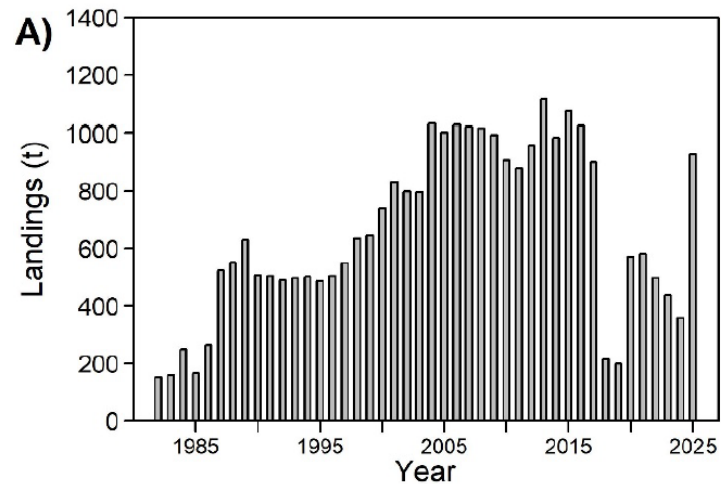


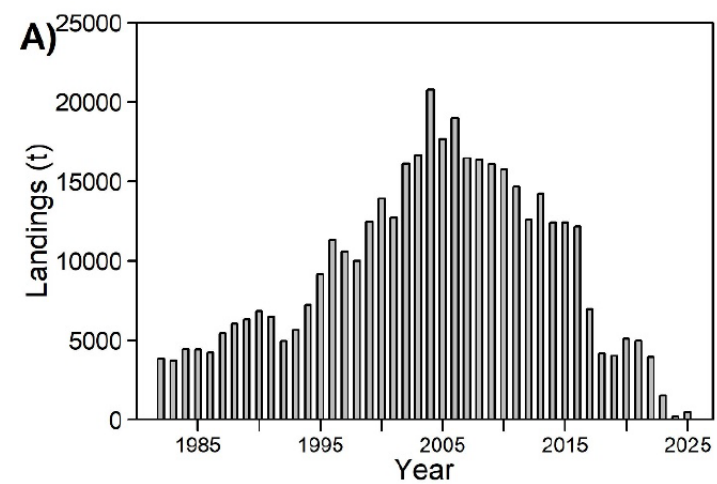
Figure 3. Four Shrimp Fishing Areas (SFA) in the Estuary and Gulf of St. Lawrence Northern Shrimp Fishery proposed by Bourdages et al. (2023) and subsequently implemented. Taken from Bourdages et al. (2023).

The EGSL fishery is managed using TACs, ITQs, and the use of biological reduction devices (BRD – a rigid Nordmøre grate) to minimize bycatch, particularly for juvenile ground fish. Management of these stocks is consistent with the PA Framework in Canada since an LRP ($0.4 B_{MSY}$) has been adopted, a USR ($0.8 B_{MSY}$) and TRP (B_{MSY}) have been proposed but not adopted, and HCRs are in place for each status zone (DFO 2026d; 2023). One noteworthy feature of the HCR is that the relative harvest rate (F/F_{MSY}) when a stock is in the critical zone below the LRP is $0.5 F_{MSY}$ rather than 0

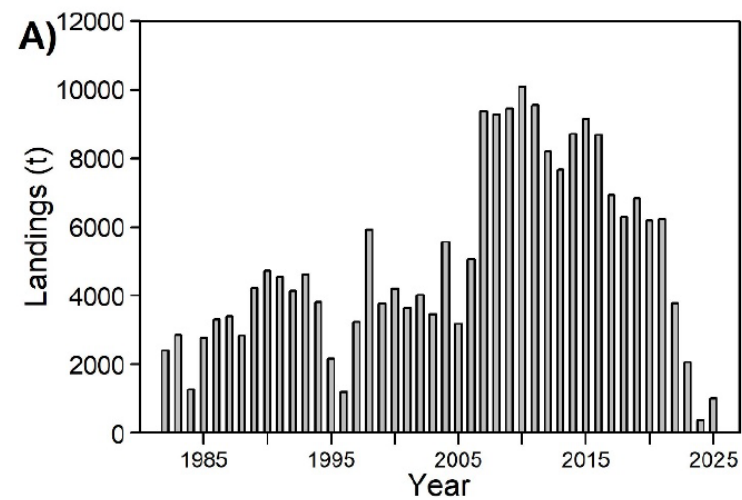
Estuary



Sept-Îles



Anticosti



Esquiman

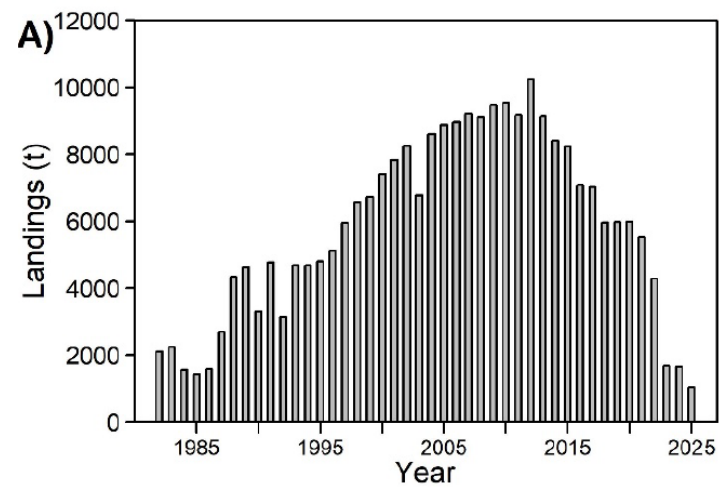


Figure 4. Landings from 1990 to 2025 by stock unit in the Estuary-Gulf of St. Lawrence Northern Shrimp Trawl fishery. The 2025 data are preliminary as of January 5, 2026. Note differences in the scale of the vertical (landings) axis. Taken from DFO (2026d).

Harvest Control Rules

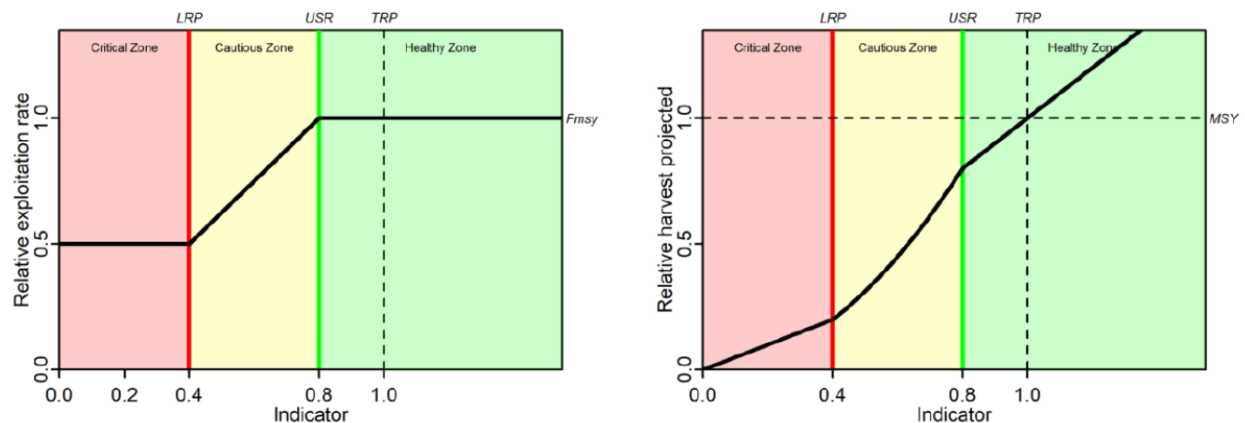


Figure 5. Harvest control rules presenting relative exploitation rate (F/F_{MSY} , left) and relative projected maximum harvest (right) as a function of the stock status indicator (B/B_{MSY}). The reference points are presented on the panels by the vertical lines which define the three zones of the precautionary approach. Taken from (DFO 2026d).

(Figure 5). The current status of the Estuary stock is in the Healthy zone while the remaining three stocks are below the LRP in the Critical zone and rebuilding plans have been developed and implemented for these stocks.

Stock status determination prior to 2025 used trends and estimates from a standardized commercial CPUE index and a fishery-independent index of shrimp abundance from an annual ecosystem survey in the Gulf of St. Lawrence combined into a single stock indicator. Over the last decade, the commercial CPUE showed that Northern Shrimp abundance was stable or increasing while the survey index showed a substantial decline in abundance, i.e., the commercial CPUE index displayed evidence of hyperstability since these indices sample different portions of the stocks. Because of the increasing divergence in these indices, the perception of stock status was likely misleading and the use of the single stock indicator is no longer considered appropriate (Smith and Bourdages 2024). This conclusion led to the implementation of a modeling approach to stock assessment based on a surplus production model, to track trends and evaluate stock status relative to the PA framework (Smith and Bourdages 2024; DFO 2026d).

The most recent stock assessment (DFO 2026d) highlights the risks for Northern Shrimp stocks from ecosystem changes observed in recent years in the Gulf of St. Lawrence. Warming of deep waters and oxygen depletion are exposing Northern Shrimp stocks to adverse environmental conditions which are likely to reduce productivity, and predation by Redfish has increased leading to historic declines in three of the four stocks (Bourdages et al. 2022; DFO 2026d). In addition, the reduction in the geographic range of Northern Shrimp distribution resulting from the squeezing effect of warmer oxygen poor deep waters increases the risk to the stock of both increased predation and exploitation. The outlook for the EGSL stocks is dependent on the sensitivity and

resilience of Northern Shrimp to environmental changes, predation pressure and fishing pressure.

More detailed results are found in Appendix 2.

Eastern Scotian Shelf Shrimp Trawl Fishery

The Eastern Scotian Shelf (ESS) Northern Shrimp trawl fishery operates in waters off the east coast of Nova Scotia and is near the southern limit of the species' global distribution (Figure 6). This fishery is relatively small in terms of landed quantities and operates under an 'evergreen' management plan (Hardie et al. 2018) that establishes permanent sharing arrangements between the three fleet sectors, consisting of 56 licences in the Scotia and Gulf mobile fleets (both trawl fleets) and a Scotia trap fleet. The trap fleet has not operated since 2022 (LRQA 2023).

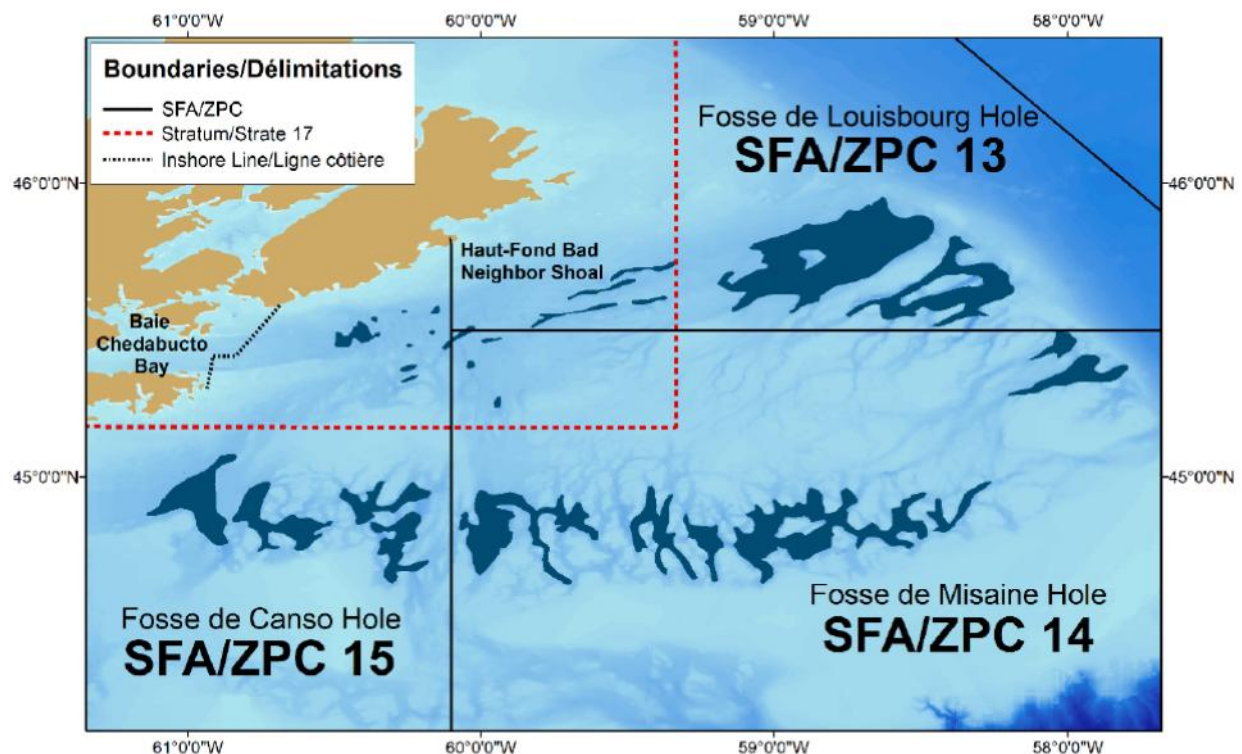


Figure 6. Boundaries of the Eastern Scotian Shelf Northern Shrimp fishery. The Shrimp Fishing Areas (SFA) fall within Northwest Atlantic Fishing Organization divisions 4Vn and 4VsW. The fishery is characterized by four areas: Louisbourg Hole (SFA 13), Misaine Hole (SFA 14), Canso Hole (SFA 15) and an inshore area within SFA 13-15 known as Bad Neighbour shoal (stratum 17). Taken from McDonald et al. (2025).

The ESS fishery provides important economic benefits to harvesters along the eastern shore of mainland Nova Scotia, south-eastern Cape Breton, and in the southern Gulf of St. Lawrence. It also generates significant benefits to the coastal communities where

the shrimp are landed and processed. Landings from the fishery have ranged between 1,000 t and more than 5,400 t since the fishery began in the 1980s, but catch and effort have decline substantially since 2015 resulting in 2025 landings of 673 t by eight active licences, the lowest since 1991 (Figure 7; Hardie et al. 2025).

The ESS fishery is managed using TACs and is a limited entry fishery, with all trawl licences under Individual Transferable Quotas (ITQs) since 1998. TAC recommendations are distributed 69.5% to the Scotia trawl fleet, 22.5% to the Gulf trawl fleet, and 8% to the Scotia trap fleet. The Scotia trap fleet quota is redistributed amongst the trawl fleets when the trap fleet is inactive. Stock assessment transitioned in 2024-25 from an indicator approach to a science framework based on a spatio-temporal delay-difference model to evaluate stock status and health. A fishery-independent survey has been conducted annually since 1995 under a joint project agreement (JPA) between DFO and Industry. Management of this fishery is considered compliant with the PA Framework as an LRP and USR have been adopted and HCRs proposed for each status zone. The stock is currently estimated to be in the Cautious zone and a catch of 700 t in 2026 is expected to result in a 0.7% decrease in total biomass and 51.9% probability of stock decline (DFO 2026f).

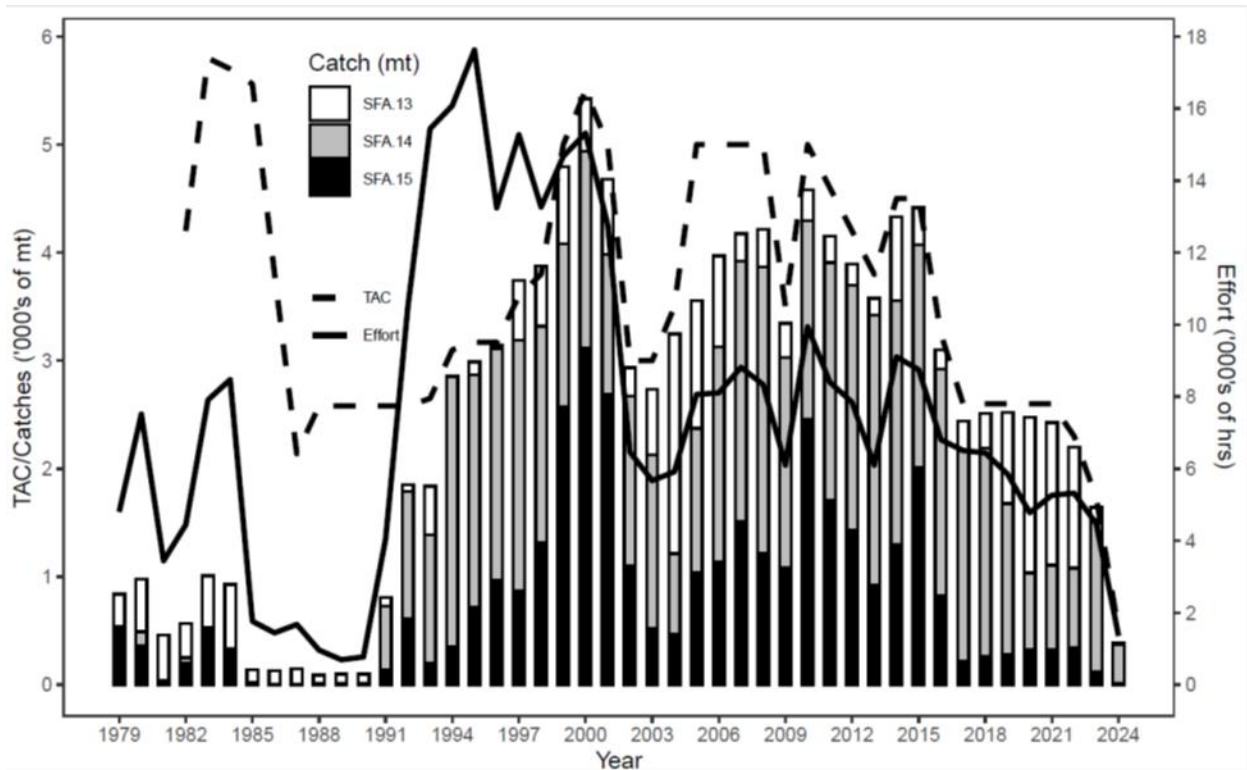


Figure 7. History of catch (t), TAC (t) and effort (hours) in the Eastern Scotian Shelf Northern Shrimp fishery in Shrimp Fishing Areas 13-15 from 1979-2024. Taken from Hardie et al. (2025).

A traffic light analysis (TLA) was used to determine stock status and qualitatively assess risks to the stock prior to the 2024-25 season. The TLA incorporates 21 indicators of abundance, production, fishing effects and ecosystem derived from the survey/model, a snow crab survey and a summer ecosystem survey (predator abundance indicators) along with satellite observations of temperature and chlorophyll a (McDonald et al. 2025). The range of each indicator is categorized into good (green), cautious (yellow), and bad (red) for shrimp and the number of indicators in each zone provides additional qualitative context for the health of the stock and informs adaptive TAC adjustments. The TLA was retained in the new science framework because it supplements the model outputs and qualitatively informs stock status (five indicators are model outputs) (DFO 2026f).

A key feature of the management of the ESS fishery is the use of an LRP and USR based on unfished biomass, B_0 , as recommended by McDonald et al. (2025). This recommendation was accepted and implemented because using MSY-based choices implicitly assumes that fishing pressure drives changes in stock abundance and there was no evidence for this relationship in the data available for this stock. McDonald et al. (2025) suggested that a historical proxy be used to estimate B_0 , which they defined as the model estimated maximum observed spawning stock biomass (SSB) for the 2005-present period. While the logic beyond this choice for reference points is useful, the proxy approach recommended means that the estimate of B_0 will shift as SSB values are re-estimated and a new estimate added annually from the assessment model.

The ESS Northern shrimp stock is at the southern end of the range for this species and is sensitive to environmental changes, particularly water temperature since Northern Shrimp thrive in cold water (0–5°C). Rising bottom and sea-surface temperatures observed across the Scotian Shelf have significantly stunted recruitment and driven downward biological productivity trends and TAC (DFO 2025; 2026f). Because quotas closely mirror fluctuating ocean conditions, economic impacts are felt as processing plants face direct, immediate employment challenges when TAC cuts are implemented.

The ESS trawl fishery was first certified as sustainable by the Marine Stewardship Council in August 2008 and the inshore trap fishery was added to the certification in 2014 (LRQA 2023b). The trap component of the fishery withdrew from the certification in September 2022 because poor market conditions for trap-caught shrimp meant it was not feasible economically to maintain the certification. As of November 2024, the trawl fishery has suspended its certification due to the impact of changing climatic conditions on stock productivity and survival, abundance and subsequent TAC recommendations.

More detailed results are found in Appendix 3.

Newfoundland-Labrador Northern Shrimp Trawl Fishery

The Newfoundland and Labrador Northern Shrimp fishery takes place along the Labrador Shelf and Northeast Newfoundland Slope, from the Flemish Cap on the northern edge of the Grand Banks to Baffin Bay/Davis Strait (Figure 8). The area consists of four SFAs and two Arctic assessment zones and targets Northern Shrimp, although Striped Shrimp (*P. montagui*) are a secondary target in the Western Assessment Zone and SFA 4 to the north.

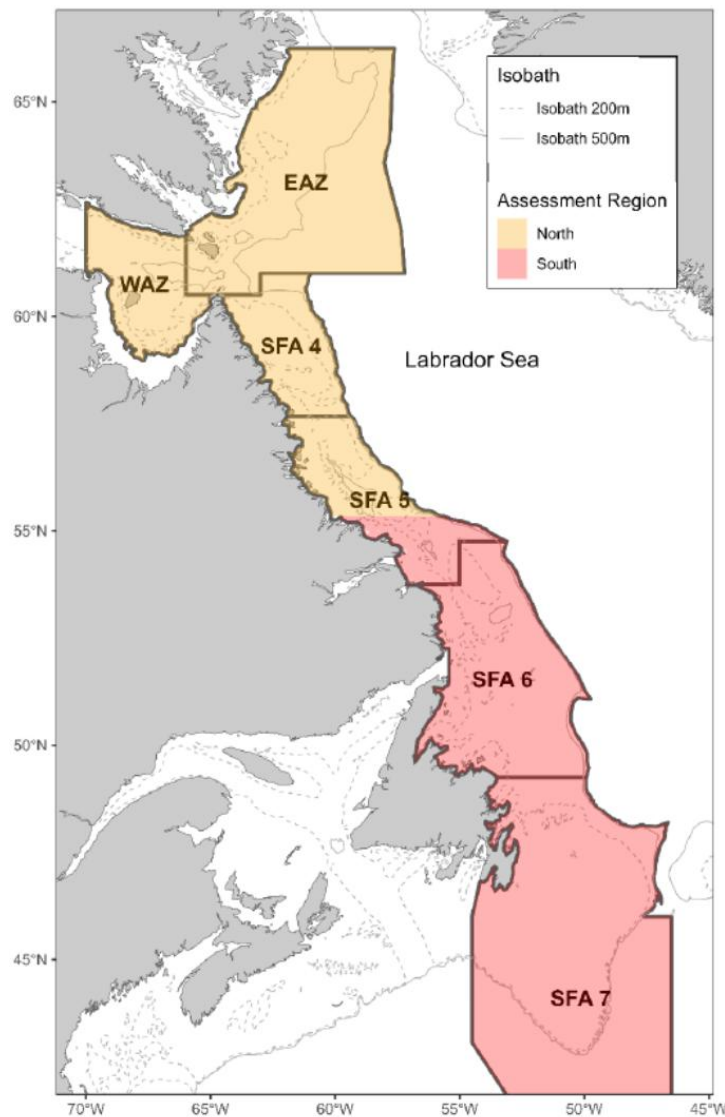


Figure 8. Newfoundland-Labrador Northern Shrimp fishery, showing the six previously used shrimp fishing areas (SFA) (Eastern Assessment Zone [EAZ], Western Assessment Zone [WAZ], SFAs 4–7) and the two new stock assessment regions (North Stock Assessment Region – NSAR; South Stock Assessment Region – SSAR) used in the revised assessment framework. Taken from DFO (2025b).

Both smaller inshore trawlers and larger offshore freezer trawlers participate in the fishery and have differing management and monitoring requirements. The offshore fleet consists of 6-10 active vessels with home ports in Newfoundland and Nova Scotia and is managed by quota in each SFA, which is allocated equally to each of the 17 licence holders (not vessels) and is transferable. Offshore vessels spend 300-320 days at sea annually fishing further north than the inshore fleet, and are required to have 100% observer coverage to monitor bycatch, discarding and high grading, gear restrictions, closure restrictions, and collect catch samples for size composition, weight-by-species, effort and bycatch composition (DFO 2018). The inshore fleet consists of about 260 licences of small vessels based in Newfoundland-Labrador and Quebec and includes vessels from Innu Nation and Nunatsiavut fishing in the Western and Eastern Assessment Zones (DFO 2018). The inshore fishery is competitive and continues until the quota is filled or the season closes the fishery and all landings from this fleet are monitored through dockside monitoring rather than scientific observers.

A new stock assessment framework was implemented for the 2025/26 season, combining four SFAs and two assessment zones into northern (NSAR) and southern (SSAR) stock assessment regions based on a new understanding of stock structure (Baker et al. 2025), and an integrated statistical catch-at-length model to better account for larval dispersal between areas (DFO 2025b). Catch has ranged between 25,867 t and 44,604 t in the NSAR between 2015-16 and 2024-25 (Figure 9) and between 7,237 t and 53,304 t in the SSAR over the same period (Figure 10). TAC usage in NSAR has ranged between 85 and 99% prior to 2019-20 and is mostly less than 87% since 2020-21 (Figure 9). In contrast, TAC usage in SSAR is above 90% for most of the time series, but has declined below 95% since 2023-24 and in 2024-25 declined to 68% when a catch of 7,237 t was recorded (Figure 10). Landed value of the Northern Shrimp fishery in NL for 2025 was approximately \$139.8 million (CAD) from 28,285 t of catch.

The fishery is managed under the PA framework and uses TACs to control exploitation of the target stock. A LRP based on B_0 has been adopted, but the proposed B_0 -based USR has not been adopted. The rationale for this choice for reference points appears to be similar to the rationale for this choice in the ESS Shrimp trawl fishery (e.g., McDonald et al. (2025)). Harvest control rules are available for each zone of the PA framework and it should be noted that there is a guideline that TAC changes in a given year should not exceed 15% of the previous TAC unless stock decline is steep. Assessment and status determination are model-based at the SAR level and advice on TAC is provided at the SFA level for management purposes. Shares of the TAC in each SFA are allocated to the offshore and inshore fleets and special allocation holders in specific SFAs, including Indigenous organizations. Bycatch of groundfish species occurs, but is not considered a major concern for this fishery. Striped Shrimp are managed as bycatch in SFA 4 and a 4,033 t limit is in place for the offshore fleet (DFO 2024a).

If the proposed USR were adopted, then the current status for each stock in 2024 is in the Healthy Zone of the PA Framework. The female SSB in the NSAR was above the

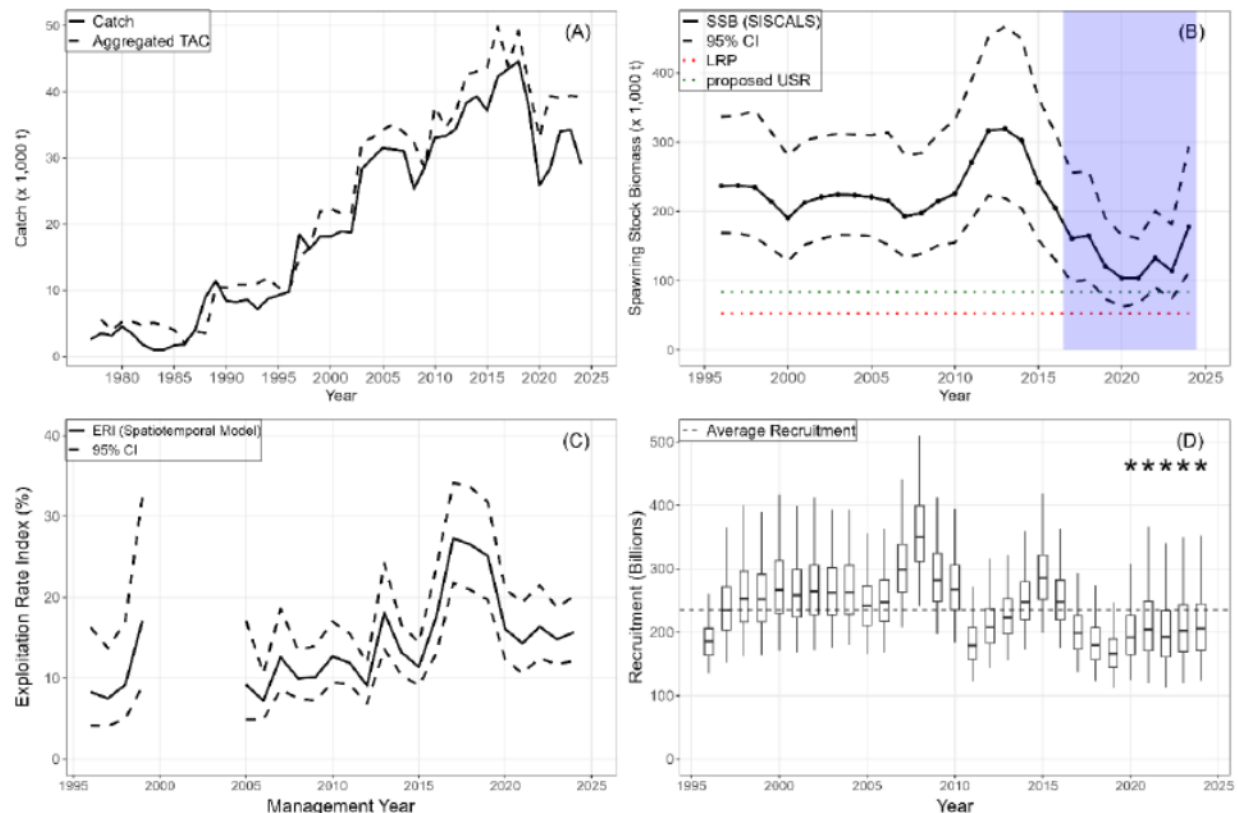


Figure 9. Northern Shrimp in the Northern Stock Assessment Region (NSAR). (A) Catch (x 1,000 t) and aggregated Total Allowable Catch (TAC) (x 1,000 t) by year (data for 2023/2024–2024/2025 are preliminary), (B) Spawning Stock Biomass (SSB x 1,000 t), from the stock assessment model, by year in relation to the Limit Reference Point (LRP: $0.5 \times \text{Biomass at Maximum Sustainable Yield } [B_{MSY}]$ -proxy; median estimate) and proposed Upper Stock Reference (USR: $0.8 \times B_{MSY}$ -proxy; median estimate), blue shading indicates the 8-year window used to represent recent natural mortality and length at transition in SISCALS, (C) Exploitation rate index (ERI; %) based on catch and spatiotemporal Fishable Biomass (FB) index from the same year, (D) Estimated recruitment (5–11 mm carapace length) from SISCALS (box: 25th, 50th, and 75th percentiles; whiskers: 95% confidence interval [CI]), time-series mean (1996–2019; dashed horizontal line), and simulated recruitment over the last five years (*). Taken from DFO (2025b).

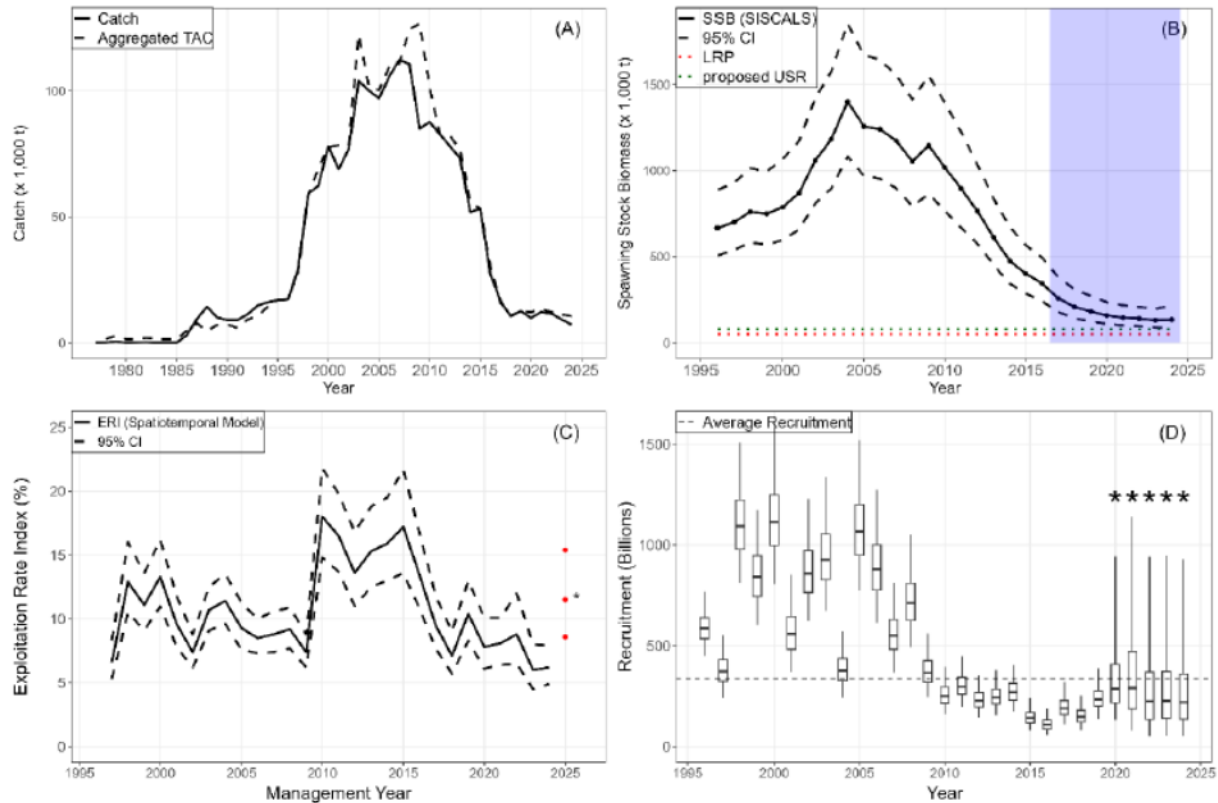


Figure 10. Northern Shrimp in the Southern Stock Assessment Region (SSAR). (A) Catch ($\times 1,000$ t) and aggregated Total Allowable Catch (TAC; $\times 1,000$ t) by year (data for 2023/2024–2024/2025 are preliminary), (B) Spawning Stock Biomass (SSB $\times 1,000$ t), from the stock assessment model, by year in relation to the Limit Reference Point (LRP: $0.5 \times \text{Biomass at Maximum Sustainable Yield } [B_{MSY}]$ proxy; median estimate) and proposed Upper Stock Reference (USR: $0.8 \times B_{MSY}$ proxy; median estimate), blue shading indicates the 8-year window used to represent recent natural mortality and length at transition in SISCALS, (C) Exploitation rate index (ERI; %) based on catch and spatiotemporal Fishable Biomass (FB) index from the previous year (*2025/2026 projected ERI and confidence intervals [CI] considering the same aggregated TAC as in 2024/2025; in red), (D) Estimated recruitment (5–11 mm carapace length) from SISCALS (box: 25th, 50th, and 75th percentiles; whiskers: 95% confidence interval, time-series mean (1996–2019; dashed horizontal line), and simulated recruitment over the last five years (*). Taken from DFO (2025b).

LRP (greater than 99% probability) and above the proposed USR (greater than 99% probability) in 2024 and the female SSB for in the SSAR was above the LRP (greater than 99% probability) and above the proposed USR (greater than 98% probability). TAC increases for Northern Shrimp in 2025-26 of between 3 and 50% relative to 2024-25 were implemented in SFAs and EAZ, while a decrease of 14% in the WAZ (DFO c, d).

The Newfoundland-Labrador Northern Shrimp trawl fishery, including both the inshore and offshore fleets, was certified as sustainable by the Marine Stewardship Council in 2011 and has been recertified every five years since that time (LRQA 2026). The current certificate expires in 2027.

More detailed results are found in Appendix 4.

Barents Sea Northern Shrimp Trawl Fishery

The Barents Sea Northern Shrimp fishery is an industrial-scale fishery targeting Northern Shrimp in the cold waters of the Arctic, mainly in the central Barents Sea, particularly around the Hopen area and the Svalbard fishing protection zone (SFPZ) of Norway (Figure 11). This offshore fishery is conducted by large freezer-trawlers primarily from Norway and Russia, with vessels from Greenland, Iceland, the Faroe Islands and several EU countries also participating. Four of the main participants, Norway, Russia, Faroe Islands, and Estonia (European Union), have MSC-certified sustainable fisheries. The fishery is highly lucrative, with annual catches fluctuating between 20,000 and 130,000 t since the late 1970s and recent catches peaking at 95,000 t in 2024 (Figure 12). The most recent stock status determination concluded that the stock is at safe or healthy biomass levels and is not depleted by overfishing, with relative exploitable biomass (B/B_{MSY}) estimated to be 1.39 and relative F (F/F_{MSY}) of 0.64, with a 23% probability that fishing mortality was above F_{MSY} (Figure 13).

The Barents Sea fishery largely occurs within the EEZs of Norway and Russia, but there is an area of high-seas, called 'the Loophole' between these zones that is under the jurisdiction of the Northeast Atlantic Fisheries Commission (Figure 11). Although Norway and Russia manage the stock separately, national regulations have been harmonized between the two coastal states and are discussed at the annual sessions of the Joint Norwegian – Russian Fisheries Commission (JNRFC). Annual quota advice for the Barents Sea stock is provided by the joint NAFO/ICES NIPAG Working Group using a stochastic surplus production model and an MSY-based reference point framework for stock status determination. Short-term projections of plausible harvest scenarios are used to estimate the probabilities that the stock exceeds key reference points such as MSY $B_{trigger}$ (USR defined as a proportion of B_{MSY} in the Canadian context) and B_{lim} (LRP in the Canadian context) that inform harvest decision table (Figure 13). However, there is no overall management plan, joint TAC or HCRs established for this stock among all

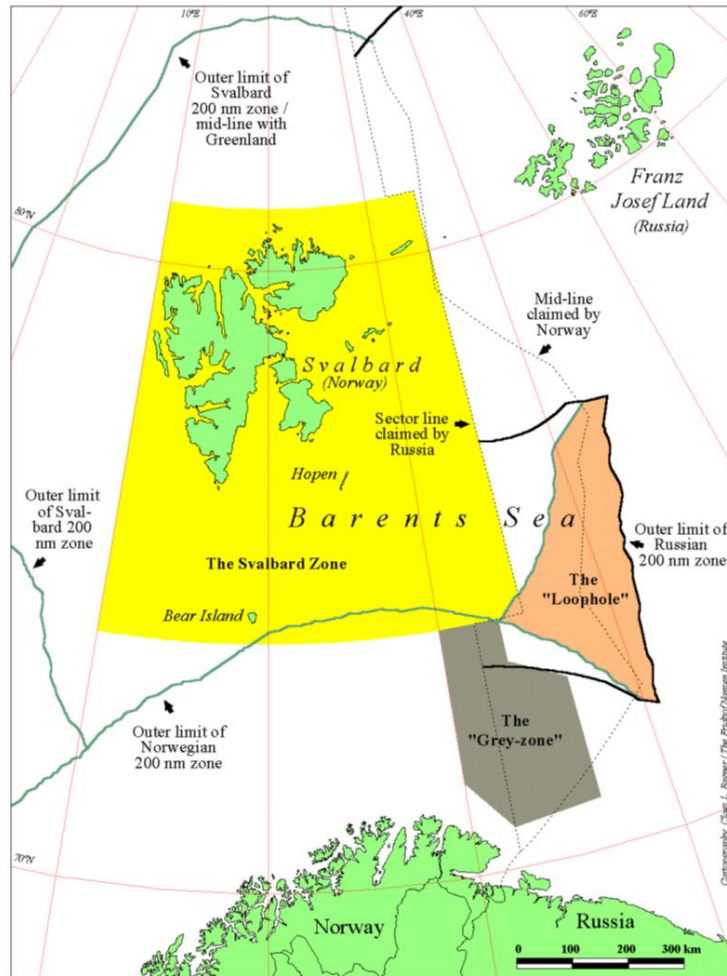


Figure 11. Barents Sea ecoregion and administrative zones including the exclusive economic zones (200 nm limit) of Norway and Russia, the high seas 'Loophole' pocket, and the Svalbard Fishery Protection Zone (SFPZ). Taken from Stokke (2001).

of the parties utilizing the resource. In the absence of an overall TAC and HCR, key regulation has occurred through controls on fishing effort by Norway and Russia on vessels fishing within their EEZs, including limits on licenses and days fished, minimum landing size (> 15 mm CL), and area closures and move-on rules when CPUEs triggers for key bycatch stocks are exceeded. Because Russian scientists were unable to participate in the joint NIPAG Working Group since the war in Ukraine began, a partial TAC has been implemented for the Russian EEZ based on a Russian stock assessment.

Despite stock biomass remaining well above B_{MSY} throughout the history of the Barents Sea fishery and recruitment being sufficient to keep the stock at this level, recent data show a decline is occurring towards long-term average biomass levels. At present, there are no HCRs that define management actions when stock biomass declines to levels close to MSY $B_{TRIGGER}$ or B_{LIM} , or fishing mortality increases to levels above F_{MSY} . The absence of a common management plan results in total catches largely shaped by

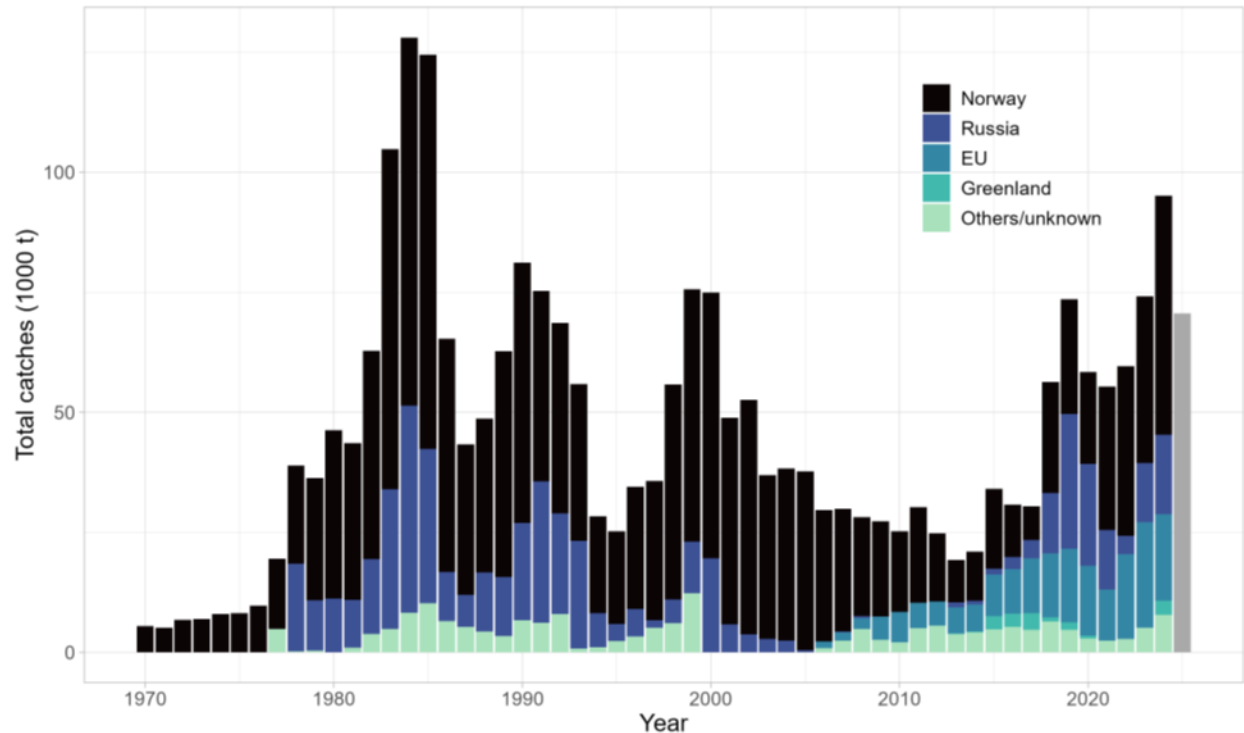


Figure 12. Total catches of Northern Shrimp in the Barents Sea fishery by country and year, 1970-2025. Catches are assumed to be identical to reported landings. Value for 2025 is predicted based on preliminary reporting. Taken from Zimmermann et al. (2026).

economic conditions rather than biological limits and increases the risk of sudden effort shifts and uncontrolled increases in fishing pressure, particularly displacement from other quota-limited fisheries in the Barents Sea (e.g., Atlantic Cod and other key stocks), given the economic value of Northern Shrimp and the lack of a formal TAC.

The fishery was previously conducted mainly in the central Barents Sea and on the Svalbard Shelf along with the Goose Bank (southeast Barents Sea), but has seen an eastward shift in effort into international waters in the Loophole in the last decade. Decreasing catch rates and more frequent area closures due to bycatch of juvenile Atlantic Cod and Haddock exceeding trigger catch rates on the traditional shrimp fishing grounds, and high fuel costs are the main reasons for the observed change in fishing pattern.

More detailed results are found in Appendix 5.

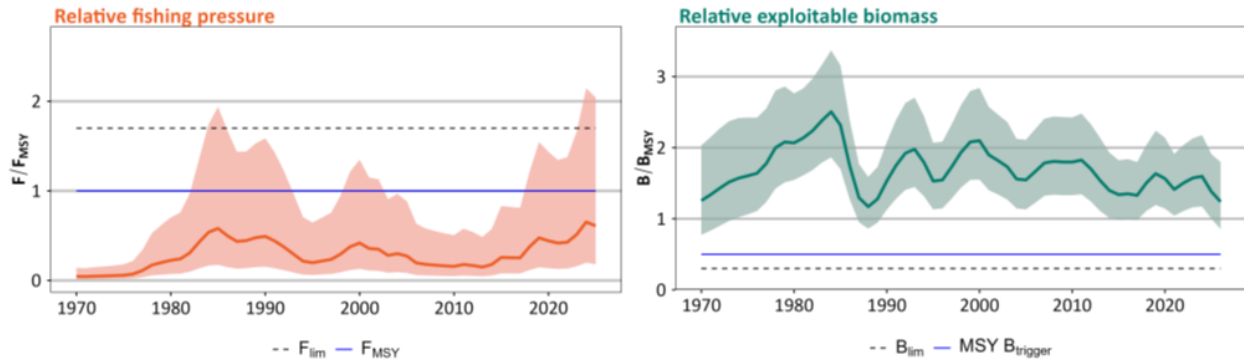


Figure 13. Estimated relative exploitable biomass (B/B_{MSY}) and fishing mortality (F/F_{MSY}) at the beginning of the year for the Barents Sea Northern Shrimp stock, 1970-2025. Solid lines represent the mean estimates, shaded surfaces the 95% confidence intervals. Solid and dashed horizontal lines show the MSY and precautionary approach reference points, respectively. The solid blue lines show the F_{MSY} and MSY $B_{trigger}$ values, which are $F/F_{MSY} = 1$ and $B/B_{MSY} = 0.5$, respectively. The dashed lines show F_{lim} and B_{lim} values, which are $F/F_{MSY} = 1.7$ and $B/B_{MSY} = 0.3$, respectively. Taken from Zimmermann et al. (2026) and IMR (2026).

Skagerrak and Norwegian Deep Shrimp Trawl Fishery

The Skagerrak and Norwegian Deep (SKND) shrimp trawl fishery is a high-value but ecologically sensitive fishery currently facing challenges from low recruitment and historically low biomass levels. The fishery targets Northern Shrimp and is located in the North Sea along the Norwegian coast south of 62 °N and along the southern coast of Norway and Sweden at the entrance to the Baltic Sea (Kattergut) between Sweden and Denmark (Figure 14; Søvik and Thangstad (2014)). Roughly 120-140 fishing vessels from Norway, Sweden and Denmark participate in this fishery and are mostly 10-25 m in length. The fishery is managed through a long-term management strategy (LTMS) negotiated and shared between Norway and the European Union (EU) (ICES 2023a). Catches have ranged between 5,000 t and 16,000 t since the 1970s (DNV 2024) and were 6,563 t in 2023-24 and 4,707 t in 2024-25 (Figure 15; DNV 2024; ICES 2025a).

The SKND fishery has been managed with a TAC shared amongst the three countries based on historical landings with Norway, Denmark and Sweden receiving 59%, 27% and 14%, respectively, between 2011 and 2023 (ICES 2023b). The TAC used for management purposes is negotiated between the EU and Norway annually based on the outcome of the stock assessment process. Realized catches in the fishery have exceeded the maximum advised catches over at least the last decade because stock assessment advice is for total catch (landings and discards) whereas national authorities in Norway, Sweden, and Denmark record only total landings in their catch records (Ulmestrand et al. 2014). Although measures are in place in all three countries, discarding continues to occur and can be problematic for this fishery.

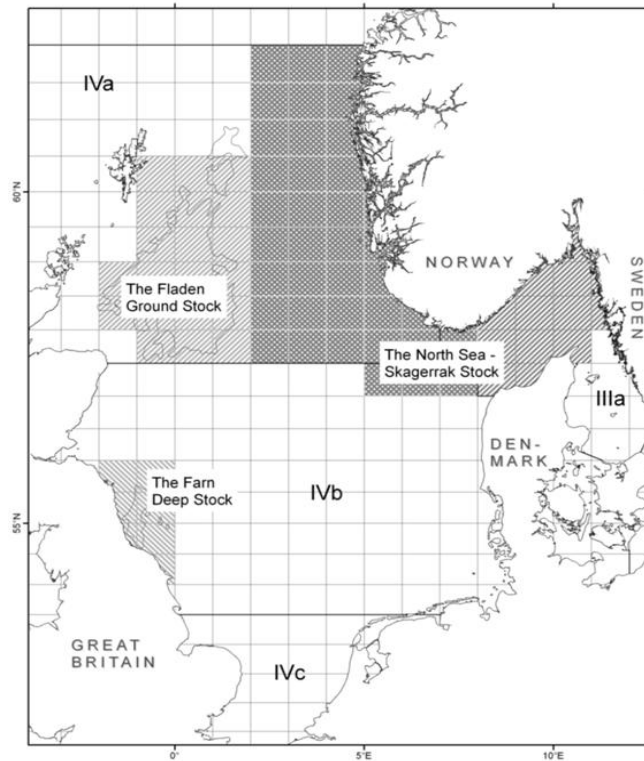


Figure 14. Distribution of Northern Shrimp stocks in the North Sea, including Skagerrak and the Norway Deep, and the ICES defined management units. Grid is standard "ICES squares" (0.5° lat. by 1° long.). Taken from Søvik and Thangstad (2014). Genetic evidence shows genetic heterogeneity between the three stocks in this graphic, i.e., these are distinct biological units.

The SKND stock is assessed annually by the joint NAFO/ICES Pandalus Assessment Group (NIPAG) using a length-based statistical catch-at-length model (based on the SS3 model platform, Methot and Wetzel (2013)) fitted to length-frequency distributions from commercial catches and stock surveys (ICES 2022). An updated version of the model was implemented in 2022-23 and led to lower estimates of SSB, higher estimates of F and a downward revision of recruitment relative previous models (ICES 2023a; 2025b). An ensemble of three models is used for stock status determination against MSY-based biological references consistent with the Canadian PA framework, where each model in the ensemble differs based on the assumed level of natural mortality.

The new model along with new reference points introduced in 2022-23 led to a worsening perception of stock status (ICES 2025b). SSB has been below B_{LIM} (LRP) and F has exceeded F_{MSY} since 2010 (Figure 16), placing the current state of the stock as overfished but overfishing is not occurring as fishing pressure is below F_{target} (which is F_{MSY}) and spawning-stock size is below MSY $B_{trigger}$ (USR in Canada) and B_{lim} (LRP in Canada). ICES does not employ the zone terminology (Healthy, Cautious, Critical) used in the Canadian PA framework when assessing stock status. However, based on the outputs from the most recent assessment in 2025 (ICES 2025b), stock status is placed in the Critical zone rather than in the Cautious or Healthy zone (as outputs from previous

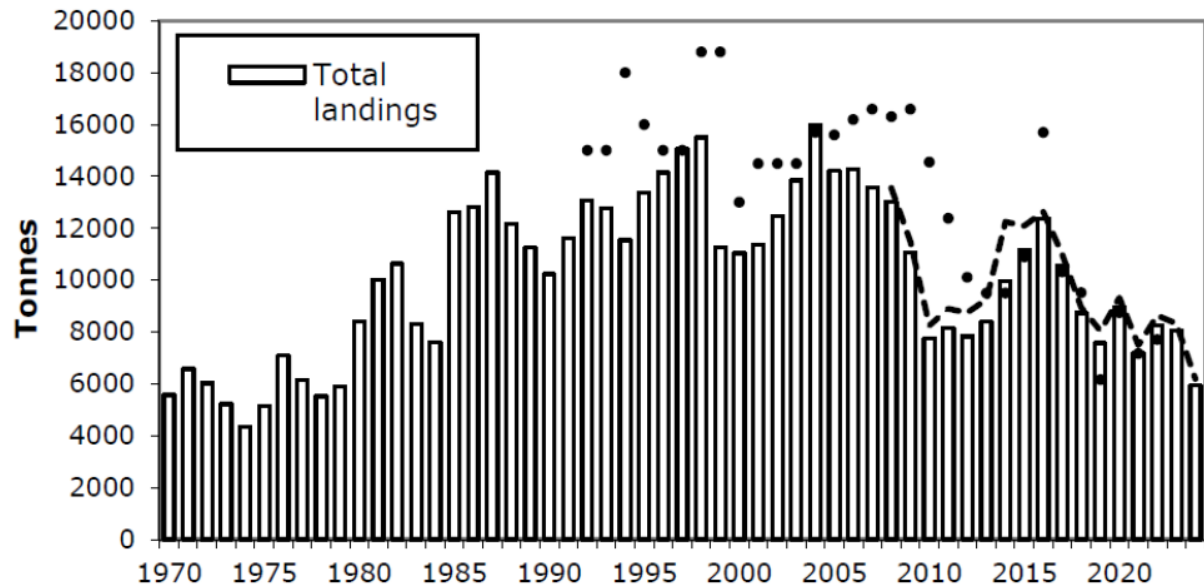


Figure 15. Northern shrimp in Skagerrak and Norwegian Deep fishery, 1970-2022 showing TAC, total landings and total estimated catch including estimated Swedish discards for 2008–2024, estimated Norwegian discards for 2009–2024 and estimated Danish discards for 2013-2024. Boiled portions of the landings have been corrected for loss of weight due to boiling (Sweden all years, Norway 2000-2023, Denmark 2000-2024). Landings, discards and TAC (1992-2022) are given for calendar years. Dots represent TAC advice and dashed line is the estimated catch including discards. Taken from DNV (2024) and ICES (2025a).

model iterations were showing SSB above B_{LIM} and F below F_{MSY}). A rebuilding plan has been adopted jointly by Norway and the EU for the stock that requires that TACs are set in line with F being maintained at or below F_{MSY} , which is expected to ensure that stock biomass is rebuilt towards B_{MSY} (ICES 2023b).

The downgraded perception of stock status resulted in harvest advice to substantially reduce TAC to promote rebuilding of the stock. TAC advice for the 2025-26 fishing season was 4,010 t, which represents a value of F/F_{MSY} of 0.45, resulting in a modest expected increase in SSB/MSY $B_{TRIGGER}$ from 0.37 in 2025 to 0.56 in 2026 with a probability of 49.3% that SSB will be $< B_{LIM}$ in 2026 (ICES 2025a, b). The 2025-26 TAC is a 12% reduction relative to 2024-25 advice of 4,557 t and is linked to a revised estimate of SSB/ SSB_{target} in the last few years due to the higher-than-expected catches in assessment year 2023 (6,563 t), which exceeded both the scientific advice (5,125 t) and the TAC set by EU-Norway negotiations (6,076 t), which removed a larger number of females from the population than was forecasted (ICES 2025b).

Predicting when the stock will return to MSY $B_{trigger}$ level ($=0.8 B_{MSY} = USR$ in the Canadian context) is difficult to estimate because stock dynamics of *Pandalus* are driven by highly unpredictable patterns in annual recruitment. Stock changes and the fishery are known to be driven by recruitment variability and it is likely that successive years of

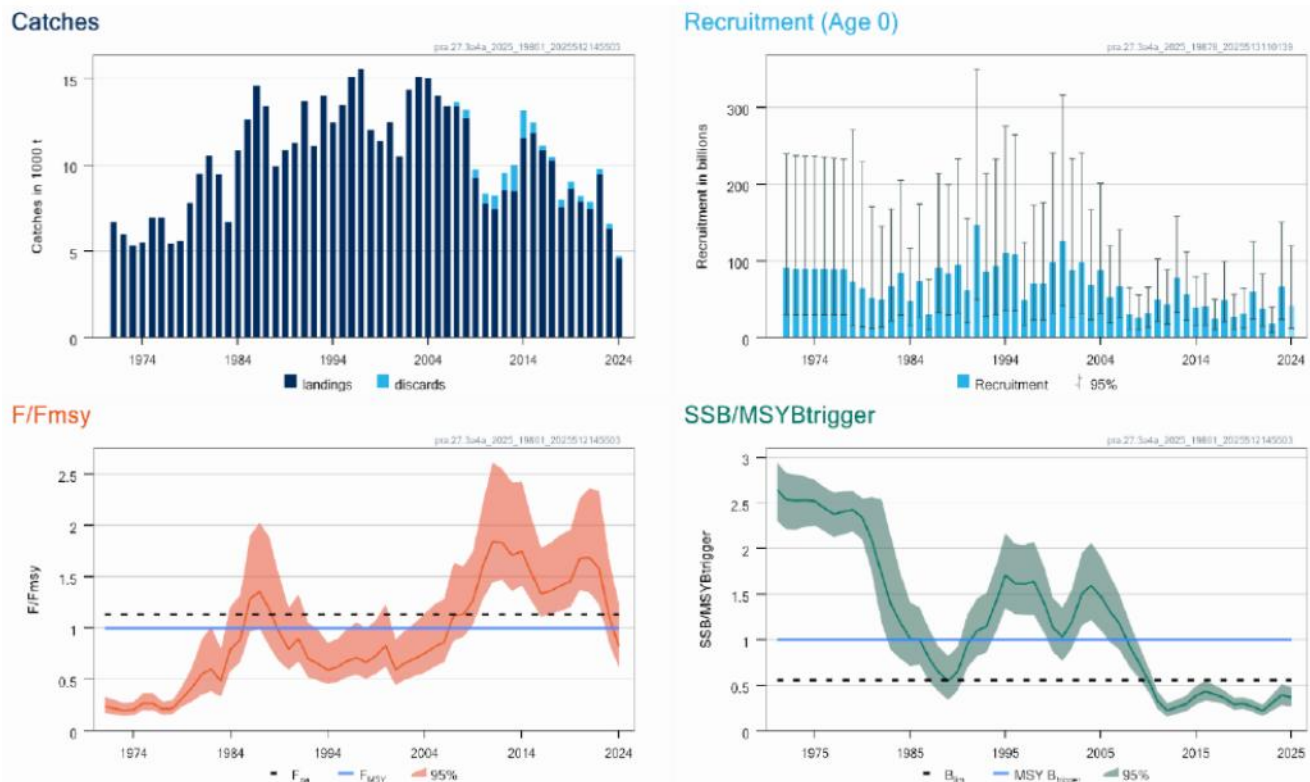


Figure 16. Summary of the 2025 stock assessment for Northern shrimp in ICES Divisions 3.a and 4.a East. Total catch, recruitment, F and SSB from 1971 to 2025 are shown. Total catch includes estimated discards since 2008 (t). The assumed recruitment value for 2022 and 2023 (estimated on 1 July) is shown in a lighter shade of blue. $BPA = MSY B_{TRIGGER}$. Spawning-stock biomass (SSB) is the biomass of mature females. Catches are for calendar years; all other values are for assessment years, starting 1 July. SSB and R are depicted with 90% confidence intervals and predicted recruitment from 2024 (based on the stock recruitment relationship) is shown in a lighter shade of blue. Taken from ICES (2025b).

good recruitment will be needed to rebuild the stock towards its biomass targets. Given the size selectivity of the fishery, it is also important that strong cohorts are given the opportunity to reach maturity as females and reproduce prior to being removed. Otherwise, the stock is unlikely to recover as expected (ICES 2025a, b).

The Norwegian portion of this fishery was certified by the Marine Stewardship Council (MSC) in June 2016 and recertified in Dec 2021. This MSC certification was voluntarily suspended in 2024 because the stock assessment showed that SSB has been below B_{lim} since 2011 and F was above F_{MSY} over the same period. The certification remains suspended in 2025 because the assessment continues to show that SSB is below B_{lim} , while F has been reduced below F_{MSY} . Norway has identified rebuilding this stock above B_{lim} to $MSY B_{trigger}$ as a priority management issue, which affects its engagement on an agreed management plan for the Barents Sea Shrimp trawl fishery.

More detailed information on this fishery is found in Appendix 6.

United States Gulf of Maine Shrimp Trawl Fishery

The Gulf of Maine (GOM) Northern Shrimp trawl fishery has historically provided a small but valuable seasonal fishery to the eastern states of Maine, New Hampshire and Massachusetts. The fishery takes place in winter when egg-bearing females move into inshore waters and ends in the spring under regulatory closure (December-April). Income from this fishery supplements groundfish revenues during a portion of the year when little activity occurred (Clark et al. 2000). The main fishing grounds are in the western portion of the GOM within the United States EEZ in deeper basins at depths of 90-180 m, where bottom temperatures are coldest (Figure 17). Abundance of Northern Shrimp is relatively low in the eastern GOM. This stock is at the southern limit of the distribution of Northern Shrimp and is vulnerable to adverse environmental variation.

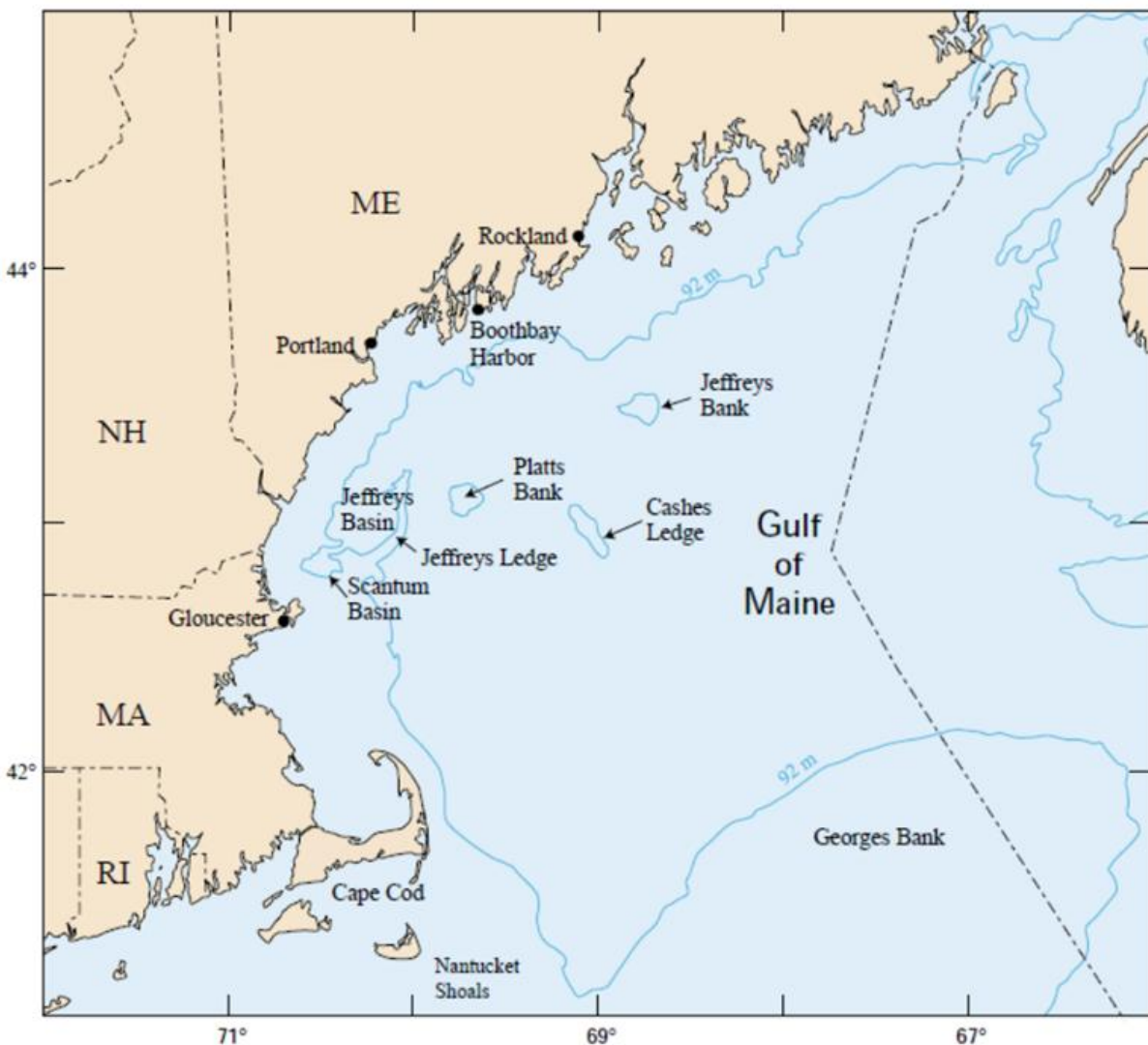


Figure 17. Gulf of Main Northern Shrimp Fishery Area. Taken from Clark et al. (2000).

The fishery exhibits evidence of a classic boom and bust cycle with at least two closures in its history prior to 2014 (Figure 18). Commercial fishing began in 1938 and during the 1940s and 1950s majority of annual landings were small (<300 t) in Maine and eventually declined to 0 t from 1954 to 1957. The stock recovered in the late 1950s and underwent a rapid expansion in landings, peaking in 1969 at 12,837 t (ASMFC 2016, 2024). Over the next decade, landings dropped and the fishery closed in 1978 due to stock collapse, reopened in 1979 and produced stable landings through the 1990's, with peaks of 5,262 t and 9,117 t in 1987 and 1996, respectively (Figure 18). Landings then declined to 450 t in 2002 only to rebound again to an average of 3,583 t during 2003-2012 period. The fishing season was cut short in 2010 with 6,123 t landed due to the industry exceeding the recommended landings cap for that year, and concerns about small shrimp catches (ASMFC 2016, 2025a). The 2011 fishing season was similarly cut short and in 2012 further restrictions with gear-specific seasons, landings days, and trip limits were implemented and TAC was set at 2,223 t and the fishery would close when the projected landings reached 95% of the TAC. A "do no harm" fishery for the 2013 season resulted in a fishing mortality rate (0.53) above the target (0.38), despite the

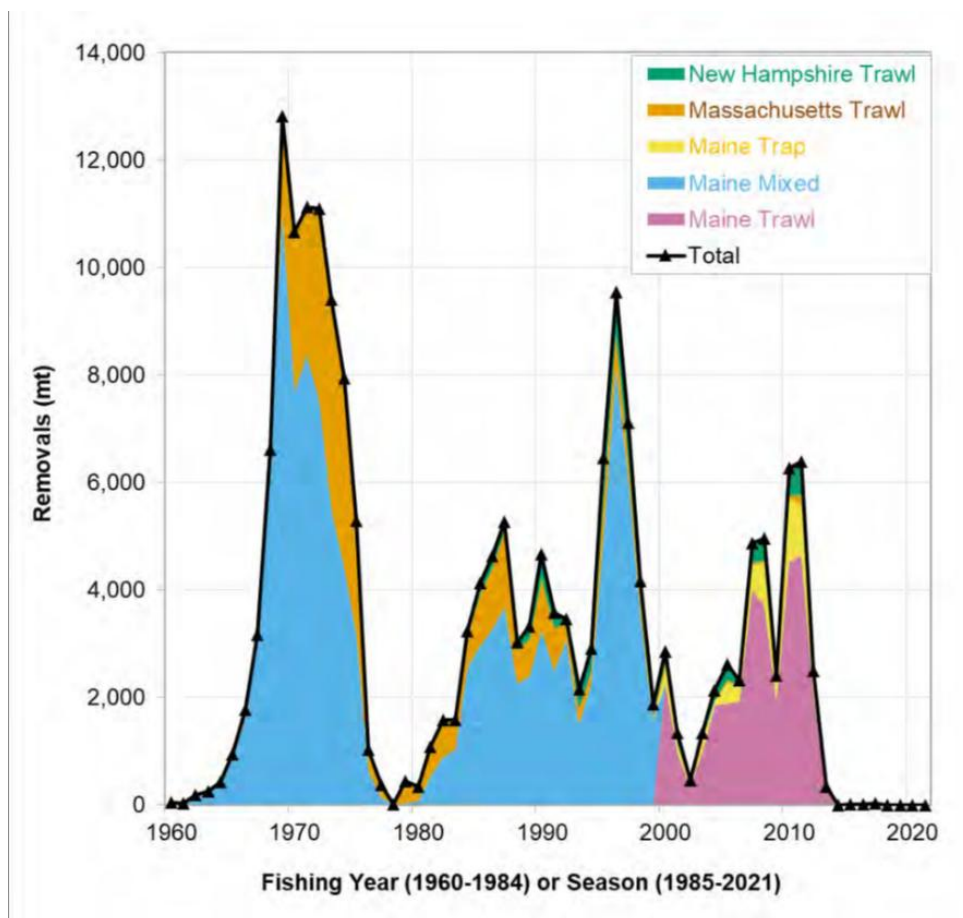


Figure 18. Northern Shrimp landings from the Gulf of Maine by state and gear, 1960-2024. Taken from ASMFC (2024).

fact that only 49% of the TAC was harvested (307 t of 631 t; ASMFC 2016, 2024). Finally, in 2014 a moratorium on fishing was put in place as a result of recruitment failure and stock collapse. The moratorium remains in effect through at least 2028 due to continued stock depletion (ASMFC 2025a).

The GOM fishery was a competitive open access fishery with no limitations on licence eligibility, although the number of licences declined as buybacks in the groundfish fleet reduced capacity (Clarke et al. 2000). A hard TAC is the primary tool used to manage the fishery and is allocated 80% to Maine, 10% to New Hampshire, and 10% to Massachusetts (ASMFC 2016). A statistical catch-at-length model (with time-varying M and maturity-at-length) is used to estimate total abundance, SSB, recruitment and average fishing mortality and is tuned to two fishery-independent survey indices of abundance: (1) an inshore Maine-New Hampshire survey in the spring and a summer survey conducted by the ASMFC, that was terminated in 2023. Management decision-making also is informed qualitatively by the results of a TLA indicator analysis of indices of abundance (survey indices, SSB and recruitment from the model), fishery performance (costs, revenue) and environmental trends (SST, bottom temperature, predation pressure index) from 1984 to the present. There are currently no biological reference points for the GOM Northern Shrimp stock (ASMFC 2024) so stock status determinations are based on trends in the model results and TLA analysis along with management triggers set for temperature and recruitment. The temperature trigger is reached when two out of three consecutive years of winter surface temperature and spring bottom temperature in the Gulf of Maine fall below the 80th percentile of the reference period, 1984-2017 (2025b). If this trigger is achieved, then a winter sampling program will be considered to evaluate biomass. The recruitment trigger is reached when the stock experiences non-failed recruitment for three consecutive years (2025b). If this trigger is achieved, then a stock assessment update will be conducted.

A stock assessment update in 2024 shows that GOM Northern Shrimp SSB has remained at low levels since 2013 and that recruitment (proportion of Shrimp between 11 and 18 mm CL) was low for 2022-2023, continuing the series of below-average year classes for the last ten years (Figure 19). The 2025 data update and management trigger evaluation confirmed these findings and reported that total abundance was a new low for the time-series (below the 20th percentile) and recruitment was below the 20th percentile for the past 3 yrs (2023-2025) (ASMFC 2025b). SSB in 2023 was estimated at 279 t, well below the time series median of 4,732 t and the 20th percentile of the reference period, 1984-2017 (2,721 t), in contrast to the index of predation pressure and winter surface temperature from the TLA, which showed improvement for Northern Shrimp in the most recent year of data (ASMFC 2025b). Stock projections show that in the short-term under recent levels of M and recruitment, median SSB is expected to decline 54% in 2025 relative to 2023, even under a no fishing ($F=0$) scenario. Based on this analysis the stock is considered depleted but no overfishing is occurring because the moratorium has been in effect since 2014. These short-term

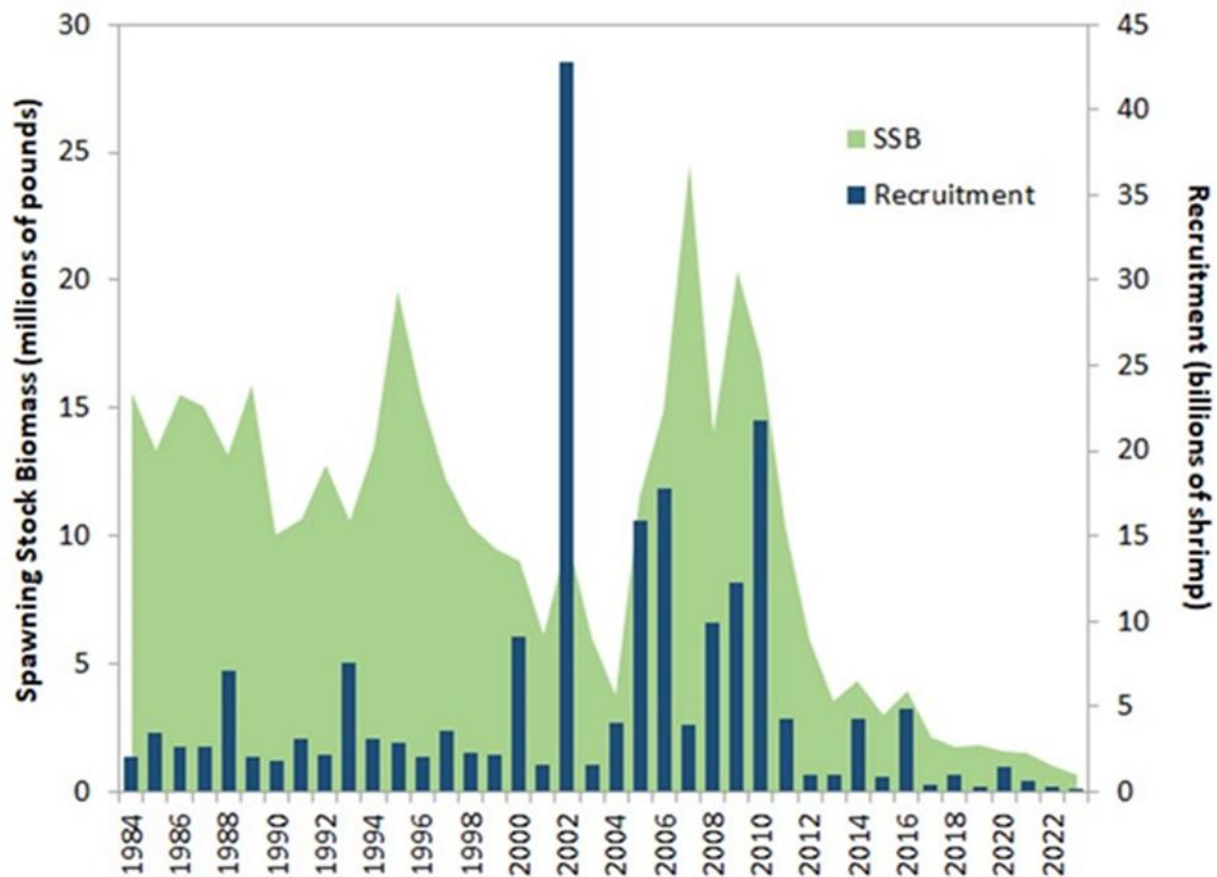


Figure 19. Spawning stock biomass (SSB) and recruitment of Northern Shrimp in the Gulf of Maine shrimp stock, 1984-2023. Taken from ASMFC (2024). 20th and 80th percentile triggers used to manage this stock are based on a reference period, 1984-2017.

projections also showed that if the maximum research set aside is fished (26.5 t) to evaluate stock rebuilding, then the median SSB is expected to be 13% lower in 2025 than under the no fishing scenario (ASMFC 2025c).

The repeated collapse and rebuilding of the GOM Northern Shrimp stock throughout the history of the fishery is related to fishing and environmental conditions affecting larval dispersal from spawning grounds and recruitment into the fishable biomass. Collapses in the late 1970s and early 2000s are attributed to uncontrolled increases in effort as a result of switching from groundfish to Northern Shrimp when groundfish stocks collapsed or were at very low abundance levels (Clarke et al. 2000). Poor recruitment, owing to high bottom temperatures during the winter also contributed to the early 2000s collapse (ASMFC 2024). The latest closure to the fishery is the moratorium which began in 2014 and remains in effect through at least 2028 due to continued stock depletion (ASMFC 2025b).

Recruitment of northern shrimp is related to both SSB and ocean temperatures, with higher SSB and cooler temperatures during sensitive periods producing stronger recruitment. Ocean temperatures in western GOM have increased over the past two decades and have sustained unprecedented highs in the past 10 years although the 2025 winter surface temperature was cooler compared to previous years. Increasing predation pressure from Silver Hake and other groundfish species tends to lower recruitment of Northern Shrimp. Low SSB, poor environmental conditions for recruitment and increasing predation pressure over at least the last decade have combined to inhibit recovery in the GOM Northern Shrimp stock. A 2024 winter survey showed negligible catches, confirming the population has not recovered and pilot sampling in the winter of 2025 was largely unsuccessful (ASMFC 2025c), resulting in the recommendation to suspend winter sampling in 2026.

More detailed information on this fishery is found in Appendix 7.

United States West Coast Ocean Shrimp Trawl Fishery

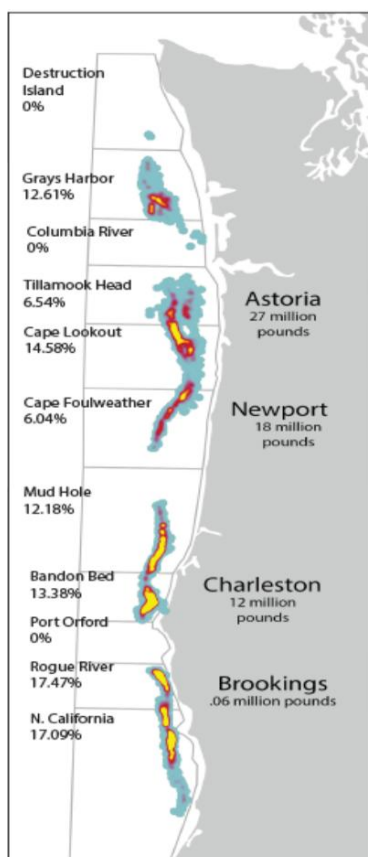


Figure 20. Heat map of Ocean Shrimp catch by state statistical areas for 2025. Taken from Smith et al. (2026).

The Washington, Oregon, and California Ocean Shrimp fishery is a commercial trawl fishery along the west coast of the United States from Washington to northern California (Figure 20). The fleet consists of 85-90 vessels that actively targets Ocean Shrimp on green mud and sandy-mud substrates at depths between 90 and 180 m and the majority of vessels are double-rigged (MRAG 2026b), in contrast to single nets used in the BC Shrimp trawl fishery. Ocean Shrimp (Smooth Pink Shrimp in Canada) is managed as a single, contiguous stock because strong seasonal upwelling and California Current dynamics constantly mix the pelagic larvae across broad areas (Hannah 1995), preventing localized genetic divergence, i.e., there is no detectable genetic variation. Although the fishery occurs in federal waters (3-200 miles offshore), it is managed cooperatively by the three states through harmonized regulations, monitoring, and limited entry permits (Hannah et al. 2018; Wargo and Ayres 2017; CDFW 2022; MRAG 2026b).

The fishery began in 1950 and 1951 when large, deep-water shrimp beds were discovered off the coast of California and Oregon. California established the first set of commercial rules, seasons, and geographic quotas in 1952 and by 1956 the commercial fishery expanded north to Washington. Catches increased rapidly to a peak of 38,692 t

(85.3 M lbs) in 1978 and then collapsed in 1983 due to the strong El Niño event (Figure 21). Following a period in the late 1980s, 1990s and 2000s of average catches in the 13,608-15,876 t range (30-35 M lbs), a second peak of 42,366 t (93.4 M lbs) occurred in 2015 (Figure 21). Aggregate catches in all three states were 31,298 t (69 M lbs) in 2024, which is an 18% increase relative to the 2023 catch (58.4 M lbs) (Forster et al. 2025) and in 2025 the total catch was 35,816 t (78.96 M lbs), which is a 14% increase relative to 2024 (Smith et al. 2026). In both years, catches from Washington comprised 28% of the total while no catches were landed in California. The absence of landings in California is not due to the absence of shrimp from state waters, rather it was relative to a water tax making processing of the catch too expensive and the subsequent product uncompetitive in domestic and global markets (MRAG 2026b).

The Ocean Shrimp fishery is a “recruitment fishery” wherein annual catches are strongly affected by the strength of the year class entering the fishery that year (Hannah and Jones 1991, Hannah 2010). Recruitment success is determined during the pelagic larval phase and is related to an early and vigorous spring transition to upwelling conditions (Hannah 2010, 2011). Ocean Shrimp recruitment is positively correlated with upwelling in general, and negatively correlated with SST (Rothlisberg 1975, Rothlisberg and Miller 1983, Hannah 1993) while Smooth Pink Shrimp recruitment off the west coast of Vancouver Island is very weakly correlated with SST two years previously (Perry et al. 2015). Ocean temperatures of 8-11°C are apparently favorable for early larval survival (Rothlisberg 1975, Hickey 1989) while anomalously strong upwelling can reduce recruitment (Hannah 2011) through offshore transport (Parrish et al. 1981, Hill

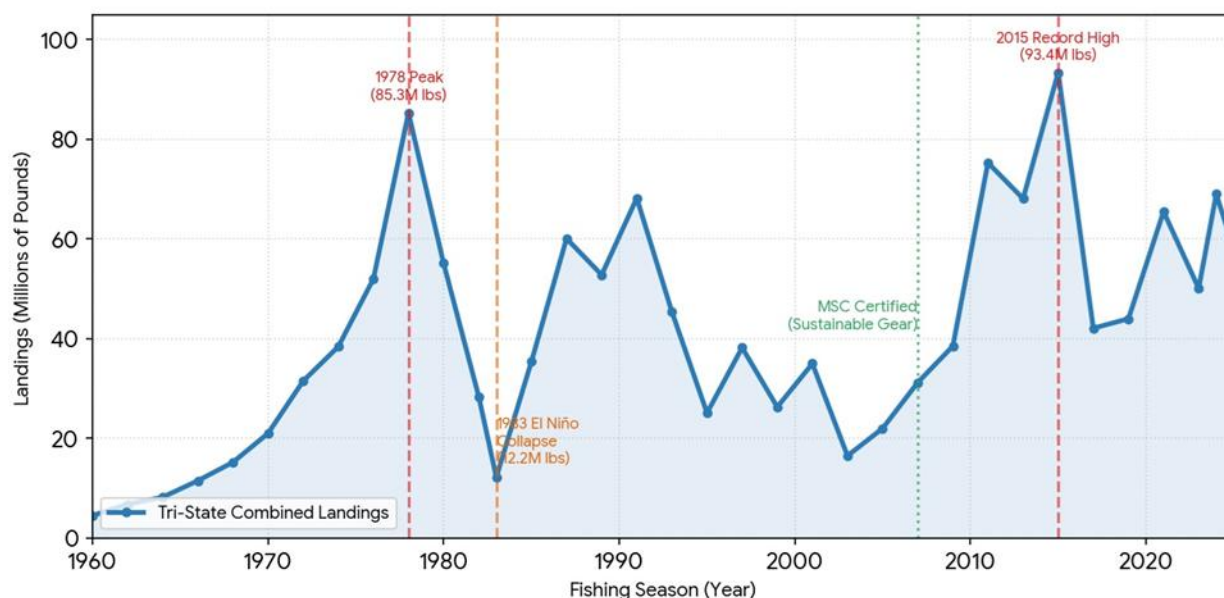


Figure 21. Aggregated Pink Shrimp (*Pandalus jordani*) landings from Washington, Oregon and California from 1960 to 2025. Data taken from the Oregon Department of Fish and Wildlife (ODFW), [ODFW Annual Pink Shrimp Reviews](#), the Washington Department of Fish and Wildlife (WDFW) historical landing databases integrated into the [WDFW Coastal Pink Shrimp Fishery Management Plan](#), and the California Department of Fish and Wildlife (CDFW), [CDFW Marine Species Reports for Pink \(Ocean\) Shrimp](#).

1991), disrupt feeding strata and limit the availability of food to larval shrimp (Hannah 2011). Recruitment is also negatively correlated with April sea level height (Hannah 1993, 2011), which probably reflects the spring transition and the beginning of upwelling.

Effort controls are used to manage the Ocean Shrimp fishery with season and Shrimp size as the main tools rather than a TAC and vessel quotas. A fixed season from April 1 to October 31 across all three states is employed, with a winter closure intended to protect egg-bearing females from harvest. Vessels are legally required to maintain a landing average of < 160 Shrimp/lbs (count per pound, or CPP Index) to prevent growth overfishing. If the CPP index rises above this figure (meaning the shrimp are too small), then it triggers localized (if only one of the state fleets triggers it) or seasonal closures of the fishery (if all fleets are reporting small shrimp) (MRAG 2026). The average CPP for shrimp landed in Oregon in 2024 was 127/lbs and 132 shrimp/lbs for shrimp landed in Washington (Smith et al. 2026). Dockside monitoring of all landings is used to collect biological samples for size, sex and maturity throughout the fishing season and commercial CPUE from logbooks is actively tracked weekly to evaluate the pattern of change, which proceeds from high CPUE in May and June through a steady, predictable decline into October as the fleet 'fishes down' the available biomass (Smith et al. 2026). Because the fishery occurs in federal waters, the Pacific Fishery Management Council (PFMC) enforces overlays to protect co-habiting groundfish and essential fish habitat including mesh size limits, mandatory use of rigid-grate BRDs, LED lighting on the footrope, and mandatory use of operational VMS for vessel tracking (MRAG 2026b).

Although biological reference points have not been established for the Ocean Shrimp stock, catch rate triggers called fishery action levels are in place as decision points to keep the stock within safe biological limits. The limit action level specifies that when the Apr-Jan (the larval year) average SLH at Crescent City, California, is > 7.5 ft and the June average catch per tow in the fishery is < 10,000 lbs, then the fishery is closed as soon as possible or within 10-days of this public declaration and the start of the following season is delayed until April 15 to safeguard recruitment (Hannah and Jones 2014b). The target action level specifies that if average catch rates in June are < 12,500 lbs per tow and > 10,000 lbs per tow, then the current fishing season is closed two weeks early on October 15 and the opening the following season is delayed two weeks until April 15 (Hannah and Jones 2014b). This additional month is intended to provide an extended window for the stock to spawn and grow undisturbed. These catch rate triggers are based on observations of the lowest observed catches per trip from which the stock recovered (in 1983 and 1988) reported by Hannah and Jones (2014b) and were adopted by all three states, but no occasions have arisen in which they were implemented in the last 2-3 decades. Fleet-wide CPUE was 26.52 t (58,469 lbs)/trip in 2025, which is the highest in the history of this fishery (Smith et al. 2026). Since fleet-wide CPUE is well above both the target action level (12,500 lbs/trip) and the limit

action level (10,000 lbs/trip), landings for Washington and Oregon combined in 2025 are the largest harvest since 2015 and the average size of harvested shrimp is below the management ceiling of 160 shrimp/lbs, it is believed that there is zero biological threat of stock depletion and the stock is not overfished and overfishing is not occurring (Smith et al. 2026).

Stock status of the Ocean Shrimp stock is not directly determined as there is neither an assessment model nor biological reference points. Stock strength is modeled as recruitment using environmental indicators rather than adult abundance or spawning biomass based on the spring transition, offshore transport and sea level height (SLH) (Groth 2022). Recruitment forecasts are produced in April before the fishery opens using predictive models that lag oceanographic metrics by one year because Ocean Shrimp do not recruit into the fishery until they are Age 1 (13-15 months old) so ocean conditions monitored during the spring and summer of Year 1 directly forecast the harvestable biomass of Year 2 (Hannah and Jones 2014a, b). Recruitment forecasts are paired with real-time sampling of the Body Condition Index (BCI – a measure of weight-to-length fatness ratio) from dockside samples collected during the first week of the season in April because BCI is strongly negatively correlated with overall seasonal CPUE required to harvest the stock (Groth et al. 2026). Recruitment forecasts are also balanced against the forecasted biomass of predatory groundfish, particularly Pacific Hake, which migrate into the region and can reduce year-class strength through heavy consumption (MRAG 2026b). The forecast for 2026 is for average to slightly above average recruitment into the fishery (Smith et al. 2026).

Management of Eulachon bycatch in the Ocean Shrimp fishery is a key issue as it is for the BC Shrimp Trawl fishery. Eulachon accounts for 1.71% of bycatch in 2019-21 (last 3 yrs of available data), when reported catches in Ocean Shrimp trawl fishery were 441.1, 568.9 and 352.3 t, respectively (Gustafson et al. 2023). Unidentified shrimp account for 1.09% of bycatch and Slender Sole 0.35%; Pacific Hake 0.16% and unidentified squid excluding Humboldt Squid account for 0.14%. All other species (invertebrates and finfish) account for less than 0.1% on a species basis (Gustafson et al. 2023). Coastwide Eulachon bycatch data are not available after 2021, however, 97 and 73 t are reported in WA for 2022 and 2023, respectively, which is a decrease from prior years (MRAG 2026b). WA typically accounts for a disproportionate share of Eulachon bycatch relative to its share of total bycatch. Because the southern DPS of Eulachon was listed as Threatened under the Endangered Species Act in 2011 (NMFS 2017), Eulachon bycatch in the Ocean Shrimp trawl fishery is exempted from the take prohibitions in the ESA under and Incidental Take Statement (ITS). The ITS sets a dynamic incidental take limit of 0.02% of the minimum Columbia River spawning run calculated as a five-year geometric mean (NMFS 2017).

Mandatory gear requirements, real-time data monitoring, and spatial avoidance strategies are all deployed to reduce Eulachon bycatch. Mandatory gear requirements included the use of Nordmøre grate BRDs in the trawl net with LED footrope lights. The

combination of BRD and LED footrope lights significantly reduced Eulachon bycatch with no effect on Ocean shrimp catch (Hannah et al. 2015; Lomeli et al. 2020). Scientific observer coverage to provide real-time monitoring has averaged about 12.5% of trips since 2011 (Gustafson et al. 2023) and coverage in 2023 was about 12% averaged across all three states, which is above the recent 5 year median of about 10% (Somers et al. 2024). Because 100% observer coverage was not logistically feasible, the collected observer data on bycatch:shrimp catch ratios are used to calculate fleet-wide bycatch estimates and these estimates are continuously weighed against the recovery targets set in the federal Eulachon Recovery Plan (NMFS 2017). Observer coverage ceased after the 2024 fishing season and harvesters were asked to self-report bycatch. Past comparisons of self-reported bycatch in logbooks with observer reports have shown that self-reported estimates are always lower (Gustafson et al. 2023). When gear modifications are insufficient, spatial tools such as predictive species distribution modelling may be used to keep shrimp fishing away from high-density Eulachon schools. For example, Rasmuson et al. (2025) showed that Eulachon are significantly more abundant around complex rock-and-mud interfaces, i.e., at the edges of the soft green mud channels where Ocean Shrimp are abundant. If Shrimp vessels rely on bottom-typing sonar tools to stay within pure, soft green mud channels, then it could contribute to reduced Eulachon bycatch. The practicality of this approach has not been tested at present. More recently, Liu et al. (2026) used environmental DNA (eDNA) to map the marine distribution of Eulachon along the west coast of the United States and found that Eulachon eDNA has a distribution weighted towards the ocean surface and is spatially associated with major river mouths (e.g., Columbia River, Klamath River) and productive offshore banks (e.g., Hecata Bank). Temperature and prey density are key covariates, with Eulachon more likely to be found in warmer waters (temperatures above 11 °C) with higher prey concentrations (i.e., Euphausiids).

Ocean Shrimp abundance fluctuates significantly based on ocean temperatures and environmental conditions, with high recruitment events routinely generating massive fishery yields. The economic viability of this fishery rests on a high volume of landings to offset the low unit pricing for shrimp (MRAG 2026b). Ex-vessel prices (the money paid directly to fishermen at the dock) have only slowly rebounded from a severe historic low of \$0.30/lbs in 2009 up to an average of \$0.54 to \$0.55/lbs over the last five years and were \$0.52/lbs on average in 2025 (Smith et al. 2026). Major external market challenges that directly threaten profitability margins in this fishery include competition with global aquaculture, which depresses wholesale margins for wild-caught cold-water Shrimp, and high and variable overhead costs from high fuel prices, escalating hull insurance premiums, and the cost of maintaining high-tech gear, which combined reduce a vessel's net margins (MRAG 2026b). The Ocean Shrimp trawl fishery was the first cold-water Shrimp fishery to achieve MSC certification for sustainability in 2007, which allows processors to market the catch at a premium to sustainability-conscious grocery chains and international European markets.

More detailed information on this fishery is found in Appendix 8.

British Columbia Prawn and Shrimp by Trap Fishery

The commercial Prawn and Shrimp trap fishery in British Columbia began in Howe Sound in 1914 (DFO 2026h). The fishery targets Spot Prawn, with a small incidental catch of other shrimp species and small commercial fisheries directed at Coonstripe Shrimp and Humpback Shrimp. Spot Prawn accounts for > 95% of total prawn landings in British Columbia, representing the second highest landed value among invertebrate fisheries in BC, after Dungeness Crab (Krumsick and Araujo 2025). A single coastwide stock is assumed for assessment, management and status determination purposes.

Commercial trap fishing occurs in near-shore areas at depths of 40 to 100 m along the BC coastline (Figure 22). Most of the commercial harvest occurs in the Strait of Georgia (60%), because of the proximity to large markets for sale of live and fresh caught prawns to the public and processors, and the remainder occurs along WCVI (10%) and north and central coasts (25%) (DFO 2026h). Although Spot Prawns have been

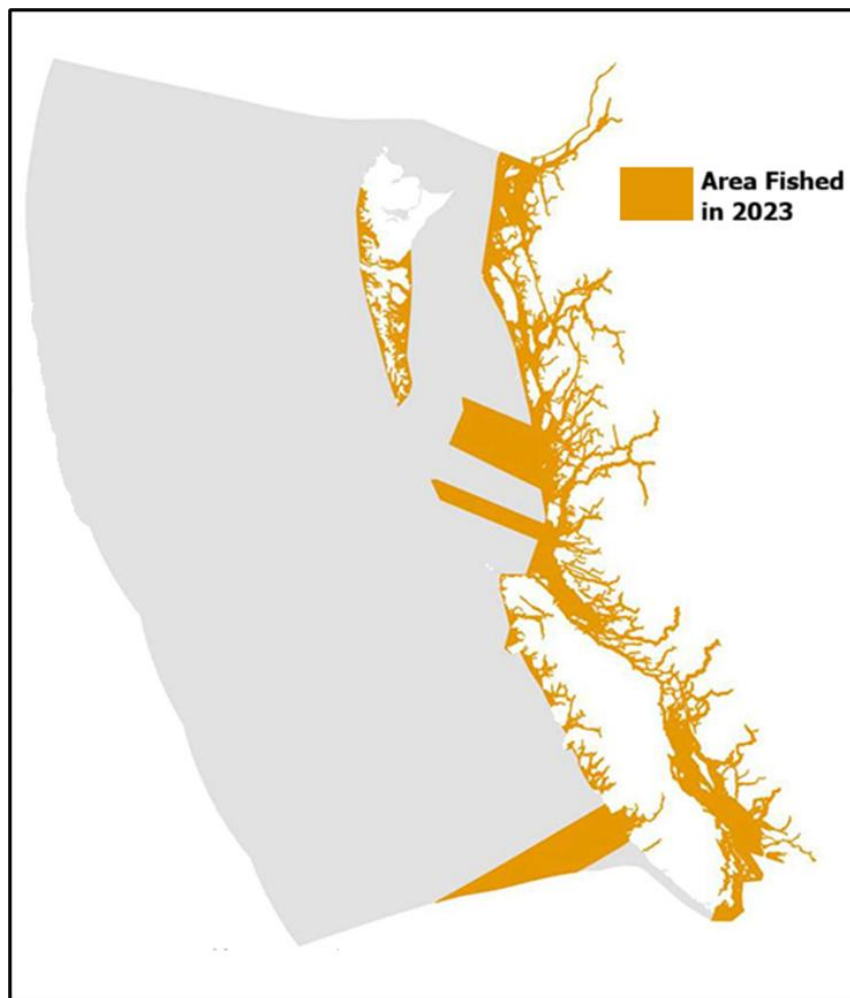


Figure 22. Spot Prawn commercial harvest from Pacific Fishery Management Areas (PFMAs) along the British Columbia coastline in 2023.

PFMAs from which harvest is recorded are shown in gold. Grey area is the Canadian Exclusive Economic Zone (EEZ). Taken from DFO (2026i).

observed in offshore areas, densities are not high enough to support commercial fishing or provide sufficient incentive for the prawn fleet to explore fishing possibilities, given the short season.

A fairly large recreational fishery for Spot Prawn occurs annually, with most of the recreational prawn catch coming from the south coast in the Strait of Georgia (80%) and WCVI (15%) (DFO 2026h). The highest recreational prawn fishing effort is in Saanich Inlet, Stuart Channel, Alberni Inlet and Howe Sound, and includes the waters around, Quadra / Cortes Islands, Powell River and Sechelt, Nanaimo, Barkley Sound, and Gold River/Tahsis. In 2023, 69% of recreational days (>55,000 days) were spent fishing for prawn/shrimp in the Strait of Georgia while only 17% of prawn/shrimp fishing days occurred in Haida Gwaii, the Central Coast and the North Coast areas. The remaining 14% of fishing days was spent in Barkley Sound (~8,000 days) and Johnstone Strait (~9,000 days) (DFO 2026h).

The commercial fishery has been open about 35 days on average over the last 5 years, typically opening in mid-to-late May and closing by the end of June. This fishery uses traps, with restrictions on trap size and the use of rot cords to prevent ghost fishing of lost traps. Each licence holder can fish a maximum of 300 traps, 50 traps per groundline (six groundlines total) and can only haul gear once daily between 0700 and 1900 hours (DFO 2026h). Trap tags were issued to 204 active vessels in 2025, of which 165 were licensed for single trap allotment (300 traps maximum) and 39 were stacked with an additional trap allotment transferred from another vessel (500 traps maximum).

Annual landings generally showed an increasing trend from the development of the fishery up to 2009, when landings peaked at 3,400 t (Figure 23; DFO 2026i). Annual catches have been variable since 2009, but show a declining trend to the lowest catch in 2017 of 1,200 t (DFO 2026i). Catches have averaged 1,770 t from 2018 to the present. Landed value of the fishery has followed a similar pattern to catches but has risen consistently since 2020 (Figure 23). The 2023 fishery landed 1,600 t with a landed value of \$73.1 M (DFO 2026i).

The Spot Prawn fishery is managed by a fixed-escapement model, a standardized CPUE index of the abundance of female Spot Prawns called the Spawner Index (SI) (Figure 24). This model is designed to safeguard the spawning stock biomass available at the time of egg hatching (assumed to be the end of March) to provide sufficient recruitment to sustain future Prawn populations (Boutillier and Bond 2000; Rutherford et al. 2004), i.e., to avoid recruitment overfishing. During the months in which the commercial Spot Prawn fishery occurs, the maturity stages of Spot Prawns in every 2nd or 3rd trap along a typically 50-trap string are quantified by observers. The number of 4-yr old Spot Prawns within each trap, correcting for varying bait and gear types with varying catch

efficiencies, and averaging the sampled traps along a single line, is used to estimate the Spawner Index value. This threshold represents a minimum monthly index (MMI),

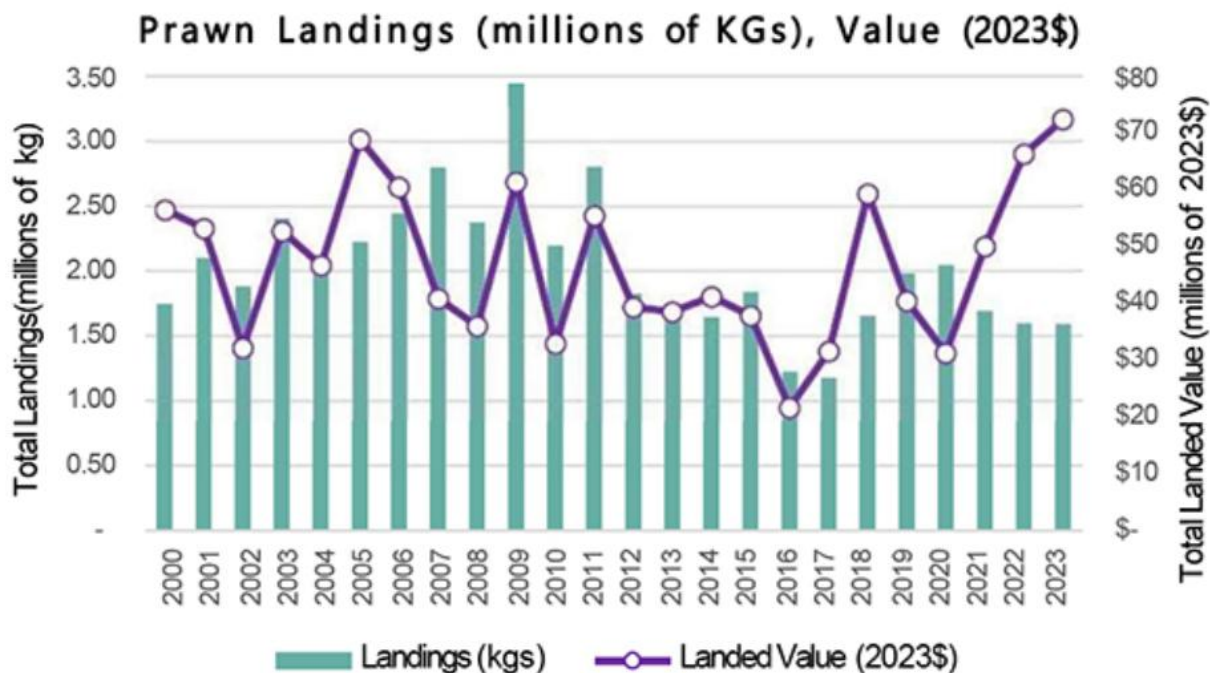


Figure 23. Landings (millions kg) and Landed Value (in 2023 \$) for the British Columbia coastwide Spot Prawn fishery, 2000-2023. Taken from DFO (2026i).

determined for March when Spot Prawn release their eggs, that is thought to sustain the Spot Prawn stock. These thresholds are then back-calculated from the March MMI based on the estimates of non-commercial fishery natural mortality (M) obtained from 10 years of research at unfished sites across 10 years (1973 to 1982) to determine minimum monthly indices for all months (Boutillier and Bond 2000; Rutherford et al. 2004).

Buffers are built into the MMI SI values so that subareas close before they present a conservation risk of dropping below the baseline during the period it takes to review the newly acquired data and accommodate the uncertainty in the SI associated with sampling. These buffers are +10% of the baseline, used to manage the fishery throughout the coast, and +25% higher than the baseline, which is used to manage in high use (HU) areas, i.e., areas with a large number of recreational fishers in the winter following the commercial fishing season (e.g., Howe Sound) (Krumsick and Araujo 2026). The management framework is believed to be more conservative in its approach to closures than application of the LRP, i.e., the management framework would lead to closure at higher levels of biomass in each month than the LRP.

The commercial fishery is opened coastwide at the beginning of the season. Sample SI values are continuously estimated by observers from commercial catches and compared

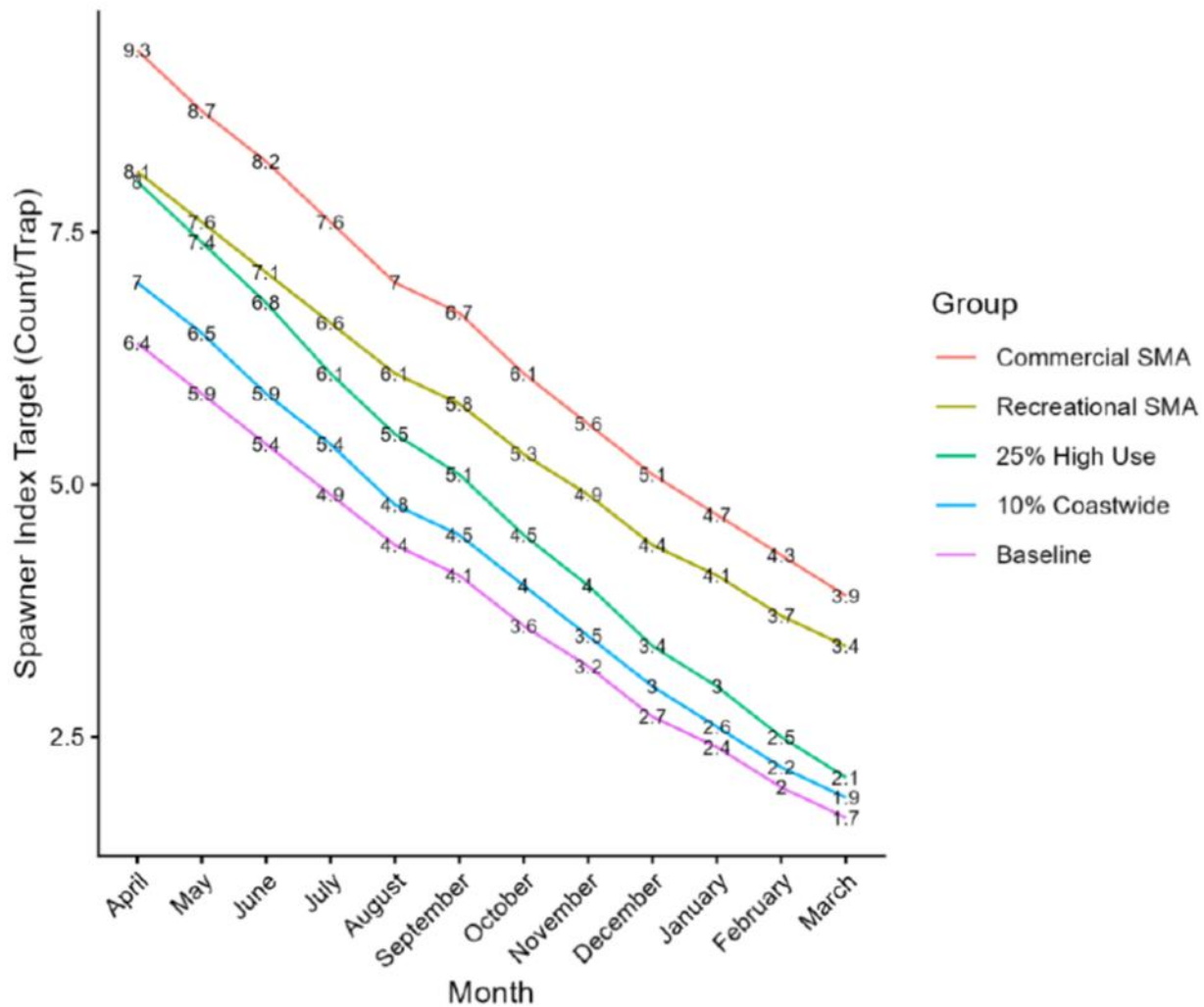


Figure 24. Spawner index (SI) threshold by month for each of the four management scenarios along with the baseline thresholds as established by Boutillier (1988). Each PFMA Subarea is assigned to either the 10% coastwide, 25% high use or recreational/commercial Special Management Area (SMA). If the measured spawner index in a given PFMA Subarea fall below the relevant monthly spawner index threshold, then the commercial fishery will close for the remainder of the year or the winter recreational fishery will not open for that PFMA Subarea. Taken from Krumsick and Araujo (2026).

to the MMI + buffer for each month. If the SI is found to be below the MMI + buffer value, then the subarea is closed for the remainder of the commercial fishery. As the fishery progresses temporally and subareas systematically close, a point is reached where a coastwide closure decision is made for the commercial fishery, often because effort is concentrated in a small number of subareas. For the recreational fishery, if a subarea is found to be below threshold during fall surveys, then winter recreational Spot Prawn fishing opportunities from January to March are not opened for that subarea. Food, social and ceremonial fisheries (FSC) associated with First Nations are open year-round.

The SI index is considered representative of Spot Prawn abundance because traps are able to cover and sample Spot Prawn throughout most of their habitat. An unpublished preprint by Rossi et al. (2013) reported a negative relationship between abundance and fishing efficiency that caused catch rates to remain high amid declining abundance, i.e., hyperstability in the SI. However, this finding has not been substantiated by peer-reviewed published reports to date. Hyperstability, if it exists in the SI, creates a conservation risk for Spot Prawn by causing management decisions to be based on overly optimistic impressions of stock status (Rossi et al. 2013).

Although the management of the Spot Prawn fishery uses escapement-based SI reference points to address both growth and recruitment overfishing, it is not strictly compliant with the PA Framework, which focuses on biological reference points and HCRs depending on the stock status zone determination. Growth overfishing is controlled through the use of seasonal closures, size limits, trap mesh size requirements, fishing time restrictions, and a single haul limit. Recruitment overfishing is controlled using a fixed escapement-based model indexed on the number of female spawners per trap. These assessment and management frameworks appear to have achieved the goals of PA framework management since stock status has been considered healthy, despite substantial fishing pressure for at least the last decade.

More detailed information on this fishery is found in Appendix 9.

Australian Northern Prawn Fishery

The Australian NPF is a tropical trawl fishery along the north coast of Australia from Cape York in the east to Cape Londonderry in the west (> 6,000 km of coastline) and primarily targets Tiger Prawns (two species) and Banana Prawns (two species), with two species of Endeavour Prawns as a major byproduct of the fishery (Figure 25). The NPF has three sub-fisheries and two distinct fishing seasons annually: the Banana Prawn sub-fishery, operating from 1 April to mid-June, the Tiger Prawn sub-fishery operating from 1 August until the end of November, and a distinct sub-fishery in the Joseph Bonaparte Gulf (JBG) in western Australia sub-fishery that follows the Banana and Tiger Prawn fishing seasons (Butler et al. 2025). Prawns account for >95% of the landed catch and Tiger Prawn (two species) are the economic driver (MRAG 2026a). At present, the status of all stocks is not overfished and not subject to overfishing.

Total catch of all species has ranged between about 2,000 t in the 1970s to about 12,000 t in the 1980s and then declined to annual catches ranging between 4,000 t and 6,000 t since the 1990s. Catches of individual species range from a less than 1,000 t annually (Redleg Banana Prawn, Red Endeavour Prawn) to greater than 1,000 t and 2,000 t annually (Grooved Tiger Prawn and White Banana Prawn, respectively) (Figure 26). Banana Prawns typically comprise 70-80% of total catch in the 2021-24 period while Tiger Prawns comprised 15-22% and Endeavour Prawns 4-9% of the catch during

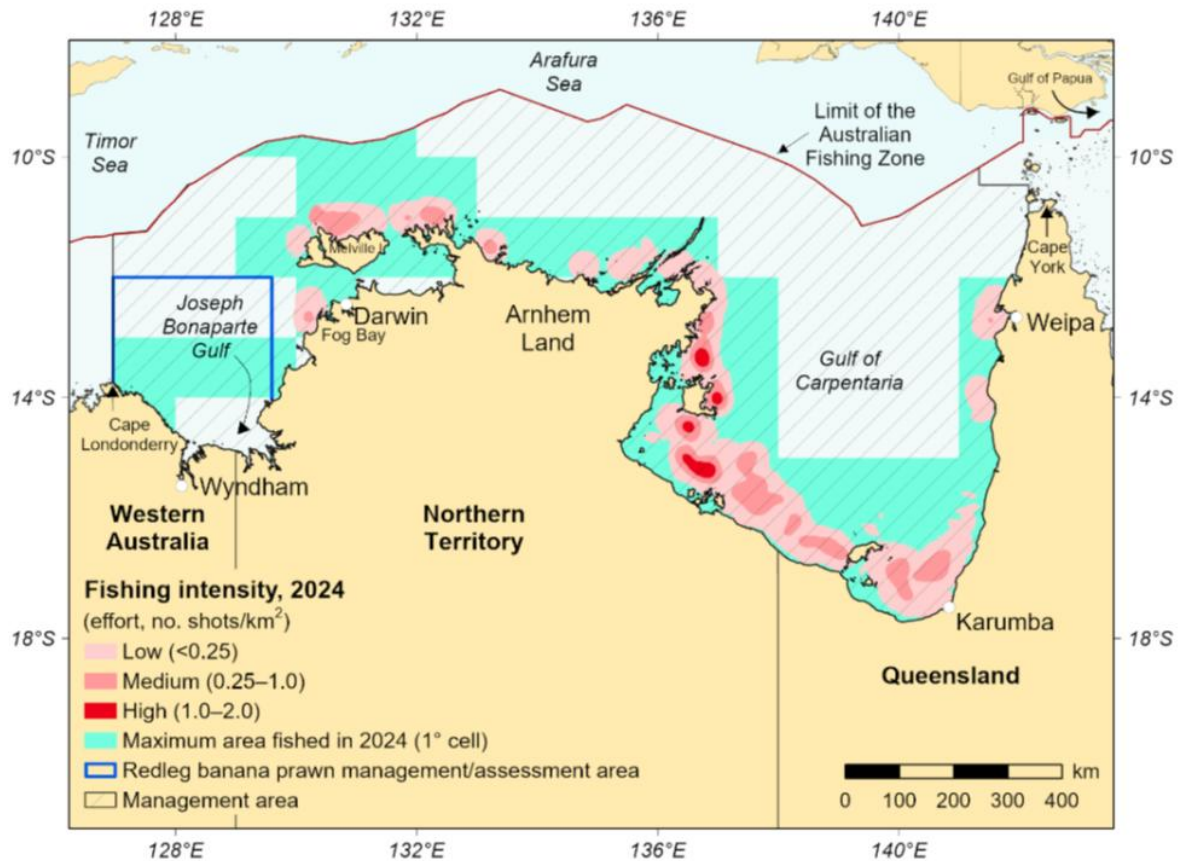


Figure 25. Spatial scope of the Australian Northern Prawn Fishery and fishing intensity in the 2024 fishing season. Taken from Butler et al. (2025).

the same period. Total catch in 2024 was 5,683 t and is a 32% reduction relative to the 2023 catch of 8,381 t (Butler et al. 2025).

The Australian Fisheries Management Authority (AFMA) and NPF Industry Pty Ltd. (NPF) entered into a co-management arrangement in 2012 that lays out the roles and responsibilities of each party. The NPF focuses on developing and implementing the bycatch strategy for the fishery, research and development of BRDs, providing fishery economic information through an annual survey and funding and overseeing the training for a crew-based monitoring program (CMO) for bycatch (AFMA and NPF 2024).

The goal of management is to maximize net economic returns (NER) from the fishery averaged over a seven year period using effort controls to achieve this goal, which is unique among the fisheries reviewed (AFMA 2024). A minimum effort threshold (MET) of 4,004 boat-days has been established for the fishery and individual transferable effort (ITE) quotas for Tiger Prawns are used. Both LRPs and TRPs have been adopted for the Tiger Prawn and Banana Prawn stocks and consist of a biomass-based LRP of 0.5 S_{MSY} and a TRP of S_{MEY} , where S is spawning biomass and MEY is maximum

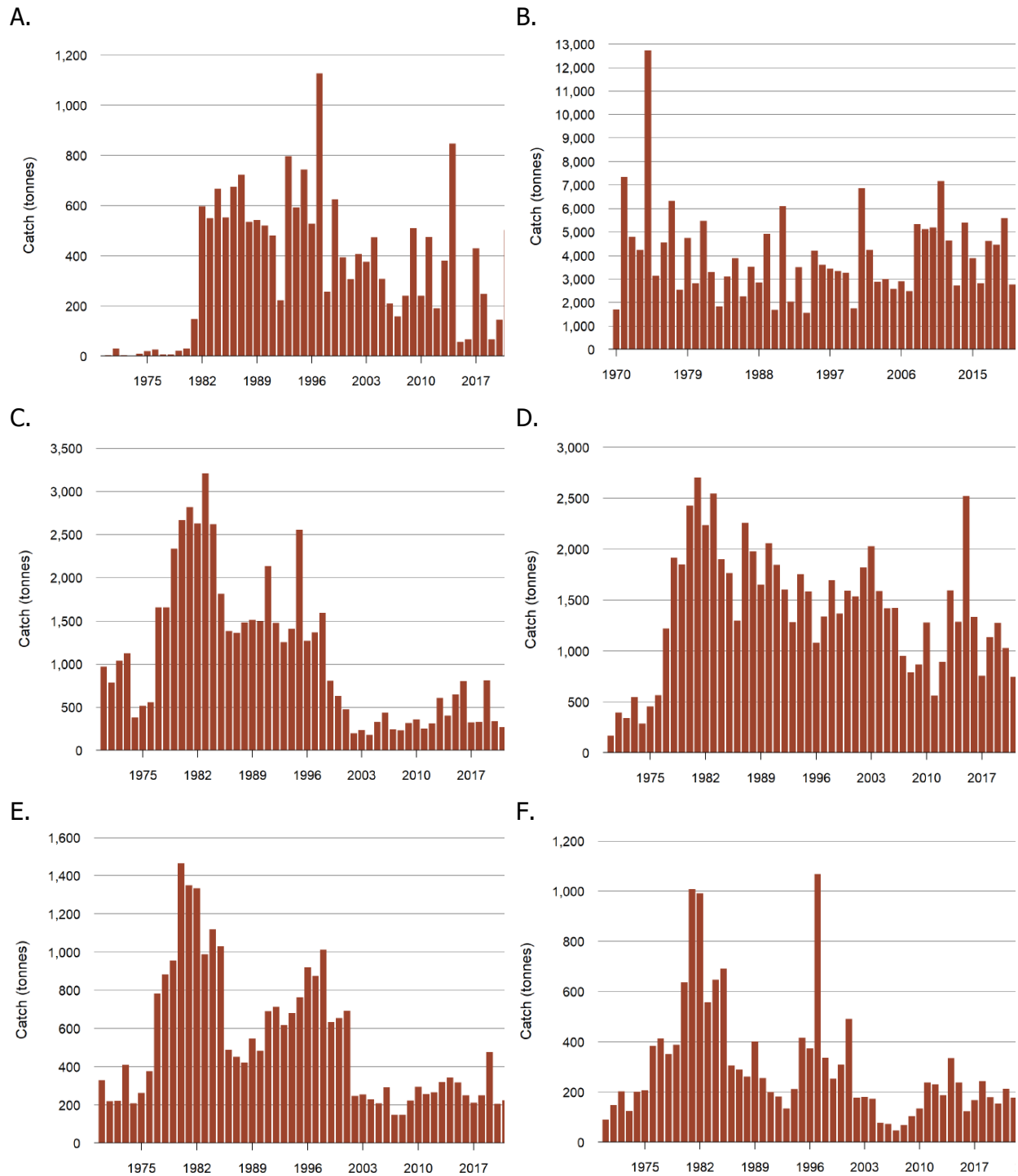


Figure 26. Northern Prawn Fishery catches, 1970-2024 seasons. A – Redleg Banana Prawn; B – White Banana Prawn; C – Brown Tiger Prawn; D – Grooved Tiger Prawn; E – Blue Endeavour Prawn; F – Red Endeavour Prawn. Taken from Butler et al. (2025).

economic yield. A bioeconomic model (combining a surplus production assessment model with economic information for the fishery) is used to evaluate status relative to the LRPs and TRPs for Tiger Prawns and Banana Prawns (AFMA 2024, 2025). Provided that the LRP for either Tiger Prawn species is not breached, the MET for the fleet is applied in the model to ensure that the fishery remains economically viable while still achieving the MEY target within a 7-year timeframe (AFMA 2024). Management of the Banana Prawn fishery includes an MEY-based catch rate trigger (kg/boat/day) based on catch rate information for specified reference periods, wherein the average CPUE is calculated and, if the value falls below the MEY catch trigger, then the fishery is closed a week later (AFMA 2024, 2025). The current status of all stocks is not overfished and overfishing is not occurring (Butler et al. 2025).

The crew member observer (CMO) program is a second unique feature of the NPF management system. The CMO program has been in place since 2003 to collect data (including photos for species verification) on interactions with species at high-risk from fishing activity and those listed as Endangered, Threatened and Protected (ETP) (AFMA and NPFI 2024; MRAG 2026a). Participants are selected from among fishing vessel crews and are paid by NPFI to increase the observer coverage in the fishery. Annual training is provided by AFMA and other species experts to support this program. AFMA also deploys their scientific observers to collect data from a smaller portion of the fishery than is observed through the CMO program. The CMO target is to annually monitor at least 2,340 trawl shots (about 12% of fishing) across both fishing periods for ETP and high-risk species, and Sawfish and Sea Snakes and for 85% of interactions to be photographed for species ID and verification.

Although most recent estimates of NER for the fishery are positive, it also shows a downward trend since 2015–16 (Figure 27). Tiger Prawn stocks have become a watch point for the fishery, and spawning biomass for both Tiger Prawn species have been below their maximum economic yield (MEY) targets (and on a declining trend) since 2016, suggesting that NER is not being maximized (Butler et al. 2025). ITE quotas for Tiger Prawns allow effort quota to flow to highest-value use, which, combined with decision rules for early closure of Banana Prawn and Tiger Prawn seasons, helps the fishery adjust to challenging economic conditions.

More detailed results are found in Appendix 10.

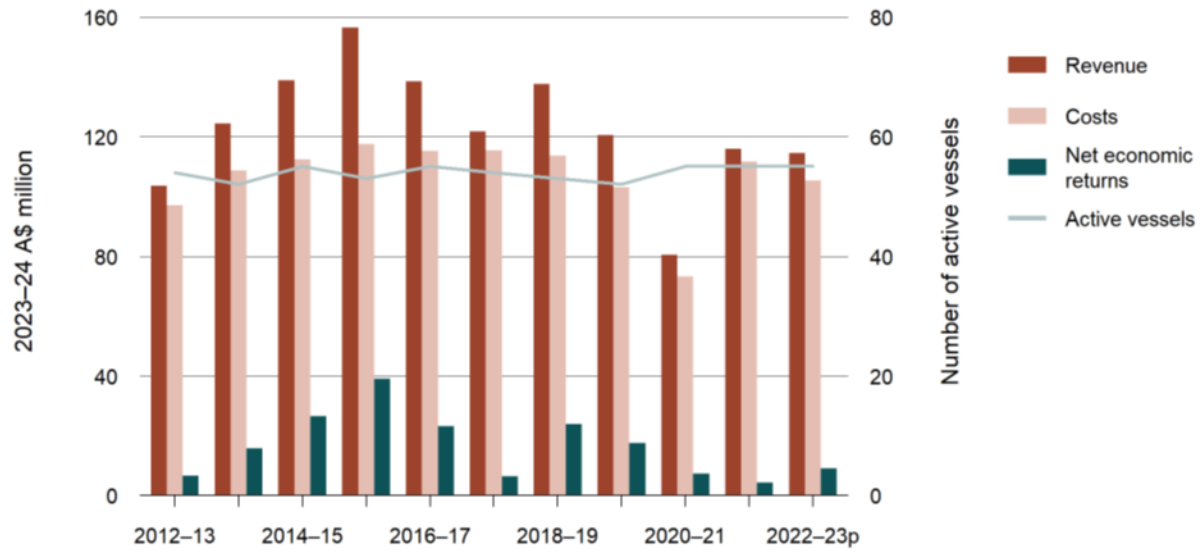


Figure 27. Real revenue, costs, net economic returns (NER) and active vessel numbers, 2012–13 to 2022–23 in the Australian Northern Prawn fishery. Taken from Butler et al. (2025).

Discussion

The assessment and management frameworks of nine Shrimp trawl fisheries and one Prawn trap fishery were reviewed to identify alternative management options for the British Columbia (BC) Shrimp trawl fishery. The management approach as well as management and science considerations in each fishery are summarized to identify the key features for consideration in the Canadian context. The following discussion evaluates the benefits and limitations of these features in the relevant jurisdiction as well as the Canadian context but does so in a roundabout way of comparing similarities and differences between the different management approaches. Alignment with the National DFO Sustainable Fisheries Framework (SFF) Policy requirements will be evaluated and new approaches to address concerns with the current BC Shrimp trawl fishery management framework will be identified for future consideration.

Changes to the management framework put forward for consideration in this report are incremental to the current system rather than transformational to a new framework. Incremental changes are expected to be more easily accepted because they can be implemented with minor modifications to existing processes and procedures that are within the expectations of all participants. Transformational change is unlikely to be successful at present because it represents a sharp departure from current experience of participants, particularly national approaches to fisheries management. If there is interest in transformational change, then studying the management approach and policy requirements in the Australian NPF, is a good place to start. The Australian NPF was included in this review to provide contrast with management of temperate cold-water Shrimp stocks, but the approach would certainly align with DFO SFF Policy requirements for reference points, harvest control rules and removal references. Benefits of this approach are that it explicitly focuses on maximizing the net economic returns to harvesters (and processors) while using biologically-based reference points to provide guardrails to fishing.

Management Framework Similarities

The fisheries reviewed in this report, with the exception of the BC Prawn trap fishery, use trawl gear, primarily otter trawls, equipped with rock hoppers on the footrope or chains to target Shrimp. Many of the vessels in these fisheries are double-rigged (two nets simultaneously), triple-rigged, or quadruple-rigged because these gear configurations are considered more efficient and effective at maximizing catches (AFMA 2024). The Canadian fisheries on the west coast (BC Shrimp trawl) and the east coast (NL, ESS, ESGL Shrimp trawl) stand out as single net trawl fisheries. All of the trawl fisheries reviewed require the mandatory use of Nordmøre grates near the codend of the net (bar spacing may vary) to reduce finfish bycatch since bycatch in Shrimp trawl fisheries is an important management challenge for these fisheries worldwide owing to the overlap in groundfish and shrimp fishing grounds and the smaller mesh sizes relative to groundfish trawl nets. The implementation of the Nordmøre grate BRD

around 1991 has led to reductions in finfish bycatch > 90% relative to nets not equipped with this device. This level of bycatch reduction coupled with catch-rate triggers for commercially important bycatch species (e.g., Atlantic Cod, Capelin) and move-on rules (e.g., Barents Sea and NL trawl fisheries) have proven to be sufficient for dealing with remaining bycatch in many fisheries. However, both the BC Shrimp trawl fishery and the United States West Coast Ocean Shrimp trawl fishery employ additional measures (footrope lights) directed at reducing the bycatch of Eulachon, which is considered Endangered and Threatened in Canada and the United States, respectively. The Australian NPF has an active program researching methods to reduce bycatch of Sawfish led by Industry (AFMA and NPFI 2024).

Seven of the trawl fisheries reviewed target a single species, either Northern Shrimp (*P. borealis*) in the Atlantic and Arctic Oceans or Smooth Pink Shrimp (*P. jordani*) in the Pacific Ocean and treat other species as bycatch. Single-species targeting means that single species management and assessment approaches can be implemented successfully. Single-species schemes treat catches of secondary commercial species as bycatch (e.g., Striped Shrimp in the NL Shrimp trawl fishery). The Australian NPF manages Endeavour Prawns as bycatch because the two distinct fishing seasons provide an effective way to compartmentalize these non-target catches into two separate sub-fisheries within the overall fishery. The BC Shrimp trawl fishery is the only fishery reviewed in which more than one species is targeted by the fishery. While single-species management approaches have been applied with mixed success in BC, developing a multi-species multi-gear (MSMG) or ecosystem approach to assessment and management might be an option considering the overlap in habitat, life history and fishing season. The benefits, limitations and costs of such an approach are not clear at present as none of the fisheries reviewed approach assessment and management from a multi-species or ecosystem perspective.

There are three ways in which a fishery can be managed to reduce or mitigate impacts on the target stock(s), bycatch stocks, and ecosystems in which the fishery operates: (1) catch controls, (2) effort controls, and (3) spatial access controls. Catch controls such as TACs limit the removals and fishing mortality on target stocks and when combined with mesh size requirements and use of BRDs to reduce finfish bycatch, TACs are an effective tool for managing the impacts of a Shrimp trawl fishery. Effort controls such as a minimum effort threshold (MET) and TAE used in the Australian NPF have also proven to be effective at controlling fishing effort used to remove Prawns from the stock and keep the fishery economically viable. Spatial access controls include closures of areas supporting fragile biogenic habitat forming species such as corals and sponges or important nursery and spawning habitats. The majority of fisheries reviewed combine catch controls and spatial access controls, with only the Australian NPF, BC Prawn Trap fishery, and the US West Coast Ocean Shrimp fishery combining effort controls and spatial access controls into effective management frameworks.

The majority of trawl fisheries reviewed use fishery-independent surveys to track changes in biomass and abundance combined with a model to capture stock dynamics, estimate stock status, and provide harvest advice. Some form of a surplus production model, which relies only on catch and effort data and will estimate MSY, is used to determine stock status and provide harvest advice. Model usage of this kind carries the implicit assumption that fishing drives changes in stock biomass and that changes in spawning biomass affect recruitment. However, it is not clear whether or not these relationships have been demonstrated or plausibly assumed prior to the application of models in many of the reviewed fisheries. For example, a surplus production model is used for assessment of the Barents Sea Northern Shrimp stock (Zimmermann et al. 2026) even though it is clear that fishing has had no detectable impact on changes in stock abundance throughout the history of the fishery (see Figures 12 and 13). Furthermore, in many of the fisheries reviewed there is considerable discussion of the fact that recruitment is highly variable and related to environmental conditions such as temperature and currents influencing larval dispersal, i.e., a stock-recruit relationship is not detectable. When the implicit assumptions of the models that are relied on to provide harvest advice are not checked, it means that conservation risks to the stock under management may be higher than estimated in the advice provided.

The use of a precautionary approach framework (reference points, harvest control rules, removal rates dependent on stock status) is pervasive in the fisheries reviewed. While these frameworks differ in their details with respect to reference points and exploitation rates, they all attempt to sustain the stock within safe limits to prevent recruitment overfishing (below LRP) and growth overfishing (above TRP). The majority of PA frameworks used MSY-based choices for reference points and HCRs, despite little evidence that fishing pressure can impact stock biomass. The exception is the Australian NPF which uses MEY-based reference points and HCRs (AFMA 2024, Butler et al. 2025) and the US west coast Ocean Shrimp fishery which relies on empirical action levels tied to catch rates in the spring, below which there will be insufficient female biomass to sustain minimal recruitment levels to the stock (Hannah and Jones 2014b). All of the fisheries reviewed apply a PA framework to the management of Shrimp stocks with the exception of the US west coast Ocean Shrimp trawl fishery.

Biomass indices based on fishery-independent surveys are the clear choice for tracking the response of biomass to fishing over time in the Shrimp trawl fisheries reviewed. This method has drawbacks if only a fraction of the stock is accessible in trawlable habitats (Dunham et al. 2002) and it requires standardization for gear effects when multiple gears are used in the fishery (e.g., the BC Shrimp trawl fishery). However, the Shrimp fisheries reviewed overwhelmingly use otter trawl gear and any lack of access to portions of the stock is not due to untrawlable habitat (smooth sandy mud is the prime habitat), but bottom contact closures put in place to protect sensitive biogenic habitats and important habitats for other commercially valuable stocks.

An alternative approach is to track commercial CPUE trends to measure Shrimp stock responses to a particular harvest rate. However, CPUE in repeated trawl catches of shrimp are highly variable, even when trawling occurred at the same site within the span of a few days (Dunham et al. 2002). Catch rates in trawl fisheries for mobile species are known to be highly stationary and are generally considered to be inadequate indicators of short-term trends in biomass unless the trawling takes place over the entire range of the animal (Dunham et al. 2002). High stationarity means that abundance trends remain high and relatively stable even though the true abundance is declining or low; this state is referred to as hyperstability. This phenomenon occurs because there is a filling effect wherein biomass removed by the commercial fishery is replaced by biomass from nearby areas of high density that are not fished, artificially maintaining the CPUE index. Hyperstability in CPUE is a conservation risk since management decisions could be based on overly optimistic impressions of stock status and this risk is an important reason that fishery-dependent CPUE is not directly used to support decision-making in many fisheries. Despite these concerns about CPUE, many of the fisheries reviewed track commercial CPUE in-season as a qualitative indicator of fishery performance and a measure of the seasonal pattern of fishing-down the stock (e.g., Smith et al. 2026).

Management Framework Differences

At-sea scientific observers are deployed in all of the fisheries reviewed in this document to monitor the catch of target and non-target bycatch species. In nearly all examples, observers are placed on large offshore freezer trawlers rather than smaller inshore coastal trawlers (e.g., NL fishery, Barents Sea fishery). When observers are placed on factory trawlers, which spend most of the fishing season at sea, they typically provide nearly 100% coverage of fishing operations. Observers are rarely placed on smaller inshore trawlers, which are usually required to submit to 100% dockside monitoring instead (e.g., EGSL fishery, NL inshore component, SKND fishery, US west coast Ocean Shrimp fishery, Australian NPF). Where observers are placed on inshore trawl vessels, coverage typically ranges from 10 to 15% of catch up to 25% maximum (e.g., Australian NPF, SKND fishery, US west coast fishery). None of these fisheries consistently record bycatch of endangered, threatened or protected species. These findings are in contrast to the BC Shrimp trawl fishery management plan which required 100% observer coverage on tows made in the WCVI offshore areas to monitor Eulachon bycatch against the EAL. This requirement was reduced to 25% for the 2026-27 fishing season (DFO 2026j). The lack of fishing in these productive offshore areas in the last few years has resulted in Eulachon bycatch that is well within the 4 t EAL, but the economic viability of the fishery has suffered as a result. The US west coast Ocean Shrimp fishery is also challenged by Eulachon bycatch and harvesters were required to carry observers to cover 10-15% of landings. After the 2024 fishing season, this fishery lost observer coverage provided by the West Coast Groundfish Observer Program (WCGOP) and has not replaced it, asking harvesters to self-report, which is known to be biased low relative to observer information (Gustafson et al. 2023).

Research is currently underway to evaluate the efficacy of electronic monitoring but a timeline for testing is not available at present (Smith et al. 2026). About 80% of the vessels in the Russian fleet in the Barents Sea fishery have implemented a digital bycatch recording system ("Bort 2.0"), developed jointly with WWF and PINRO scientists, that enables systematic recording of discarded bycatch and includes illustrated reference guides to assist crew in species identification. Reports generated by the software are verified onboard and transmitted to a monitoring specialist, with aggregated data subsequently reviewed by an independent expert (UCSL 2026). The veracity of this performance claim is unverified at present, but if true, then it is likely that this digital system would only be practical on large freezer trawlers.

The majority of trawl fisheries reviewed seek to ensure conservation of the stocks harvested followed by economic prosperity of the harvesters except the Australian NPF where maximizing economic benefits is the explicit goal of the management process. Net economic returns are maximized through the implementation of MEY as a target for the fishery and the use TAE to manage in-season effort. MEY is an economic metric representing the fish stock level that maximizes total sustainable profit (total revenue minus total harvesting costs) and it occurs at a higher biomass level than MSY because harvesting fish becomes progressively more expensive as the fish population declines (Lagarde et al. 2018). In contrast, MSY requires a high amount of fishing effort to achieve the maximum physical volume of fish, leaving less biomass in the water while MEY is reached at a lower fishing effort level where the gap between revenue and cost is widest, resulting in higher biomass in the water (Holma et al. 2019). Lower effort leaves a higher biomass intact. MEY as a target is potentially more conservative than MSY in achieving conservation benefits.

Considerations for Change

Implementation of the PA framework to manage the BC Shrimp trawl fishery is not optional for DFO as the Fish Stock Provisions (s.6,7) in the Revised *Fisheries Act* use the words 'must' and 'will' rather than more permissive language such 'may' and 'should' in describing the obligations for long-term conservation and sustainable use of fish stocks. Further, implementation is consistent with the Sustainable Fisheries Framework policy enunciated in 2009 and Canada's commitments made in signing the United Nations Fish Stocks Agreement in 2001.

DFO has developed a critical pathway document that outlines steps to changing the management of the Shrimp trawl fishery in British Columbia (Appendix 11). The steps described in Appendix 11 taken together with some of the considerations for the PA framework described below may form the basis for addressing Industry concerns with the fishery. However, it should be noted that some of the considerations raised in this document could lengthen the timelines in the critical pathways document because the same people will be involved in delivering these steps so prioritization may be required. There is no one transformational change identified in the fisheries reviewed, only a series of incremental steps to improve the Shrimp trawl management system.

The advantages and disadvantages of the items discussed for consideration in BC Shrimp trawl fishery management are collated in Table 3.

Precautionary Approach Framework

While implementation of the PA framework is not optional, there is flexibility in the choices made for implementation. First, MSY-based choices are often made for reference points and HCRs to manage fisheries in Canada based on policy advice that appears to identify $0.4 B_{MSY}$ and $0.8 B_{MSY}$ as 'default' LRP and USR choices, respectively. MSY is not the only choice for reference points. Both the NL and ESS trawl fisheries in eastern Canada use reference points based on unfished biomass (B_0) rather than MSY because there is no detectable relationship between Shrimp abundance and fishing in these fisheries (McDonald et al. 2025). Second, the default approach in many Regions, including Pacific Region, is to use a harvest rate of 0 if the LRP is breached, i.e., close the fishery to fishing when status is determined to be in the Critical zone. The PA policy and regulations for the Fish Stock Provisions both indicate that harvest rates in the Critical Zone should be set at a rate sufficient to permit rebuilding within agreed timeframes. Provided the appropriate analysis is completed and the results show that some level of fishing will not inhibit rebuilding, then harvest rates other than 0 may be possibilities when a stock is in the Critical Zone. For example, three of the four Northern Shrimp stocks in the EGSL fishery are in the Critical Zone, but fishing, albeit at a low exploitation rate, is permitted and occurs using $F/F_{MSY}=0.5$ to calculate allowable harvest (DFO 2026d, e). There is flexibility in the implementation of the PA framework (Table 3) and recent experience transitioning to different choices of reference points and harvest control rules in the NL, EGSL, and ESS fisheries (DFO 2026d, f, g). Some of the concerns expressed by Industry regarding the use of the PA framework may be mitigated by discussions on choices for implementation.

The practice of estimating biomass reference points such as the LRP from proxies for B_{MSY} or other reference point choices rather than estimates based on stock assessment procedures and modeling bears some scrutiny. The practice is based on recommendations from a 2008 workshop on applying the PA framework to Prawn and Shrimp stocks in Canada (DFO 2009) and has never been tested. Proxies such as the average of log biomass from a reference period (i.e., the geometric mean) or the highest observed spawning biomass from a reference period are employed but there is little scientific justification for these choices. Even when appropriate stock assessment modeling and procedures are available (e.g., integration of catch and abundance trend information in biomass assessments), proxies for B_{MSY} or B_0 estimates continue to be used (e.g., DFO 2026f, g). Future management should consider adopting appropriate population modeling and either estimate MSY from the model (Table 3) or test the appropriateness of the chosen proxy. This kind of work can be undertaken, but it will take people and time to get a workable model in place if deemed a priority. It also means that other activities may not be completed if attention is diverted to this project.

Table 3. Advantages and disadvantages of tools that could be implemented to improve BC Shrimp trawl fishery management.

Consideration	Advantages	Disadvantages
PA Framework Flexibility	• MSY-based reference points are not the only choice • $F=0$ when stock in Critical zone is not only choice, if it can be shown that stock will rebuild with some level of fishing	• Both MSY-based reference points and $F=0$ in the Critical zone are treated as defaults so approval of other choices will require careful documentation of the logic and consequences for the stock
Indicators	• Provide qualitative information on fishery, environmental, oceanographic and predators that can inform risks around harvest decisions • Indicators can be monitored in-season and can provide early signals for timely management actions • Monitor trends in recruitment, especially in the absence of a stock model	• Choice of indicators is critical and should reflect fishery, critical life history events of Shrimp (egg development and hatching, larval dispersal) • State of the Ocean reporting provides a compendium of indicators in British Columbia monitored annually, but will require time and effort to compile and expert assistance from Science

Stock Models	• Estimates unobserved parameters such as total biomass, spawning stock size, and mortality rates • Estimates parameters used for reference points (e.g., MSY) rather than relying on proxies with limited scientific justification • Provides the basis for calculating TACs, tracks historical trends to determine stock status relative to reference points • Projects how the stock will respond under different fishing intensity scenarios	• Will produce incorrect estimates if catch is underreported or scientific surveys do not cover the entire stock range; • Relies on historical data so has difficulty accommodating sudden ecosystem shifts, marine heatwaves, or unexpected reproductive failures in real time • Many models assume natural mortality or ocean productivity are constant and their values are often poorly estimated • Substantial investment of time and effort by Science/FM/Industry; prioritization needed
Management Strategy Evaluation	• Highlights tradeoffs between competing objectives for a fishery • Creates a simulation environment in which management approaches can be tested and evaluated before being used in the real world • Can constructively address opposing viewpoints on appropriate management • Shifts debate from current year TAC to long-term sustainability of the stock and fishery	• Requires strong and sustained collaboration between scientists, harvesters, and managers • Considerable modeling expertise is needed to implement successfully • Lack of existing capacity within Science to conduct MSE at present • Scientists, harvesters, managers would need to prioritize MSE over other Science activities

Adaptive Management	• Structured iterative approach to manage complex systems in face of uncertainty • Treats management strategies as experiments to monitor and adjust based on real-time feedback • Stewardship fishery proposal in Strait of Georgia by Industry may provide building blocks for an experiment	• Requires strong collaboration between DFO and Industry for which present conditions may not be ideal • Not a quick way to resolve issues
Offshore-Inshore Management	• Provides opportunities to try different approaches • Management reflects species complexity inshore vs simplicity offshore	• Potentially introduces complexity to management with two different approaches
Sustainability Certification	• Necessary for competitiveness in global markets • Can achieve higher price for certified product	• Imposes costs on all sectors to achieve certification and annual costs to maintain certification

Indicators

Nearly every fishery reviewed in this report explicitly monitors a variety of stock, environmental, and fishery performance indicators as part of the management function. These indicators provide a qualitative view of risks to the stock, particularly recruitment, and fishery and are used to supplement decision-making. In at least two fisheries (US Gulf of Maine and Canadian ESS) a formal TLA is used in which the range of each indicator is classified as bad, cautious or good for Shrimp productivity and the number of indicators in each category is totaled as means of conveying risk. Most fisheries apply a more informal analysis to indicators using thresholds based on experience to qualitatively inform the risk for management decisions on TAC. The BC Shrimp trawl fishery does not use indicators in the management framework at present, although recruitment is known to be strongly influenced by environmental factors. The annual [State of the Pacific Ocean](#) reporting conducted by DFO Science provides a compendium of physical, biological and oceanographic indices monitored within BC coastal and high seas waters annually. Indices chosen for Shrimp management should be relevant to the Shrimp life history and trawl fishery and could include SST during the winter (when eggs are hatching and larvae developing), spring upwelling and offshore transport (affecting larval dispersal for spawning areas), and predator indices (e.g., indices of abundance of predatory fish such as Pacific Hake, Rockfish, and Sablefish).

Stock Models

Six of eight trawl fisheries reviewed have implemented a stock assessment model to estimate biomass, track trends and provide forecasts for harvest advice, despite limited evidence that fishing strongly affects biomass or that SSB affects recruitment. Only the BC Shrimp trawl fishery and the US West Coast Ocean Shrimp fishery do not make use of model-based assessment. A range of models are used from the relatively simple Shaeffer production model, which needs only catch and effort data and can be tuned to survey indices, but will estimate MSY, to more sophisticated statistical catch-at-length models, which use fishery-dependent and independent data in a weighted matrix and assume a stock-recruitment relationship, despite no evidence demonstrating this relationship. The value of a stock model is that it estimates unobserved parameters such as total biomass, spawning stock size, and fish mortality rates, provides the mathematical basis for calculating TACs, tracks historical trends by reconstructing past stock sizes to determine if a stock is currently overfished or recovering, and projects how the population will respond next year under different fishing pressures. But a stock assessment model is a simplified snapshot of reality that suffers from inherent limitations including: (1) producing incorrect estimates if harvesters underreport catches (e.g., highgrading is occurring as in the SKND fishery), or if scientific surveys do not cover the entire stock range; (2) because models rely on historical data, they have difficulty accommodating sudden ecosystem shifts, marine heatwaves, or unexpected reproductive failures in real time; and (3) many models assume natural mortality or ocean productivity stay constant over time, which is unlikely to be true under climate change, and the values for these constants are often poorly estimated, which can be

influential on model outputs. On balance, the ability to estimate important quantities such as B_{MSY} and F_{MSY} to monitor Shrimp stocks and project forward to the following year may help to address Industry concerns in the BC Shrimp trawl fishery about delayed openings until survey data are analyzed as those data could be added to the model and used to project forward to the following year, permitting more timely and predictable fishery openings. However, transitioning from the current index-based assessment to a model-based assessment will be time consuming (for Science staff currently conducting survey index work and then tasked with model development) and not straight-forward as a model specific to the protandric life history of Shrimp will be needed. Recent experience with this transition is available in Quebec Region (EGSL fishery), Maritimes Region (ESS fishery), and Newfoundland-Labrador Region (NL Shrimp Trawl fishery) in Canada and should be consulted if model implementation is contemplated.

Management Strategy Evaluation

Management Strategy Evaluation (MSE) is a simulation-based framework used by scientists and managers to test how different fisheries management strategies perform under real-world uncertainties (Punt et al. 2016). Unlike a traditional fisheries stock assessment model, which uses optimization to estimate a best catch amount or predict future catches, MSE creates a virtual environment in which various management approaches are tested for robustness to expected uncertainties and achievement of specific objectives deemed important to participants. The resulting outputs helps identify tradeoffs between strategies that are most robust and best balance the achievement of competing goals, such as maximizing industry profits while ensuring long-term conservation of a stock.

A MSE functions as a closed feedback loop that simulates the entire adaptive management cycle and consists of three components. First, an Operating Model (OM), which represents the "true" underlying biology of the fish stock and the ecology of the ocean. Second, a Management Procedure (MP), which is a pre-agreed framework being tested including an observation model simulating the data collection process, an estimation model simulating the stock assessment, and a HCR that specifies adjustments to TAC or fishing effort based on the estimated stock status. Third, a strong and sustained collaboration between scientists, managers, Industry and other stakeholders to define fishery objectives, make choices regarding reference points and HCRs, and, most importantly, to evaluate the tradeoffs in achieving specific objectives such as maximizing economic profit and maximizing catches.

Where traditional stock assessments models evaluate a single "best case" scenario or an ensemble of scenarios to address key uncertainties, MSE accepts that uncertainty exists and evaluates whether a strategy succeeds even if the data or scientific assumptions are wrong (Punt et al. 2016). A well implemented MSE has the potential to shift the debate from this year's quota to agreeing on long-term sustainability rules for the stock and fishery. By integrating harvesters, scientists, and policy-makers early on,

it is transparent and builds consensus on the tradeoffs and compliance before the regulations are finalized. An MSE process can be a way to constructively address strongly opposing viewpoints on strategies and tactics for management as appears to be present in the debate on BC Shrimp trawl management. While the potential benefits are great, costs will also be high as extensive resources in terms of people and time would be needed to implement this approach, to the extent that it would be prioritized over other activities by scientists and managers. A deliberate decision to go forward taken with harvesters, processors, scientists and managers would be needed.

A slimmed down alternative to the full MSE experience described above is the use of a desktop MSE, which is based on rudimentary input from harvesters and policy-makers, but is largely developed and conducted by scientists (e.g., Walter et al. 2023). Desktop MSEs are becoming more common because it is recognized that they can be useful in resolving scientific uncertainties that cannot be addressed through the traditional stock assessment model approach. A desktop MSE can also contribute to the discussion of tradeoffs in achieving objectives or at least highlight some of the challenges with specifying objectives and HCRs. Whichever MSE approach is chosen, it will require a high degree of scientific modeling expertise and time to develop the framework and an estimate of at least two years to get to a working operating model is probably conservative, unless an existing model can be adapted. At present, there is little capacity to implement an MSE process within DFO Science unless other tasks are reprioritized.

Adaptive Management

The BC Shrimp Trawl Industry has expressed concerns about the considerable amount of management overhead in closing areas because one of three species is in the Critical zone while other species are in the Healthy zone, sudden closures or openings of SMAs in-season based on new data, and short-openings/sudden closures due to the EAL, which create unpredictable fishing opportunities that do not support BC-based processing. These concerns seem to stem, in part, from the application of LRPs to three species in 36 SMAs, i.e., treating each species in each SMA as a separate stock, resulting in a patchwork of openings and closings in a given fishing season. Some of this concern can be mitigated by the implementation of the coastwide stock definitions recommended by DFO (2025f) and the application of reference points at the regional scale that consider the comments on implementation above. However, managers will still require advice on harvest at smaller spatial scales which should be at a scale larger than the existing SMAs. Among the fisheries reviewed in this report, none manage the fishery at the fine spatial scale of the SMA, although many conduct statistical reporting at finer spatial scales. One proposal is to consider aggregating SMAs into sub-regional scale for management purposes: as an initial proposal consider Haida Gwaii, Prince Rupert, Central Coast, Strait of Georgia, and WCVI as logical self-contained sub-regions, using SMAs within each sub-region for catch reporting. Since little is known about movement dynamics or larval dispersal in the three stocks targeted by the BC Shrimp trawl fishery, there may be a concern about local depletions within these sub-regional

areas. One way to address this concern is to consider an adaptive management approach, monitoring commercial CPUE in-season to follow the pattern of fishing down and close an area within a sub-region to further commercial fishing when an agreed limit or trigger is reached.

Adaptive management is a structured, iterative "learning by doing" approach used to manage complex systems in the face of uncertainty (Williams 2011). It involves implementing policies or strategies, actively monitoring their outcomes, and continually adjusting future actions based on real-time data and environmental feedback. Instead of treating plans as rigid, unchangeable roadmaps, adaptive management treats management strategies as ongoing experiments, which would allow DFO and Industry to learn what works, reduce scientific or operational uncertainty over time, and avoid repeating mistakes. A stewardship fishery in the Strait of Georgia proposed by Industry in 2022 might provide the basis for designing an adaptive management experiment at the sub-regional level and should be considered going forward, especially in light of the changes that DFO is contemplating to stock definitions, reference points, assessment and management.

Offshore and Inshore Management

The fishery offshore of WCVI is fundamentally distinct from the inshore fishery along WCVI, Strait of Georgia, Prince Rupert and Central Coast. The two main differences are the high Shrimp productivity and Eulachon bycatch in the offshore WCVI areas relative to other areas of the coast. In addition, the offshore WCVI fishery component is essentially a single species fishery (Smooth Pink Shrimp) unlike other areas, but similar to most of the trawl fisheries reviewed in this report. Given the differences, it might be prudent to explore a different management approach for the offshore WCVI area, assuming that Eulachon bycatch can be appropriately addressed and mitigated. A differential management approach depending on offshore or inshore area is amenable to exploration through an MSE or potentially, adaptive management.

Eulachon Bycatch

One of the key management issues for the BC Shrimp trawl fishery is Eulachon bycatch management. COSEWIC assessed the Central Coast and Fraser Designatable Units (DU) of Eulachon as Endangered and the Nass/Skeena stock as Threatened in 2011 and the United States listed the southern distinct population segment (DPS) as threatened under the Endangered Species Act (ESA) in 2010 (NMFS 2017). The Southern DPS consists of all Eulachon spawning in coastal rivers south of the Skeena-Nass watershed, including the Fraser, Columbia, and Klamath Rivers. The lack of separation between the Fraser River and southern US populations of Eulachon, particularly the Columbia River, is consistent with results of the most recent genetic analysis of coastal stock structure (Sutherland et al. 2021), i.e., there is no detectable genetic separation of Eulachon spawning in these rivers. Eulachon bycatch is managed differently in Canada and the United States: Canada uses a hard 4 t cap on Eulachon bycatch (i.e., the EAL), which triggers a closure to commercial fishing in the WCVI offshore areas, the most

productive Shrimp grounds, when it is reached (DFO 2026b); the United States sets a dynamic incidental take limit for the Ocean Shrimp fishery of 0.02% of the estimated minimum Columbia River Eulachon run calculated as a five-year geometric mean (NMFS 2017), which shuts down the fishery immediately if exceeded. At present, the West Coast Ocean Shrimp fishery in the United States has never been closed because of Eulachon bycatch while the EAL is cited as a primary driver behind reduced catches and viability of the BC Shrimp trawl fishery in the last decade.

Changes to the EAL are unlikely to occur until new scientific advice is available showing that the risks to the Fraser River Eulachon stock from the Shrimp Trawl fishery are lower than is currently perceived. DFO Science is currently developing a framework integrating all available Eulachon data from annual multi-species surveys off WCVI (i.e., Shrimp surveys), egg and larval collections in the spring in the Fraser River, and other survey efforts (e.g., Dealy and Hodes 2019) to test out scenarios for Eulachon and develop future management options. While the framework will not provide Eulachon harvest advice to inform the Shrimp trawl fishery management, it could be used, when available, to evaluate potential Eulachon bycatch options in the Shrimp trawl fishery. This approach is at least two years away from providing useful outputs. In the interim, an analysis of survey and logbook data for spatial and temporal variability in Eulachon and Shrimp presence/absence may provide some insight into times or areas where harvesters can reduce bycatch.

Sustainability Certification

Certification for sustainability is increasingly viewed as a necessity for competitiveness in global markets. Attaining certification imposes costs on Industry and there is an annual cost to Industry to maintain their fishery certification. Many of the fisheries reviewed in this document are certified for sustainability by the Marine Stewardship Council, including the US west coast Ocean Shrimp fishery, four of the fleets in the Barents Sea fishery, the Australian NPF, and the NL Shrimp trawl fishery. The Skagerrak-Norwegian Deep, ESS, and EGSL fisheries have suspended certification while they work to rebuild stocks back into the Cautious zone or above. The only fishery not certified and to never attempt certification, is the BC Shrimp trawl fishery. Some consideration should be given to the benefits and costs of certification of the BC Shrimp trawl fishery when the economic fundamentals are in a better position.

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Appendix 1 – British Columbia Shrimp Trawl Fishery

1. Fishery Overview	
Target Species:	• <i>Pandulus jordani</i> (Smooth Pink Shrimp); <i>P. borealis</i> (Spiny Pink Shrimp); <i>Pandalopsis dispar</i> (Sidestripe Shrimp)
Stock Structure:	• Each species has been managed as separate stocks in each of 36 Shrimp Management Areas (SMAs) coastwide (3 x 36 stocks); • Recent research found that there is no evidence of stock structure in Canadian waters and recommended a single coastwide stock for each species (DFO 2025); • Work is underway to implement the coastwide stock recommendation;
Location:	• The shrimp trawl fishery takes place within 34 of the 36 SMAs from large offshore areas to smaller inshore waters; • Major shrimp grounds are located in Barkley Sound, offshore in areas 124 and 125, the SOG, Central Coast adjacent to Rivers Inlet-Fitz-Hugh Sound and Goose Islands in Queen Charlotte Sound (which is closed), and waters around Prince Rupert;
Fleet:	• Number of vessels has declined since 1998 to 45 in 2014/15; because of high abundance in WCVI offshore areas in 2015 and 2016, the number of active vessels increased to 65 but has declined since this time to 19 active vessels in 2024, which is a 5% decrease since 2023; • 203 S licences and 26 FS communal licences are available in the commercial fishery; • Several FN have treaty rights to fish for shrimp for domestic or FSC purposes; • Commercial fishery consists of 207 S licences (vessel-based) and 26 FS licences (issued to FN only). • 23 of 233 S and FS licence holders participated in commercial fishery in 2024; • Recreational – 349,000 tidal water resident adult fishers in 2024-25, but numbers that reported fishing for shrimp are not available; • Shrimp and prawn made up 28% of recreational shellfish fishing days (6% of total fishing days) and 33% of shellfish expenditures (4% of coastwide expenditures) in 2023-24;
Gear:	• Beam and otter trawls are used in the commercial fishery; • Beam trawls are used in inshore channels and consist of a rigid horizontal beam that holds the mouth of the net open as it is towed, keeping the gear slightly off the seafloor;

	• Otter trawls are used in larger open waters and offshore locations along WCVI and consists of a net with the mouth held open by doors on either side; • Recreational fishers may only use traps, ringnets or spear fish while diving;
Economic and Social Context:	• Pink Shrimp comprise the majority of catch and is typically landed fresh on ice for processing; • Secondly, Sidesripe Shrimp, which are larger and have a higher value than Pink Shrimp, are landed finger-packed (heads on) and frozen at sea or sold fresh directly to the public; • Both landings and landed value peaked in 1996 (7,657 t and \$22.7 M in 2024\$, respectively) and have declined to 115 t landed with a value of \$1.0 M in 2024, with the exception of a brief increase in 2015 and 2016; • Shrimp harvest is landed on Vancouver Island (45%), the Lower Mainland (45%) and the North Coast (10%) and the majority is processed where it is landed; • Shrimp processing does not contribute significantly to the processing industry. On average, from 2014-2024 the fishery contributed roughly 14,500 hours of annual processing employment and around \$332,000 in annual wages; • The increased in landings for 2015 and 2016, resulted in a substantial increase in processing, providing over 55,000 hours of annual employment or \$1,200,500 in annual wages on average; • Value of Shrimp and prawn exports in 2024 (which is driven primarily by Spot Prawn exports) was \$69.5 M CAD, with China (\$41.1 M) and the US (\$19.3 M) being the primary markets; export value in 2024 represents a 32% decline relative to export value in 2023; • In 2023, \$579 K in value-added from wholesaling and processing was generated by 22 companies, mostly located in the lower mainland; • The shrimp trawl fishery directly contributes \$758K (GDP) to the provincial economy, with a direct employment and income contribution of 78 jobs and \$498K, respectively;
History:	• The shrimp trawl fishery began developing rapidly in the 1960s when a downturn in the Salmon and Halibut fisheries occurred; • Licences were available for any commercial fishing vessel and most areas were open seasonally with no catch ceilings until stock assessments began in 1973; • Offshore shrimp grounds were fished and majority of catch was landed US ports; • Expansion of fishing and processing capacity directed at offshore shrimp stocks, and Canada's declaration of a 200-nautical mile

	fisheries jurisdiction in 1977, led to licence limitation. Licence eligibility was restricted to vessels that had landed shrimp in 1975 and 1976; • Once licence eligibility was finalized in 1978, a total of 249 'S' licence eligibilities were issued. • Shrimp effort off WCVI increased in 1995 and 1996 and all shrimp areas were fished because of changes in groundfish and salmon management strategies, most notably a salmon licence buy-back that resulted in 100 vessels having only an S licence; • Shrimp abundance levels were also high in 1995 and 1996, along with a high price being offered for shrimp for those two years; • Catch ceilings were in place for WCVI but the rest of the coast was open on a seasonal basis (April 1 to October 31) with no catch limits; • Significant changes in the management of the shrimp trawl fishery were implemented in 1997 based on more precautionary management, risk adverse principles, and selective fishing practices; • 36 Shrimp Management Areas (SMA) were defined, total allowable catches (TAC) were set to limit exploitation, a seasonal opening for the offshore Pink Shrimp fishery was implemented, and the development of industry-funded programs to monitor catches and contribute to stock assessment were initiated; • The 'shrimp year' was defined for opening/accounting for catch ceilings. In 2003, the official licence year was changed to run from April 1 to March 31 the following year; • Catch ceiling and a Total Allowable Catch (TAC) are both tools designed to limit the amount of fish harvested, but they are applied differently based on the precision of data and the specific fishery; • Catch ceilings are commonly used as a maximum upper cap to provide operational flexibility in fisheries in which annual biomass surveys determine allowable harvest rates; • TAC is a specifically calculated total allowable amount set for a particular species or stock in a given area for commercial fisheries with comprehensive monitoring;
2. <u>Stock Status and Science</u>	
Stock Assessment Framework:	• Area-swept fishery independent trawl surveys are conducted at fixed stations to estimate an index of shrimp biomass and to monitor trends in abundance over time in portions of 13 of the 36 SMAs; • Initial catch ceilings are established annually for each species in each SMA using provisional reference points and estimated stock

	biomass and harvest rates are applied depending on the status of the stock in each SMA (see HCRs section); • A five-year running average is used to forecast biomass by species and SMA. Initial catch ceilings are defined before the season and are adjusted when new in-season biomass estimates are available; • In SMAs for which there are no survey data, catch ceilings are based on the 10th or 25th percentile of the pre-1997 catch history – generally 10 t in inshore areas and 25 t for offshore areas; • A recent science review (DFO 2025) recommended managing Smooth Pink, Spiny Pink, and Sidestripe as single coastwide stocks rather than separate stocks in each SMA due to a lack of evidence for multiple sub-stocks; • This review also evaluated the survey design and recommended switching to a systematic sampling station design to improve accuracy and precision of biomass estimates and using a survey area of 70,421 km² to support the single coastwide stock definition for each species; • A spatiotemporal model (i.e., sdmTMB) was recommended to improve accuracy and bias in biomass estimates in support of the single coastwide stock definition; this model requires a minimum of 10 survey tows that are positive for shrimp within the survey area in each year surveyed; 200 tows (not all will be positive for shrimp) are expected to be achievable annually in future surveys; • A workplan has been developed to implement these Science recommendations and address concerns of Fisheries Managers;
Stock Dynamics:	• Shrimp stock size shows high inter-annual variation. This high variability in biomass estimates results in high inter-annual variability in catch ceilings; • Recruitment is believed to be more strongly influenced by environmental conditions, especially conditions impacting pelagic larval dispersal, than spawning stock size; • Fishing has little influence on stock productivity and abundance, hence conventional fishery models, which assume a production function, have not been applied in the assessment of shrimp; • Martell et al. (2000) reconstructed <i>P. jordani</i> stocks off the WCVI and found that survey biomass estimates in the offshore areas are good predictors of pre-season vulnerable biomass and recommended using pre-season estimates combined with a formal assessment model to calculate annual TACs; • Martell et al. (2000) also reported that in years of low SSB, recruitment in areas offshore of WCVI was through immigration;

	relatively little is known about the movement dynamics of shrimp stocks along the coast; • Due to variability in stock status of Pink and Sidesripe Shrimp across and within SMAs, it is believed that there is a moderate likelihood that commercial shrimp trawl fisheries are driving these stocks;
Biomass Indices:	• Biomass indices are calculated for each SMA in which the survey is conducted, typically about 13 of 36 SMAs; these index values are reported relative to LRPs, USRs and stock status zones defined in the PA Framework; • Combined 2025 Pink Shrimp biomass estimate for SMA 124OFF and SMA 125OFF is 5,182.4 t, which is above the USR of 2,342.9 t); SMAs 230OFF, 210OFF and 23IN were not surveyed in 2025; • SMA Fraser River in 2025 – combined Pink Shrimp biomass is estimated as 148.12 t and is above the LRP of 89 t and below the USR of 178.1 t; Sidesripe Shrimp biomass index is estimated to be 182.12 t and above the USR of 136.8 t; • SMA 14 in 2025 – biomass index for Smooth Pink Shrimp is estimated to be 407.2 t and is above the USR of 250.6 t; Sidesripe Shrimp biomass is estimated as 28.04 t, above the LRP (27.9 t) and below the USR (55.9 t); • SMA GTSE in 2025 – Smooth Pink Shrimp biomass index is estimated to be 330.8 t and is above the USR of 294.3 t; Sidesripe Shrimp biomass is 48.5 t, placing it above the LRP of 31.4 t but below the USR of 62.9 t; • SMA 16 in 2025 – estimated biomass for Smooth Pink and Spiny Pink Shrimp combined is 84.8 t, and is above the LRP (45.9 t) and below the USR (91.9 t); estimated Sidesripe Shrimp biomass is 10.86 t, and is below the LRP (10.9 t); • SMA PRD was surveyed in 2024 – estimated biomass index for Spiny and Smooth Pink Shrimp combined was 457.98 t and is above the LRP (391 t) and below the USR (782.1 t); estimated Sidesripe Shrimp biomass is 576.1 t and is above the USR of 469.9 t;
Reference Points:	• Provisional references points compliant with the Precautionary Approach are based on recommendations from a workshop of experts (DFO 2009); • Reference points are based on the biomass at maximum sustainable yield, i.e., B_{MSY}. B_{MSY} is a model estimated quantity, but standard catch-at-age models are not viable for shrimp stocks. Therefore, a proxy of this quantity is used and is estimated as: • $B_{prox} = \ln$ (average biomass during a productive period), where $LRP = 40\% B_{prox}$

	USR = 80% B_{prox}; • These reference points are currently under review and may change depending on the results of a CSAS process expected to occur in May 2026;
Stock Status:	• In 2025, several DFO biomass surveys were conducted. The 2025 survey in Shrimp Management Areas (SMAs) 124OFF and 125OFF indicated the combine Smooth and Spiny Pink Shrimp was in the Healthy zone; • The survey conducted in SMA 14 indicated Smooth Pink Shrimp was in the Healthy zone and Sidesripe Shrimp was only slightly above the Limit Reference Point in the Cautious Zone; • The survey conducted in SMA GSTE indicated Smooth Pink Shrimp was in the Healthy zone, and Sidesripe was in the Cautious zone; • The survey in SMA FR indicated combined Pink Shrimp estimates were in the Cautious zone and Sidesripe Shrimp was in the Healthy zone; • Survey results for SMA 16 indicated combined Pink Shrimp biomass estimate was in the Cautious zone and Sidesripe Shrimp was in the Critical zone;
Catch Data:	• 201 t landed in 2023-24, which was a 73% increase relative to 2022; • 115 t landed in 2024-25; maximum catch available was 3,175.15 t (3.6% used) • About 43% of landings are made in the north coast and rest comes from WCVI and South Coast;
3. <u>Management and Governance</u>	
Management Framework:	• Meet conservation objectives and ensure healthy and productive fisheries and ecosystems; • Manage fisheries to provide opportunities for economic prosperity; • Provide stability, transparency, and predictability in fisheries management and improved governance; • Fixed harvest rate management strategy using catch ceilings in SMAs based on survey results; • Harvest of Pink and Sidesripe Shrimp is primarily conducted under commercial licence - there are no sharing or allocation arrangements in place for the fishery; • Harvest opportunity is determined under the stock assessment and management framework. • Harvest of Pink and Sidesripe Shrimp by First Nations for FSC or domestic use; recreational harvest; and by other gear types in

	the commercial fishery is considered small and is not taken into consideration in setting annual catch ceilings; • Commercial fishery is limited entry, vessel-based licence (S) and party-based licence (FS – First Nations) eligibilities established in 1997; currently 26 FS and 207 S licences; • S licence must be renewed annually regardless of whether or not fishing occurred. If not renewed, then the licence is relinquished and cannot be renewed going forward. • Recreational fishers require tidal water licence, which must be renewed annually; approximately 349,000 adult fishers in 2024/25, but no information on numbers reporting shrimp caught;
Total Allowable Catch (TAC):	• Fishery is managed to species-specific annual catch ceilings by SMA that are set to limit exploitation; • Since species overlap spatially and temporarily, an SMA will be closed when a species-specific ceiling is reached; • Minimum size limit for Spot Prawn is 33 mm CL;
Harvest Control Rules (HCR):	• Provisional HCRs have been established consistent with the Precautionary Approach: • If stock status is estimated in the Critical zone (biomass below LRP), then the harvest rate is 0 and the SMA does not re-open until a new stock assessment shows it to be in the Cautious or Healthy zones; • If stock status is estimated to be in the Cautious zone (biomass between the LRP and USR), then harvest rate varies between 0 and 35% based on a formula; • If stock status is estimated to be in the Healthy zone, then the harvest rate is 35% as recommended by Martell et al. (2000) based on analysis of the offshore trawl fishery in SMAs 124OFF and 125OFF. • If the LRP or USR are not defined for an SMA, then a catch ceiling is based on survey biomass and a harvest rate of 33%. This harvest rate is based on a Gulland model with $M=0.3$, $MSY = 0.5 \times M \times B_0$; note that the use of $M=0.3$ is a guess for natural mortality in this stock and it assumes M is constant throughout the life cycle; most research and observations show that M in shrimp stocks is strongly correlated to predation pressure, particularly Pacific Hake, along the west coast of North America (e.g., Hannah 1995);
Monitoring Program:	• Shrimp Trawl Catch Monitoring program tracks commercial landings in-season and monitors status of SMA catch ceilings; • Consists of hailing prior to fishing and offloading and catch reporting through logbooks and fish slips;

	• Verification of landing weight, species composition, and quality against hailed or other reported figures (e.g., logbook) is accomplished through random dockside monitoring by an observer; • Catch sampling occurs at the dock and is conducted by at-sea observers; samples are collected for size and age analysis and to assess shrimp and non-target species composition; • Vessels operating within SMA 124OFF and 125OFF through 2025 were required to have 100% at-sea observer coverage because of concerns regarding Eulachon bycatch; this has changed to 25% of fishing days for the 2026-27 fishing season; • Vessels operating in SMAs 23IN and 23OFF and 21 OFF are required to have at-sea observer coverage on 25% of fishing days; • Additional 20 days of at-sea observer coverage for use in other SMAs along the coast. • Logbooks recording daily fishing activities and estimated catch weight by shrimp species are submitted within 28 days following the end of each month in which fishing occurred; • Fish slips recording landed weight by species, amount paid by species are submitted to DFO within 7 days of an offload; • Operational VMS is mandatory;
4. <u>Ecosystem and Environmental Impact</u>	
Bycatch Management:	• Mandatory use coastwide of Bycatch Reduction Devices (BRDs), such as Nordmøre grates and large mesh panels and at least five LED lights on the central portion of the net; BRDs with maximum spacing of 19 mm between bars along WCVI and offshore and 31.75 mm spacing elsewhere; • Hay et al. (1999a) estimated that between June and Dec 1997, otter trawls caught 200 t of Eulachon and beam trawls caught 37.2 t; offshore WCVI and Central Coast were hotspots for Eulachon bycatch and a similar pattern was reported in 1998 (Hay et al. 1999b); these estimates may represent a 'worst-case scenario' as they were made before BRDs were introduced to the fishery; • In contrast, Olsen et al. (2000) estimated that beam trawls caught substantially more finfish (except Eulachon) and non-shrimp invertebrate bycatch than otter trawls in the 1997-1999 period; • Can retain incidentally caught Spot Prawn; all other species, including Eulachon, cannot be retained;

	• May retain up to 100 incidentally caught legal sized (33 mm CL) Spot Prawn (<i>Pandalus platyceros</i>) when the commercial prawn season is open; • Retention of Opal Squid (<i>Loligo opalescens</i>) limited to amount that does not exceed 2% of total shrimp weight onboard; • Octopus – all incidentally caught octopus (<i>Enteroctopus defleini</i>) may be retained; • Eulachon is a focus of bycatch management because COSEWIC assessed the Central Coast and Fraser River stocks as Endangered in 2011; groundfish trawl and shrimp trawl fisheries were identified as threats; • A formal evaluation of the effectiveness of BRDs and footrope lights in reducing Eulachon bycatch in the Canadian fishery has not occurred; however, Hannah et al. (1996, 2015) found that these measures reduced bycatch in the Oregon Ocean Shrimp fishery by at least 90% without affecting shrimp catch; • Eulachon action levels (EAL) of 4 t in WCVI offshore fishing grounds has been in place for many years; once Eulachon bycatch exceeds these levels, fishery is closed in those SMAs; • No fishing has occurred and thus no Eulachon bycatch in SMAs 124OFF and 125OFF since the 2023/24 season because it is not economically viable to incur the time and cost to train observers coupled with lack of an established market for the product and the potential for quick closure due to EAL being exceeded; • In-season Eulachon bycatch estimate for WCVI was ~ 1 t in 2023/24 and ~0.5 t in 2024/25;
Ecosystem Impacts:	• Shrimp larvae are important prey for many finfish species such as Pacific Hake, Turbot, Spiny Dogfish, Pacific Cod, and various rockfish and skate species (Butler 1980, and Hannah 1995). • Shrimp are opportunistic detritus feeders and prey on polychaete worms, sponges, diatoms, Euphausiids, and other crustaceans (Butler 1980).
Habitat Impacts:	• There is a high risk for direct or indirect habitat impacts in this fishery; • Glass sponge reefs in Queen Charlotte Sound and Hecate Strait are closed to trawling; • Rockfish conservation areas (RCAs), Marine Protected Areas (MPAs), National Wildlife Conservation Areas (NWCAs) and National Marine Conservation Areas (NMCA) are also closed to trawling; • Queen Charlotte Sound SMA is closed to shrimp fishing owing to concerns about the status of Central Coast Eulachon stocks;

Climate Effects:	- Recruitment is believed to be more strongly influenced by environmental conditions than spawning stock size, but no formal relationships predicting recruitment in these stocks are available; - Annual biomass surveys identify age classes comprising biomass estimates in surveyed SMAs so an index of recruitment is available to monitor as an indicator of stock health;
5. <u>Performance and Sustainability</u>	
Certification:	Fishery does not have certification because of low harvest activity levels and high costs relative to economic value of the fishery;
Economic Viability:	- The fishery is currently in a period of low participation due to high operating costs and market competition. - Eco-certification (Marine Stewardship Council – MSC) of the NL and US west coast Ocean Shrimp trawl fisheries provides a competitive advantage to these fisheries in consumer markets; - BC shrimp trawl fishery has not had the capacity to engage in certification due to the current low harvest and low revenue environment, but may need to consider doing so in order to compete with consumer preferences for eco-certified shrimp from other jurisdictions; - The implementation of the 4 t Eulachon Action Level (EAL) for bycatch in the offshore fishery (124OFF and 125OFF) and the requirement for 100% observer coverage in this component of the fishery (changed to 25% for the 2026-27 season) is cited by Industry as contributing to the lack of economic viability in this fishery; lack of fishing in the last few years is related to the high costs of the observer program and the uncertainty regarding the length of opening before the EAL is reached; - While work is continuing to simulate future scenarios for the shrimp trawl fishery in response to changes in management measures, including the EAL, catch ceilings, survey design and reference point calculations, results will not be available until 2027-29 period;
Compliance:	- No emerging enforcement issues; - Monitoring patrols of closed areas/times and enforcement of retention rules and gear configurations occur regularly; - Inspections focus on fishing vessels at-sea and at landing ports to inspect catch on board, bycatch gear in nets, hauls, landing records and harvest logs;
6. <u>Source Documents</u>	
Boutillier et al. (1999); DFO (2009); DFO (2024b); DFO (2025e, f); DFO (2026j, k); Hannah (1995); Martell et al. (2000); Hannah et al. (1996); Hannah et al. (2015); Hay et al. (1999a, b)	

Appendix 2 - Estuary-Gulf of St. Lawrence Shrimp Trawl Fishery

1. Fishery Overview	
Target Species:	• <i>Pandalus borealis</i> (Northern Shrimp)
Stock Structure:	• Genomic analysis results show that Northern Shrimp in the Estuary and GSL are distinct from stocks on the Scotian shelf and NL/Arctic; • Recent high resolution genomics work (Bourret et al. cited in Bourdages et al. 2023) demonstrates genetic differentiation between SFAs in the estuary and GSL supporting the conclusion of reproductive isolation; • Northern Shrimp are assessed and managed as separate stocks (biological units) in each of the four SFAs 8, 9, 10 and 12;
Location:	• Fishery is located in the estuary and Gulf of St. Lawrence in SFAs 8,9, 10 and 12 on both sides of the Laurentian Channel and in the Anticosti and Esquiman channels at depths between 200 and 300 m; • Fishing also occurs in the Sept-Iles region west of Anticosti Island and the estuary between the Saguenay Fjord and Baie Comeau on the north shore; • Fishery operates April 1 to Dec 31
Fleet:	• Vessels range in length between 16.7 and 27.4 m; • Limited entry fishery with 111 licence eligibilities in 2017; • 10/111 licences have been issued to First Nations; • 102 fishing licences were active in the 2021 fishery;
Gear:	• Otter trawls with minimum mesh size of 40 mm to allow undersized shrimp to escape; • Use of Nordmøre grates is mandatory to reduce finfish bycatch;
Economic and Social Context:	• The fishery is crucial to regional economies, with shrimp brought to local plants for cooking, peeling, and quick-freezing. • 5 shrimp processing plants in Quebec, and 2 in NB; • About 60% of product is exported to European market and rest is sold in Canada and U.S.;
History:	• The fishery has been managed by TAC since 1982; • Shrimp fishery EGSL began in 1965 when the first commercial catches were made in the western Gulf. • Fishing targeting shrimp intensified and the use of higher performance fishing vessels and gear contributed to the rapid increase of landings; • In the late 1970s and early 1980s shrimp fishing was done by two groups of fish harvesters, which were defined in the mid-80s:

	Group A consists of harvesters from Western Newfoundland and Labrador and Quebec, while Group B consists of fish harvesters from Quebec and New Brunswick; • An individual quota program was established for Group B in 1991 and for Group A in 1996; • In 1998, a temporary allocation was authorized to benefit core groundfish harvesters of PEI and NS; temporary allocation quotas were dependent on the TAC and varied based on stock abundance in the EGSL. In 2009, DFO stabilized access for the various fleets involved in the shrimp fishery; • Collapse of cod and Redfish stocks in the mid-1970s and the low prices paid for these species led to increased demand for fishing licences for Northern Shrimp and the number of fishing licences increased until 1980 to a limit of 111 licences; • Licences had to be limited so as to not further increase fishing capacity on groundfish species since all the Northern Shrimp fishing licence holders were also holders of groundfish fishing licence;
1. <u>Stock Status and Science</u>	
Stock Assessment Framework:	• Stock assessment of Northern Shrimp in the EGSL is conducted every two years with a stock update provided in intervening years; • Prior to 2025, the status of each stock was assessed based on two indicators: standardized commercial CPUE and index of shrimp abundance from the ecosystem survey; one of the main issues was the fact that these two indices showed significant divergence primarily because the two indices do not represent the same fraction of each stock; this result led to the implementation of a modeling approach to track trends and evaluate stock status relative to the PA framework; • Bayesian surplus production model was implemented for the 2025 assessment based on recommendations of Smith and Bourdages (2024) to estimate the trajectory of the four shrimp stocks over time; uses commercial landings data and index of total biomass derived from the annual ecosystem survey; • This model does not integrate information on the size or age structure of the stock, and simplifies the productivity processes (recruitment, growth, natural mortality, etc.) to the estimated parameters r and K, which are the population growth rate and the support capacity of the environment, respectively; • The absolute annual values of biomass (B) and exploitation rate (F) estimated by the model do not make it possible to distinguish

	the effects of changes in productivity and fishing on stock dynamics, and are therefore considered unreliable; • Only their trajectory over the entire series is informative, and the relationship between the relative biomass (B/B_{MSY}) and the relative exploitation rate (F/F_{MSY}) could serve as a guide to establish fishing removals which will reduce the risk of overfishing; • An ecosystemic survey to describe the biodiversity of Gulf species and the physical and biological oceanographic conditions is the main source of fishery-independent abundance indices for several species, including Northern Shrimp; • This survey has been conducted annually in August since 1990 using a stratified random design and shrimp trawl to sample around 200 stations on average; stratification is based on depth; • Biomass estimates in each tow are based on area-swept methodology and kriging is used to spatially interpolate and derive a biomass index value for each stock; • A bridging analysis comparing model outputs with results of indicators analysis previously used for stock status was conducted and results found to be consistent;
Biomass Indices:	• Relative biomass indices are estimated by the SPM for each stock; this replaces the commercial CPUE and survey index used prior to 2025;
Reference Points:	• Limit Reference Point (LRP): 0.4 (40%) of B_{MSY}; • Upper Stock Reference (USR) proposed: 0.8 (80%) of B_{MSY}; • Target Reference Point (TRP) proposed: B_{MSY} • Removal Reference (RR) proposed: relative exploitation rate at MSY when the stock is in the healthy zone (F_{MSY});
Stock Status:	• Estuary: above the proposed USR with a probability of 96% and is in the Healthy zone; • Sept-Îles: below the LRP with a probability >99.9% and is in the critical zone; • Anticosti: biomass is at the LRP with a 50% probability and is in the critical zone; • Esquiman: below the LRP with a probability of 67% and is in the critical zone;
Catch Data:	• Landings gradually increased from nearly 1,000 t at the start of exploitation in the 1970s to more than 35,000 t in the late 2000s; • Landings have subsequently declined, reaching 2,570 t in 2024 and 3,381 t in 2025 (preliminary data as of January 5, 2026), out of overall total allowable catches (TAC) of 3,060 t and 3,809 t, respectively; • The landings in 2024 and 2025 are the lowest recorded since 1974 for the Sept-Îles, Anticosti and Esquiman stocks;

2. <u>Management and Governance</u>	
Management Framework:	• Fishery has been managed by TAC since 1982 and PA framework has been in place for these stocks since 2012; • TAC shares have been stabilized since 2009; • Sept-Îles, Anticosti, and Esquiman stocks have been subject to a rebuilding plan since fall 2025 (all are in the critical zone). • The main objective of the rebuilding plans is to promote biomass growth until it reaches a level above the LRP with a 75% probability. Due to the recent decline in productivity observed for these stocks, no rebuilding timeline could be established; • Estuary stock is still in the healthy zone, but a decline is projected for 2026;
Total Allowable Catch (TAC):	• Estuary (SFA 12): 995 t; • Sept-Îles (SFA 10): 917 t; • Anticosti (SFA 9): 2,009 t; • Esquiman (SFA 8): 1,498 t; • Total TAC for 2026 is 5,419 t; • TAC in each SFA is then allocated to Group A and B harvesters according to fixed sharing rules;
Harvest Control Rules (HCR):	• HCRs show different relative harvest rates or biomass depending on the status of the stock; • Stocks in the healthy zone can be fished at F_{MSY}, while stocks in the cautious zone are fished at rate declining from F_{MSY} to $0.5 F_{MSY}$ at the LRP; • Stocks below the LRP are subjected to fishing at $0.5 F_{MSY}$, which means declining harvest as the stock declines below the LRP; • These rules permit fishing to continue at declining levels as a stock declines below the LRP in the critical zone; presumably this approach is consistent with the principle that "... the level of exploitation on a given stock (if any) be consistent with the recovery of that stock during the period of the rebuilding plan" as specified in the PA Framework. How this level of fishing pressure was determined is not clear from the available documentation but may be in some of the documents that are cited as 'in prep' in Bourdages et al. (2022, 2023);
Monitoring Program:	• Monitoring of fishing activity and catches is maintained through mandatory use of a VMS, completion of log books, a dockside monitoring program that covers 100% of the landings, and an industry-funded observer program with a target coverage of at least 5% of fishing trips in each year; • All shrimp are landed for processing as fresh (iced) whole, shell-on, with the exception of one at-sea catcher/processor vessel;

	This vessel is subject to 50% observer coverage to mitigate concerns about high-grading or the discarding of small shrimp;
3. <u>Ecosystem and Environmental Impact</u>	
Bycatch Management:	- Technical conservation measures include a minimum mesh size (40 mm) and, since 1993, the compulsory use of the Nordmøre grate to reduce groundfish bycatch; - Protocol to limit small bycatch is also in place, particularly to limit the catch of small Redfish (<i>Sebastes</i> spp.), Atlantic Cod and Greenland Halibut; - Data collected by at-sea observers shows that, on average, bycatch weight represents approximately 2% of the total Northern Shrimp catch; - Main bycatch species in 2025 were, in order of importance, Greenland halibut, Capelin, Herring, American plaice, Redfish and Witch Flounder; - Estimated total catches for each of these species represented less than 1% of their estimated relative biomass during the EGSL ecosystem survey;
Ecosystem Impacts:	- Predation pressure from Redfish (<i>Sebastes</i> spp.) has been high over the last nine years and is considered a key factor contributing to the decline of this species; - Spatial overlap between shrimp and Redfish varies across stocks: it is currently low for Estuary and Sept-Îles stocks, while it is greater for Anticosti and Esquiman stocks; - Redfish biomass has been declining since 2020, but predation pressure is expected to remain at historically high levels in the coming years; - Although the Sept-Iles, Anticosti, and Esquiman stocks remain in the critical zone, an improvement in their status was observed in 2025; this improvement could be attributed in part to decreased predation by Redfish and reduced fishing pressure;
Habitat Impacts:	11 conservation areas (8,571 km²) are closed to bottom trawling to protect coral and sponge habitats; - Trawl footprint has decreased from 15,000 km² in the early 1990s to about 10,000 km² by 2022, which may mean that the impact of the fishery on habitat has declined during this period;
Climate Effects:	Northern Shrimp in the EGSL have experienced warming waters and a decrease in dissolved oxygen (DO) in its habitat for over 15 years, exposing a portion of these stocks to environmental conditions approaching the tolerance limit of the species and have likely affected stock productivity;

	• These changes have led to a shift in the distribution of the Estuary and Sept-Iles stocks, where the shrimp now occupy grounds in shallower waters than previously observed; these waters are colder and more oxygenated; • No changes in distribution based on depth have yet been observed for Anticosti and Esquiman stocks; these stocks continue to be exposed to warmer, low oxygen conditions; • Deep water temperatures have stabilized over the past three years, but these conditions are predicted to continue to deteriorate in the long term according to different climate change scenarios and lead to a decrease in suitable habitat for Northern Shrimp;
4. <u>Performance and Sustainability</u>	
Certification:	• EGSL shrimp fishery was certified by the MSC in 2008 (SFAs 9, 10 and 12) and 2009 (SFA 8);
Economic Viability:	• Due to the critical status of most stocks, DFO has set significantly reduced harvest projections for the 2026 season based on the Precautionary Approach; • New flexibility measures (100% quota transfers) were introduced for 2024–2025 to help the fleet adapt to stock declines;
5. <u>Source Documents</u>	
• Bourdages et al. (2022); Bourdages et al. (2023); DFO (2026d); DFO (2026e); LRQA (2023); Smith and Bourdages (2024); DFO (2023);	

Appendix 3 - Eastern Scotian Shelf Shrimp Trawl Fishery

1. Fishery Overview	
Target Species:	• <i>Pandalus borealis</i> (Northern Shrimp)
Stock Structure:	• The Northern Shrimp stock (SFAs 13-15) is a management-based stock unit based on historical fishing boundaries; • Surveys focus on the core shrimp habitat and are considered to more closely represent a single biological unit on the Scotian shelf; • Genetic studies show genetic differentiation (i.e., limited gene flow) between NL, SS and the Gulf of St. Lawrence supporting the conclusion that these bioregions harbour separate and distinct stocks;
Location:	• Shrimp Fishing Areas (SFAs) 13-15, along the northern half of the east coast of NS and around Cape Breton Islands; • Trawl fishing activity from 2010 to 2020 has been greater on grounds where water depths are approximately 175 to 320 m;
Fleet:	• Three fleets: Scotia and Gulf mobile fleets and a Scotia trap fleet; vessels in the Gulf fleet are > 65-100 ft in length while vessels in Scotia fleet are < 65 ft in length; • 56 licences distributed across 3 fleets: 28 in the Scotia mobile fleet, 14 in the Gulf mobile fleet, and 14 in the Scotia trap fleet; • FN own 15 licences in the Scotia mobile fleet and 1 in the trap fleet; • No changes in the number of licences since 2005;
Gear:	• Mobile fleet: otter trawl gear with mandatory Nordmøre grate to reduce bycatch and 40 mm minimum mesh size; • Trap fleet – 100 traps per licence; • Mobile sector fishes primarily in April and May, but in recent years the Gulf fleet has been fishing in July and August; • Trap sector fished historically from July to April or May of the following year (1996–97 to 2001). In recent years, fishing has occurred mostly in late-October or early-November to March; trap fleet has not fished in the last few years because of low demand for trap-caught shrimp;
Economic and Social Context:	• Scotian Shelf shrimp fishery is small, representing less than one percent of landed value in the Maritimes Region; • Fishery provides important economic benefits to harvesters along the eastern shore of mainland Nova Scotia, south-eastern Cape Breton, and in the southern Gulf of St. Lawrence. It also

	generates significant benefits to the coastal communities where the shrimp is landed and processed; • Landings from the fishery have fluctuated over the last two decades, reaching a peak of 5,454 t in 2000 before decreasing to just under 2,800 t in 2003, and rising again to approximately 5,000 t in 2010. Landed value peaked at \$12.0 million in 2000, followed by a steady decline to an estimated landed value in 2010 of approximately \$4.8 M; • For the 2001 to 2010 period, the average landed price reported for shrimp in the Scotian Shelf fishery reached a high of \$2.26/kg in 2002, after which price declined significantly; • Average price from 2006 to 2010 was approximately \$1.03/kg. Pressures that are likely to have contributed to the price decline include an increase in the global supply of shrimp and a strong Canadian dollar; • Because quotas closely mirror fluctuating ocean conditions, processing plants face direct, immediate employment challenges when TAC cuts are implemented;
History:	• The ESS Northern Shrimp fishery in shrimp fishing areas (SFAs) 13–15 began in the late-1970s, but was underutilized because of non-selectivity of the gear, i.e., fishers were unable to operate within allowable groundfish bycatch limits; • Fishery expanded with the introduction of the Nordmøre grate in 1991, which reduced bycatch restrictions; • In the mid-1990s, a trap fishery was established in inshore areas (stratum 17 on maps) resulting in both mobile and trap fleets; • All mobile licences (28 Maritimes and 14 Gulf licences) have been managed under Individual Transferable Quotas (ITQs) since 1998; • The Total Allowable Catch (TAC) was first reached in 1994, when individual SFA quotas were replaced with an ESS region-wide TAC; • TAC allocations set in 1999 to 90% mobile and 10% trap and were revised to 92% and 8%, respectively in 2005; • Annual negotiations occur for the transfer of uncaught trap quota to the mobile fleet; • Industry-funded port sampling program to collect monthly samples from commercial catch established in 1995; • Fishery-independent trawl survey was initiated in the mid-1990s;
2. <u>Stock Status and Science</u>	
Stock Assessment Framework:	• A new science framework was established in early 2025 to evaluate stock health using a spatio-temporal delay-difference

	model rather than the Traffic Light Approach, TLA (see McDonald et al. 2025); • Model captures spatial dynamics in the underlying population dynamics and estimates, SSB, total biomass, recruitment and exploitation indices project total biomass estimates for the upcoming year to evaluate the effect of different harvest levels on stock status, exploitation rate and changes in SSB; • Although a relationship between total biomass and fishing mortality was identified by the model, the impact of fishing on the stock becomes confounded with higher natural mortality caused by environmental changes; • Assessment is based upon both fishery-dependent and fishery-independent data; • McDonald et al. (2025) also recommended changes to the TLA, which incorporates 21 indicators of abundance, production, fishing effects and ecosystem derived from the survey/model, snow crab survey and a summer ecosystem survey along with satellite SST to qualitatively inform risk assessment for this stock; • Range of each indicator is categorized into good, cautious and bad for shrimp and used to provide additional context for the health of the stock and inform adaptive TAC adjustments by tallying up the number of indicators in each zone; • DFO-Industry collaborative fishery-independent survey has been conducted since 1995 using a commercial vessel and standardized survey protocols; • Survey uses a stratified random station design, with four strata (areas) and 15 stations in each stratum (at depths > 85 fathoms); in Stratum 17 (inshore area), station selection is based on presence of LaHave clay bottom sediment; • Conducted during daylight hours (shrimp near the bottom) in June annually and focuses on covering the four holes in which shrimp aggregate rather than the overall range; • Uses area-swept method to estimate stock biomass; • Also use data on sympatric species (e.g., Atlantic Cod, Greenland Halibut) in ESS shrimp areas from ecosystem surveys and from the Snow Crab survey to develop predator indices; • Length frequency data are used from both the survey and commercial port samples; • Recruitment of shrimp is quantified via a belly bag attached to the footrope and net belly that captures shrimp < 12mm
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	carapace length; this net has been used since 2002 as an index of recruitment, but data quality prior to 2005 is uncertain;
Stock Dynamics:	• ESS shrimp stock dynamics are driven primarily by environmental factors such as water temperature and predator abundance; • ESS shrimp are at the southern edge of the species distribution and therefore may be more vulnerable to sudden changes in environmental factors;
Biomass Indices:	• Model-estimated SSB in 2025 is 13,365 t, which is an 11.3% increase relative to 2024, the second annual increase in a row, following large annual decreases from 2021 to 2023; • Model-estimated total biomass in 2025 is about 25,000 t, which is an 18.9% increase relative to 2024 and the second annual increase in a row, following large annual decreases from 2021 to 2023; • Model-estimated recruitment in 2025 is about 800 t and represents a 47.7% decrease relative to 2024, but remains above the long-term average (2005-2025);
Reference Points:	• McDonald et al. (2025) recommended an LRP and USR based on an historical proxy of B_0, defined as the model-estimated maximum SSB observed, which means it will shift slightly each year; • LRP = 20% of model-estimated maximum SSB from 2005 to 2025; • USR = 50% of model-estimated maximum SSB from 2005 to 2025; • Maximum SSB = ~39,912 t in 2010; • LRP = 7,982 t; USR = 19,956 t in 2025 ;
Stock Status:	• Model-estimated SSB was of 13,365 metric tonnes (t) in 2025, which was above the LRP and below the USR, placing the stock in the Cautious zone; [probabilities are not calculated or given in the available literature]
Catch Data:	• Catch peaked at > 5,000 t in 2000, declined to below 3,000 t in 2004 and then rose to around 4,000 t annually through 2015; catch and effort have decline substantially since 2015, especially after 2022; • 2025 catch was approximately 673 t and effort (hours fished) is the lowest on record since 1991; • Most catch has occurred historically in SFA 14 and secondarily SFA 15; More than 90% of 2025 catch is from SFA 14; • 8 licences in the Scotian fleet were active in 2021 and 7 in 22; • 7 licences in the Gulf fleet were active in 2021 and 8 in 2022; • In 2025, effort was reduced further to 10 vessels; the trap fleet ceased operating after 2022;

3. Management and Governance

Management Framework:	• Fishery is managed using TACs and is limited entry fishery; • All trawl licences have been under Individual Transferable Quotas (ITQs) since 1998; • TAC in SFA 13-15 is distributed as three units with quota shared between the Scotia mobile fleet (69.5%), the Gulf mobile fleet (22.5%) and the shrimp trap fleet (8%); • Quota is transferable between vessels and fleets but arrangements can only be made on a seasonal and temporary basis; • Trap fleet quota is redistributed amongst the mobile fleets while the trap fleet is inactive; • In SFA 13-15, the mobile fleet holds 92% of the TAC, split 25%:75% between the Gulf-based vessels and Maritimes-based vessels; • Trap fleet has 8% of the TAC, which is fished competitively; trap fishing ceased after the 2022 season; • The 2025 fishing season exhibited the lowest fishing effort since introduction of the Nordmøre grate in 1991, although it exhibited a substantial increase in commercial CPUE compared to 2024; • Low effort and increased CPUE coincided with the second lowest TAC (i.e., 700 t) set for the fishery since 1991; • The 2025 TAC resulted in only eight active licences (all fleets combined) and resulted in port sampling yielding 20 samples which is well below the 50 sample target for the fishery; only 20 samples were collected in 2024 as well;
Total Allowable Catch (TAC):	• A range of catch scenarios up to 900 t were conducted for the 2026 fishing season decision tables; • All scenarios exhibited probabilities > 99% that the SSB will remain above the LRP and probabilities of < 1% that the SSB will increase above the USR; • TAC increased to 700 t in 2025 from 500 t in 2024, with 2025 exhibiting the second lowest exploitation rates on the total population and on the female population since 2005; • Catch of 700 t in 2026 would correspond to an exploitation rate of 2.8%, which is projected to result in a 0.7% decrease in total biomass and a probability of stock decline of 51.9%;
Harvest Control Rules (HCR):	• Healthy zone: maximum of 20% of the SSB harvested; • Cautious zone: gradual decline in the rate of removals; • Critical zone: no removals;
Monitoring Program:	• Logbook data (catch, effort, location) are available from 1993 to the present;

	• 100% dockside monitoring of the trawl fleet began in 1994 and the trap fleet has had 20% dockside monitoring since it began in the mid-1990s; • Catch samples from every trawl tow are analyzed for length (carapace), weight, sex, sexual development and presence of roe; • Trap samples collected monthly and annually - all trap samples and 50 trawl samples are analyzed; • Bycatch data from 2013 to 2023 are from observer coverage of 16 mobile sector trips (194 tows), resulting in coverage of 3 or fewer trips per season across SFA 13-15 or between 0 and 2.6% of mobile fishing hours. • Trap sector observer sampling initiated in 2018 to provide bycatch information for the inshore region; little activity in the trap sector since 2020 so no more observed trips; • Licence holders in SFA 13-15 contribute financially to the science program, and a joint project agreement guides the conduct of the annual shrimp survey; • 100% monitoring of landings through the Dockside Monitoring Programme (DMP) for the trawl fishery, with a target of 20% coverage for the trap fishery, although in recent years prior to the lack of fishing activity in 2021 and 2022, the coverage rate averaged 35-40% in the trap fishery; • Trawl fishery is subject to up to 5% at-sea observer coverage and electronic VMS is mandatory; • Vessel landings are recorded and an additional record is provided through a shrimp weighout slip completed by the buyer; • All vessels must complete and submit log books on a trip-by-trip basis from which a standardized (Scotia fleet) and unstandardized (Gulf fleet) CPUE series are estimated; • Observer programme provides information on CPUE and size and sex composition of the shrimps in both trawl and trap fishery catches, although the trap fishery has virtually ceased to operate in 2021 and 2022; • Approximately 50 port samples are collected annually from the trawl fishery for size, sex, and egg developmental stage; samples for biological characteristics are also collected annually from the trap fishery when it was operational;
4. <u>Ecosystem and Environmental Impact</u>	
Bycatch Management:	• Nordmøre grate with minimum bar spacing of 25 mm is mandatory in trawl gear;

	• Bycatch, on average, accounts for 1% of catch since 2013 with three most common species being Atlantic Herring (0.31%), Silver Hake (0.18%) and Alewife (0.1%); • Observer data support the conclusion that trawl configurations, including use of Nordmøre grates, continues to minimize bycatch; • Bycatch data for trap sector is limited to 3 years and amounts to < 1% of total catch; Snow Crab was most common bycatch by weight;
Ecosystem Impacts:	• Northern Shrimp survival is strongly linked to temperature and predation pressures, both of which can be highly variable spatially and temporally; • Northern Shrimp has substantial value as a forage species, so the fishery must not threaten conservation of other species for which Northern Shrimp is an important food source; • Northern Shrimp populations are strongly influenced by various environmental and ecological factors. These factors include ocean currents, temperature, depth, dissolved oxygen, salinity, habitat specifications, and prey-predator dynamics; • Predation indicator (TLA analysis), which is an indicator of groundfish and finfish abundance increased relative to 2024 value and is at its highest level in the time series (1995–2025); • In contrast, the Cod, Turbot, and American Plaice Predation indicator, which is an indicator of abundance for these three species specifically within areas of higher shrimp densities in the Shrimp Fishing Areas, only slightly increased in 2025 relative to 2024 and is near its historical low in the time series (1995–2025); • Shrimp are a vital prey species for groundfish like cod; management set a Limit Reference Point (LRP) to ensure shrimp abundance remains high enough to support groundfish recovery;
Habitat Impacts:	• Impact of the fishery on sensitive benthic areas is well known; Coral and sponge reef areas are closed to fishing along with other sensitive areas and MPAs; • Compliance is monitored through reports on fishing activity generated as often as daily;
Climate Effects:	• Bottom temperatures observed during the 2025 trawl survey increased relative to slightly lower temperatures observed from 2023 to 2024, and remain high compared to the time series (1995–2025); • Warm bottom temperatures are believed to have a negative impact on the ESS Northern Shrimp stock • Spring SST in 2025 decreased relative to previous years, potentially indicating more favorable conditions for early recruits, but remain high compared to the time series (1995–2025);

	The stock is highly sensitive to water temperature changes; cooler conditions generally lead to slower growth but longer life spans and larger maximum sizes;
5. <u>Performance and Sustainability</u>	
Certification:	- ESS Shrimp trawl fishery was first certified as sustainable by the Marine Stewardship Council in August 2008; the inshore trap fishery was added to the certification in 2014 and in September 2022 the trap fishery was withdrawn from the certification owing to poor market conditions for trap caught shrimp; - As of November 2024, the trawl fishery client implemented a self-suspension from certification due to changing climatic conditions affecting stock productivity and survival;
Economic Value:	- Because of high fishing costs and relatively low prices, shrimp fishers search out areas with the largest <i>P. borealis</i> and the highest catch rates, mainly in depths from 150 - 400 m; - Catch rates are usually lowest at night and highest during the day.
6. <u>Source Documents</u>	
DFO (2025a); DFO (2026); Hardie et al. (2018); LRQA (2023b); McDonald et al. (2025)	

Appendix 4 - Newfoundland and Labrador Shrimp Trawl Fishery

1. Fishery Overview	
Target Species:	Northern Shrimp, <i>Pandalus borealis</i>; secondarily Striped Shrimp (<i>Pandalus montagui</i> – not covered by this review);
Stock Structure:	One biological unit but two separate stocks of Northern Shrimp in the Northern and Southern Assessment Regions;
Location:	- Fishing occurs in Shrimp Fishing Areas (SFAs) 4,5, and 6 along the Labrador Shelf and Northeast Newfoundland Slope, from the Flemish Cap, northern edge of the Grand Banks to Baffin Bay/Davis Strait; - Within this area are closures related to the protection of coral habitats and sensitive spawning/nursery areas of commercially important species such as Turbot, Snow Crab, and Atlantic Cod are enforced; MPAs and EBSAs are also closed to bottom contact gear;
Fleet:	- Offshore fleet (17 licences) consists of 6-10 active factory freezer trawlers > 100 ft and > 500 t in size; - Fishing trips in the offshore fleet last 20-75 days, with 9-12 trips per year and 300-320 sea days annually; - Inshore fleet (about 260 vessel-based licenses) in NFLD and Quebec is composed of vessels < 100 ft in length and < 50 t in size; - Trip limits and harvesting caps for NL inshore vessels are determined and regulated by the industry. - Various special allocation holders, including the Innu Nation and Nunatsiavut Government, are part of the inshore fleet component of this fishery and fish in the WAZ and EAZ areas;
Gear:	- Otter trawls on both smaller inshore and larger offshore components of the fleet equipped for bottom contact; - Minimum mesh size of 40 mm in nets;
Economic and Social Context:	- Offshore fleet produces size-sorted, cooked and frozen-at-sea product packaged for export to global markets; - Implementation of Chinese tariffs in 2025 has resulted in a shift to raw, frozen product for new markets to replace the share lost because of Chinese tariffs; - Inshore fleet typically lands fresh shrimp to be processed (peeled, cooked, frozen) by onshore processors; some catch is frozen at sea but it is not a large component; - Offshore fleet operates year-round and further north than the inshore fleet and have home ports in NFLD and NS; they provide employment to large crews; additionally, servicing of vessels and

	shipping of product provide benefits to home ports; occasionally land product in Greenland; • Inshore fleet is based in coastal communities of NL and Quebec and provide economic benefits for crews and through land-based processing and shipping as well as vessel services.
History:	• Fishery began in SFA 5, off the coast of Labrador in the mid-1970s, primarily in Hopedale and Cartwright Channels; • Fishery expanded into SFAs 4 and 6 when fishable densities of Northern Shrimp were identified in these areas; • Fishery expanded outwards towards the edge of the continental shelf in SFAs 4-6 during the early 1990s, with associated TACs periodically increased over the next 2 decades; • Management year was changed from calendar year to fiscal year (Apr 1 – Mar 31) in 2003; • A bridging programme allowing each licence holder to carry over unused quota from the previous year or borrow from next year's quota was established for the offshore fleet in 2007 and the inshore fleet in 2012-2015; • Striped Shrimp is taken as bycatch in SFA 4 Northern Shrimp fishery; a bycatch limit of 4,033 t was implemented in 2013, along with better reporting of catches in the quota management system; • Striped Shrimp in SFA 4, EAZ and WAZ are assessed separately from Northern Shrimp and are the target species for many of the special allocation arrangements previously identified; • SFAs 4-6, EAZ and WAZ were managed for Northern Shrimp independently of each other up until 2024 when the assessment was revamped to provide advice on stock status in two assessment regions (combining 6 SFAs) and a new LRP was implemented.
2. <u>Stock Status and Science</u>	
Stock Assessment Framework:	• Six SFAs off the east coast of NL, Quebec and Nunavut (Baffin Island) were revised into two new stock assessment regions (North and South) in 2024 to provide harvest advice for Northern Shrimp, moving away from assessing individual SFAs; revision based on analysis by Baker et al. (2025) showing that there was a northern and southern cluster of shrimp using biological traits and updated genomic and larval dispersal patterns; • A new Bayesian size-structured stock assessment model (SISCALS - Spatially Integrated Statistical Catch-at-Length/Size) was implemented in 2025. This model incorporates fishery and survey biomass indices from spatiotemporal modeling and size composition data to estimate trends in Northern shrimp biomass,

	recruitment, natural mortality rates, and stock status for each stock assessment region. It also better accounts for larval dispersal between areas. • Fishery-independent surveys are conducted by DFO in the fall in some areas and in the summer by Industry in other areas; • Projections of SSB for NSAR and SSAR under constant exploitation rate scenarios ranging from 0 to 30% and including current exploitation rate, are conducted to evaluate the effect of harvest on stock status; • While stock status is determined for each SAR, harvest advice is provided at the SFA scale;
Stock Variability:	• Drivers of change are poorly understood: there is no evidence that fishing significantly influences stock abundance; it is believed that environmental factors, particularly oceanographic conditions, drive stock variability through effects on larval dispersal and rates of exchange between SFAs within the fishery (DFO 2024); • Predation and food chain impacts on shrimp variability are poorly understood, but may be drivers of change as well;
Biomass Indices:	• NSAR (North): Fishable biomass for 2024 was 185,200 t, a 19.7% decrease from 2023; • NSAR SSB was 177,800 t in 2024, a 56% increase relative to 2023, but below the long-term mean (1996-2023: 207,900 t); • SSAR (South): Fishable biomass for 2024 was 92,300 t, a 20.8% decrease from 2023 and the lowest on record; • SSAR SSB was 134,700 t in 2024, an increase of 2.2% relative to 2023, but far below the long-term mean (1996-2023: 707,500 t);
Reference Points:	• Reference points are defined based on a B_{MSY}-proxy for each SAR; the B_{MSY}-proxy = $0.4 \times B_0$; • LRP for each SAR is $0.5 \times B_{MSY}$-proxy; • USR proposed for each SAR is $0.8 \times B_{MSY}$-proxy. • The LRP has been accepted and implemented in the 2024 assessment while the USR remains proposed at this time (DFO 2025); • The use of B_0 rather than B_{MSY} is based on the idea that B_{MSY} assumes that fishing is the primary driver of change and variability in stock abundance; there is no evidence of this relationship; • B_0 is estimated as the geometric mean of female SSB index during a reference period in each SFA; the reference periods are intended to represent the most productive conditions in each SFA but differ in length: 1996-2003 in SFA 6, 1996-2001 in SFA 5 and 2005-09 in SFA 4 (Le Corre et al. 2026);
Stock Status:	• 2024 Northern Shrimp SSB in NSAR is estimated to be above the LRP with > 99% probability and if the proposed USR was

	adopted, then the stock is in the Healthy Zone with a 99% probability; • 2024 SSB in SSAR is above the LRP with > 99% probability and would be in the Healthy Zone with 98% probability if the USR was adopted;
Catch Data:	• Catch has ranged between 25,867 and 44,604 t in the NSAR between 2015/16 and 2023/24 and between 7,283 and 53,304 t in the SSAR over the same period; • Total catch in 2024/25 in NSAR was 29,083 t (73% of TAC) and total catch SSAR was 7,237 t (68% of TAC). • TAC usage in NSAR ranges between 85 and 99% from 2015/16 to 2019/20 and is mostly less than 87% since 2020/21; • TAC usage in SSAR is above 90% for most of the time series, including two overages in 2015/16 and 2017/18, but has declined below 95% since 2023/24;
3. <u>Management and Governance</u>	
Management Framework:	• Stocks are managed by TAC in each SFA within the two stock assessment areas established for the 2025 season and percent shares are used to allocate TAC to different sectors in SFAs in the SARs; • Assessment and status determination are conducted at the SAR level and advice on TAC is provided at the SFA level for management purposes; • This system identifies shares of the TAC in each SFA allocated to the offshore and inshore fleets and special allocation holders in specific SFAs, including Indigenous organizations; • Offshore fleet is managed by quota (called Enterprise Allocation, EA) in each SFA, which is allocated equally to each of 17 licence holders (not vessels) and can be transferred among EA licence holders; • Inshore fishery in NL and Que is competitive and continues until quota is filled or the season closes the fishery; NL vessels are managed by trip limits and caps since 1997 regulated by Industry; • Limited entry fishery; no new licences available; • Only those holding a licence in the previous year are eligible for renewal in the current year;
Total Allowable Catch (TAC):	• Fishable biomass consists of shrimp (male and female) which have a carapace length > 17 mm; • TAC decisions for 2025-26 fishing season (relative to 2024-25 season) are: • Eastern Assessment Zone: Increased by 11.4% to 2,469 t for <i>P. montagu</i>, and increased by 12.8% to 9,600t for <i>P. borealis</i>;

	• Western Assessment Zone: Decrease by 2.8% to 14,95 6t for <i>P. montagui</i> and decrease by 14.4% to 3,584 t for <i>P. borealis</i>; • SFA 4: Increased by 4.3% to 16,220 t for <i>P. borealis</i> and <i>P. montagui</i> bycatch limit remained at 4,033 t; • SFA 5: Decreased by 3.3% to 12,208 t for <i>P. borealis</i>; • SFA 6: Increased by 50% to 13,363 t for <i>P. borealis</i> to support the inshore fleet;
Harvest Control Rules (HCR):	• Managed under a Precautionary Approach (PA) framework, with specific harvest rules for each stock zone (Healthy, Cautious, Critical); • Healthy Zone: base target exploitation rate of 15% of fishable biomass; should not exceed F_{MSY}, which has not been estimated for these stocks, but is believed to be well above the base target rate; Changes in TAC should not exceed 15% of the previous TAC unless stock decline is steep; • Cautious Zone: if SSB is in the upper half of the zone, then exploitation rate should not exceed $\frac{2}{3} F_{MSY}$; if SSB is in the second lowest quadrant of the zone, then exploitation rate should not exceed $\frac{1}{2} F_{MSY}$; and if SSB is in the lowest quadrant of the zone, then exploitation rate should not exceed 15% of exploitable biomass; TAC should not increase if SSB is projected to decline or is in a declining trend; • Critical Zone: when SSB is below the LRP, then measures must be implemented to promote rebuilding above the LRP within 6 years; Any fishing mortality must be in the context of a rebuilding plan and should not exceed 10%; • As specified, these harvest control rules leave room for negotiation of final exploitation rates in all status zones; these negotiations will be based on factors other than the science, particularly in the Critical zone where the use of socio-economic criteria might not be appropriate for stock health;
Monitoring Program:	• Offshore fleet is required to have 100% observer coverage to monitor bycatch, discarding and high grading, gear restrictions, area and closed time restrictions and collect data on size composition of the catch, catch weight by species, effort, by-catch composition, etc. • Inshore fleet is monitored through dockside sampling of landed catch; Dockside monitoring is conducted on all landings and biological samples are collected to determine length frequency, sex and weight of catch; • A target of 10% observer coverage was established for the inshore fleet, but coverage has been well below this level over the last decade;

	• Offshore fleet is not subject to dockside monitoring because they have 100% observer coverage; • Logbooks and fish slips are also required to be submitted. • VMS is mandatory for all vessels in both fleets;
4. <u>Ecosystem and Environmental Impact</u>	
Bycatch Management:	• Mandatory use of Nordmøre grates to reduce groundfish bycatch; maximum grate spacing for inshore vessels is 22 mm; maximum spacing for the offshore fleet is 22 mm in outside waters (NAFO areas) and 28 mm in Canadian waters. • Juvenile Redfish (<i>Sebastes</i> spp.) are the most common bycatch species, with Arctic Cod, Greenland Halibut, Eelpouts, Thorny Skates, Lanternfish and Sculpins also reported; • Licence conditions prohibit the retention of SARA species identified as endangered or threatened, which includes Northern Wolffish and Spotted Wolffish; these species are rarely encountered; • If incidental catch of groundfish in any tow is > 2.5% or 100 kg total, then vessel must change position by at least 10 nmi; • If total bycatch of Capelin in any tow is > 5 t or 10% of shrimp catch weight, then the vessel must use active avoidance measures to reduce Capelin bycatch;
Ecosystem Impacts:	• Northern Shrimp is a key forage species for a variety of predators; dependence on shrimp as prey is related to the availability of alternate prey sources; • Management of key forage species such as shrimp, under an ecosystem approach, requires adoption of conservative approach with lower fishing mortality and higher biomass reference points than those that would be adopted under single-species management approach – the current standard; • Northern Shrimp productivity is heavily influenced by increasing groundfish (e.g., Atlantic Cod) predation as the ecosystem shifts from shellfish to finfish dominance;
Habitat Impacts:	• This fishery uses bottom contact gear, which will have an impact on benthic populations, communities and habitats. • Several areas have been closed to bottom contact gear to address sensitive benthic habitats such as corals, sensitive benthic spawning or nursery habitats for finfish, and areas identified as vulnerable marine ecosystems, MPAs and ecologically and biologically sensitive areas (EBSAs); • Depending on the fleet, compliance with these closures can be verified with VMS data and observer reports;

	No formal assessment of the impacts on trawled area exists and the annual trawl footprint is unknown, but is not frozen;
Climate Effects:	Summer ocean bottom temperature were average to above average in the NSAR and record high sea surface temperatures were noted in the SSAR in 2024; these high temperatures may negatively impact future recruitment;
5. <u>Performance and Sustainability</u>	
Certification:	Certified by the Marine Stewardship Council (MSC) since 2011; current certificate expires in June 2027;
Economic Value:	- Landed value in NL for 2025 was approximately \$139.8 million from 28,285 tonnes of catch; - The industry produces over \$300 million CAD in annual exports, supports around 700 jobs in NL, and sustains roughly 2,000 additional shore-based positions in coastal communities;
6. <u>Source Documents</u>	
Baker et al. (2025); DFO (2018); DFO (2024a); DFO (2025, b, c, d); DFO (2026g); LRQA (2026)	

Appendix 5 – Barents Sea Coldwater Prawn Trawl Fishery

1. Fishery Overview	
Target Species:	• <i>Pandalus borealis</i> (Northern Shrimp or Cold Water Prawn)
Stock Structure:	• Barents Sea including Spitsbergen; a single stock is considered in the Barents Sea and on the Svalbard fishery protection zone (SFPZ) (ICES 2022);
Location:	• Primarily in the Barents Sea and the Svalbard fishery protection zone, ICES Divisions I and II; • Norwegian logbook data show decreased fishing activity in the central Barents Sea since 2008, coupled with increased effort further east in international waters in the “Loop Hole”. Information from the industry points to higher densities of shrimp in this area and area closures in the traditional central basin due to bycatch of juvenile fish as the main reasons for the change in fishing pattern. In recent years, several fish stocks have increased substantially in the Barents Sea and as a consequence bycatch restrictions (area closures) have had an increasing effect on the distribution of the shrimp fishery; • Main fishing grounds of Russian vessels have moved eastward near the coastal waters of the Novaya Zemlya Archipelago at the same time as Norwegian fishing shifted;
Fleet:	• Norway (roughly 40-75%+), Russia, EU, Greenland, and Iceland; • The Barents Sea stock is exploited by the Norwegian and Russian fleets, while other vessels (Greenland, Iceland, the UK, and EU) are restricted to the SFPZ and “Loop Hole”; • The Barents Sea Loophole is a high seas pocket located between the EEZs of Norway and Russia; the regional management regime between Norway and Russia does not cover this area; • The Norwegian fleet underwent a restructuring in the 2010s, resulting in fewer large trawlers (>28 m in length) operating offshore and a much smaller group of coastal vessels (< 21 m) operating inshore; traditional vessels used single trawls, but by 2010, about 90% of the fleet was using multiple trawls; • 31 Norwegian vessels in the offshore fishery in 2024, all using double or triple trawls; very little catch in 2024 by coastal fleet; • Russian vessels of 34-65 m in length target shrimp in the Barents Sea and comprise the largest portion of the fleet, with smaller vessels (<34 m) operating inshore; • Five (5) Estonian vessels with an average length of 64 m operate in the SFPZ targeting Northern Shrimp;

	• Four vessels between 50 and 80 m in length from the Faroe Islands also target shrimp in the SFPZ; • Greenland has one vessel 66-88 m in length targeting Northern Shrimp; • Lithuania has two trawlers > 40 m in length targeting shrimp; • Additionally, the Faroe Islands, through bilateral agreements, is allowed to fish under Russian jurisdiction, the SFPZ is under Norwegian management, and the Loop Hole is under NEAFC jurisdiction (Addison et al. 2023);
Gear:	• This fishery is offshore so large factory trawlers fishing bottom gear equipped with rock hoppers on the footrope and mandatory Nordmøre grates to reduce bycatch are employed; • Most vessels are single net, but an increasing number are double and triple rigged; • Minimum mesh size is 35 mm stretched; codend mesh is 44 mm;
Economic and Social Context:	• The fishery is primarily driven by economic conditions and market demand rather than quotas, as the stock has remained robust under current fishing pressure; • A significant portion of the product (sorted, cooked and frozen) is exported to the UK and Japan.
History:	• Norwegian vessels initiated the fishery in 1970. As the fishery developed, vessels from several nations joined and landings increased rapidly; • Catches peaked in the 1983-85 period, averaging 119,119 t per year, with highest annual catch in 1984 of 128,062 t; • Following the peak catches, there was a decline followed by a rebound in the early 1990s, then a second decline and rebound around 2000; • Catches underwent a long slow decline to 2013, when 19,651 t were caught, the lowest in the time series since 1977; this decline was partly due to a downturn in market prices for shrimp products and higher prices for groundfish (meaning it was more profitable to fish for groundfish), and a major restructuring of the Norwegian fleet towards fewer and larger vessels; • Norwegian vessels accounted for around 46-92% of the total catches in that period and Russia, Iceland, Greenland and the EU for the rest; • Catches have recovered since 2013 and in 2024 peaked at 95,163 t; Norwegian vessels are responsible for about 1/3 of these catches; • In the Barents Sea, annual catches have fluctuated between 20,000 and 130,000 tonnes since the late 1970s. Norway and Russia fish on this stock, together with third party countries

	(mainly from EU). The fishery is mainly carried out by large trawlers; • The fishery takes place throughout the year but can be seasonally restricted by ice conditions. Fishing activity occurs generally in March to October, with peak activity in May to August; • The fishery was previously conducted mainly in the central Barents Sea and on the Svalbard Shelf along with the Goose Bank (southeast Barents Sea). Norwegian logbook data since 2009 show decreased activity in the Hopen Deep and around Svalbard, coupled with increased effort further east in international waters (the “loophole”); • Information from the Norwegian industry points to decreasing catch rates and more frequent area closures due to bycatch of juvenile fish on the traditional shrimp fishing grounds, as well as economic causes as a result of fuel taxation, as the main reasons for the observed change in fishing pattern;
2. <u>Stock Status and Science</u>	
Stock Assessment Framework:	• The stock in the Barents Sea and Svalbard area (ICES Subareas I and II) has always previously been assessed along with other Northwest Atlantic Fisheries Organization (NAFO) and International Council for the Exploration of the Sea (ICES) stocks by the joint NAFO/ICES Pandalus Assessment Group (NIPAG); • Russian scientists are no longer permitted to attend ICES Working Groups due to the war in Ukraine and as a result NIPAG have not assessed the stock since 2021; • Despite the lack of a NIPAG stock assessment, an alternative bilateral working group was convened in recent years consisting of IMR scientists from Norway and PINRO scientists from Russia who carried out annual stock assessments and provided annual catch advice; • In 2025 following disagreements between Norway and Russia (as outlined above), the stock assessment of the Barents Sea shrimp fishery was carried out by IMR scientists alone (Zimmermann et al. 2026). Based on the IMR stock assessment, catch advice was provided in an IMR report (IMR 2026). Although not formal ICES catch advice, the assessments and catch advice that were produced previously by the joint IMR/PINRO working group and by IMR alone in 2025 follow the methodology agreed at previous NIPAG meetings; • The stock assessment model used by NIPAG, the joint IMR/PINRO working group and by IMR alone in 2025 is a stochastic version of a surplus production model formulated in a

	state-space framework Surplus Production in Continuous Time (SPiCT); • The model synthesizes information from input priors including the initial population biomass in 1969, the carrying capacity (K) and Maximum Sustainable Yield (MSY), a series of shrimp catches and four independent series of shrimp biomasses (Zimmermann et al. 2026) to estimate trends in exploitable stock biomass, SSB, and F; • The available length data were used in the 2025 stock assessment to calculate recruitment (abundance of shrimp < 15 mm CL) and modeled with a GAMM including spatial and spatio-temporal random effects. • Standardized CPUE based on Norwegian logbook data provides a fishery-dependent index of stock density in fished areas and is indicative of shrimp > 15 mm CL, i.e., more than 1 year old (females and older males); • Historically, the logbook data represented fishing activity from most of the stock's distribution area. However, the fishery has contracted increasingly into a more limited area in the central Barents Sea in the last decade. Although in recent years the proportion of total catches taken by Norway has varied, it has remained between one third and more than half of the total catches; • Russian and Norwegian fishery-independent surveys were conducted in their respective EEZs of the Barents Sea from 1984 to 2002 and 1982 to 2004, respectively, to assess the status of the Northern Shrimp stock. • These surveys were replaced by the joint Norwegian-Russian Barents Sea Ecosystem Survey (BEES) in 2004, which occurs in Aug and Sept. This survey monitors shrimp along with a multitude of other ecosystem variables in the Barents Sea and around Svalbard; this index reflects trends in total stock biomass (since it includes shrimp < 15 mm CL) rather than exploitable biomass, but the difference is considered negligible; • A winter demersal fish survey (WS) has covered the ice-free parts of the Barents Sea in the beginning of the year since the 1990s, with the inclusion of the Russian EEZ since the 2000s. While designed to survey Atlantic Cod and Haddock, the winter survey observes Northern Shrimp on a large proportion of its stations and their catches were recorded consistently over the past two decades; • Fishery catches (1970-2025); two survey indices: the combined Norwegian and Russian shrimp surveys (1984-2002) and the Norwegian/Russian ecosystem survey (2004-2025); one fishery-
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	based index (standardized CPUE from Norwegian logbooks) (1980—2025); • Standardized CPUE index from the Russian fleet; recruitment and length indices from the Norwegian/Russian ecosystem survey (2004—2025) provide auxiliary indicators of stock development; • Short-term projections to evaluate catch scenarios and the probability of exceeding reference points are estimated;
Stock Dynamics	• Although temperature is a likely driver for stock dynamics and distribution, no relationship of temperature with observed catch rates or stock biomass could be found during analysis conducted at the benchmark assessment (ICES, 2022); • Reduction in biomass index values since 2020 and especially in 2025 (lowest in the time series) support the conclusion that fishing pressure is a driver of stock dynamics;
Biomass Indices:	• The aggregate Norwegian-Russian survey index prior to 2004 shows similar trends to the logbook generate CPUE index, although the fluctuations are larger; • The BESS index is out of phase with the CPUE index up until about 2020, after which both are in phase and show a steep decline in index values;
Reference Points:	• Four reference points are considered: $MSY B_{trigger}$ and F_{MSY}, representing the MSY approach, and B_{lim} and F_{lim}, representing the precautionary approach; • $MSY B_{trigger}$ is defined as 50 % of B_{MSY}, i.e., $B/B_{MSY} = 0.5$; • $B_{lim} = B/B_{MSY} = 0.3$ and $F_{lim} = F/F_{MSY} = 1.7$; • B_{MSY} and F_{MSY} are estimated directly in the model;
Stock Status:	• Exploitable stock biomass (B) was estimated to above B_{MSY} for the entire time series since 1970. The lowest biomass level in the mid-1980s occurred following some years with high catches. Since this time, the stock has varied but has remained above B_{MSY} although it shows a declining trend towards B_{MSY} since 2020 with an increasing probability that B is less than B_{MSY}; • The corresponding mean estimate of fishing mortality has remained below F_{MSY} throughout the history of the fishery, with only three periods during the 1980s, around 2000 and since 2018 that the estimates indicate a (low) probability of exceeding F_{MSY}; the probability of F exceeding F_{MSY} has been slowly increasing since 2020; • At the beginning of 2025, relative exploitable biomass (B/B_{MSY}) was estimated to be 1.39, with a <0.1 probability of being below $MSY B_{trigger}$ and B_{lim}. • At the beginning of 2025, the model estimates that relative F (F/F_{MSY}) is 0.64, with a probability of 23% that fishing mortality was above F_{MSY};

	• The model results show that relative exploitable stock biomass will decrease to 1.24 at the beginning of 2026, with a < 1 % probability that exploitable biomass will be below MSY $B_{trigger}$ at the beginning of 2026; • Based on these estimates, the stock is considered to be at safe or healthy levels and not depleted;
Catch Data:	• Catches have increased since 2017 to 95,163 t in 2024; • Predicted catch for 2025 was 70,606 t, although catch advice was $\leq 150,00$ t;

3. Management and Governance

Management Framework:	• Norway and Russia manage the stock separately, but national regulations have been harmonized between the two coastal states and are discussed at the annual sessions of the Joint Norwegian – Russian Fisheries Commission (JNRFC); • Although ICES provides annual quota advice for the Barents Sea stock based upon an MSY framework and provides probabilities that the stock exceeds key reference points such as MSY $B_{trigger}$ and B_{lim}, there is no overall management plan or joint total allowable catch (TAC) established for this stock; • In the absence of an overall TAC and HCR, key management regulation has been control on fishing effort, primarily through limits on licences and days fished, minimum landing size (> 15 mm CL), area closures when triggers for key stocks are exceeded and move-on rules, a partial TAC was implemented for the Russian Exclusive Economic Zone (EEZ) based on a Russian stock assessment, and technical measures to minimize capture of juvenile shrimps; • The above restrictions cover the Russian and Norwegian EEZs, and the SFPZ, but not the Loop Hole, which is international waters; • The fishery in the Norwegian EEZ and SFPZ is regulated through effort controls (licences/number of vessels/fishing days). Fishing activity of licence holders is constrained by bycatch rules and gear restrictions designed to limit ecological impact but not explicitly cap total catches, whereas the activity of third country fleets operating in the SFPZ is also restricted by the number of effective fishing days and the number of vessels by country; • Vessels from other countries, including those from Estonia, Denmark, Lithuania, Germany, Latvia and Portugal are not permitted to fish in the Norwegian EEZ, but they are permitted to fish within the SFPZ, and in international waters to the southeast of Svalbard known as the 'Loophole' under the jurisdiction of NEAFC;
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	• The number of vessels permitted to fish in the Svalbard FPZ is limited by country (3 for Estonia, 6 for Lithuania) and by an overall limit on effective fishing days (377 for Estonia, 31 for Denmark, 73 for Germany, 647 for Lithuania, 60 for Latvia, 20 for Portugal) set by the Norwegian authorities;
Total Allowable Catch (TAC):	• Catch advice from 2020 to 2025 averaged 146,500 t reflecting what was perceived to be a strong stock, while realized catch averaged 57,111 t during this period; • This changed in 2024 when landings peaked at 95,000 t, providing new information on how the stock responds when fishing pressure increases substantially; • Catch advice for 2026 is $\leq 83,000$ t, which is 45% decrease relative to advice for 2025 (150,000 t); • The decrease in 2026 catch advice was caused by strong negative signals of both stock indices after a peak in catches in 2024 and increasing uncertainty in the assessment; the 2025 BESS value is the lowest in the time series (2004 to present) and this downward signal follows the high catches in 2024, consistent with the stock reacting to fishing pressure more quickly than previously assumed; • The Northern Shrimp stock in the Barents Sea has not been heavily fished over longer periods since the onset of its fishery, representing a challenge for the estimation of the productivity and resilience of the stock at lower biomass levels, increasing the uncertainty of the stock assessment, prompting a more precautionary approach in line with MSY principles; • Uncertainty is linked to the stock's response to an increase from current catch levels to fishing at or near F_{MSY}, suggesting that constraining the year-to-year increase in total catch is of particular importance when phasing in a management plan; • There is currently no overall TAC for the stock and catches are therefore largely unrestricted by biological limits. Changes in catches over time are assumed to follow mostly economic drivers (Lancker et al. 2023), including decreases in other major fisheries such as Atlantic Cod in the Barents Sea; • There is a TAC in the Russian EEZ and Faroe Island vessels fishing in this area receive a 4,000 t annual TAC from Russia;
Harvest Control Rules (HCR):	• No formal harvest control rules have been established, but annual assessments by IMR (Norway) follow HCRs established by ICES; • In practice catches are unconstrained by biological limits, rather realized catches are less than TAC advice as a result of bycatch rules which lead to closures on shrimp grounds when juvenile abundance of key stocks exceeds species-specific triggers,

	economic factors such as fuel costs, and ecological factors such as warming temperatures which have resulted in an eastward shift in fishing effort; • Several candidate harvest control rules performed well in an MSE and were presented for a common management strategy in 2024 (Trochta et al. 2024) but none have been implemented at present; • While there is no formal management plan, the four MSC-certified fisheries (Russia, Norway, Estonia, Faroe Islands), which account for at least 90% of catches, have agreed to a code of conduct which specifies total catches shall not exceed the best available scientific advice, F shall not exceed F_{MSY}, and a harvest control rule specifies that if biomass is below $B_{trigger}$, then F shall be reduced linearly from F_{MSY} at the trigger to 0 at B_{lim};
Monitoring Program:	• All vessels are required to provide active VMS reporting; • Observers are deployed on Russian vessels sporadically, and the last observer deployment in demersal and shrimp fisheries occurred in 2023, with coverage for 126 days, which amounts to 25% coverage of these fisheries – the breakdown between shrimp and other demersal species is not available; observers collect data on fish and benthic bycatch during shrimp tows; • Russian vessels (about 80%) have carried an electronic bycatch monitoring system since 2021 to provide quantitative information on species and quantity (weight or pieces); • Norway uses a designated reference fleet of high-seas and coastal vessels staffed with experts to collect detailed biological samples, assess bycatch, and document discards;
4. <u>Ecosystem and Environmental Impact</u>	
Bycatch Management:	• Use of Nordmøre grates to reduce bycatch is mandatory; • Bycatch of finfish is estimated from at-sea observers and research surveys and corrected for differences in gear selectivity and raised with corresponding shrimp catches from logbooks to estimate overall bycatch; • Temporary closing of areas with excessive bycatch of juvenile Atlantic Cod, Atlantic Haddock, Greenland Halibut, Redfish or Northern shrimp < 15 mm carapace length (there are triggers for each species) is used to mitigate bycatch; • The current rule-of-thumb is that if the estimated bycatch ratio (number of juvenile fish/yield of shrimp (kg)) for Atlantic Cod exceeds 0.8, the bycatch ratio of Atlantic Haddock exceeds 2.0, or the bycatch ratio of Redfish or Greenland Halibut exceeds 0.3 in a certain area, that area will be closed until bycatch ratios are shown to be acceptable (Aldrin et al. 2012);

	- Discards of shrimp are not quantified but are assumed to be minimal as the fishery is not limited by quota, i.e., they assume that high grading is not occurring because the usual reasons (quota restrictions, higher price for large shrimp) are not present; - Russia reports that catches by weight between 2021 and 2025 were 99.9% Northern Shrimp, on average (UCSL 2026); Capelin and Arctic Cod were the only bycatch species retained and reported during this period; Endangered, threatened and protected species are not encountered by this fishery;
Ecosystem Impacts:	- As an important forage species in the Barents Sea, Northern Shrimp is subject to bottom-up and top-down pressures from the environment and predation, respectively. - An MSE of HCRs in 2024 accounted indirectly for many of these environmental-ecological dynamics by including uncertainty between iterations (both process and observation errors), and by testing an alternative scenario of drastically reduced carrying capacity. Thus, the evaluated HCRs can be considered robust against impacts of environmental change or ecosystem dynamics; - Since the 1980s, the Barents Sea has shifted from a situation with high fishing pressure, cold conditions and low demersal fish stock levels, to a state of high levels of demersal fish stocks, reduced fishing pressure and warmer conditions. A substantial decline of Atlantic Cod over the past years is consistent with this reversal trend; - Cod is a major predator of Northern Shrimp, but there is no clear evidence of predation as driver of shrimp population dynamics. - The relationship between shrimp biomass and cod biomass has been investigated during the benchmark assessment but was not found to be significant given the available data (ICES,2022c); - As predator biomass may not be representative of predation pressure, further investigations into shrimp consumption by cod and potential impacts on stock dynamics are recommended;
Habitat Impacts:	- Majority of Russian fleet effort occurs at depths of 251-300 m (65%) followed by 23.5% in the 201-250 m depth range and 9% at depths of 301-350 m; - Areas in which the Russian fishery operated did not change in 2025 relative to 2024, with a spatial footprint of 22,300-24,200 km² in 2025, roughly similar to 18,500-20,400 km² in 2024; - Russia indicates that shrimp trawls used in the Barents Sea are lighter than bottom trawls used for cod and haddock fisheries and as a result the groundrope is lighter and the gear exerts less contact with the seabed, limiting its impact on benthic habitat;

	Norwegian vessels operate on fishing grounds where sensitive seabed habitats like deepwater coral gardens and sponge grounds (so called VMEs) are known to occur. Norwegian vessels are required to report bycatch of VMEs > 1kg since 2014 and to date, no such reports have been received; thus this fishery is considered to have minimal impact on VMEs (sponges, corals, sea pens);
Climate Effects:	- Although temperature is a likely driver of stock dynamics and distribution, no relationship of temperature with observed catch rates or stock biomass could be found during analysis conducted at the benchmark assessment (ICES, 2022); - Abundance of 1-year-old shrimp is positively correlated to SSB the previous year and to temperature of the previous winter, and negatively correlated with the number of 1-year-old cod (Aschan and Ingvaldsen 2008);
5. <u>Performance and Sustainability</u>	
Certification:	- The FIUN Russian Barents Sea Shrimp Fishery received initial MSC certification in Sept 2021. This certification will expire at the end of Aug 2026; 8 vessels are included in this certification; - The FIFS Faroe Islands North East Arctic Cold Water Prawn fishery was initially certified by MSC in Dec 2013 and was recertified in 2017 and 2023. Current certification expires in Nov 2029; - The Norway North East Arctic Cold Water Prawn fishery was initially certified by MSC in Mar 2012 and recertified in 2017 and 2023. Current certification expires in Dec 2028; - The Estonia North East Arctic Cold Water prawn fishery received MSC certification in Nov 2013 and was recertified in 2018 and 2024. Current certification expires in May 2029; - The Estonian Certificate also covers vessels from Denmark, Lithuania, Germany, Latvia and Portugal fishing under Estonian licences;
Economic Viability:	- Scientific advice for 2026 recommended cutting the total allowable catch 45% to protect the stock from overexploitation; - Lower market prices and a restructuring of the fishing fleet have historically affected the viability of the Norwegian fishery, and could again impact the industry; - The Barents Sea fishery runs year-round, with the majority of landings occurring in the May-September period. Nearly one-quarter of the catch is exported to the United Kingdom, at a value of £12 million in 2010;

	• Lancker et al. (2023) highlighted that maximum economic yield for the stock is likely lower than MSY, consistent with economic factors limiting the fishery; • The economic drivers of fisheries dynamics could provide insights on economically optimal harvest strategies; • The management strategy evaluation conducted in 2024 (Trochta et al. 2024) provided a comprehensive simulation framework to test management strategies but did not include economic components. It is therefore recommended to expand the simulation framework with an economics component to improve fishery dynamics understanding and develop economic performance indicators and reference points; • Information from the Norwegian industry points to decreasing catch rates and more frequent area closures due to bycatch on the traditional shrimp fishing grounds, as well as economic causes due to fuel taxation, as the main reasons for the observed change in fishing pattern;
6. <u>Source Documents</u>	
• Aldrin et al. (2012); Aschan and Ingvaldsen (2008); DNV (2025); DNV (2026); GTC (2024); ICES (2021); ICES (2022); IMR (2026); Lancker et al. (2023); Trochta et al. (2024); UCSL (2025); UCSL (2026); Zimmermann et al. (2026)	

Appendix 6 - Skagerrak and Norwegian Deep Shrimp Trawl Fishery

1. <u>Fishery Overview</u>	
Target Species:	• <i>Pandalus borealis</i> (Northern or Cold Water Shrimp)
Stock Structure:	• Single stock in the Skagerrak and Norwegian Deep area distinct from the Fladen Ground and Farn Deep stocks based on differences in biological estimates and trends in fishery data; • Genetic evidence also supports a single stock definition for Skagerrak and Norwegian Deep (Knutsen et al. 2015) and shows little gene flow between this stock and the northern Barents Sea stock;
Location:	• This fishery is located in the North Sea, in Swedish, Danish and Norwegian waters of ICES Divisions IIIa West and IVa East (Skagerrak and Norwegian Deep); • Occurs in offshore waters along the Norwegian coast south of 62 °N, along the southern coast of Norway and Sweden at the entrance to the Baltic Sea (Kattergut between Denmark and Sweden); • It is managed jointly by Norway and the EU, and advised by ICES; • The main distribution of the stock has shifted eastward to Skagerrak, with hardly any shrimp left in the northern parts of the Norwegian Deep;
Fleet:	• Vessels from Norway, Denmark and Sweden exploit this stock; • Number of Danish vessels targeting shrimp decreased from 191 in 1987 to only eight in 2022; vessels leaving the fleet have predominately been small as the average vessel size has increased from 20 to 26 m during this period; • Number of Norwegian vessels participating in the shrimp fishery has decreased from more than 400 in 1995 to just above 100 by 2022; vessels <10.99 m in length dominate in terms of numbers, followed by vessels in the 11–14.99 m length group; • Norwegian fleet has changed since the mid-1990s as the number of trawlers <10 m and in the 11-20.99 m size classes has decreased, while there has been an increase in vessels 10–10.99 m size group; • A high number of small Norwegian vessels (<15 m) operate in the Skagerrak, while the fleet in the west is more varied. The small vessels tend to fish along the coast, while the larger vessels fish more offshore;

	• The Swedish specialized shrimp fleet (landings of shrimp exceeding 10 t per year) has decreased from more than 60 vessels in 1995-1997 to around 30 vessels in 2018-2023; size of these vessels is between 12 and 35 m, with a 12 m average; • Larger Swedish trawlers generally operate in the eastern and central part of Skagerrak and smaller trawlers mostly fish in the Swedish coastal zone inside a 'trawling border' where special regulations apply for the use of trawls;
Gear:	• Bottom trawl either single or double-rigged with minimum mesh size of 35 mm stretched measure and mandatory use of bycatch exclusion devices; • A ban on high-grading was implemented by the EU in 2009 and Norway has had a discard ban for many years; • Efficiency of the Danish fleet has increased due to the introduction of twin trawls and increased trawl size since the early 1990s; • Twin trawls were introduced in the Norwegian fleet in 2002, and in 2011-2023 were used by more than half of the Norwegian trawlers longer than 15 m; • There was no major change in single trawl size or design in the Swedish fleet, but during the last ten years, landings of the twin trawlers have increased from 7 to > 50% by 2022 and constitute most of the total Swedish landings;
Economic and Social Context:	• Between 1994 and 1999 the Danish shrimp fisheries in Fladen and SKND were about the same size, but since 2000 the Fladen fishery declined and ceased in 2004; at present, all Danish shrimp landings come from Skagerrak and Norwegian Deep; • Since 'at sea' boiled shrimp fetch better prices, an increasing number of Danish vessels now land boiled shrimp. In 2020 and 2021, around 1/3 of the landings were boiled compared to 12% in 2005; • The majority of the Danish catches are still landed in Danish fishing ports unprocessed directly to a few large factories processing almost all sizes of shrimp; • Approx. 50% of the Norwegian landings from Skagerrak are from vessels ≥ 15 m, whilst in the Norwegian Deep, about 80% of the landings come from vessels ≥ 15 m; • Almost all Norwegian catches are landed in ports along the Norwegian coast, with a small portion landed in Denmark and Sweden; • Boiled shrimp constituted $\sim 50\%$ and 60% of the landings from the Skagerrak and the Norwegian Deep, respectively, in the 2012-2021 period;

	• There are two different markets for <i>Pandalus</i> in Sweden, resulting in two different kinds of landings: a) higher value, larger sized shrimp sorted by a 10.5 mm sieve and boiled on board before landed, and b) lower value, smaller sized shrimp, sorted by a 8.5 mm sieve, landed fresh and sold for further processing. About 50% of the landings have consisted of boiled shrimp recently; • In some years, the Swedish shrimp fishery has been constrained by the Swedish share of the TAC, resulting in fishers high grading their catches to increase the amount of higher-value boiled shrimp; • In 2012, 2% of the Swedish shrimp trawls had a mesh size ≥ 45 mm; this increased to 41% in 2014, as fishers try to increase size selectivity and capture larger shrimp;
History:	• The shrimp fishery in the Norwegian Deep and Skagerrak has been exploited since the end of the 19th century. The fishery expanded in the 1960s and by 1970 landings had reached 5,000 t. Landings exceeded 10,000 t in 1981, after which landings fluctuated but steadily increased to a peak of around 16,000 t in 2004; • Landings declined significantly from 2004 to 2010, most likely due to poor recruitment, but increased following the 2014 recruitment (age 1) which at the time was the highest level of recruitment in the time series; • Poor recruitment in the last few years has resulted in lower catches with total catches (landings + discards) being approximately 8,500 tonnes in 2022 (ICES 2023); • Estimated recruitment (age 0) in 2021 based on the stock survey was the highest for decades and the abundance of age-1 Shrimp observed in the 2023 survey showed that this initial recruit (age 0) year-class persisted to produce the highest 1-group year class since 2014 (NAFO/ICES, 2023);
2. <u>Stock Status and Science</u>	
Stock Assessment Framework:	• Shrimp stock in SKND is assessed annually by the joint NAFO/ICES <i>Pandalus</i> Assessment Group (NIPAG); • An ICES benchmark assessment in 2016 (NIPAG 2019) implemented a length-based SS3 model fitted to length-frequency distributions from commercial catches and stock surveys to estimate SSB and other relevant parameters; • Further changes occurred in 2022 and 2023, when a new SS3 model was developed and new reference points were developed, changing the perception of stock status; • Model uses a quarterly time step, two areas and six fleets with a population comprising 8+ age classes and incorporates

	hermaphroditism whereby individuals are born as males but change sex to females at approximately age 2; catches are used in the model and in the forecast; • An ensemble of three models is used to estimate the status of the stock, where each model differs based on the assumed level of natural mortality; • Assessment year and TAC year is 1 July to 30 June; • Implementation of the new model led to lower estimates of SSB, higher estimates of F and a downward revision of recruitment relative to previous model outputs, but trends were similar; • Data inputs include length–frequency distributions from commercial landings, discards, catches, and surveys; • Commercial landings and discards (since 2007), commercial catches (since 1970), and a survey index derived from Norwegian shrimp surveys (based on three survey time series: 1984–2002; 2003–2004, and 2005–onwards); • Short-term projections are conducted using various catch scenarios to derive TAC advice conforming to the PA framework, in this case rebuilding the stock above B_{LIM} within 2 generations (6–8 years for <i>Pandalus</i>) with only a 5% probability of being below B_{LIM};
Stock Dynamics	• Dynamics of the stock and the fishery are driven by recruitment variability, and it is likely that successive years of good recruitment will be needed to rebuild the stock towards its biomass targets; • Conversely, successive years of poor recruitment (i.e., lower than expected based on the stock's stock recruitment relationship) will lead to further reductions in stock status and catch advice; • Given the size selectivity of the fishery, it is also important that strong cohorts are given the opportunity to reach maturity as females and reproduce prior to being removed. Otherwise, the stock is unlikely to recover as expected; • Studies in both the North Sea (e.g., Fladen Ground) and in Canadian waters (e.g., Flemish Cap) show that in the absence of good recruitment, exploited stocks of <i>Pandalus</i> can quickly collapse and may take many years (even decades) to recover even in the absence of fishing (ICES 2017b; Cardinale et al. 2023).
Biomass Indices:	• Total biomass by year and area is provided by the Norwegian survey; • Norwegian Deep (ND) – index values have been below 10,000 t since 2006 and since 2015 have probably been around 5,000 t; there is a slight increasing trend from 2015 to 2024, but it is not statistically significant;

	• Skagerrak (SK) – exhibits similar pattern to ND, but values are higher around 5,000-6,000 t; • Combined index – Exhibited values above 20,000 t from 1991 to 2006 (peaking in 1997) and then declined to values less than 10,000 t, except in 2013 and 2022; it also exhibits a slight increasing trend since 2015, but again the trend is not statistically significant;
Reference Points:	• ICES uses both MSY approach reference points (B_{MSY}, F_{MSY}) and precautionary approach reference points (B_{LIM}, B_{PA}, F_{PA}); • These reference points are ratios of current estimates to B_{MSY} or F_{MSY} compared with the previously defined reference points which had specific values of SSB or F; • B_{LIM} - Minimum biomass below which recruitment is expected to be impaired or the stock dynamics are unknown (this is the limit reference point – LRP); • B_{MSY} - Biomass corresponding to the maximum sustainable yield (biological reference point); the peak value on a domed yield-per-recruit curve; • B_{PA} - Precautionary biomass below which SSB should not be allowed to fall to safeguard it against falling to B_{LIM}, usually this is biomass with < 5% probability of being below B_{LIM}; • $B_{TRIGGER}$ (= B_{MGT}) - Value of spawning stock biomass (SSB) that triggers a specific management action. The 5th percentile of the equilibrium distribution of SSB when fishing at F_{MSY}, constrained to be no less than B_{PA}; • F_{LIM} - Fishing mortality rate that is expected to be associated with stock 'collapse' if maintained over a longer time (precautionary reference point); • F_{MSY} - F giving maximum sustainable yield (biological reference point); • F_{TARGET} (F_{MGT}) - F level defined in the Long Term Management Strategy; • F_{PA} - Precautionary buffer to avoid that true fishing mortality is at F_{LIM} when the perceived fishing mortality is at F_{PA}; • Reference points developed during the ICES (2022) benchmark assessment are: • $MSY\ B_{TRIGGER} = 0.8 \times (0.3 \times B_0)$, where $0.3 \times B_0 = B_{MSY}$, and set to ensure that the probability of SSB falling below B_{LIM} does not exceed 5%; [this point appears to be equivalent to the USR in the Canadian context] • $B_{LIM} = 0.15 \times B_0$; • $F_{MSY} = F$ that will achieve B_{MSY}; • $F_{PA} = F$ that ensures SSB exceeds B_{LIM} with 95% probability;

Stock Status:	• Stock status is evaluated relative to reference points in a probabilistic framework; • The 2025 assessment showed that since 2007, when the SSB of mature females exceeded $MSY B_{TRIGGER}$, $SSB/MSY B_{TRIGGER}$ has decreased and was below B_{LIM} since 2010. In general, the SSB relative to $MSY B_{TRIGGER}$ has been around 0.25-0.45 for the last 10 years; • The estimated $SSB/MSY B_{TRIGGER}$ on 1 July 2025 decreased slightly to 0.37, and is below B_{LIM}; • The 2025 assessment also shows that F relative to F_{target} ($=F_{MSY}$) remained relatively stable from the beginning of the 1990s to 2006. After 2006, F/F_{target} increased steeply to 1.84 in 2012, which is the highest observed value in the time-series. F has been estimated above F_{target} in all years between 2007 and 2023; • The estimated F relative to F_{target} in 2024 is 0.82, which represents a large decrease in F/F_{target}; for example in 2022 $F/F_{TARGET} = 1.13$; • Stock status is equivalent to the Critical zone in the Canadian PA framework, i.e., biomass is below the LRP; • The estimated recruitment for 2023 (calendar year 2024) is relatively good at 66.0 billion recruits (age-0 in SS3) and is one of the highest in the last 20 years. However, these recruits have not been observed in the data so the estimate is based on the stock recruitment relationship, which is parameterized as a Beverton-Holt SR relationship, and is associated with considerably uncertainty; • Estimated recruitment in 2024 is 41.0 billion recruits and is around the average level of recruitment since 2005;
Catch Data:	• 2023-24 landings were 6,310 t with 253 t discarded for a total catch of 6,563 t, which is 28% greater than TAC advised by ICES (5,125 t) and 8% greater than the TAC agreed to by the EU-Norway (6,076 t); • 2024-25 landings were 4,557 t, with 150 t of discards for at total catch of 4,707 t, which is 3% greater than the advised TAC and agreed TAC (4,557 t); • Realized catches have exceeded the maximum advised catches in recent years because ICES advised catches include estimates of discards whereas national authorities do not take discards into account and record total landings as total catches which leads to overshooting catch;
3. <u>Management and Governance</u>	
Management Framework:	• The fishery has been managed through a TAC since 1992;

	• TAC advice is provided by NiPAG and is based on an assessment of status against reference points using a length-based analytical assessment model since 2016; • The TAC used for management purposes is negotiated between the EU and Norway, although the ICES advice forms the basis for these negotiations; The Norwegian quota is sub-divided into three four-month periods January-April, May-August and September-December with 40%, 30% and 30% respectively, of the total annual quota; • This subdivision controls supply to the market and more controls on the closure of the fishery during any of these 4-monthly periods if the quota is reached; • Additionally, within these 4-monthly periods, vessels may be allocated an individual quota for each of the three 4-monthly periods; • TAC advice from ICES includes discards in catch, whereas Sweden, Denmark and Norway include only landed catch in their catch data; • Approximately 9.5 and 3.2% were discarded in Sweden and Denmark fisheries, respectively, in 2023; • Discards in the Norwegian fishery are estimated to be 1-4% of total catch in the 2017-2024 period;
Total Allowable Catch (TAC):	• The TAC is shared amongst the three countries based on historical landings with Norway, Denmark and Sweden receiving 59%, 27% and 14%, respectively, between 2011 and 2023; • TAC for 1 July 2025 to 30 June 2026 should be no more than 4,010 tonnes, which represents a value of F/F_{MSY} of 0.45, resulting in a modest expected increase in SSB/MSY $B_{TRIGGER}$ from 0.37 in 2025 to 0.56 x in 2026 with a probability of 49.3% that SSB will be $< B_{LIM}$ in 2026; • The 2025-26 TAC is a 12% reduction relative to 2024-25 advice of 4,557 t; • The reduction in catch advice is linked to a revised estimate of SSB/SSB_{target} in the last few years due to the higher-than-expected catches in assessment year 2023 (6,563 t), which exceeded both the scientific advice (5,125 t) and the TAC set by EU-Norway negotiations (6,076 t) and has removed a larger number of females from the population than was forecasted. These exceedances also resulted in an SSB that is below B_{LIM} whereas the 2024 assessment predicted a recovery in SSB above B_{LIM};
Harvest Control Rules (HCR):	• HCR has been revised based on outcomes of an MSE workshop in 2023;

	• HCR is based upon reference points $MSY B_{TRIGGER}$ set at 90% of $0.3 \times B_0$ (B_{MSY}) and $F_{TARGET} = F_{MSY}$, designed to achieve a biomass level with only a 5% probability of being below B_{LIM} and achieve the highest possible catches; • When the stock is below $MSY B_{TRIGGER}$, a reduced exploitation rate is calculated as: ○ $F_{Year} = F_{MSY} \times (SSB_{Year}/MSY B_{TRIGGER})$, with the condition that SSB_{Year+1} must have > 50% probability of exceeding B_{LIM}; • Realized catches have been above TAC for several years and high grading is known to occur in some of the fleets, supporting the conclusion that the harvest strategy for this stock is not working; • Note that the HCR shows F beginning to decline when SSB reaches $B_{TRIGGER}$; F continues to decline to 0 when SSB reaches 0, i.e., there is no concept that B_{LIM} is a decision point for F and that below B_{LIM} there should be no fishing;
Monitoring Program:	• Landings data at the trip level are based on logbooks and sales slips at the spatial resolution of the ICES rectangle since 1990; • Estimates of total discards, based on on-board sampling, have been available from Sweden since 2008 and from Denmark since 2009; • Norway initiated the coastal reference fleet program in 2016 within which some shrimp vessels report all catches, including discards; • Observer programs in each of the three fleets collected data on catch composition (including discards and bycatch), length frequency distributions of shrimp, maturity and sex ratio; • Port sampling programs sample all landings in each country for length frequency, maturity and sex ratio; • Norway conducts an annual fishery-independent survey with a depth-stratified (four zones) fixed station design with standardized operating procedures in the Jan-Mar period to assess the distribution, biomass, recruitment, and demographic composition of the shrimp stock, as well as the size of shrimp predator stocks and the measurement of hydrographical conditions in the stock area (Søvik and Thangstad 2021); swept area is used to estimate total biomass and abundance in number indices; • This survey usually occurs in January or February and provides important information on the age 1 cohort (recruitment), which is not observed in the commercial catch until after the summer of the same year • About 300 shrimps are sampled from each haul; the length of each shrimp is measured, and the sex and maturation stage is determined;

4. Ecosystem and Environmental Impact

Bycatch Management:	• Nordmøre grates are mandatory to reduce finfish bycatch and bycatch of small shrimp (< 15 mm carapace length); bar spacing in the grates is 19 mm; • Bycatches of about 10-25% (by weight) of commercially valuable fish and Atlantic Lobster can be made if quotas permit it; • Saithe (240 t), Monkfish (119 t), and Atlantic Cod (105 t) are the most common bycatch species; all other bycatch species are < 60 t caught; • No catch of endangered, threatened or protected species has been reported; • Use of sorting grids effectively reduces fish bycatch. However, "high-grading" (discarding smaller, less valuable shrimp < 15 mm carapace length) has been a noted concern in some parts of the fleet to maximize the value of limited quotas; • New markets have been developed for the smaller shrimps, reducing the incentive to discard, but it continues to occur; • Although measures to prevent high grading are in place in all three countries, it continues to occur;
Ecosystem Impacts:	• While predator-prey interactions are known and predator indices are compiled from annual survey data, it is not clear whether or not this information is used in the assessment or in formulating recommendations to managers; • Largest densities of Saithe are found in shallow water and Roundnose Grenadier is found in deep water; An increasing trend in the predator index excluding Saithe, Blue Whiting and Roundnose Grenadier, is due mainly to increasing catch rates of Atlantic Haddock, Rabbit Fish and Velvet Belly; Saithe, Blue Whiting, Roundnose Grenadier, Velvet Belly and Atlantic Haddock have been shown to feed on shrimp in Skagerrak;
Habitat Impacts:	• Trawling occurs on soft muddy bottoms and fishing footprint was unchanged from previous years; • While most grounds are considered stable, concerns exist regarding overlap with vulnerable marine ecosystems (VMEs) in the Skagerrak; • Fishing activities do not overlap in time and space with any known VMES in the Norwegian Deep;
Climate Effects:	• Recruitment in <i>Pandalus</i> populations is known to be driven more by environmental factors such as bottom water temperature and predation levels than by spawning stock biomass; • Recruitment has been extremely low since 2008, which is the primary driver of current low stock levels;

	• Warming bottom temperatures and changes in fjord hydrography are potential external pressures on the stock; • Although indices of bottom water temperature and predators are compiled annually, it appears that TAC advice from NIPAG and other measures are based solely on the analytical results of stock status and the application of HCRs, i.e., index values do not modify the harvest advice in any way;
5. <u>Performance and Sustainability</u>	
Certification:	• The Norwegian portion of this fishery was certified as sustainable by MSC in June 2016 and recertified in Dec 2021, which expires Dec 2026; • MSC certification was suspended in 2024 because the 2024 stock assessment showed that SSB has been below B_{lim} since 2011 and F was above F_{MSY} over the same period; • Certification remains suspended in 2025 because the assessment continues to show that SSB is below B_{LIM}, while F has been reduced below F_{MSY};
Economic Viability:	• The Norwegian fishery in SKND is a key commercial activity, with annual Norwegian catches of this species totaling approximately 30,000 t, generating a market value of roughly NOK 1 billion (over all <i>P. borealis</i> fisheries, including Barents Sea); • The SKND fishery is characterized by a high-value, mixed-species catch, with smaller coastal vessels (often <15m) supplying fresh, boiled shrimp to the market. Large shrimp are boiled on board and landed fresh for the Norwegian and Swedish markets, fetching the highest prices, reaching approximately NOK 110/kg by 2022; Smaller shrimp are landed raw on ice for industrial processing, and return lower prices, roughly NOK 15–18/kg; • The fishery is vital for small coastal vessels, particularly in southern and western Norway, where vessels often target shrimp while also collecting other high-value species which bolster profitability, such as <i>Nephrops norvegicus</i> (Norway Lobster), Atlantic Cod, Monkfish and Hake; • The introduction of the Nordmøre grid reduced the profitability of smaller vessels, leading to pilot studies on using modified grids (e.g., with a lower gap) to improve bycatch of larger, valuable species like <i>N. norvegicus</i>; • While the fishery is economically valuable, fuel usage is high in this fishery, particularly for smaller vessels; • The Norwegian Directorate of Fisheries notes that the economic impact extends beyond active fishers to local processing and sales, maintaining traditional fishing communities along the southern coast;

6. Source Documents

- DNV (2024); Knutsen et al. (2015); ICES (2022); ICES (2023a); ICES (2023b); ICES (2025a); ICES (2025b); Søvik and Thangstad (2014); Ulmestrand et al. (2014)

Appendix 7 – Gulf of Maine Northern Shrimp Trawl Fishery

1. Fishery Overview	
Target Species:	• <i>Pandalus borealis</i> (Northern Shrimp)
Stock Structure:	• Single stock, no evidence of genetic connectivity to the ESS stock;
Location:	• East coast of the United States in the Gulf of Maine (GOM); • Stock and fishery occur in western portions of the GOM in deeper basins at depths of 90-180m, where bottom temperatures are coldest; abundance in the eastern GOM is relatively low; • Largely a winter fishery (Dec-Apr), with insignificant landings between May and Nov;
Fleet:	• The number of vessels participating in the fishery in recent years has varied from a high of 347 in 1996 to a low of 144 in 2006; • Most vessels participate in the groundfish fishery and only secondarily fish shrimp in the winter months when they are nearshore; • In 2013 (last year before the moratorium began), there were 208 vessels; 182 from Maine, 13 from Massachusetts, and 14 from New Hampshire; • 72 Maine vessels were trap vessels, and the remainder (136) were trawl vessels; • Majority of vessels are 30-50 feet in size; • An increasing number of vessels from Maine are trap vessels; • Recreational fishery is very limited, is usually carried out with the recreational lobster trap fishery, and is for personal use;
Gear:	• Mainly use otter trawls with 44.5 mm stretched mesh in codend and rigged with rollers or chains depending on area trawled; • Trawl over soft mud bottoms; • Some Maine vessels fish traps and are limited to 1,000 trap submersions per year;
Economic and Social Context:	• Historically, northern shrimp have provided a small but valuable fishery to the New England states. The fishery is seasonal in nature, peaking in late winter when egg-bearing females move into inshore waters and ending in the spring under regulatory closure; • Income from this fishery supplemented groundfish revenues during a portion of the year when little activity occurred; • Because the fishery has been open access, effort has shifted into it when groundfish fishing was poor and has contributed to several stock declines;

	• The fishery is not economically viable at present (2026) and there are no prospects for future rebuilding at present;
History:	• Commercial fishery began in 1938 and during the 1940s and 1950s majority of landings were in Maine; Landings peaked at 255 t in 1945, declined in the 1950s and were 0 from 1954 to 1957; • In the late 1950s the fishery recovered and experienced a rapid expansion in landings, peaking in 1969 at 12,837 t; • Over the next decade, landings dropped precipitously and the fishery closed in 1978 due to stock collapse; • Fishery reopened in 1979 and produced stable landings through the 1990's (peak landings occurred in 1987 and 1996 at an estimated 5,262 t and 9,117 t, respectively); • Landings declined to 450 t in 2002, the lowest levels observed since the 1978 closure, but landings again increased to an average of 3,583 t during 2003-2012; • Fishing season was cut short in 2010 with 6,123 t landed due to the industry exceeding the recommended landings cap for that year, and concerns about small shrimp; • Season was similarly cut short in 2011, and the 2012 season was further restricted with gear-specific seasons, landings days, and trip limits; TAC was set at 2,223 t and would close when the projected landings reached 95% of the TAC; • 2013 season, which was classified as a "do no harm" fishery, resulted in a fishing mortality rate (0.53) above the target (0.38), despite the fact that only 49% of the TAC was harvested (307 t of 631 t); • Due to recruitment failure and a collapsed stock, a fishery moratorium has been in place since 2014;
2. <u>Stock Status and Science</u>	
Stock Assessment Framework:	• Statistical catch-at-length model (University of Maine Model – UME) with time-varying M and maturity-at-length is used to estimate total abundance, SSB, recruitment and average fishing mortality; • Stock projections are conducted under different assumptions of M, recruitment and F, including no fishing ($F = 0$); • Two annual surveys provide biomass indices to which the model is tuned: inshore spring Maine-New Hampshire survey and a summer Atlantic States Marine Fishery Commission (ASMFC) survey; the summer ASMFC was terminated after the 2023 sampling, leaving the spring inshore ME-NH survey as the only biomass index;

	• The ASFMC summer survey monitored the relative abundance (number of shrimp), biomass (weight of shrimp), and composition of the northern shrimp stock throughout the Gulf of Maine and focused on offshore waters (depths > 50 m) and was timed to sample both males and females during the summer when they are expected to be offshore; • The ME-NH Inshore Trawl Survey is performed along the coastal waters of Maine and New Hampshire in spring and fall and began in the fall of 2000; • Benchmark assessments conducted periodically (2018, 2025) with updates annually in intervening years; • Model outputs are combined with an index-based approach, the traffic light analysis (TLA), to formulate advice to managers; • TLA includes indices of abundance (survey abundance indices, SSB, recruitment), fishery performance, and environmental trends (SST and bottom temperature, predation pressure index) from 1984 to present; • The TLA approach categorizes annual values of each index as one of adverse (red), cautious (yellow) and favourable (green) based on a 1984-2017 reference period to illustrate the state of the population, environmental conditions, and fishery; • Qualitative status reference levels for the abundance and biomass indices are below the 20th percentile is an adverse state, and above the 80th percentile is a favorable state; • Qualitative status reference level for the environmental indicators are below the 20th percentile is a favorable state and above the 80th percentile is an adverse state, as higher temperature and predation pressure have negative consequences for northern shrimp;
Biomass Indices:	• SSB in 2024 was estimated to be 279 t, the lowest in the series and below the median of 4,732 t; • Biomass indices from both surveys have both been below the 20th percentile of the reference period since at least 2020; • Recruitment indices from both surveys also have been below the 20th percentile of the reference period since at least 2020;
Reference Points:	• Currently no biological reference points for northern shrimp (ASMFC 2024); • Stock status is based on trends from the model results and TLA analysis relative to the 20th and 80th percentiles;
Stock Status:	• 2024 Stock Assessment Update indicates the stock remains in a depleted condition, with biomass at low levels since 2013; confirmed by the 2025 update, which reported that total abundance was a new low for the time-series (below the 20th

	percentile) and recruitment was below the 20th percentile for the past 3 yrs (2023-2025); • SSB in 2023 was estimated at 279 t, well below the time series median of 4,732 t and the 20th percentile of the reference period (2,721 t); • Additionally, recruitment (proportion of shrimp between 11 and 18 mm carapace length) remained low for 2022-2023, a continuation of the series of below-average year classes for the last ten years; • Index of predation pressure and winter surface temperature showed improvement in the most recent year of data; • Stock projections show that in the short-term under recent levels of M and recruitment, median SSB is expected to decline 54% from 2023, even under the F=0 scenario; • If the maximum research set aside is fished, then median SSB is expected to be 13% lower in 2025 than under the F=0 scenario; • Based on this analysis the stock is considered over-fished and no fishing is recommended; no research sampling in 2026 is recommended;
Catch Data:	• Catch data exhibit classic boom and bust cycle in this fishery; • Six week pilot winter sampling program was conducted in February – March 2025 under a research set-aside quota of 26.5 mt (or about approximately 58,400 lbs). • 70 individual northern shrimp were caught in total, weighing approximately 2.42 pounds, and representing less than 1% of the research set-aside quota; • It was recommended that this program not continue in 2026;
3. <u>Management and Governance</u>	
Management Framework:	• This is a competitive open access fishery with no limitations on licence eligibility; the number of licences has decline in recent years as federal buybacks in the groundfish fleet have reduced capacity; • Although a control date has been established (June 7, 2011), limited entry provisions have not been implemented to control effort; • A hard TAC is the primary tool used to manage the fishery; TAC is allocated 80% to Maine, 10% to NH and 10% to Mass; • Fishing season (Dec 1-May 31), seasonal closures, trip limits, trap limits, days out of the fishery and research set-asides are other tools used in managing the fishery; • Model outputs (including projections based on M and recruitment, combined with TLA of biological, fishery and environmental indicators and evaluation of management triggers, including

	recruitment and temperature triggers that signal potential improvement in stock conditions, are used to manage the fishery; • The recruitment trigger is achieved when the stock experiences non-failed recruitment for three consecutive years. If achieved, a stock assessment update will be conducted; • The temperature trigger is considered reached when two out of three consecutive years of winter surface temperature and spring bottom temperature in the Gulf of Maine fall below the 80th percentile of the reference period. If achieved, a winter sampling program will be considered; • Focus is on limiting exploitation (F) to $F=0.34$ or lower through changes in season length (to produce a desired level of catch – an indirect management method), closures and restricted openings; • Since the 2014 fishing moratorium went into effect, most of the analysis has focused on TLA and evaluation of management triggers and results have not been encouraging since the stock is not recovering; • Management actions appear to occur at the state level and are somewhat uncoordinated as a result, despite the coordinating function provided by the ASMFC; • Historical record shows that a management strategy centered around a winter fishery to maximize recruitment potential and yield per recruit prospects, with direct controls on fishing mortality to ensure that biological targets are not exceeded, provides the best option for maintaining a healthy resource;
Total Allowable Catch (TAC):	• 87% of TAC (when there is a fishery) is allocated for the trawl fishery and 13% for the trap fishery based on historical landings by each gear type; • The coastwide TAC is allocated 80% to ME, 10% to NH and 10% to Massachusetts; • Season is closed when a pre-determined percentage (between 80–95%) of the annual TAC is projected to be caught; • Fishing moratorium has been in place since 2014 to help the population recover, but the stock remains in poor condition due to low numbers and warmer ocean temperatures hindering recruitment; • ASMFC maintained the current moratorium on northern shrimp fishing for another three years through the 2028 fishing year, with no sampling program in 2026; • This action responds to the northern shrimp stock remaining at low biomass levels over the past decade despite the fishing moratorium implemented in 2014;

Harvest Control Rules (HCR):	• US fisheries harvest rules are based on depletion and follow the F_{40-10} rule (and associated biomass levels); • There is no indication that this approach was followed for the GOM shrimp fishery, rather attempts to control effort (and TAC achievement) were implemented through changes in the fishing season in terms of length and timing of openings; it was clearly unsuccessful as numerous analyses consistently showed that F was well above target ($F=0.34$);
Monitoring Program:	• All states require weekly reporting of catch and landings data; • Approximately 2-5% of commercial shrimp landings from ME, NH, MASS, have been subsampled for size and sex-stage composition data since the early 1980s; these states target at least 2% of commercial landings in that state for port sampling; • Vessels can be required to carry at-sea observers when requested, and coverage targets are 5% of total trips for high priority fisheries and 2% of total trips for all other fisheries; • Fishery independent surveys – ASMFC ended in 2023; ME-NH inshore trawl survey continuing but does not cover same area or range of northern shrimp habitat as summer survey;
4. <u>Ecosystem and Environmental Impact</u>	
Bycatch Management:	• Regulations are in place to minimize non-shrimp bycatch and minimize the catch of small (male) shrimp with low market value; • Use of Nordmøre grates in trawls is mandatory with maximum spacing of 22 mm; • Bycatch in trawl fishery is about 2-3% by weight; bycatch in trap fishery is 1.1-1.2% by weight of landed catch;
Ecosystem Impacts:	• <i>P. borealis</i> is at the southern edge of its range in the GOM and thus is more vulnerable to environmental variation and changes than other stocks further north;
Habitat Impacts:	• Given the short duration of the fishery when it operated (4-6 weeks), fishing effort occurs over soft substrates, and short season permits some recovery of substrate, shrimp fishing is believed to have modest impacts on benthic habitat in the GOM; • Given the high uncertainty in the future prospects for the northern shrimp fishery and the current moratoriums due to the stock collapse, the long-term impacts of the fishery on shrimp habitats are highly uncertain. Current low levels of effort in the fishery may have neutral or slightly positive habitat effects;
Climate Effects:	• Survival during the first year of life is negatively correlated with ocean temperature during two periods: (1) during the time of the hatch and early larval period, and (2) during the late summer when ocean temperatures and water column stratification are reaching their maximum;

	• Recruitment of northern shrimp is related to both SSB and ocean temperatures, with higher SSB and cooler temperatures during these sensitive periods producing stronger recruitment; • Environmental influences on recruitment have increased in importance since around 2000; • Ocean temperatures in western GOM northern shrimp habitat have increased over the past two decades and have sustained unprecedented highs in the past 10 years although the 2025 winter surface temperature was cooler compared to recent years; • The increasing trend in temperatures is consistent with an increasingly inhospitable environment for northern shrimp;
5. <u>Performance and Sustainability</u>	
Certification:	• None;
Economic Viability:	• Not viable at present as stock has not rebuilt over the past decade since the initial moratorium in 2014;
6. <u>Source Documents</u>	
• ASMFC (2024, 2025b); Clark et al. (2000); ASMFC (2025c – pilot winter sample program); ASMFC (2016); ASMFC (2025a); Moffett et al. (2012);	

Appendix 8 – West Coast Ocean Shrimp Trawl Fishery

1. Fishery Overview	
Target Species:	• <i>Pandalus jordani</i> (Smooth Pink Shrimp or Ocean Shrimp)
Stock Structure:	• A single stock is assumed for assessment, management and stock status determination purposes; no supporting analysis for this assumption is available;
Location:	• Occurs in federal waters of the United States from 3-200 miles off the coasts of Washington, Oregon, and California; • Closed within 3 miles of the coast in all states (coastal territorial waters), except in OR where permits may be obtained; • Also closed areas include certain banks (e.g., Hecata) and canyons within the main fishing area to protect biogenic and sensitive habitats;
Fleet:	• Limited entry in WA, OR, and CA; • 60 vessels, 899 trips in OR (2024); 25 vessels, 415 trips in WA (2024); CA info not part of report (see CDFW online reporting);
Gear:	• Otter trawl; most vessels double rigged (nets both sides); minimum mesh size in the codend of 1 3/8 inches (36 mm) and no minimum in WA or OR;
Economic and Social Context:	• Primarily fresh shrimp on ice, brought to shore for processing so majority of trips are < 24 hr. in duration; • Some vessels may produce frozen-at-sea product, but are required to provide samples of 25 lbs of whole frozen shrimp and fresh shrimp from the same trip to dockside monitors;
History:	• State research vessels discovered large, deep-water shrimp beds off the coast of California and Oregon between 1950 and 1951; • California officially established the first set of commercial rules, seasons, and geographic quotas in 1952; • Commercial shrimp fishery expanded north to Washington in 1956 in part because the introduction of mechanical peeling machines in the late 1950s made processing highly efficient, transforming Pink Shrimp into a lucrative commodity; • Early fishermen were restricted to small beam trawls, but by 1963, regulations allowed the use of highly efficient otter trawls; • The fleet eventually upgraded to large, "double-rigged" vessels utilizing two nets simultaneously to maximize catches; • While early landings were concentrated heavily in California, the center of abundance shifted significantly and from the 1980s onward, Oregon was the dominant leader, typically accounting for over half of the entire West Coast harvest;

	• OR Pink Shrimp Fishery was the first cold-water shrimp fishery in the world to achieve the MSC certification for sustainability in 2007, followed later by the wider West Coast fleet; • Mandatory implementation of Bycatch Reduction Devices (BRDs) in 1991 slashed Eulachon bycatch rates to under 5%; • In the mid-2010s, fishermen voluntarily began attaching green LED lights along the lines of their nets, which allowed non-target species to escape the net and reducing Eulachon bycatch by up to 90%;
2. <u>Stock Status and Science</u>	
Stock Assessment Framework:	• Do not collect fishery-independent data (i.e., survey); use in-season fishery-dependent data from logbooks and port sampling; • No stock assessment model, but stock strength is modeled as recruitment using environmental indicators rather than adult abundance or spawning biomass: 1. Spring Transition - The timing of the spring oceanographic transition is the single most critical factor. An early, strong transition to northwesterly winds triggers nutrient-rich upwelling, providing essential planktonic food for newly hatched larvae; 2. Offshore Transport - Strong upwelling is beneficial, but excessive, violent winds between April and July can create too much surface water movement. This physically sweeps shrimp larvae too far offshore, away from their ideal bottom habitats, depressing local recruitment 3. Sea Level Height (SLH) - Sea Level Height at Crescent City, California, is used as a proxy for recruitment success. Lower sea levels correlate with colder waters and stronger southward transport in the California Current, which are optimal for high shrimp survival. Higher sea levels signal warm, nutrient-poor conditions that cause stocks to crash; • Recruitment forecasts are produced in April before the fishing season opens and using predictive models that rely on lag-year oceanographic metrics (specifically low Sea Level Height at Crescent City, CA, and moderate upwelling) paired with real-time biological sampling of the Body Condition Index (BCI) from dockside samples during the first week of the season in April; • BCI measures the physical weight-to-length "fatness" ratio of shrimp and is strongly negatively correlated ($r = -0.86$) with the overall seasonal CPUE required to harvest the stock (Groth et al. 2026);

	• The recruitment forecasting model uses lagged ocean condition effects because Pink Shrimp do not heavily recruit into the trawl fishery until they are Age 1 (approx. 13-15 months old); as a result the ocean conditions monitored during the spring/summer of Year 1 directly forecast the harvestable biomass of Year 2. • Final recruitment forecasts are balanced against the forecasted biomass of predatory groundfish, particularly Pacific Hake, which migrate heavily into the region and can strip out a year-class through heavy consumption; • Research conducted looking at variability of growth in time and space as a determinant of optimal season opening date to avoid harvesting young (1-yr old) shrimp (Oken et al. 2025). Results show a latitudinal pattern with shrimp recruiting at smaller sizes farther north; thus delaying opening would likely benefit harvesters in areas and years with smaller shrimp and higher fishing mortality;
Stock Dynamics:	• Stock dynamics are characterized by substantial natural variability from year-to-year driven primarily by large-scale oceanographic conditions rather than fishing pressure; • This stock is a classic "recruitment fishery," where the annual harvest depends heavily on incoming, young-of-the-year shrimp; • Recruitment in Ocean Shrimp is driven by environmental conditions during the pelagic larval phase and not strongly influenced by fishery catch; • Because Pink Shrimp have a short lifespan (typically 3 to 4 years), the population cannot buffer consecutive years of poor reproduction. Stock strength is modeled using environmental indicators rather than traditional adult spawning counts or biomass;
Biomass Indices:	• Biomass indices are not directly estimated but several fishery-dependent indices and biological indices are evaluated annually; • Catch Per Unit Effort (CPUE), typically measured as pounds of shrimp caught per hour of trawling, is assumed to be directly proportional to exploitable stock biomass density (no supporting evidence for this assumption was reviewed). Because the fleet uses a mix of older single-rig vessels and modern, double-rigged trawlers, all logbook data are converted into a standardized "single-rig equivalent" hour so that changes in CPUE reflects an changes in shrimp biomass rather than a technological upgrade in the fleet; CPUE is tracked weekly and follows a pattern of very high CPUE in May and June, followed by a steady, predictable decline through October as the fleet steadily "fishes down" the available annual biomass;

	• BCI is a reliable contemporaneous biomass indicator because it captures the effect of ocean conditions on the physical mass of individual shrimp while at the same time capturing environmental effects on stock survival and aggregation density; BCI is negatively correlated with CPUE; • Age-1 Recruitment Index - Measures the percentage of the biomass composed of one-year-old shrimp. A dominant Age-1 index means the biomass is expanding; • Count-Per-Pound (CPP) Index: Vessels are legally required to maintain a landing average of < 160 shrimp per pound to prevent growth overfishing. If the CPP index spikes (meaning the shrimp are too small), then it triggers localized (if only one of the state fleets) or seasonal structural closures (if all fleets are reporting small shrimp);
Reference Points:	• Biological reference points have not been established for this stock but fishery reference points based on fishery dependent catch rates (Hannah and Jones 2014b) are used to manage the fishery and provide guardrails against recruitment overfishing; • Target reference point - average catch rates in June are below 12,500 lbs per trip (most vessels land fresh shrimp on ice so trips are < 24 hr. in duration); if the TRP is triggered, then the current fishing season is cut short and closes two weeks early on October 15 (instead of October 31), and the opening of the following fishing season is delayed two weeks until April 15 (instead of April 1). This additional month is intended to provide an extended window for the stock to spawn and grow; • Limit reference point - fleet-wide average catch rate below 10,000 pounds of shrimp per fishing trip during any calendar month of the season and April – January SLH at Crescent City > 7.5 ft in the larval year; If both criteria are met, then the fishery is shut down immediately within 10 calendar days of public notice, and the start of the following season is delayed until April 15 to safeguard recruitment; • These catch rate triggers are based on lowest observed catches per trip from which the stock recovered (in 1983 and 1988) reported by Hannah and Jones 2014b) and are referred to as action levels rather than reference points, although they are clearly decision points in the management of this stock; • These action levels were adopted by all three states, but no occasions have arisen in which they were implemented in the last 2-3 decades;
Stock Status:	• Fleet wide CPUE is well above both the target reference point (12,500 lbs/trip) and the limit reference point (10,000 lbs/trip),

	landings for Washington and Oregon combined have exceeded 35,816 t (79 million lbs), which is the largest harvest since 2015; • The average size of harvested shrimp around a mean of 127 shrimp/lb, which is below the management ceiling of 160 count/lb, which is interpreted to mean that recruitment overfishing is not occurring; • Based on all of these factors, it is believed that there is zero biological threat of stock depletion and the stock is not overfished and overfishing is not occurring (the US bases stock status on depletion level rather than status zones based on the level of harm occurring to the stock from fishing pressure);
Catch:	• 69.0 million lbs in 2024, consisting of 19.6 M lbs in WA and 49.4 M lbs in O1R; no landings in CA in 2024). Catch is up from 58.4 M lbs in 2023; • 78.96 M lbs landed in 2025 (14% increase relative to 2024), consisting of 22.16 M lbs in WA and 56.8 M lbs in OR; no landings were recorded from CA;

3. Management and Governance

Management Framework:	• OR FMP adopted in 2018 (Hannah et al. 2018); • WA FMP adopted in 2017 (Wargo and Ayres 2017); • CA FMP adopted in 2022 (CDFW 2022); • The Ocean Shrimp fishery occurs in federal US waters (3-200 miles offshore) and is based on a cooperative, state-led framework. Management relies on strict effort-control regulations, technical gear innovations, and dynamic harvest control rules because there are no federal quotas or total allowable catch (TAC) limits for this stock; • Effort Controls – rules are coordinated in all three states to prevent cross-border regulatory conflicts and include: 1. Unified Season: The commercial fishery operates from April 1 through October 31, with a mandatory winter closure to protect egg-bearing females during their spawning cycle; 2. The 160-Count Rule: Vessels are legally prohibited from landing catches that average more than 160 shrimp per pound (72 per kg). This rule acts as a biological size limit, ensuring that fleets do not target or decimate small, one-year-old juvenile shrimp; 3. Limited Entry Permits: To prevent overcapitalization, all three states require Limited Entry (LE) shrimp trawl permits. For example, Washington maintains a capped fleet of around 83 active licences, preventing an influx of outside vessels from overwhelming the stock;
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	• Gear Requirements and Federal Overlays - While the states manage the shrimp, the federal Pacific Fishery Management Council (PFMC) enforces overlays to protect co-habiting groundfish and essential fish habitat (EFH): 1. Mesh Size Limits - Nets must maintain a minimum mesh size of 1.38 inches (36 mm) to maximize the passive escapement of zero- and one-year-old shrimp; 2. Bycatch Reduction Devices (BRDs) - Rigid-grate or netting-panel BRDs are mandatory to mechanically deflect larger species—like Rockfish, Salmon, and finfish—out of the net while letting shrimp pass into the codend; Maximum spacing between bars is < ¾ inch; 3. LED Footrope Lighting - State regulations mandate the attachment of five green LED lights 4 ft apart in the central 16 ft of the footrope to create a visual escape cue to guide endangered Eulachon and juvenile flatfish downward and out of the trawl path; 4. Vessel Monitoring Systems (VMS) - All active shrimp vessels must carry operational VMS tracking to ensure that trawling occurs only in federal waters (generally 3–200 miles offshore) and entirely avoids restricted groundfish conservation zones; • Biological Harvest Control Rules (HCR) – Ocean Shrimp management relies on a dynamic HCR: 1. Environmental and Catch Tracking - The HCR evaluates stock health by monitoring environmental indicators (such as sea-level height) alongside the active fleet's CPUE; 2. Early Season Interventions - If the June CPUE drops below a proxy target threshold of 12,500 pounds per fishing trip, it triggers automatic management interventions. 3. Preemptive Closures - If the stock exhibits severe stress or low abundance, the HCR legally forces an early closure of the current season or delays the start of the following season to safeguard spawning biomass; • No directed fishery in CA in 2024 in part because increased water rates meant it was cost-prohibitive to process shrimp in CA. Boats fishing out of northern CA landed their catch in OR using OR landing permits. Because there were no landings in CA ports, there was no port sampling of Pink Shrimp in 2024; • In 2024, average sampled size was 127 shrimp per pound in OR catch, which was the same as in 2023. Size has varied between 92 to 210 shrimp per pound across all areas and months; • In 2024, average size was 132 in WA catch areas, which is slightly higher than in 2023. Average counts ranged from 109 in
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	October to 151 in May. Five samples exceeded the 160 shrimp per pound maximum – penalty includes forfeiting the catch and may include a suit for twice the fair market value of the catch;
Total Allowable Catch (TAC):	• Management of this fishery is based on effort controls rather than catch controls so a TAC is not calculated nor are quotas allocated to vessels;
Harvest Control Rules (HCR):	• Fishery began in CA in 1952 and until 1976 area TACs were used to manage the fishery. In 1976, seasonal closures, size limits and mesh size were implemented by CA and then harmonized with OR and WA in 1981; • There is no formal harvest control rule at present. Season and size limits are the primary tools used to manage the fishery; • If the Jan-Apr average sea level height at Crescent City is < 7.5 m and the June average catch per tow is < 10,000 lbs, then the fishery is closed as soon as possible; • If the average June catch per tow is between 10,000 and 12,500 lbs, then the fishery is closed two weeks early in October and opened two weeks later in April, i.e., additional protection is afforded to egg-bearing females and the spawning period;
Monitoring Program:	• Primary tool consists of port sampling in each state at major ports to collect data on counts per pound, length, sex and transition state, and some individual weights on a weekly basis; • Logbooks must be maintained detailing each tow the precise GPS coordinates, tow duration (start/stop times), average depth, estimated catch weight, and any observed bycatch; logbooks are collected weekly; • Fish tickets are collected to verify catch weights in logbooks; • VMS tracking is mandatory to ensure vessels do not encroach into closed areas, marine protected zones, or state-specific territorial boundaries; • At-sea observers from the West Coast Groundfish Observer Program (WCGOP) have tracked a percentage of trips for catch and bycatch since 2004; WCGOP discontinued this service in the shrimp fishery after the 2024 fishing season; • No replacement for the observer program has been identified;
4. <u>Ecosystem and Environmental Impact</u>	
Bycatch Management:	• Eulachon bycatch is managed using a combination of mandatory gear requirements, real-time data monitoring, and spatial avoidance strategy; 1. Mandatory Gear Requirements - Technical modifications to shrimp trawl nets are legally mandated across all three states to allow Eulachon to escape before the net is hauled;

	2. LED Footrope Lights - Because Eulachon naturally swim downward when startled by illumination, green LED lights along the net's footrope guide 90% of encountering Eulachon out through the open space beneath the net; 3. Rigid-Grate Bycatch Reduction Devices (BRDs) - Trawl vessels must use rigid metal or plastic grates positioned at the throat of the net, featuring a narrow vertical bar spacing that mechanically blocks larger finfish—including adult Eulachon—from entering the codend, deflecting them upward and out of an escape hatch; • Mandatory Observer Coverage and Data Tracking: 1. West Coast Groundfish Observer Program (WCGOP): Operated by NOAA Fisheries, the WCGOP places human observers on a rotating percentage of the shrimp fleet. Observers log the precise weight and count of all Eulachon caught; the placement of WCGOP observers on shrimp vessels was discontinued after the 2024 fishing season; Vessels were asked to self report Eulachon bycatch, which is known to be lower than observer estimated bycatch; 2. Bycatch Estimation Models: Because 100% observer coverage was not logistically feasible, NOAA used the collected observer data on bycatch:shrimp catch ratios to calculate fleet-wide bycatch estimates. These data are continuously weighed against the recovery targets set in the federal Eulachon Recovery Plan (NMFS 2017); • Spatial and Habitat Avoidance - When gear modifications are insufficient, spatial tools are used to keep shrimp fishing away from high-density Eulachon schools: 1. Substrate Mapping - Predictive Species Distribution Models (SDMs) show that Eulachon bycatch spikes significantly around complex rock-and-mud interfaces. Shrimp vessels rely on bottom-typing sonar tools to stay within pure, soft green mud channels where Pink Shrimp gather but Eulachon are sparse; 2. Preemptive Time/Area Closures - If observers report a major surge of juvenile Eulachon in a specific area, emergency closures can be issued by the states to block the fleet from those specific fishing grounds until the schools migrate out of the zone; since the WCGOP is not longer servicing the fleet, this tool is likely not effective anymore; • Eulachon accounts for 1.71% of bycatch in 2019-21 (last 3 yrs of available data), when reported catches in this fishery were 441.1, 568.9 and 352.3 t, respectively; unidentified shrimp account for 1.09% of bycatch and Slender Sole 0.35%; Pacific
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	Hake 0.16% and unidentified squid excluding Humboldt Squid account for 0.14%. All other species (invertebrates and finfish) account for less than 0.1% on a species basis; • Coastwide Eulachon bycatch data are not available after 2021; however, 97 and 73 t are reported in WA for 2022 and 2023, respectively, which is a decrease from prior years. WA typically accounts for a disproportionate share of Eulachon bycatch relative to its share of total bycatch; • Observer coverage in shrimp fishery averaged 12.5% in OR, 14.7% in CA and 12% in WA since 2011 (Gustafson et al. 2023); • Coverage rate in 2023 was about 12% averaged across all three states, which is above the recent 5 year median of about 10%; • Estimates of bycatch rates based on logbook data are typically lower than rates estimated from observer data, when these comparisons were made; • Limits of 500 lbs of groundfish per day and 1,500 lbs per trip, not to exceed amount of shrimp landed; • Sub-limits of 300 lbs of Lingcod per month and 2,000 lbs of Sablefish; • Canary Rockfish, Yelloweye Rockfish and Thornyhead Rockfish retention is prohibited; • Eulachon Bycatch Management - Because the fishery occurs in both state territorial waters (0–3 miles out) and the federal Exclusive Economic Zone (EEZ) (3–200 miles out), any overarching federal authorization or funding—such as NOAA approving the Pacific Fishery Management Council's (PFMC) Groundfish Fishery Management Plan, which impacts overlapping trawl grounds—serves as the legal trigger forcing a Section 7 consultation; • The primary objective of the Section 7 consultation is to complete a formal Jeopardy Analysis of whether the cumulative bycatch of the shrimp trawl fleet will "jeopardize the continued existence" of the Southern Eulachon DPS or cause the "destruction or adverse modification" of critical marine habitats across its entire geographic range (from the Mad River in California up through British Columbia), factoring in concurrent threats like climate change, river damming, and marine survival shifts; • The result of this process is a formal written Biological Opinion (BiOp), which has consistently concluded that while the shrimp fishery does interact with Eulachon, the operations are not likely to jeopardize the continued existence of the species provided that the fleet utilizes the technical mitigation measures—
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	specifically rigid-grate BRDs and mandatory green LED footrope lights (NMFS 2017); - the BiOp includes a legally binding Incidental Take Statement (ITS) which grants a formal exemption to strict "take" prohibitions outlined in Section 9 of the ESA and legally permits a baseline level of unintentional Eulachon mortality during standard commercial shrimp operations. Incidental take is calculated as a fixed percentage or ratio of Eulachon bycatch weight relative to total landed shrimp biomass, heavily derived from state observer and logbook monitoring programs; - The ITS contains nondiscretionary "Terms and Conditions" that must be executed to maintain the legal take exemption including mandatory annual reporting of estimated total Eulachon bycatch metrics, routine physical field inspections of vessel trawl gear (verifying the 0.75-inch maximum BRD bar spacing), and active funding and support for state-level biological research to optimize how gears behave at varying depths and configurations; - The ITS sets a dynamic incidental take limit 0.02 percent (0.0002) of the calculated minimum Columbia River Eulachon run calculated as a five-year geometric mean;
Ecosystem Impacts:	- While the fishery involves dragging small-mesh trawl nets along the ocean floor, its modern ecosystem footprint is considered small and comprehensive reviews by the Pacific Fishery Management Council (PFMC) and independent sustainability audits categorize the fishery as low-impact; - Shrimp are an important "forage species" in the California Current Ecosystem, acting as a primary food source for major marine predators including Pacific Cod, Pacific Hake, Pacific Halibut, Sablefish, and various marine mammals; - Ecosystem modeling shows that the total biomass of Pink Shrimp is dictated almost entirely by ocean climate cycles (such as upwelling strength and La Niña events) rather than commercial harvests; - Interactions with larger protected species such as whales, sea lions, and sea turtles, are non-existent in this fishery because the nets move too slowly to trap highly mobile marine mammals and operate far outside the geographic range of sea turtles;
Habitat Impacts:	- Bottom trawling has a reputation for destroying seafloor habitats. However, this fleet uses a unique gear profile designed to minimize contact with the substrate: - Semi-Pelagic Configuration - Ocean Shrimp trawls are designed as "semi-pelagic" arrays rather than plowing directly into the

	mud bottom. The heavy fishing line of the net is legally suspended 35 to 70 cm above the seafloor. • Groundline Array - Only a separate, light, parallel groundline maintains direct contact with the mud to flush the shrimp upward, reducing seafloor scraping, leaving deep-sea mud-dwelling invertebrates largely undisturbed; • Spatial Mud Preference - Pink Shrimp are primarily found over soft, green-mud, and sandy-silt ocean bottoms. Because hitting rocky reefs or hard structures would tear nets, fishers avoid high-bias biogenic habitats like deep-sea corals, sponge reefs, and rocky kelp forest foundations. These biogenic habitats are also closed to bottom contact by management agencies;
Climate Impacts:	• The Ocean Shrimp fishery is considered a “recruit fishery” because annual catches are strongly affected by the strength of the year class entering the fishery that year (Hannah and Jones 1991, Hannah 2010); • Forecasting recruitment of shrimp is difficult (Hannah 2010). Recruitment success of Ocean Shrimp is determined during the pelagic larval phase and is related to an early and vigorous spring transition to upwelling conditions (Hannah 2010, 2011); • There are also positive correlations between recruitment and upwelling in general, and negative correlations with SST (Rothlisberg 1975, Rothlisberg and Miller 1983, Hannah 1993). • Ocean temperatures of 8-11°C are apparently favorable for early larval survival (Rothlisberg 1975, Hickey 1989), but as larvae age they have wider thermal tolerances (Hannah 1993). However, anomalously strong upwelling can reduce the local recruitment (Hannah 2011); the hypothesized mechanism for this effect is offshore transport (Parrish et al. 1981, Hill 1991); • Strong upwelling can disrupt feeding strata and limit the availability of food to larval shrimp (Hannah 2011). Recruitment is also negatively correlated with April sea level height (Hannah 1993, 2011), which probably reflects the effects of upwelling;
5. <u>Performance and Sustainability</u>	
Certification:	• The US West Coast Pink Shrimp fishery received MSC certification for sustainability in Dec 2007. It has been recertified four times, with the most recent occurring in Aug 2023, which expires in Aug 2028;
Economic Viability:	• The economic viability of the fishery operates on a high-volume, highly variable commodity model. While the fishery is biologically robust and is Oregon's second most valuable commercial fishery (behind Dungeness crab), its financial sustainability is

	continuously squeezed between volatile global trade forces and rigid overhead operation costs; • The financial foundation of the fleet rests on the volume of landings to offset low unit pricing. Combined landings across Oregon and Washington reached a highly productive window exceeding 78 million pounds. Oregon alone yielded 56.8 million pounds, representing the highest catch in the fishery’s history, but ex-vessel prices (the money paid directly to fishermen at the dock) have only slowly rebounded from a severe historic low of \$0.40/lb up to an average of \$0.54 to \$0.55/lb; Despite these pricing rebounds lifting overall state values, the flat price-per-pound has failed to keep pace with operational inflation; • The fleet faces major external market challenges that directly threaten its profitability margins, primarily from (1) competition with global aquaculture (cheap, farm-raised shrimp imports from countries like Ecuador and India, account for roughly 90% of the US domestic consumption market) which depresses wholesale margins for wild-caught cold-water shrimp, (2) high variable overhead costs from high marine diesel fuel prices, escalating hull insurance premiums, and the cost of maintaining high-tech gear, which reduce a vessel’s net margins. • This fishery was the first cold-water shrimp fishery to achieve MSC certification, which allows processors to market the catch at a premium to sustainability-conscious grocery chains and international European markets;
6. <u>Source Documents</u>	
• CDFW (2022); Forster et al. (2025); Groth (2022); Groth et al. (2026); Gustafson et al. (2023); Hannah (1993); Hannah (2010, 2011); Hannah and Jones (1991); Hannah and Jones (2014a, b); Hannah et al. (2018); MRAG (2026b); NMFS (2017); Oken et al. (2025); Rothlisberg (1975); Rothlisberg and Miller (1993); Smith et al. (2026); Sutherland et al. (2021); Wargo and Ayres (2017)	

Appendix 9 – British Columbia Prawn and Shrimp Trap Fishery

1. Fishery Overview	
Target Species:	• <i>Pandalus platyceros</i> (Spot Prawn)
Stock Structure:	• Stock structure is uncertain but is assumed to be a single coastwide stock for assessment, management and status determination purposes; [supporting analysis for this assumption is not readily available]
Location:	• Fishing occurs in near-shore areas in depths of 40 to 100 m along the BC coastline; • Most commercial harvest occurs in the Strait of Georgia (60%), because of the proximity to large markets for sale of live and fresh caught prawns to the public and processors, and the remainder occurs along WCVI (10%) and north and central coasts (25%); • Although Spot Prawns have been observed in offshore areas, densities are not sufficient to support fishing or incentivize the prawn fleet to explore the possibility, given the short season; • Most of the recreational prawn catch comes from the south coast in the Strait of Georgia (80%) and WCVI (15%). The highest recreational prawn fishing effort is in Saanich Inlet, Stuart Channel, Alberni Inlet and Howe Sound, and includes the waters around, Quadra / Cortes Islands, Powell River and Sechelt, Nanaimo, Barkley Sound, and Gold River/Tahsis; • In 2023, 69% of recreational days (>55,000 days) were spent fishing for prawn/shrimp in the Strait of Georgia while only 17% of prawn/shrimp fishing days occur in Haida Gwaii, the Central Coast and the North Coast areas. The remaining 14% of fishing days was spent in Barkley Sound (~8,000 days) and Johnstone Strait (~9,000 days);
Fleet:	• The commercial fishery is a limited entry, competitive fishery with 246 licence eligibilities, of which, 62 are designated communal commercial licences for First Nations participation in the commercial fishery; First Nations now hold 25% of commercial licence eligibilities; • 201 vessels actively fish on average because seasonal transfers of trap allotments to other licenced vessels occur (called stacking); • Recreational effort was low until the mid-1990s when it began growing with increased prawn abundances in the south coast and concomitant declines in salmon and rockfish stocks; • Commercial vessels range in size from 3.05 to 20.68 m; Two types of vessels in the fishery: (1) freezer vessels (about 60% of

	the fleet), which flash freeze whole prawns at sea and return to port a few times during the season to deliver and provision, and (2) the remaining vessels (40% of the fleet) are 'live' vessels, usually high-speed, with live tanks of seawater on deck that usually return to port daily to supply processors or conduct direct to public sales; • Trap tags were issued to 204 active vessels in 2025, of which 165 were licensed for single trap allotment and 39 were stacked with an additional trap allotment transferred from another vessel;
Gear:	• This is a trap fishery; • Traps must meet the following criteria: ○ A minimum mesh size of 38.1 mm (1 ½ in), which allows most undersize prawns to escape; ○ A maximum volume of 170 L for web or soft-mesh traps, and 100 L for wire mesh traps; and ○ Traps must have biodegradable rot cords which allows the trap to open freely after this cord disintegrates and open tunnels to prevent the trap from 'ghost' fishing if lost; • During the season, each licence holder can fish a maximum of 300 traps and can only haul the gear once per day, between the hours of 7 am and 7 pm; • Up to two licences can be fished on one vessel, which is referred to as 'stacking'. A stacked vessel can fish a maximum of 500 traps, once per day; • In Special Management Areas, only 150 traps on 3 groundlines can be fished, and/or 250 traps on 5 groundlines for stacked vessels; • A minimum of 20 and maximum of 50 traps per ground line; • For vessels fishing one prawn licence, there is a maximum of six lines of gear (300 traps) to be hauled once per day. For 'stacked' vessels, there is a maximum of 10 lines (500 traps) to be hauled once per day;
Economic and Social Context:	• Historically, the commercial fishery has been one of the most valuable fisheries in the Pacific Region, with landed value in the range of \$39 - \$57 million between 2011 and 2014; • Fishery value changed in 2016 when the estimated landed value of the fishery dropped sharply due to a drop in both landings and price. Prices and landings recovered in 2017 and 2018, with both measures showing year-over-year improvements. In 2020, the total landings reached its highest level since 2011, but low market prices seem to have put downward pressure on the total landed value in 2020. • Prices up to 2020 did not include any potential bonus payments that some processors may pay to harvesters after the sale of the

	product. Given that bonus payments contribute a significant portion of the fishery revenue, starting in 2021 bonus payments have been included in prices. Thus, the increase in landed value since 2021 was partially due to the inclusion of bonus payments in addition to changes in prices. • The processing of prawns landed in the province is another source of economic value. The wholesale value for prawn in 2024 was slightly over \$73M, and this value decreased by 11% between 2023 and 2024. It accounted for 21% of the wholesale value of the province's wild shellfish products in 2024 and supports a sizeable share of the province's wild shellfish processing employment. However, it is possible that this figure includes prawns and shrimp that are imported for further processing and value added; • A 2017 report on linkages between seafood harvesting and processing estimated that 2016 wages stemming from the processing of prawns is ~\$2,400 (2016\$, or 133 hours) per metric tonne. In 2024, direct prawn labour processing costs (i.e., wages paid to employees working in the prawn processing sector) were about \$4 million (2024\$). • Prawn landings and processing occur mainly in the Lower Mainland (53% and 59%, respectively) and on Vancouver Island (38% and 32%, respectively). Only about 9% of landings and processing happen in the North Coast of B.C.; • In 2023, 12% of the active recreational fishing population (26,000 fishers) targeted prawn or shrimp species. Around 4% of all recreational fishing expenditures in 2023 (\$25 million) are attributable to prawn or shrimp species. • These recreational prawn/shrimp expenditures translate into more than \$13 million in provincial GDP, supporting around 130 jobs, and providing around \$9 million in household income to families across B.C.;
History:	• Commercial trap fishery began around 1914 in Howe Sound, gradually expanding and reaching prominence in the mid-1970s; • Trapping expanded to Knight and Kingcome Inlets in the early 1950s and these inlets led B.C.'s prawn production until about 1970; • A period of growth occurred between 1979 and 1989 following a series of exploratory prawn surveys (1976-1979) to assist development of the fishery in the north and central coasts of B.C., with the number of vessels reporting landings increasing from approximately 50 to 305 vessels out of an eligible 900 licences issued in 1989;

	• In 1990, licence limitation was implemented and there are currently 246 commercial licence eligibilities; • Annual landings generally showed an increasing trend from the development of the fishery up to 2009. Since 2009, annual catches have been variable. A large decrease in catch was observed in 2010 followed by a high annual catch in 2011. • From 2012 to 2015, prawn landings remained relatively consistent ranging from approximately 1,648 t to 1,842 t and then declining in 2016 and 2017 to approximately 1,219 t and 1,178 t, respectively. • From 2018 to 2020, catches have been increasing from 1,657 t in 2018 to 2,047 t in 2020, and then decreased to 1,695 t in 2021 and 1,599 t in 2022;
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2. Stock Status and Science

Stock Assessment Framework:	• Spot Prawn stocks are managed and assessed based on an escapement-based model, which estimates the number of potential spawners per standardized trap (the Spawner Index - SI) after taking into account natural mortality; • Growth and mortality parameters for the model are obtained through semi-annual fishery independent surveys. Fishery independent index surveys are also conducted in the fall to monitor stock status prior to spawning; • During the commercial fishing season, a sub-set of the commercial traps hauled are sampled by independent observers to monitor stock status relative to the in-season management targets; • Annual commercial trap fishery landings are considered a reasonable and reliable proxy of stock abundance because the traps generally sample the entire range of the stock; • Rossi et al. (2013 – a pre-print uploaded to arXiv, but no evidence of subsequent publication in a peer-reviewed journal) reported a negative relationship between abundance and fishing efficiency which causes catch rates to remain high amid declining abundance for BC Spot Prawn., i.e., hyperstability in the SI; • Fishery-independent surveys are conducted in the spring and fall; • After the commercial season is closed, Spawner Index surveys are conducted in the fall prior to spawning in Alberni Inlet, Stuart Channel, Saanich Inlet and Howe Sound. These surveys monitor stocks prior to spawning relative to SI reference points in areas where most recreational prawn effort occurs to determine whether winter recreational harvest is permissible. • The Pacific Prawn Fishermen's Association (PFFA) has conducted the sampling in the three high use areas, Saanich Inlet, Stuart
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	Channel and Alberni Inlet and DFO conducts the survey in Howe Sound. PFFA conducted their surveys in 2025, but discontinued them in 2026; • In-season SI samples are collected by on-board observers; • 1,409 SI samples were collected during the commercial season in 2025, averaging 352 per week. These samples are processed and analyzed by DFO and are the basis for in-season advice on stock strength; • 19 observers were deployed coastwide in 2025, with four in North and Central Coast and 6 in South Coast and 6 providing admin support; • 2,050 strings were sampled for SI data in 2025, averaging 54 strings/fishery day. 177 of 204 active fishing vessels were sampled (87%) and 444 person-days of on ground monitoring occurred for the 27 d fishery in 2025; • Observers also conduct gear inspections and monitor rockfish bycatch (since 2002); • In 1997, the management framework's SI for the commercial fishery was increased to 25% above base SI in specific locations to maintain fishing opportunity for the recreational fishery. These high use (HU) areas are locations with increased recreational fishing pressure due to proximity to population centers, and locations have changed over time to protect additional popular recreational fishing areas; • Coastwide, the commercial fishery was managed to 10% above base, except in High Use areas where it is managed to 25% above base; • In 2006, an experimental management strategy was phased in for Saanich Inlet and Stuart Channel over two years designed to ensure that the March target for these Special Management Areas (SMAs) was twice the base target. The plan increased the commercial SI target to approximately 50% above base and increased recreational to approximately 35% above base, which reflected a 15% differential for both sectors. Alberni Inlet was added to this plan in 2007 and phased in over two years;
Stock Dynamics	• Population dynamics are highly volatile and driven by a complex mix of recruitment variability induced by abiotic and oceanographic factors such as currents influencing larval dispersal and temperature shifts, intrinsic biological traits including protandric hermaphroditism and density-dependent mortality during molting, and human harvesting. Because Spot Prawns have a relatively short lifespan (roughly 4 years), their population strength experiences significant inter-annual fluctuations without an "average" baseline of abundance;

Biomass Indices:	• The spawner index is the average number of females or transitional prawns which will become females and complete their life cycle in the final year, caught by a standardized trap fished for 24 hours; • From April to July there are three index numbers and from August to March there are only two. In all cases, the first number of the series is the original "base line" spawner index which was established more than 20 years ago as part of the management framework; A baseline SI was established for each month; • The second number is a value 10 % greater than the original base line number. This is the index number that is presently used to manage commercial and select recreational prawn fisheries. It is higher than the baseline to provide an additional margin of safety, for example, by providing a buffer for possible delays in invoking closures in fisheries on prawns, whether closures of the commercial fishery in-season or recreational fishery when needed. • The third number is an index value 25% higher than the base line. This index number only appears for the period of the commercial fishery from April through July. It is the management target for closures in areas where there are a large number of recreational fishers following the commercial fishing season; in some cases an index value 35% higher than the base is used for recreational fisheries or 50% higher than the base for commercial fishing;
Reference Points:	• Based on research in Howe Sound, Boutillier and Bond (2000) estimated a maximum sustainable yield (B_{MSY}) for Spot Prawn of 3.9 SI units in March, which led to a LRP of 1.56 SI (40% B_{MSY}) and an upper stock reference (USR) of 3.12 SI (80% B_{MSY}) in March based on recommendations in a 2008 workshop (DFO 2009); • The management framework was not adjusted downward to align with the LRP (i.e., Base was not reduced from 1.7 SI to 1.56 SI), maintaining a conservative management approach; • The LRP SI is applied at the coastwide level. The management framework uses more conservative SIs based on where the fishing activity is occurring (at a subarea level) and closure decisions should occur before reaching the LRP SI; • During the commercial season, the subarea fishery decisions should close using the more conservative SIs, therefore the LRP would not be crossed if it were to be applied at a subarea level; • The complex nature of the management framework also means the USR is not a point that changes the management approach;

Stock Status:	• Mean spawner index value during the first week of the commercial fishery has ranged from 11.5 to 22.2 SI units, which is double to more than 3 times the baseline threshold for the month when the fishery began in each year since 2002; • The 2025 commercial season began with a coastwide SI value of 16.2 SI units, which was more than twice the baseline threshold; • Stock is considered to be healthy and in the Healthy zone;
Catch Data:	• The most recent estimate of landed weight is 1.6 million kg in 2023, continuing a decline that began in 2020; • No estimates of landings are available for 2025 because not all logbooks have been returned and processed; • The primary indicator of stock status for 2026 will be the sample results obtained at the start of the 2026 commercial prawn season;

3. Management and Governance

Management Framework:	• The commercial fishery is a limited entry, competitive fishery with seasonal closures, in-season area closures, gear limits, gear marking requirements, trap mesh size requirements, minimum size limits, non-retention of prawns with eggs, daily fishing time restrictions and a daily single haul limit. Over 97% of the catch is prawns, with a small incidental catch of Humpback Shrimp, Coonstripe Shrimp and Pink Shrimp (Northern and Smooth); • Minimum size limit is 33 mm carapace length (CL); catch is sorted and undersized prawns must be released immediately on a trap-by-trap basis; • Minimum size limit for headed prawns is 22 mm telson length (Telson is the central piece of the tail fan); • Prawns carrying eggs must also be released on a trap-by-trap basis; • The conservation objective for management of the fishery is to ensure that a minimum number of female spawners are available at the time of egg hatch; • An escapement-based model, the Spawner Index Model (Boutillier and Bond 2000), is the main tool used to assess prawn stocks and manage the commercial fishery season to ensure the spawning stock biomass available at the time of egg hatching (presumed to be the end of March) provides sufficient recruitment to sustain the stock; • The Spawner Index (SI) is a standardized catch per unit effort (CPUE) model based on ensuring a minimum number of female spawners are available at time of egg hatch, which normally occurs around the end of March (called the minimum monthly index – MMI);
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	• Monthly SI values are back calculated from the MMI based on estimates of natural mortality in Knight and Kingcome Inlets over 10 years (1973-1982); • Buffers are built into the monthly SI values so that subareas close before they present a conservation risk of dropping below the baseline during the period it takes FM to review the data; the buffers also accommodate the uncertainty in the SI associated with sampling; • The SI is established coastwide and monitored in-season. Seasonal closures are implemented as fishing effort approaches the monthly index. Once implemented, the area remains closed to commercial fishing to the end of the spawning cycle and the opening date of the commercial season the following year. The closure protects the remaining egg bearing females from commercial fishing mortality through to the end of the larval hatching period; • The fishery continues until Fishery Managers agree that a large enough portion of the coast has closed and the remaining clustered fishing effort has become difficult to adequately manage, with additional considerations such as the status of known productive subareas, at which point the commercial fishery is closed for the remainder of the year. • The hyperstability in the Spawner Index reported by Rossi et al. (2013) creates conservation risks by causing management decisions to be based on overly optimistic impressions of stock status; • Hyperstability and the impact on conservation risk is a major objection to the use of CPUE indices as the primary tool supporting management decision-making; • Commercial fishing season is short, opening no earlier than May 1 to allow for the spawning cycle to complete and for increased growth of the prawns prior to harvest, improving catch weight and value and closes mid to late June, 6-8 weeks in length; • The commercial Spot Prawn fishing season has exhibited a decline from 72 days in 2003 to 27 days in 2025, averaging about 35 days over the last five years; • The recreational fishery is an open entry fishery with a daily limit, two-day possession limit, gear limits and gear marking requirements. Prawns with eggs cannot be retained and there is no size limit; • The recreational fishery is open for most of the coast throughout the year. In response to concerns about growing recreational effort in the 1990s, seasonal closures have been implemented since 2001 to protect egg bearing female prawns from
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	recreational fishing mortality during the critical winter spawning period (January 1 to March 31), through to the end of the larval hatching period (which normally occurs around the end of March); • Recreational data does not differentiate between shrimps and Spot prawns, i.e., they are aggregated into Shrimp and Prawn catch; • Spawner index sampling conducted in the fall prior to spawning helps to determine whether winter recreational harvest in selected areas where most recreational prawn effort occurs may be permissible; • The recreational fishery is also managed from subarea and coastwide scales. Some subareas have higher SI targets (i.e., HUs and SMAs) and additional management considerations, while the rest of the coast is managed to the base SI. The food, social, and ceremonial (FSC) fishery is not managed to SI targets;
Total Allowable Catch (TAC):	• A TAC is not calculated or used to manage this fishery; • This is a limited entry, competitive fishery in which catches continue until the SI value in a subarea triggers the closure of that subarea and eventually, the fishery coastwide;
Harvest Control Rules (HCR):	• Spot prawn are managed on two spatial scales: a subarea by subarea basis, and the larger coastwide scale; • The commercial fishery is opened coastwide at the beginning of the season. Closures systematically occur on a subarea basis when the SI reaches the commercial SI target for the month (and area, if applicable) or after considering other factors; • As the fishery overall progresses and subareas close, a point is reached where a coastwide closure decision is made for the commercial fishery; • A management framework has not been established for the coastwide stock if it is in the Cautious or Critical zones; [This is a problem for compliance with the Fish Stock Provisions in the Revised <i>Fisheries Act</i>]
Monitoring Program:	• Hail out requirements; • VMS is mandatory beginning 72 hr. before first fishing until vessel returns to port and all catch is offloaded after the last fishing trip; • Information about fishing operations (Fishing Operations At-Sea Report) and spawner index information must be provided while at-sea; • Observers are required to collect samples for spawner index monitoring; each sample consists of a complete string of gear set for at least 12 hours, with a minimum of every 4th trap contributing to the sample. A minimum of 12 traps from each string of gear;

	• Species, number and weight of rockfish bycatch caught in the string sample for SI data must also be provided; • Fishing Operations At-Sea Report is based on at least 45 traps hauled from the water and examined; • Set and haul data must be provided to service provider no later than 5 minutes following the setting or retrieval of each string of gear; • The set and haul data are used to guide observers to fishing vessels when they are fishing; • Log books are mandatory and fish slips of all catch are required;
4. <u>Ecosystem and Environmental Impact</u>	
Bycatch Management:	• Bycatch of most non-target species has not been a concern in the prawn and shrimp by trap fisheries due to the nature of trap fishing and the minimal diversity of bycatch. Non-target species are easily sorted and quickly returned to the water with presumed low mortality, and bycatch must be returned to the water immediately and in a manner that causes the least harm. However, juvenile rockfish (<i>Sebastes</i> spp.) that are small enough to be able to enter trap tunnels and that do not leave before being brought to the surface are presumed not to survive release due to their inability to equilibrate air bladders to rapid changes in depth (Rutherford et al. 2009); • A rockfish conservation strategy was implemented in 2002 to protect inshore rockfish stocks; The commercial prawn trap fishery was permitted to continue in RCAs because rockfish encounters in traps were very low (average – 0.006 rockfish/trap); • Whale entanglement in trap ground lines and buoy lines is an ongoing concern; encounter protocols to reduce the risk of entanglement have been adopted by the commercial fishery;
Ecosystem Impacts:	• Free-swimming larvae of Spot Prawn likely comprise a significant portion of the nekton and are prey for a variety of life stages and species of finfish and other aquatic organisms; • Once Spot Prawns have settled to the bottom, after their larval stage, and have found suitable protective habitat, natural mortality is likely reduced. At this stage they are preyed upon by bottom fish and octopuses; • Spot Prawns are opportunistic foragers, consuming fresh, moribund or dead organic material. Stomach contents of Spot Prawns near Vancouver held the remains of polychaete worms and unidentified crustaceans;

Habitat Impacts:	• Traps can impact biogenic structures, including corals and sponges, through crushing, entanglement or scouring. The potential impact of traps on marine habitats is dependent on a variety of factors, including characteristics of the bottom where they are set, weight, size and construction of traps, retrieval methods, sea state, weather, tides and currents, and ground line length (DFO 2010); • Coral and sponge reefs along with other sensitive habitats and MPAs are closed to trap fishing;
Climate Effects:	• The relationship between Spot Prawn abundance and water temperature is inversely correlated over long-term timelines, where rising ocean temperatures generally lead to population declines and recruitment failure; • While short-term spikes in temperature accelerate individual metabolism and growth rates, sustained thermal stress undermines the survival of the species at critical life-history stages; • Colder water temperatures during the pelagic larval stage are associated with much stronger year-class recruitment; • Fecundity is highly sensitive to ambient temperatures. Elevated temperatures disrupt the timing of this sexual transition and have been linked to lowered fecundity (fewer eggs produced per female); • As local bottom waters warm past their optimal thresholds, Spot Prawn shift their distribution northward or into deeper, cooler trenches to survive, collapsing localized coastal abundance; • Heavy rains and melting snow pack flood coastal environments, dropping salinity below the ideal 25–35‰ threshold leading to localized impacts on shallow nearshore nursery areas because freshwater plumes trigger osmoregulatory shock, forcing prawns to abandon these habitats;
5. <u>Performance and Sustainability</u>	
Certification:	• BC Spot Prawns are recommended by the Vancouver Aquarium's OceanWise program and listed as a "Good Alternative" by the Monterey Bay Aquarium's Seafood Watch, largely due to the use of highly selective trap methods that avoid habitat destruction;
Economic Viability:	• In 2023, 77% of revenues for prawn licence holders came from prawn fishing with the rest coming from other fisheries. Halibut (9%), Geoduck(4%), Crab (3%), Sablefish (2%), Tuna (2%), Sea Cucumber (1%), Salmon Troll (1%), and Rockfish, Red Sea Urchin, Schedule II, and Salmon Gillnet (all less than 1%);

	• Prawn and shrimp are mostly shipped frozen to markets in China (57%) and the USA (38%), followed by Hong Kong (3%), Vietnam (1%), and Japan (0.4%); • \$2M in value-added from wholesaling and processing was generated by 43 companies located in B.C. and directly contributed \$39M (GDP) to the provincial economy, with a direct employment and income contribution of 591 FTEs and \$25M, respectively; • Prawn and shrimp accounted for 31% of total recreational shellfish fishing days (8% of total fishing days);
6. <u>Source Documents</u>	
• Boutillier and Bond (2000); DFO (2026h, 2026i); Krumsick and Araujo (2026); Rossi et al. (2013); Rutherford et al. (2004)	

Appendix 10 – Australian Northern Prawn Trawl Fishery

1. Fishery Overview	
Target Species:	• Redleg Banana Prawn - <i>Penaeus indicus</i> • White Banana Prawn - <i>Penaeus merguensis</i> • Brown Tiger Prawn - <i>Penaeus esculentus</i> • Grooved Tiger Prawn - <i>Penaeus semisulcatus</i> • Blue Endeavour Prawn - <i>Metapenaeus endeavouri</i> • Red Endeavour Prawn - <i>Metapenaeus ensis</i> • Banana Prawns and Tiger Prawns are the main species targeted in the fishery, accounting for around 90% of the total catch; • Endeavour prawns are treated as bycatch in this fishery;
Stock Structure:	• Redleg Banana Prawn – a single stock is assumed for management, assessment and status determination; • Stock structure is uncertain for all other Banana, Tiger and Endeavour Prawns but a single stock in the NPF is assumed for each species for assessment, management and status determination purposes;
Location:	• Fishery occupies an area of 780,000 km² off Australia's northern coast from Joseph Bonaparte Gulf in the west to the Gulf of Carpentaria in the east, extending from the low water mark to the outer edge of the Australian Fishing Zone (AFZ) along approximately 6,000 km of coastline; • Only around 11% of the total NPF area is fished (average of 6x6 minute grids fished from 2010 to 2021) with the major trawl grounds of the NPF being in the Gulf of Carpentaria and the area to the north and south-west of Darwin;
Fleet:	• Prawn harvest by the recreational and Indigenous sectors is believed to be negligible in northern Australia; • The NPF is primarily a commercial fishery with a total of 52 vessels permitted; ▪ In the fishery there are currently: • 52 boat fishing rights (maximum number of vessels active at one time); ▪ 35,479 gear fishing rights; ▪ Gear fishing rights entitle the holder to use a net with a certain headrope and footrope length. A gear right for operators using: ▪ twin (two nets) trawl nets is currently worth 9 cm of headrope length ▪ twin tongue (two nets), triple (three nets), or quad (four nets) trawl nets has a value of 8.1 cm per gear right;

Gear:	• NPF fishers use demersal otter trawl gear, with twin, triple and quad gear allowed; most vessels have transitioned from two to four nets, a configuration that is considered most efficient; • Sorting grates are mandatory (with a design specific to the fishery) and turtle excluders are also mandatory;
Economic and Social Context:	• Fishery is valued at \$77.6 million (AUD, 2023-24); • Most of the catch is frozen fresh on-board and periodically transferred onto motherships at sea and landed at 3 main ports: Cairns, Darwin or Karumba;
History:	• The NPF developed rapidly in the 1970s, with effort peaking in 1981 at more than 40,000 fishing days and more than 250 vessels; • During the next three decades, fishing effort and participation were reduced to the current levels of around 6,000 to 8,000 days of effort and 52 vessels; • This fishery restructuring was achieved through a series of structural adjustment and buyback programs, alongside management measures to unitize and control fishing effort. Total catches also fell during this period, but by a smaller percentage; • The highest catch of all Redleg Banana Prawns reported in the fishery for all areas was 1,126 t in 1997. Over the past decade, annual catches have averaged 340 t, but with high variability. Catches were especially low in 2015 (56 t) and 2016 (66 t); • Catch of White Banana Prawn has varied over the years from around 1,500 t (1994) to above 7,000 t (2011). Seasonal catch is highly variable and is often associated with rainfall in some areas; • Catch of Brown Tiger Prawns has been variable since the fishery began in the 1970s, with annual catch up to 3,200 t through the early 1980s, but mostly less than 500 t in recent decades; • The annual catch of Grooved Tiger Prawn peaked in the early 1980s at more than 2,600 t and has shown a declining trend since then, except 2015 when catch was estimated to be 2,520 t; • Annual catches of Blue Endeavour Prawn peaked in the early 1980s at more than 1,500 t, and again in the late 1990s at 1,000 t. Since 2002, annual catches have averaged around 280 t; • Annual catches of Red Endeavour Prawn have been variable over the history of the fishery, from 47 t in 2007 to 1,067 t in 1997;
2. <u>Stock Status and Science</u>	
Stock Assessment Framework:	• Most recent assessment of Redleg Banana prawn was completed in 2024 with a model using a Beverton-Holt stock-recruit function, and quarterly time steps of catch and effort across the two fishing seasons in each calendar year to assess SB up to the most recent fishing year and estimate future effort required to

	achieve SB_{MEY}. Average historical recruitment is assumed for predicting future TAE and catch; • There is no formal stock assessment of White Banana Prawn because of high variability in recruitment and no clear stock-recruit relationship; • A formal assessment of the Tiger Prawn fishery occurs every two years and uses a multi-species approach with a weekly sex and size-structured population model for both species (Brown Tiger and Grooved Tiger); • A new single-stock Bayesian hierarchical biomass dynamic model (surplus production) was developed for assessing Blue Endeavour Prawns, which treats them as the target species; the outputs from this model then feeds directly into the multispecies assessment for Tiger Prawns (which treats Blue Endeavour Prawn as a byproduct) and is used for status determination; • The output for the Red Endeavour Prawn assessment is currently a sensitivity within the multispecies model used for Tiger Prawns and Blue Endeavour Prawn; • The resultant stock assessment outputs and estimated stock-recruitment parameters are then combined with economic parameters to form the bio-economic model whose outputs are used to set the annual level of standardized effort for the fishery (or TAE), expressed as number of fishing days; • The annual effort levels in the fishery are adjusted based on the outcomes of the bio-economic model. While a range of mechanisms are available to adjust annual effort levels in the fishery, the primary mechanisms used are modifying the season length and/or the total amount of gear allowed in the fishery each year; • There is a strong correlation between Endeavour Prawn and Tiger Prawn catches so any effort controls applied to Tiger Prawns implicitly applies to Endeavour Prawns; • Assessment of Banana Prawns is accomplished through an indicator approach including catch and CPUE, Tiger Prawn catches for weeks 1-4, costs for repairs and maintenance, and prawn prices and fuel costs; • Recruitment is monitored by an annual fishery-independent survey conducted in Jan-Feb; • A second fishery independent survey is conducted annually in July to monitor adult prawn biomass;
Stock Dynamics	• Recruitment of prawns is impacted by a range of environmental factors (rainfall, river flow, sea surface temperature, etc.) and no clear stock-recruitment relationship has been determined for Banana Prawns;

	• In contrast, while environmental factors also impact Tiger Prawn recruitment, a stock-recruit relationship has been demonstrated for Tiger Prawns;
Biomass Indices:	• NPF 2025 (Feb-Mar) index for Banana Prawn was 12.35 ± 5.76 prawns ha^{-1}, which is fourth highest in the time series, and a 50% increase relative to the 2024 value; • Brown Tiger Prawn Feb-Mar index was 2.71 ± 0.30 prawns ha^{-1} in 2025, second lowest value in the time series; • 2025 Feb-Mar index for sub-adult Blue Endeavour Prawns was 1.57 ± 0.12 prawns ha^{-1}, which is the lowest value in the time series; • July 2024 indices were 5.71 ± 0.51 prawns ha^{-1} for adult brown Tiger Prawns and 4.31 ± 0.21 prawns ha^{-1} for grooved Tiger Prawns and these values are the second lowest and above average for the time series, respectively; • July 2024 index for Blue Endeavour Prawns was 6.90 ± 0.42 prawns ha^{-1}, which is the second highest in the time series; • Over the last decade, sub-adult Tiger and Endeavour Prawn indices (Feb-Mar – recruits to the fishery) have been in a punctuated decline;
Reference Points:	• Estimate relative values: • $\text{LRP} = 0.5 S_{\text{MSY}}$, where S is spawning biomass; • $\text{TRP} = S_{\text{MEY}}$, where MEY is maximum economic yield, and was chosen because the operational objective of the fishery is MEY; • Because prawn recruitment is highly variable compared to longer-lived species, the reference point is applied using the moving average of S_t/S_{MSY} over the most recent 5 years. Thus, if the moving average falls below $0.5 S_{\text{MSY}}$, then the species status is considered overfished;
Stock Status:	• 2024 assessment estimated the spawning stock biomass of Redleg Banana Prawn in JBG at the end of 2023 (3,508 t) to be 2.34 times the spawning stock biomass LRP ($\text{SB}_{2023}/\text{SB}_{\text{LIM}}$), 1.17 times the spawning stock biomass at MSY ($\text{SB}_{2023}/\text{SB}_{\text{MSY}}$), 0.98 of the spawning stock biomass at MEY ($\text{SB}_{2023}/\text{SB}_{\text{MEY}}$). Spawning biomass has remained above SB_{LIM} since 1999; • Harvest rates for White Banana Prawn were quite high historically, potentially exceeding 90% in some years; the stock appears to be resilient to these levels of fishing pressure. There is a long history of significant catches across many generations of the stock with no evidence of overfishing in the past or present; • 2024 multispecies assessment estimated that at the end of 2023, Brown Tiger Prawn spawning biomass was 0.41 ($\text{SB}_{2023}/\text{SB}_0$), up from 0.38 in the 2022 assessment. The 5-yr average (2019-2023)

	of SB relative to SB_{MSY} (SB_{YEAR}/SB_{MSY}) was 0.87 and above the LRP of $0.5 SB_{MSY}$; • There is increasing uncertainty in the fishery about Brown Tiger Prawn productivity and the impact of the large reduction in biomass from 2023 to 2024; The most recent spawning biomass and the 5-year average of spawning biomass for brown Tiger Prawn are estimated to be above the LRP ($0.5SB_{MSY}$) and catches in 2023 and 2024 are well below the catches associated with MSY and should not drive the stock below the LRP; • The base-case estimate of spawning biomass for Grooved Tiger Prawns at the end of 2023 as a proportion of unfished spawning biomass (SB_{2023}/SB_0) was 0.55, up from 0.40 in the 2022 assessment. The 5-year average (2019 to 2023) of spawning biomass as a proportion of spawning biomass at MSY (SB_Y/SB_{MSY}) was 1.07 (above the agreed LRP used in the harvest strategy of $0.5SB_{MSY}$). The base-case estimate of spawning biomass as a proportion of spawning biomass at MEY (SB_{2023}/SB_{MEY}) was 0.72, up from 0.61 in the previous assessment; • The base-case estimate of SB for Blue Endeavour Prawn at the end of 2023 as a proportion of unfished spawning biomass (SB_{2023}/SB_0) was 1.01, up from 0.37 in the 2022 assessment. The 5-year average (2019 to 2023) of spawning biomass as a proportion of spawning biomass at MSY (SB_Y/SB_{MSY}) was 0.95 and above the agreed LRP used in the harvest strategy of $0.5SB_{MSY}$. The base-case estimate of SB as a proportion of SB at MEY (SB_{2023}/SB_{MEY}) was 1.18, up from 0.57 in the previous assessment; • The SB estimate for Red Endeavour Prawns at the end of 2023 as a proportion of unfished SB (SB_{2023}/SB_0) was 1.01, up from 0.41 in the 2022 assessment. The 5-year average (2019 to 2023) of SB as a proportion of SB at MSY (SB_Y/SB_{MSY}) was 1.00 and above the agreed LRP used in the harvest strategy of $0.5SB_{MSY}$. The base-case estimate of spawning biomass as a proportion of spawning biomass at MEY (SB_{2023}/SB_{MEY}) was 1.22, up from 1.06 in the previous assessment; • The status in 2025 of all six species is not overfished (i.e., $S_{2025}/S_{MSY} > 0.5$) and overfishing is not occurring (i.e., $E_{2025} < E_{MEY}$);
Catch Data:	• White Banana Prawns are mainly caught during the day on the eastern side of the Gulf of Carpentaria, whereas Redleg Banana Prawns are caught day and night, mainly in JBG; • Tiger Prawns are primarily taken at night (daytime trawling is prohibited during the Tiger Prawn season). Most catches of Tiger

	Prawns come from the southern and western Gulf of Carpentaria, and along the Arnhem Land coast; • Banana Prawns typically comprise 70-80% of total catch in the 2021-24 period while Tiger Prawns comprised 15-22% and Endeavour Prawns 4-9% of the catch during the same period; Endeavour Prawns are mainly caught as byproduct species when fishing for Tiger Prawns; • Total catch in 2024 was 5,683 t and is a 32% reduction relative to the 2023 catch of 8,381 t; • Blue Endeavour Prawn – 286 t • Grooved Tiger Prawn - 1,014 t • Indian white prawn – 48 t • Brown Tiger Prawn – 191 t • Red Endeavour Prawn – 140 t • Banana prawn - 3,829 t; • Total effort in the 2024 banana season was 7,708 shots while the Tiger season in 2024 was 15,489 shots; • Total Redleg Banana Prawn catch in the NPF in 2024 was 48 t, the lowest in over 40 years, well down from 2023 (309 t). Effort in 2024 was 60 days, a 60% decline from 2023 (179 days) ; • White Banana Prawn catch in 2024 was 3,829 t, down from 2023 (6,470 t), which was the third highest recorded catch since 1990. Most of the catch is taken in the Gulf of Carpentaria; • Catch of Brown Tiger Prawns in 2024 was estimated to be 191 t, down from 2023 (321 t) and the second lowest catch on record. Fishing effort in 2024 was 471 days, well down from 2023 (1,116 days); • The reduced Tiger Prawn effort in recent years (relative to the average effort for 2010 to 2021; 1,299 days) was in part a result of the AFMA/industry decision to reduce the TAE by shortening the fishing seasons; however, some vessels also reduced fishing as a result of economic conditions; • Catches of Brown Tiger Prawn in 2023 (321 t) and 2024 (191 t) are both below the estimated maximum sustainable catch of 982 t; • Catch of Grooved Tiger Prawn in 2024 was estimated to be 1014 t, up from 2023 (921 t). Average effort between 2010 and 2021 was 4,044 days. Effort in 2024 was estimated to be 3,404 days, up from 3,312 days in 2023. The reduction in effort stems from the same circumstances impacting the Brown Tiger Prawn fishery; • Catch of Blue Endeavour Prawn in 2024 was estimated at 286 t, up from 2023 (233 t). Blue Endeavour Prawn is a byproduct of
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	fishing for Tiger Prawns, and so catches are linked to changes in effort targeting Tiger Prawns; • Catches of Red Endeavour Prawn in recent years (estimated to be 140 t in 2024, 127 t in 2023, 177 t in 2022) are low compared with historical highs. Red Endeavour Prawn is a byproduct of fishing for Tiger Prawns, and so catches are largely linked to changes in effort targeting Tiger Prawns. The low catch in recent decades is related to the overall decline in fishing effort directed at Tiger Prawns, and area and time closures affecting areas where Red Endeavour Prawn were historically taken, rather than being an indication of a real decrease in Red Endeavour Prawn biomass;
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3. **Management and Governance**

Management Framework:	• The NPF is managed through a series of fixed input controls, including limited entry to the fishery and individual transferable effort units, flexible input controls including total allowable effort (TAE), and seasonal closures; a TAC for each target species is not part of the framework; • The harvest strategies also specify target reference points (TRPs) and limit reference points (LRPs) and contain harvest control and decision rules; ▪ Fishers must hold a valid boat fishing right to fish in this fishery. Fishers also need to have gear fishing rights that allow them to use a certain amount of net to catch fish in the fishery. These fishing rights are transferable to others; ▪ Fishing is divided into two seasons whose end dates depend on catch rates and may be closed early: ▪ Season 1 (mainly Banana Prawns caught): 1 April – 15 June; ▪ Season 2 (mainly Tiger Prawns caught): 1 August – end of November; • The management of the NPF is primarily based around the Tiger Prawn component of the fishery, with Endeavour and King prawns generally caught as incidental catch of Tiger Prawn fishing activities; • AFMA and NPF Industry Pty Ltd. (NPFI) entered into a co-management arrangement in 2012; NPFI focuses on developing and implementing the bycatch strategy, research and development of BRDs that have been implemented, and the crew-based monitoring program (CMO) for bycatch; • AFMA determined in 2013 that the NPF would be managed through input (effort) controls because of the difficulty in setting catch quotas (output controls) for highly variable prawn fisheries, which could result in significant economic losses in some years;
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	• Catch rates are monitored throughout the two fishing seasons and the season length can be shortened in accordance with decision rules for the Tiger Prawn fishery and Banana Prawn fishery; • Provided that the LRP for either Tiger Prawn species is not breached, a minimum effort threshold (MET) level for the fleet is applied in the model to ensure that the fishery remains economically viable while still achieving the MEY target within a 7-year timeframe chosen to achieve this target; MET = 4,004 days; • If the LRP of either Tiger Prawn species is triggered, then targeted fishing will not be permitted and effort controls will be applied to prevent fishing on species below the LRP; it helps that these species can be separated spatially and temporally; • The Banana Prawn fishery is managed by a combination of spatial and temporal closures and a fixed season length with in-season management aimed at potentially closing the season earlier to limit fishing pressure on the stock and increase the economic returns in less productive years; • Management of the Banana Prawn fishery includes an MEY-based catch rate trigger (kg/boat/day). This has been based on catch rate information for specified reference periods, wherein the average is calculated and, if the value falls below the MEY catch trigger, then the fishery is closed a week later; • The MEY trigger is bounded by a buffer of 15% of 500 kg/boat/day, meaning the minimum MEY trigger is 425 and the maximum is 575 kg/boat/day; • Fishing for Redleg Banana Prawn primarily takes place in JBG, well away from most of the other fishing in the NPF so there are separate management arrangements for this species in this area; • The Redleg Banana Prawn harvest strategy aims to keep spawning biomass (SB) above an LRP of 0.50 of the spawning biomass at maximum sustainable yield (MSY) (i.e. $0.5SB_{MSY}$). If spawning biomass of Redleg Banana Prawn is calculated to be below the LRP for 2 successive fished, data-sufficient years (minimum 70 days fished in a year), then fishing for Redleg Banana Prawns is not allowed in the following calendar year; • The Redleg Banana Prawn fishery TRP is spawning biomass at MEY (i.e. SB_{MEY}), but this has not yet been possible to calculate. Instead, AFMA has developed a proxy target for MEY, which is based on the reference period 1999 to 2010, a period of good economic performance in the fishery and so the proxy target is the modelled average spawning biomass during this period;
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	• White Banana Prawns typically display high annual natural variability in recruitment due to environmental drivers and as a result no clear stock–recruitment relationship has been estimated and no annual stock assessments to monitor stock status are available; • Instead, the White Banana Prawn harvest strategy aims to allow for sufficient escapement from the fishery to ensure an adequate spawning biomass (based on historical data), and for fishing to stop when it becomes uneconomic. The strategy considers average catch rate across the fleet (in kilograms per boat per day), alongside economic data (e.g. prices and costs) at specified times throughout the season and adjusts the season length to prevent catch rates dropping below a specified trigger; • The strategy specifies the catch-rate trigger (estimated around 500 kg per boat per day) as the point at which the weekly marginal revenue equals weekly marginal cost (that is, when average daily catch rates fall to the point where revenue generated by the catch is equal to the average daily costs of fishing, so that marginal profit falls to zero: the 'break even' catch rate); • The Tiger Prawn fishery harvest strategy, which also includes Endeavour Prawns, aims to meet an overarching fishery-level TRP by maintaining the spawning biomass for all 4 stocks at MEY (SB_{MEY}). This harvest strategy specifies individual species' LRP of $0.5SB_{MSY}$; • Due to high interannual variability in biomass, the average spawning biomass index (SB_{YEAR}/SB_{MSY}) over the past 5-year period is used when evaluating biomass relative to LRPs for Tiger and Endeavour Prawns; • If the average spawning biomass index over the previous 5 years for either brown Tiger or Blue Endeavour Prawns is calculated to be less than the LRP, then there will be no targeting of those species in the forthcoming first season (1 April to 15 June); • If average biomass of grooved Tiger Prawns is below LRP, then there will be no targeted fishing in forthcoming second season (1 August to 30 November). • If average biomass of Red Endeavour Prawns is below LRP, then there is no targeted fishing for either season;
Total Allowable Catch (TAC):	• Harvest strategy goal is to achieve an exploitation rate that keeps prawn stocks at a level equal to MEY and ensure stocks remain above the limit biomass level (B_{LM}) at least 90% of the time; • Total allowable effort (TAE) is estimated for management purposes: 2025 TAE for Tiger Prawns is 4,014 boat days (slightly

	above the MET of 4,004 boat-days); TAE for Redleg Banana Prawns is 412 boat-days in 2025; • TAC is not used in this fishery;
Harvest Control Rules (HCR):	• There is no harvest control rule, but there are a series of decision rules for the Banana Prawn and Tiger Prawn fisheries; • The goal of the decision rules is to ensure that MEY is achieved, averaged over a 7-year period; • A minimum effort threshold (MET) of 4,004 days is used for the Tiger Prawn fishery and ensures that the fishery will occur the next year unless one or both LRPs is triggered;
Monitoring Program:	• Fishery-independent data collection program based on two surveys: ○ February/March survey which provides recruitment indices for Banana, Tiger and Endeavour Prawns, and length frequency data for Tiger and Endeavour Prawns in the Gulf of Carpentaria; ○ Biennial June/July survey aimed at providing an index of abundance during the effective spawning season for the main commercial prawn species, and length frequency data for Tiger and Endeavour Prawns in the Gulf of Carpentaria; • Fishery-wide daily catch and effort are collected through an electronic logbook program for Tiger, Endeavour and King prawns, including vessel gear sheets; • Data collected through the annual gear survey run by NPFI to monitor and track changes in gear and technology in the fishery through the fishing power model; • Sales Landing Receipts, SLR (data used to ground truth the logbook data); • Two types of observers may be placed on vessels: (1) crew-based monitoring program observers (CMO) in which NPFI funds crew-members to conduct observer functions, and (2) scientific observers from AFMA; • CMO program has been in place since 2003 to collect data (including photos for species verification) on interactions with species at high-risk from fishing activity and those listed as Endangered, Threatened and Protected (ETP); Annual training is held to support this program; • Part of the goals of the CMO program are to develop mitigation measures to reduce interactions, injury or mortality of incidentally caught non-target species; • The CMO data are analyzed in conjunction with Scientific observer program data for trends in catches and to inform the NPF Ecological Risk Assessment and MSC certification;

- CMO target is to monitor at least 2,340 trawl shots (about 12% of fishing) across both fishing periods annually for ETP and high-risk species and sawfish and sea snakes for 85% of interactions photographed for species ID and verification;
- Scientific observers independently record the catch, effort and biological information of each fishing trip and take samples from the catch for scientific analysis;
- Observers also record the length, weight and sex of target species caught during a trip and report on the other wildlife, the weather conditions, the composition of commercial catch and the fate of species caught as bycatch;
- CMO observers have higher coverage (in days) than AFMA scientific observers:

Observer	2024	2023	2022	2021
CMO	987	885	862	1099
Scientific	168	154	98	213

4. **Ecosystem and Environmental Impact**

Bycatch Management:	• Management controls (size/trigger limits) are in place for a range of other bycatch species that are retained because of their commercial value; • Additionally, as a number of these species are taken as an incidental part of the Tiger Prawn catch, the effort controls which apply to Tiger Prawns also apply to these species; • CMO program funded by NPFI is focused on recording, reducing and mitigating interactions with high-risk species, ETP species and habitat-forming benthos (Corals, Sponges); focus has been on Sawfish interactions and Sea Snakes; • Four high risk protected species are all Sawfish and are the focus of ongoing mitigation and monitoring; Sawfish workplan includes development and testing of gear innovations, net materials and turtle excluder designs to reduce Sawfish interactions in trawl nets; some tests were successful at reducing interactions, others were not or it was not clear whether or not there was an impact;
Ecosystem Impacts:	• A comprehensive system of spatial and temporal closures assists in addressing biological and economic objectives of the fishery (Kenyon et al. 2005) and broader ecological requirements. • A total of 2.1% of the total managed zone of the fishery is subject to permanent closures, while 11% is subject to seasonal closures. Closures in the fishery include: ○ permanent closures of seagrass beds and other sensitive habitats; and

	○ seasonal closures of juvenile habitat, designed to coincide with recruitment phases and protect pre-spawning prawns, and ensure prawns are at a commercial size for harvesting. • Discrete spatial closures, end of season and mid-season closures are in place to protect small and spawning prawns; • A daylight trawl closure is in place during the second (Tiger Prawn) fishing season to reduce the capture of spawning Tiger Prawns; • Recent ecosystem research highlights the potential impacts of water extraction and altered river flows on prawn recruitment and broader ecosystem components in the Gulf of Carpentaria; • Models of Intermediate Complexity for Ecosystem (MICE) assessments have demonstrated that reductions in freshwater inflow can materially influence the productivity of key NPF species, particularly Banana Prawn recruitment;
Habitat Impacts:	• Habitat impacts by the fishery are mitigated through: ○ Permanent fishery closures of all known shallow water seagrass beds (2.1% of the total area); ○ Seasonal fishery closures (11% of the total area); ○ Parts of Commonwealth and state marine parks are closed to trawling; ○ Unsuitability of areas to trawling due to large reef outcrops; ○ Low density of the target prawns (e.g., Gulf of Carpentaria);
Climate Effects:	• Blamey et al. (2025) conducted a MSE for models with either a stock-climate or catchability-climate relationship for Redleg Banana Prawns; they concluded that static-based (fixed) reference points are likely to provide a more precautionary approach for highly variable species such as the Redleg Banana Prawn than time-varying reference points (e.g., dynamic B_0) and will help ensure stock conservation under climate change;
5. <u>Performance and Sustainability</u>	
Certification:	• The Australian NPF received initial certification of sustainability from MSC in Nov 2012. It has been re-certified several times and the current certification expires in July 2028;
Economic Viability:	• AUD \$77.6 million (2023–24) • The NPF is one of the most valuable fisheries in Australia. The annual gross value of production (GVP) of the fishery has varied between \$65 million and \$168 million AUD due to fluctuating annual catch, fishing effort/season lengths, market conditions and foreign exchange rates;

	• Gross value of production (GVP) for the NPF is strongly influenced by catch composition of Banana Prawns and Tiger Prawns; • Real GVP (in 2023–24 dollars) trended downwards during the last decade, from a peak of \$157 million in 2015–16 to \$87 million in 2023–24, driven by declining Tiger Prawn catches and decreasing real prices for key target prawn species; • Real GVP per active vessel also trended downward over the same period, reflecting the decline in GVP while vessel numbers remained relatively steady; • From 2012–13 to 2015–16, real net economic return (NER) followed an increasing trend, from \$6.6 million to a peak of \$39.1 million, supported by a strong increase in Tiger Prawn catch and strong prices. Since 2015–16, real NER fluctuated, decreasing to \$4.4 million in 2021–22; • The forecasted NER increase in 2022–23 to \$9.1 million reflects higher fishing revenue – driven by an 83% increase in the catch of Banana Prawns that year – and stable operating costs; • The Tiger Prawn component of the fishery has explicit MEY targets (across both Tiger Prawn stocks and the Blue Endeavour Prawn stock), and a bioeconomic model is used to estimate annual fishing effort required to move towards SB_{MEY} over a 7-year period. The targets can change with every assessment because of changes in biological and economic parameters; • Targeting MEY of the Tiger Prawn component of the fishery began in 2004–05 and is consistent with the economic objective of maximizing economic returns. The Banana Prawn component of the fishery has catch-rate triggers to stop fishing activity when catch rates become low and unprofitable (AFMA 2022); • Since 2016, spawning biomass for both Tiger Prawn species has been below the MEY targets and on an overall declining trend, although both have increased in 2022 and 2023. Spawning biomass for Redleg Banana Prawns has also been below its MEY target from 2015 to 2023 (except in 2022), although on an increasing trend during that period; • Based on these trends, fishery NER, while still positive, may not be maximized. The low post-recruitment abundance for brown Tiger Prawns in 2023 heightens the need to continue monitoring key stocks and the impact of this declining trend on MEY (and therefore the maximization of NER);
6. <u>Source Documents</u>	
• AFMA (2024); AFMA (2025); AFMA and NPFI (2024); Butler et al. (2025); MRAG (2026a)	

Appendix 11 – DFO critical pathway for commercial Shrimp trawl fishery

Critical Path for Commercial Shrimp Trawl Fishery

Element	Activity	Description	Target Completion	Comments/Rationale
A. Updating Science Survey Model	Technical Analysis (<i>DFO Marine Invertebrate Science</i>)	CSAS Review of survey methodology and Recommendations	2025 - 2026	DFO completed CSAS review in April 2025. A new model was recommended, and DFO anticipates initial steps towards implementation in 2026.
B. PA Framework	Reference Point Review (<i>DFO Marine Invertebrate Science</i>)	Technical Report	2026	To support implementation of the new survey design and biomass estimation methods, a revision or re-scaling of the existing reference points will occur. These reference points would be in effect until the subsequent CSAS review of reference points. First Steps completed in 2026, but may be multi-year implementation or adjustments.
C. Investigating Alternative PA Frameworks	Literature Review & Consultation (<i>DFO FM</i>)	DFO Contract for external literature review	2026	External literature review exploring alternative options for management frameworks such as in-season CPUE or other fishery-based metrics. DFO issue contract through outside consultant to conduct review and consultations with licence holder representatives on options.
D. Survey Gear Modifications	Consultation (<i>DFO Marine Invertebrate Science</i>)	Ongoing review of DFO Science Survey gear	2026 - 2027	DFO will continue to consult and work with licence holders to update and modify survey gear while still maintaining scientific standards for the program.
E. Updating PA Framework	Technical Analysis (<i>DFO Marine Invertebrate Science</i>)	CSAS Review of PA Reference Points and Harvest Control Rules	2028 - 2029	Current PA framework and reference points have been in place since 2009. This review will update the time series of survey data used to set reference points, and update science advice on appropriate future reference points and harvest control rules based on stock definition and assessments.
F. Investigating Alternative	Technical Analysis (<i>DFO</i>)	Possible CSAS paper exploring alternative	TBD	Build on literature review findings. Licence holders have expressed an interest to explore

Management Frameworks	<i>Marine Invertebrate Science)</i>	options for management of the fishery		alternative management frameworks for the fishery using CPUE or other metrics to assess the health and status of the stocks. Process steps to be determined upon outcomes of the contracted literature review and completion of other activities listed.
G. Fraser River Eulachon Stock Assessment Framework and PA Reference Points	Technical Analysis; CSAS Process (DFO Pelagics Science)	Phase 1: Integration of multiple data sources and uncertainties into an operating model framework for Fraser River Eulachon and identification of candidate PA compliant reference points for the stock	End 2027	Development of an operating model (OM) for Fraser River eulachon is central to evaluating the impact of candidate shrimp trawl bycatch on the stock. The OM represents the population dynamics and how individuals move through the marine environment and incorporates key uncertainties, including the genetic composition of the mixed eulachon population encountered by the shrimp trawl. This allows bycatch mortality from the Shrimp trawl fishery to be applied to a biologically plausible population rather than evaluated in isolation. Bycatch scenarios can then be assessed in terms of population-level consequences, not just total catches.
H. Simulation-Evaluation of Identified Candidate Management scenarios	Technical Analysis (DFO Pelagics Science)	Phase 2: Using the CSAS approved operating model (Phase 1) and simulation testing to evaluate alternative bycatch scenarios	~2028/2029 (dependent on consultation approach/outcomes and availability of funding)	Management scenarios, including bycatch levels, need to be identified ideally through consultations with industry and First Nations before this work can be completed. Additionally, performance metrics, such as, the probability of exceeding the identified reference points for Fraser River Eulachon or triggering the EAL for the Shrimp trawl, need to be identified. Running bycatch scenarios across multiple operating model scenarios simulated into the future will allow managers to evaluate whether
				a given bycatch limit performs acceptably across plausible futures, consistent with the DFO's precautionary approach.