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MSC Assessment Report for

The Canadian Offshore Northern Shrimp (*Pandalus borealis*) Trawl Fishery - Shrimp Fishing Area 1

Client: Canadian Association of Prawn Producers and the Northern Coalition

Version: Stakeholder Comment Draft

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1 SUMMARY

This report sets out the results of the assessment of the Canadian Association of Prawn Producers (CAPP) and the Northern Coalition (NC) Northern Shrimp Trawl Fishery in Shrimp Fishing Area 1 against the Marine Stewardship Council (MSC) Principles and Criteria for Sustainable Fishing. The assessment was carried out over the period September 2009 to December 2010.

The assessment of MSC Principle 1 was led by Michaela Aschan; Principle 2 was led by Howard Powles; and Principle 3 was led by John Angel. A full account of the assessment team's relevant experience is set out in section 10.1 of this report.

The evaluation process involved gathering information relevant to the fishery during a site visit in St. John's Newfoundland and Labrador (NL). Through discussions with other stakeholders, and by reviewing relevant literature the assessment team compiled a draft report, and 'scored' the performance of the fishery. The client agreed to the findings of the report and committed to an action plan to strengthen weaknesses identified against the MSC Principles and Criteria.

In draft form, the report was then subject to critical review by appropriate, independent, scientists ('peer review'). The comments of these scientists were taken into account and appended to the report. Following peer review, the report is released for public scrutiny on the MSC website.

This assessment is one of four MSC assessments being undertaken for the CAPP and the NC by Moody Marine Ltd on shrimp fisheries within Canada's North West Atlantic Exclusive Economic Zone (EEZ). The others are identified as separate units of certification owing to the differences in species and management regime. They are:

- *P. borealis* in SFAs 2-6;
- *P. borealis* in SFA 7; and
- *P montagui* (the striped shrimp) in SFAs 2, 3, 4

Separate assessment reports have been produced for each unit of certification.

1.1 Scores of the Principles

This assessment has resulted in the following scores against the three MSC Principles:

Principle 1: 90.0
Principle 2: 82.0
Principle 3: 87.5

1.2 The main strengths of the fishery

- It is highly likely that the stock is above the point where recruitment would be impaired.
- There are well defined and effective harvest control rules in place
- There is considerable information available regarding the stock both through detailed monitoring of the fishery and fishery independent monitoring and research to support the quota levels and harvest strategy.
- The use of the Nordmore grate helps to ensure that bycatch of other fish species is kept to a minimum.
- The 100% observer coverage and dockside landings coverage provides high confidence in the monitoring data collected for target and other bycatch and discarded species.
- There is a very comprehensive monitoring and surveillance system in place.
- There is a high level of compliance in the fishery.

1.3 The main weakness of the fishery

- Limited knowledge of the effect the fishery on habitat structure and function and on other key elements of the ecosystem.
- A lack of explicit long and short term management objectives consistent with outcomes expressed by MSC's Principles 1 and 2.
- A research plan that is sufficient to achieve objectives consistent with MSC's Principles 1 and 2.

1.4 Conditions

The assessment team identified conditions that will enable the fishery to score at least 80 against all performance indicators. These conditions are summarised as:

Condition 1 – Habitat
The client is required by the fourth annual audit to compile and assess information, develop a strategy, and take measures as appropriate such that it can be considered that the fishery is highly unlikely to reduce habitat structure and function to a point where there would be serious or irreversible harm.

Condition 2 – Ecosystem
The client is required by the fourth annual audit to compile and assess information, develop a strategy, and take measures as appropriate such that the fishery is considered highly unlikely to disrupt key elements of ecosystem structure and function to a point where there would be serious or irreversible harm.

Condition 3 – Short and long term objectives
The client is required by the first annual audit to present evidence that short and long term objectives, which are consistent with achieving the outcomes expressed by MSC's Principles 1 and 2, are explicit within the fishery's management system.

Condition 4 – Research plan
The client is required by the fourth annual audit to present a research plan that assembles current activity, identifies gaps, and provides the management system with a strategic approach to research including reliable and timely information sufficient to achieve the objectives consistent with MSC's Principles 1 and 2.

2 INTRODUCTION

This report sets out the results of the assessment of the Canadian Offshore Northern Shrimp (*Pandalus borealis*) Trawl Fishery in Shrimp Fishing Area 1 (SFA 1) against the Marine Stewardship Council (MSC) Principles and Criteria for Sustainable Fishing.

This assessment is one of four MSC assessments being undertaken for the Canadian Association of Prawn Producers (CAPP) and the Northern Coalition (NC) by Moody Marine Ltd on shrimp fisheries within Canada's Northwest Atlantic Exclusive Economic Zone (EEZ). The others are identified as separate units of certification owing to the differences in species and management regime. They are:

- *P. borealis* in SFAs 2-6;
- *P. borealis* in SFA7; and
- *P montagui* (the striped shrimp) in SFAs 2, 3, 4

Separate assessment reports will be produced for each unit of certification. Each report follows the same template and where there are similarities between the units of certification the same or similar sections of text are used.

2.1 The fishery proposed for certification

The MSC Guidelines to Certifiers specify that the unit of certification is "The fishery or fish stock (=biologically distinct unit) combined with the fishing method/gear and practice (=vessel(s) pursuing the fish of that stock)." The fishery proposed for certification is therefore defined as:

Species:	**Northern Shrimp (*Pandalus borealis*)**
Geographical Area:	**Shrimp Fishing Area 1 (SFA1)**
Method of Capture:	**Trawl**
Management System:	**Canadian Department of Fisheries and Oceans (DFO)**
Client Group:	**Canadian Association of Prawn Producers / Northern Coalition**

In the course of the certification it is possible that further companies/vessels may join the client group. This would be in accordance with the MSC's stated desire to allow fair and equitable access to the certification.

2.2 Report Structure and Assessment Process

The aims of the assessment are to determine the degree of compliance of the fishery with the MSC Principles and Criteria for Sustainable Fishing, as set out in Section 8.

This report sets out:

- the background to the fishery under assessment and the context within which it operates in relation to the other areas where the target species is fished
- the qualifications and experience of the team undertaking the assessment
- the standard used (MSC Principles and Criteria)
- stakeholder consultation carried out. Stakeholders include all those parties with an interest in the management of the fishery and include fishers, management bodies, scientists and environmental Non-Governmental Organisations (ENGO's)
- the methodology used to assess ('score') the fishery against the MSC Standard.
- a scoring table with the Scoring Indicators adopted by the assessment team and Scoring Guidelines which aid the assessment team in allocating scores to the fishery. The commentary in this table then sets out the position of the fishery in relation to these Scoring Indicators.

The intention of the earlier sections of the report is to provide the reader with background information to interpret the scoring commentary in context.

Finally, as a result of the scoring, the Certification Recommendation of the assessment team is presented, together with any conditions attached to certification.

In draft form, this report is subject to critical review by appropriate, independent, scientists ('peer review'). The comments of these scientists are appended to this report. Responses are given in the peer review texts and, where amendments are made to the report on the basis of peer review comments; these are also noted in the peer review text. Following peer review, the report is then released for public scrutiny on the MSC website.

The report, containing the recommendation of the assessment team, any further stakeholder comments and the peer review comments is then considered by the Moody Marine Governing Board (a body independent of the assessment team). The Governing Board then make the final certification determination on behalf of Moody Marine Ltd.

It should be noted that, in response to comments by peer reviewers, stakeholders and the Moody Marine Governing Board, some points of clarification may be added to the final report.

Finally, the complete report, containing the Moody Marine Ltd Determination and all amendments, will be released for further stakeholder scrutiny.

2.3 Stakeholder meetings attended

Information used in the main assessment has been obtained from interviews and correspondence with stakeholders in this fishery, notably:

- A meeting with the client on September 2, 2009 at the Courtyard Marriott hotel, St. John's;
- A meeting with DFO and the client CAPP/NC on September 3, 2009 at DFO offices in St. John's;
- A tour of the vessel client owned shrimp fishing vessel on September 2, 2009 in Bay Roberts; and
- Correspondence from stakeholder Ecology Action Centre and the Sierra Club of Canada.

2.4 Other information sources

Published information and unpublished reports used during the assessment for this fishery as are listed below. The list is generic to the four reports that have been produced in association with the assessment of the *Pandalus borealis* and *Pandalus montagui* fisheries in SFA 1-7.

Legislation and Treaties

- Fisheries Act (R.S. 1985, c. F-14C) and regulations
- Territorial Sea Geographic Co-ordinates (Area 7) Order (S.O.R./85-872
- The Convention on Future Multilateral Cooperation in the Northwest Atlantic Fisheries, NAFO, 1979
- UN Convention on the Law of the Sea, United Nations, 1982
- UN Code of Conduct for Responsible Fishing, Food and Agricultural Organization of the United Nations

Policy Papers and Agreements and Reports

- Agreement between The Inuit of the Nunavut Settlement Area and Her Majesty The Queen in Right of Canada, 1993
- Agreement Between Nunavik Inuit and Her Majesty The Queen in Right of Canada Concerning Nunavik Inuit Land Claims, 2006

- Auditor General of Canada annual reports
- Collaborative Agreement Between Fisheries and Oceans Canada (DFO) and World Wildlife Fund, October 2008
- DFO Aboriginal Fisheries Strategy, www.dfo-mpo.gc.ca
- DFO Emerging Species Policy, www.dfo-mpo.gc.ca
- DFO Fishery Stewardship and Sustainability Checklist 2008-2009
- DFO Policy Framework for the Management of Fisheries on Canada's Atlantic Coast www.dfo-mpo.gc.ca
- DFO Sustainable Fisheries Framework Policy, www.dfo-mpo.gc.ca
- Integrated Fisheries Management Plan - Northern Shrimp - Shrimp Fishing Areas (SFAs) 0-7 and the Flemish Cap, 2007
- Land Claims Agreement between the Inuit of Labrador and Her Majesty The Queen in Right of Newfoundland and Labrador and Her Majesty The Queen in Right of Canada, 2005
- Marine Institute: Project Proposal - Reducing Seabed Impacts of Bottom Trawls
- MSC Certification of the Offshore Shrimp Fisheries (>100') in areas 1, 2, 3, 4, 5, 6 and 7. Submission for the Main Assessment by the 17 Offshore Licence Holders September 2, 2009

Published papers

Anderson, P. J. 2000. Pandalid shrimp as indicators of ecosystem regime shift. J. Northw. Atlantic Fish. Sci. 27: 1-10.

Anon, 2006. Northern Shrimp (*Pandalus borealis*) in Divisions 3L,3N and 3O. NAFO, 3LNO STACFIS Report Final Draft, November 2006.13p

ASP-FFAW 2006. Shrimp schedule 2007 – Schedule "A" of the Collective Agreement between Fish, Food and Allied Workers Union (FFAW/CAW) and Association of Seafood Producers (ASP). 9 pp.

Aschan, M. and Ingvaldsen, R. 2009. Recruitment of shrimp (*Pandalus borealis*) in the Barents Sea related to spawning stock and environment. Deep Sea Research Part II: Topical Studies in Oceanography, 56: 2012-2022.

Bergström, B. 2000. Biology of *Pandalus*. Advances in Marine Biology, 38:55-256.

Bowering, W. R. and D. C. Orr 2004. By-catch of Greenland halibut (*Reinhardtius hippoglossoides*, Walbaum) in the Canadian fishery for northern shrimp (*Pandalus borealis*, Koyer) in NAFO Subarea 2 and Divisions 3KL. NAFO SCR Doc. 04/67: 18 pp.

Brodie,W., 1996. A description of the 1995 fall groundfish survey in Division 2J3KLMNO. NAFO SCR. Doc.96/27, Ser.No.N2700. 7p

Clark, S. H., S. X. Cadrin, D. F. Schick, P. J. Diodati, M. P. Armstrong and D. McCarron 2000. The Gulf of Maine northern shrimp (*Pandalus borealis*) fishery: a review of the record. J. Northw. Atl. Fish. Sci. 27: 193-226.

C-NOPB 2003. Orphan Basin Strategic Environmental Assessment. Canada-Newfoundland Offshore Petroleum Board, St. John's. 244 pp.

C-NOPB 2008. Strategic Environmental Assessment – Labrador Shelf Area. Canada-Newfoundland Offshore Petroleum Board, St. John's. 519 pp + appendices.

DFO 2003. Northern Shrimp Integrated Fisheries Management Plan. Effective 2003. Resource Management-Atlantic, Fisheries and Oceans Canada. Cat.N^{o} Fs23-429/2003

DFO, 2005. Northern Shrimp on the Eastern Scotian Shelf (SFA 13-15). DFO Can.Sci.Advis.Sec. Sci.Advis.Rep. 2005/060.

DFO, 2006a. Assessment of Division 0B-3K Northern Shrimp. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2006/007.- 19 pp.

DFO, 2006b. Northern Shrimp on the Eastern Scotian Shelf (SFA 13-15). DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2006/004.

DFO, 2006c. A harvest strategy compliant with the precautionary approach. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2006/023. 7 pp.

DFO 2006benthic. Impacts of Trawl Gears and Scallop Dredges on Benthic Habitats, Populations and Communities. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2006/025.

DFO 2007a. DRAFT Northern Shrimp Integrated Fisheries Management Plan, shrimp fishing areas (SFAs) 0-7, Flemish Cap. Effective January 2007. Resource Management Operations, Fisheries and Oceans Canada. Cat.N^{o} XXX/2003

DFO 2007b. Scotian Shelf (*Pandalus borealis*) Integrated Fisheries Management Plan. Scotia-Fundy Sector, Maritimes Region. 2007-2011. Fisheries and Aquaculture Management, Maritimes Region. Fisheries and Oceans Canada. DFO/2006-1140.

DFO 2007c. Proceedings of the Assessment Framework for Northern Shrimp (*Pandalus borealis*) off Labrador and the northeastern coast of Newfoundland. Ed. J Ennis. Can Sci.Adv.Sec. Proc. Ser. 2007/34.

DFO 2007ca. Development of a closed area in NAFO 0A to protect narwhal over-wintering grounds, including deep-sea corals. Can. Sci. Adv. Sect. Science Response 2007/002: 16 pp.

DFO 2008a. Assessment of divisions 2G-3K Northern shrimp. Can. Sci. Advis. Sec. Science Advisory Report 2008/08. 22pp.

DFO 2008b. Assessment of northern shrimp (*Pandalus borealis*) and striped shrimp (*Pandalus montagui*) in shrimp fishing areas 0, 2 and 3. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2008/018.
http://www.dfo-mpo.gc.ca/CSAS/Csas/Publications/SAR-AS/2008/SARAS2008_018_E.pdf

DFO 2009a. Northern Shrimp Integrated Fisheries Management Plan, shrimp fishing areas (SFAs) 0-7, Flemish Cap. Effective September 2009. Resource Management Operations, Fisheries and Oceans Canada. http://www.dfo-mpo.gc.ca/fm-gp/peches-fisheries/ifmp-gmp/shrimp-crevette/shrimp-crevette-2007-eng.htm

DFO 2009b. Biomass of northern shrimp (*Pandalus borealis*) and striped shrimp (*Pandalus montagui*) in shrimp fishing area 2. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2009/011.

Edinger, E., K. Baker, R. Devillers and V. Wareham 2007. Coldwater corals off Newfoundland and Labrador: distribution and fisheries impacts. WWF-Canada, Toronto. 41 pp + CD with detailed maps.

Drengstig A, Fevolden SE, Galand PE, Aschan MM. (2000). Population structure of the deep-sea shrimp (*Pandalus borealis*) in the North-east Atlantic based on allozyme variation. Aquatic Living Resources 13,121-128.

Fishbase. http://www.fishbase.org/search.php

Ennis, J. ed 2007/in prep. Proceedings of the assessment framework for northern shrimp (*Pandalus borealis*) off Labrador and the northeastern coast of Newfoundland. May 28-30, 2007, St. John's, NL. Can. Sci. Adv. Secretariat Proc. 2007.

Evans ,G.T., Parsons,D.G., and Orr,D.C., 2000. A local-influence method of estimating biomass from trawl surveys, with Monte Carlo confidence intervals.J Northw.Atl.Fish.Sci.27: 133-138

Gagnon, J.-M. and R. L. Haedrich. 1991. A functional approach to the study of Labrador/Newfoundland shelf macrofauna. Cont. Shelf Research 11: 963-974.

GEAC (Groundfish Enterprise Allocation Council) CAPP (Canadian Association of Prawn Producers) Northern Coalition 2007. Coldwater Coral Conservation Policy. 7 pp.

Gass, S. E. and J. H. M. Willison 2005. An assessment of the distribution of deep-sea corals in Atlantic Canada by using both scientific and local forms of knowledge. School for Resource and Environmental Studies, Dalhousie University, Halifax. 24 pp.
www.mcbi.org/what/what_pdfs/gass_willison_2005.pdf

Gilkinson, K., E. Dawe, B. Forward, B. Hichey, D. Kulka and S. Walsh. 2006. A review of Newfoundland and Labrador Region research on the effects of mobile fishing gear on benthic habitat and communities. Can. Sci. Adv. Secretariat Res. Doc. 2006/055: 26 pp.

Gilkinson, K. and E. Edinger eds. 2009. The ecology of deep-sea corals of Newfoundland and Labrador waters: biogeograjphy, life history, biogeochemistry and relation to fishes. Can. Tech. Rep. Fish. Aquat. Sci. 2830: vi + 136 pp.

Gordon, D.C. Jr., E.L.R. Kenchington, K.D. Gilkinson, G.B.J. Fader, C. Bourbonnais-Boyce, K.G. MacIsaac, D.L. McKeown, L.-A. Henry and W.P. Vass. 2009. Summary of the Western Bank otter trawling experiment (1997-1999): effects on benthic habitat and communities. Can. Tech. Rept. Fish. Aquat. Sci. No. 2822. vii + 70 pp.

Gordon, D. C. Jr., E. L. R. Kenchington and K. D. Gilkinson 2006. A review of Maritimes Region research on the effects of mobile fishing gear on benthic habitat and communities. Can. Sci. Adv. Secretariat Res. Doc. 2006-056: 45 pp.

Han G., and Z. Wang, 2006. Monthly-mean circulation in the Flemish Cap region: a modeling study, Estuarine and Coastal Modeling, ASCE, 138-154.

Hansson, M., M. Lindegarth, D. Valentinsson and M. Ulmestrand. 2000. Effects of shrimp-trawling on abundance of benthic macrofauna in Gullmarsfjorden, Sweden. Mar. Ecol. Progr. Ser. 198: 191-201.

Hinz, H., V. Prieto and M. J. Kaiser. 2009. Trawl disturbance on benthic communities: chronic effects and experimental predictions. Ecol. Applications 19: 761-773.

Hvingel, C. and Kingsley, M. C. S. 2006. A framework to model shrimp (*Pandalus borealis*) stock dynamics and to quantify the risk associated with alternative management options, using Bayesian methods. ICES Journal of Marine Science, 63: 68-82.

Kaiser, M. J., K. R. Clarke, H. Hinz, M. C. V. Austen, P. J. Somerfield and I. Karakassis. 2006. Global analysis of response and recovery of benthic biota to fishing. Mar. Ecol. Progr. Ser. 311: 1-14.

Kanneworff, P. 2003. Occurrence of (*Pandalus montagui*) in Trawl Survey Samples from NAFO Subareas 0+1. NAFO SCR 03/70: 4 pp.

Kenchington, E.L.R., J. Prena, K. Gilkinson, D.C. Gordon, K. MacIsaac, C. Bourbonnais, P.Schwinghamer, T.W. Rowell, D.L McKeown and W.P. Vass. 2001. Effects of experimental otter trawling on the macrofauna of a sandy bottom ecosystem on the Grand Banks of Newfoundland. Can. J. Fish. Aquat. Sci. 58: 1043-1057.

Kenchington, E., A. Cogswell, C. Lirette and F. J. Murillo-Perez. 2009. The use of density analyses to delineate sponge grounds and other benthic VMEs from trawl survey data. NAFO SCR Doc. 09/6: 15 pp.

Kingsley, M. C. S. 2007c. A provisional assessment of the shrimp stock off west Greenland in 2007. NAFO SCR Doc. 07/70, Ser. N5456: 25 pp.

Kingsley M. C. S. 2008a. The Fishery for Northern Shrimp (*Pandalus borealis*) off West Greenland, 1970–2008. NAFO SCR Doc. 08/57

Kingsley M. C. S. 2008b. CPU Series for the West Greenland Shrimp Fishery. NAFO SCR Doc. 08/62.

Kingsley Michael C.S. 2008c. A Provisional Assessment of the Shrimp Stock off West Greenland in 2008. NAFO SCR Doc. 08/64.

Koeller, P. A. 2000. Relative importance of abiotic and biotic factors to the management of the Northern Shrimp (*Pandalus borealis*) Fishery on the Scotian Shelf. J. Northw. Atl. Fish. Sci. 27:21-33.

Koeller, P., Fuentes-Yaco, C., Platt, T., Sathyendranath, S., Richards, A., Ouellet, P., Orr, D., et al. 2009a. Basin-Scale Coherence in Phenology of Shrimps and Phytoplankton in the North Atlantic Ocean. Science, 324: 791-793.

Koeller, P., Covey, M. and M. King. 2009b. An Assessment of the Eastern Scotian Shelf Shrimp Stock and Fishery in 2008 with an Outlook for 2009. Canadian Science Advisory Secretariat Research Document 2009/030, 52.pp

Kulka, D. W. and M. R. Simpson 2004. Determination of allowable harm for spotted (*Anarhichas minor*) and northern (*Anarhichas denticulatus*) wolffish. Cdn. Sci. Adv. Secretariat Res. Doc. 2004/049: ii + 31 pp.

Kulka, D., C. Hood and J. Huntington. 2008. Recovery Strategy for Northern Wolffish (*Anarhichas denticulatus*) and Spotted Wolffish (*Anarhichas minor*), and Management Plan for Atlantic Wolffish (*Anarhichas lupus*) in Canada. Fisheries and Oceans Canada: Newfoundland and Labrador Region. St. John's, NL. x + 103 pp.

Lilly, G. R. 2006. Predation on northern shrimp (*Pandalus borealis*) by Atlantic cod (*Gadus morhua*) off southern Labrador and eastern Newfoundland: the release in predation pressure is expected to continue. pp. 65-69 in Orr, D. ed. 2006.

Lilly, G. R., D. G. Parsons and D. W. Kulka 2000. Was the increase in shrimp biomass on the northeast Newfoundland Shelf a consequence of release in predation pressure from cod? J. Northw. Atl. Fish. Sci. 27: 45-61

Lilly, G. R. and E. F. Murphy 2004. Biology, fishery and status of the 2GH and 2J3KL (northern) cod stocks: information supporting an assessment of allowable harm under the Species at Risk

Act for the COSEWIC-defined Newfoundland and Labrador population of Atlantic cod (*Gadus morhua*). Can. Sci. Adv. Secretariat Res. Doc. 2004/102: 107 pp.

Lokkeborg, S. 2004. Impacts of trawling and scallop dredging on benthic habitats and communities. FAO Fish. Tech. Pap. 472: 58 pp.

Lokkeborg, S. 2007. Insufficient understanding of benthic impacts of trawling is due to methodological difficulties – a reply to Gray et al. (2006). Mar. Poll. Bull. 54: 494-496.

MacDonald, P.D.M and T.J. Pitcher, 1979. Age-groups from size-frequency data: a versatile and efficient method of analysing distribution mixtures. J. Fish. Res. Board Can. 36:987-1011.

Marine Institute, School of Ocean Technology 2008. Development of a methodology to use single beam sonar to map seabed habitat. Proposal submitted to Canadian Centre for Fisheries Innovation, April 2008.

Marine Institute n.d. Reducing seabed impacts of bottom trawls. Proposal to Atlantic Innovation Fund, 119 pp.

Martinez I, Aschan M, Skjerdal T, Aljanabi SM. (2006). The genetic structure of *Pandalus borealis* in the Northeast Atlantic determined by RAPD analysis. ICES Journal of Marine Science 63,840-850.

McCallum and Walsh 1996 and Walsh,S.J., 1996. Groundfish survey trawls used at the Northwest Atlantic Fisheries Centre,1971-present. NAFO SCR Doc 96/50. Ser.No. N2726. 18p

McCrary, J. A 1971. Sternal spines as a characteristic for differentiating between females of some pandalidae. J. Fish. Res. Board Can. 28, 98-100.

NAFO Report of the 30th Annual Meeting, Vigo Spain, September 22-26, 2000

NAFO, 2004. Report of the NAFO Study Group on Limit Reference Points Lorient, France, 15-20 April, 2004, NAFO SCS Doc. 04/12.

NAFO/ICES 2006. Report of the NAFO/ICES *Pandalus* assessment group 25 October – 2 November 2006. NAFO SCS Doc. 06/27: 68pp.

NAFO Annual Compliance Review 2008, Annex 19, FC Doc. 08/20)

NAFO/ICES 2008. Report of the NAFO/ICES *Pandalus* assessment group 23–30 October 2008. NAFO SCS Doc. 08/58: 69pp.

NAFO/ICES 2009. Report of the NAFO/ICES *Pandalus* assessment group 21–29 October 2009. NAFO SCS Doc. 09/27: 77pp

NAFO/ICES 2010. Report of the NAFO/ICES *Pandalus* assessment group 20–27 October 2010. NAFO SCS Doc. 10/22: 79pp

NAFO 2008. Formulation of advice – coral concentrations in the NRA. NAFO Scientific Council Meeting, 22-30 October 2008 pp 255-262.

NAFO 2008/0-1. Formulation of advice – northern shrimp in Subareas 0 and 1. NAFO Scientific Council Meeting, 22-30 October 2008 pp 263-264.

NAFO Conservation and Enforcement Measures, 2009, NAFO FC Doc. 09/1 Serial No. N5614

Orr, D. C., D. G. Parsons, P. J. Veitch and D. J. Sullivan. 2003. An assessment of striped shrimp (*Pandalus Montagui*, Leach, 1814) stocks from Resolution Island south along the coast of Labrador to the Grand Banks. Can. Sci. Adv. Sect. Res. Doc. 2003/070: ii + 27 pp.

Orr, D. ed. 2006. Shrimp and its environment in the Northwest Atlantic-implications for forecasting abundance and population dynamics. Can. Sci. Adv. Secr. Proc. Ser. 2006/017: 93 pp.

Orr, D. C, P. J. Veitch and D. J. Sullivan 2006. An update of information pertaining to northern shrimp (*Pandalus borealis*, Kroyer) and groundfish in NAFO Divisions 3LNO. NAFO SCR Doc. 06/73: 56 pp.

Orr, D., Veitch, P.J., and D.J. Sullivan. 2006a. Northern shrimp (*Pandalus borealis*) off Baffin Island, Labrador and northeastern Newfoundland. DFO Can.Sci.Advis.Sec.Res.Doc.2006/042

Orr, D., Veitch, P.J., and D.J. Sullivan. 2007. Northern shrimp (*Pandalus borealis*) off Baffin Island, Labrador and northeastern Newfoundland. DFO Can.Sci.Advis.Sec.Res.Doc.2007/xxx

Orr, D.C., Veitch P.J. and Sullivan, D.J. 2008. An update of information pertaining to northern shrimp (*Pandalus borealis*, Kroyer) in NAFO Divisions 3LNO, presented at the NAFO/ICES Assessment Group, October 2008. NAFO SCR Doc. 08/058, 69 pp.

Orr, D., P. Veitch, D. Sullivan, J. Firth, C. Peters and T. Inkpen. 2008. Groundfish by-catch within the northern shrimp fishery off the eastern coasts of Newfoundland and Labrador over the years 2004 – 2008. NAFO SCR 08/31 (Revised): 57 pp.

Orr, D., P.J. Veitch, K. Skanes and D.J. Sullivan. MS 2008. Northern shrimp (Pandalus borealis) off Labrador and northeastern Newfoundland. Can. Sci. Adv. Sect. Res. Doc. (unpub). 116 pp.

Orr, D. and N. Cadigan. 2009. An experiment to determine the appropriateness of reducing the Nordmore Grate spacing from 28 mm to 22 mm. Unpublished project report, DFO Newfoundland Region, 67 pp.

Ouellet, P., Savard, L. and Larouche, P. 2007. Spring oceanographic conditions and northern shrimp *Pandalus Borealis* recruitment success in the north-western Gulf ogf St. Lawrence. Mar. Ecol. Prog. Ser. 399: 299-241

Parsons, D. G. 2006. Predators of northern shrimp, *Pandalus borealis*, in the North Atlantic and interactions within the eastern Newfoundland and Labrador marine ecosystem (NAFO Divisions 2HJ3KL). pp. 61-63 in Orr ed. 2006.

Parsons, D. G. 2005a. Predators of northern shrimp, *Pandalus borealis* (Pandalidae), throughout the North Atlantic. Mar. Biol. Res. 1: 48-58

Parsons, D. G. 2005b. Interactions between northern shrimp, *Pandalus borealis* (Pandalidae) and its key predators within the eastern Newfoundland and Labrador marine ecosystem. Mar. Biol. Res. 1: 59-67

Parsons, D. G. 2006. Predators of northern shrimp, *Pandalus borealis*, in the North Atlantic and interactions within the eastern Newfoundland and Labrador marine ecosystem (NAFO Divisions 2HJ3KL). pp. 61-63 in Orr ed. 2006.

Parsons, D. G. and E. B. Colbourne 2006. Forecasting fishery performance for northern shrimp (*Pandalus borealis*) on the Labrador Shelf (NAFO Divisions 2HJ). pp 51-55 in Orr ed. 2006.

Pedersen, O. P., Aschan, M., Te, K., Slagstad, D. and Rasmussen, T. 2000. The advection and population dynamics of *Pandalus borealis* investigated by Lagrangian particle tracking model. Fisheries Research, 65:173-190.

Pedersen, S.A. and D. Zeller. 2001. A mass balance model for the West Greenland marine ecosystem. In: Guenette, S., Christensen, V. and Pauly, D. (eds). Fisheries impacts on North Atlantic Ecosystems: Models and Analyses. Fisheries Centre Research Reports 9(4). P. 111-127.

Rasmussen, B. 1953. On the variation in growth and sexual development of the deep sea prawn (*Pandalus borealis* Kr.), Serie havundersøkelser 10 (Reports on Norwegian fishery and marine investigations), A.s. John Grieg Boktrykkeri, Bergen.

Rice, J. 2006. Impacts of mobile bottom gears on seafloor habitats, species and communities: a review and synthesis of selected international reviews. Can. Sci. Adv. Secretariat Res. Doc. 2006/057: 35 pp.

Savenkoff, C., L. Savard, B. Morin and D. Chabot. 2006. Main prey and predators of northern shrimp (*Pandalus borealis*) in the northern Gulf of St. Lawrence during the mid-1980s, mid-1990s, and early 2000s. Can. Tech. Rep. Fish. Aquat. Sci. 2639: 28 pp.

Scott, W. B. and M. G. Scott. 1988. Atlantic Fishes of Canada. Can. Bull. Fish. Aquat. Sci. 291, 731 pp. University of Toronto Press.

Sévigny, J.-M., Savard, L. and Parsons, D.G. 2000. Genetic characterization of the Northern shrimp *Pandalus borealis*, in the Northwest Atlantic using electrophoresis of enzymes. J. Northw. Atl. Fish. Sci. 27:161-175

Simpson, A. W. and L. Watling. 2006. An investigation of the cumulative impacts of shrimp trawling on mud-bottom fishing grounds in the Gulf of Maine: effects on habitat and macrofaunal community structure. ICES J. Mar. Sci. 63: 1616-1630.

Spatialanalysis, GIS and Data Integration Services, 2009. Assessment of historical offshore shrimp catch and effort. 4th edition, June, 2009. Prepared for Canadian Association of Prawn Producers. Part 1, Text: 20 pp. Part 2, Figures: 49 pp.

Suuronen, P. 2005. Mortality of fish escaping trawl gears. FAO Fish. Tech. Pap. 478: 72 pp.

Tanner, J. E. 2003. The influence of prawn trawling on sessile benthic assemblages in Gulf St. Vincent, South Australia. Can. J. Fish. Aquat. Sci. 60: 517-526.

United Nations 1982 (as amended). United Nations Convention on the Law of the Sea. http://www.un.org/Depts/los/convention_agreements/convention_overview_convention.htm

Wieland, K., Storr-Paulsen, M. and Sünksen, K, 2007. Response in Stock Size and Recruitment of Northern Shrimp (Pandalus borealis) to Changes in Predator Biomass and Distribution in West Greenland Waters J. Northw. Atl. Fish. Sci., Vol. 39: 21–33

Worm, B. and R. A. Myers 2003. Meta-analysis of cod-shrimp interactions reveals top-down control in oceanic food webs. Ecology 84: 162-173

Ziemer, N. and H. Siegestad. 2008. Results of the Greenland bottom trawl survey for Northern Shrimp (*Pandalus borealis*) off West Greenland (NAFO Sub area 1 and Division 0A), 1988–2008. NAFO SCR Doc. 08/71, 34 pp.

3 GLOSSARY OF ACRONYMS, TERMS AND ABBREVIATIONS

B_{msy}	The level of biomass resulting in maximum sustainable yield
C-NOPB	Canada - Newfoundland and Labrador Offshore Petroleum Board
CAPP	Canadian Association of Prawn Producers
COSEWIC	Committee on Status of Endangered Wildlife in Canada
CPUE	Catch Per Unit Effort
CSAS	Canadian Science Advisory Secretariat
DFO	Department of Fisheries and Oceans or Fisheries and Oceans Canada
EEZ	Exclusive Economic Zone
ENGO	Environmental Non-Government Organization
ETP	Endangered, Threatened and Protected Species
FAO	Food and Agriculture Organization of the United Nations
FC	Fisheries Council of NAFO
F_{msy}	The rate of fishing mortality that results in the maximum sustainable yield
ICES	International Council for the Exploration of the Seas
IFMP	Integrated Fisheries Management Plan
IQF	Individual Quick Frozen
MCS	Monitoring Control and Surveillance
MSC	Marine Stewardship Council
MSY	Maximum Sustainable Yield
NAFO	Northwest Atlantic Fisheries Organization
NC	Northern Coalition
NGO	Non-governmental Organization
NIPAG	NAFO ICES Pandalus Assessment Group
NRA	NAFO Regulatory Area
NSA	Nunavut Settlement Area
NSAC	Northern Shrimp Advisory Committee
NSRF	Northern Shrimp Research Fund
NWMB	Nunavut Wildlife Management Board
PA	Precautionary Approach
PI	Performance Indicator
RISA	Resolution Island Study Area
SAR	Scientific Advisory Report
SARA	Species At Risk Act
SC	Scientific Council of NAFO
SFA	Shrimp Fishing Area
SG	Scoring Guidepost
TAC	Total Allowable Catch
VMS	Vessels Monitoring System

4 BACKGROUND TO THE FISHERY

4.1 Introduction

The Pandalid shrimp fisheries off of eastern Canada are described by two sets of geographical zones or areas, the Shrimp Fishing Areas (SFAs) established by the Department of Fisheries and Oceans, Canada (DFO), and the Divisions of the Regional Fisheries Management Organisation (RFMO) established by the Northwest Atlantic Fisheries Organisation (NAFO). There is not a one-to-one correspondence between these zones and divisions. The NAFO Divisions (Figure 1) originated for the assessment and management of groundfish stocks, and they pre-date the Canadian 200 mile limit that runs across the western divisions.

The Canadian SFAs 0-16 extend from Baffin Island to the Grand Banks, the Gulf of St Lawrence and the Scotian Shelf, and are wholly within the Canadian 200 mile limit that marks their seaward boundary. Figure 2 shows the location of the SFAs and, in particular, highlights SFA 1.

4.2 Biology of the Target Species

The Northern shrimp (*Pandalus borealis* Kröyer 1838) has a discontinuous circumpolar boreal distribution, and occurs thereby in the West Atlantic from the Gulf of Maine to Davis Strait. This crustacean is usually found in areas with soft, muddy sediment and where the temperature ranges from 1-6 ºC. The Northern shrimp occurs from Davis Strait in the North throughout the Labrador and the Newfoundland area and in "holes" on the Scotian Shelf at depths of 150-600m. Northern shrimp is easily identified both as young male and adult females.

Two species of *Pandalus* are harvested in Canadian waters of the northwest Atlantic. *P. borealis* is much more abundant and widespread in commercial quantities, and is the subject of most of the studies and assessments of commercial pandalid shrimp in the northwest Atlantic. *P. montagui* (striped shrimp), although widely distributed from Davis Strait to the Grand Banks, is most abundant in more northerly areas and at shallower depths (Orr et al 2003). *P. montagui* tends to be most abundant at depths less than 400 m, while *P. borealis* can be abundant at 200-600 m (Orr et al 2003). The two species tend to be found mixed in commercial densities in shelf areas near the entrance to Hudson Strait; inside Hudson Strait *P. montagui* predominates, while in other areas *P. borealis* predominates (DFO draft 2009).

P. borealis is a protandrous hermaphrodite, meaning that it matures as a male at age 2-5, mates as a male for two or three years before changing sex and spending the rest of its lifespan as a female. Shrimp in the Labrador, Newfoundland and Scotian Shelf area live for 5 to 8 years, depending on conditions. The shrimp spawn in autumn and the female carries the eggs until April-May when they hatch, and the pelagic larvae are released (Bergström 2000). The larvae will spend the first month in the upper layers but during their development they become more bottom orientated as they develop through 6 stages before finally settling on the bottom after approximately 2 months. Particle tracking models reveal that the larvae may be transported as far as 300km during the pelagic phase (Pedersen et al. 2000). Ocean currents at the Canadian west coast are generally from north to south and could act to foster dispersal of shrimp over large continental shelf areas (particularly at the larval stage) This larval transport may explain why the shrimp does not form genetically distinct populations, but rather consists of one meta-population with genetic gradients through the population (Martinez et al. 2006). However, isolated bays and fjords seem to develop their distinct populations (Sévigny et al. 2000; Drengstig et al. 2000).

The recruitment of one year old shrimp seem to be directly dependent on the spawning stock biomass (biomass of spawning females) but is also affected by the timing and duration of the phytoplankton bloom (Aschan and Ingvaldsen 2009; Koeller et al. 2009a). Intuitively the relationship between parent

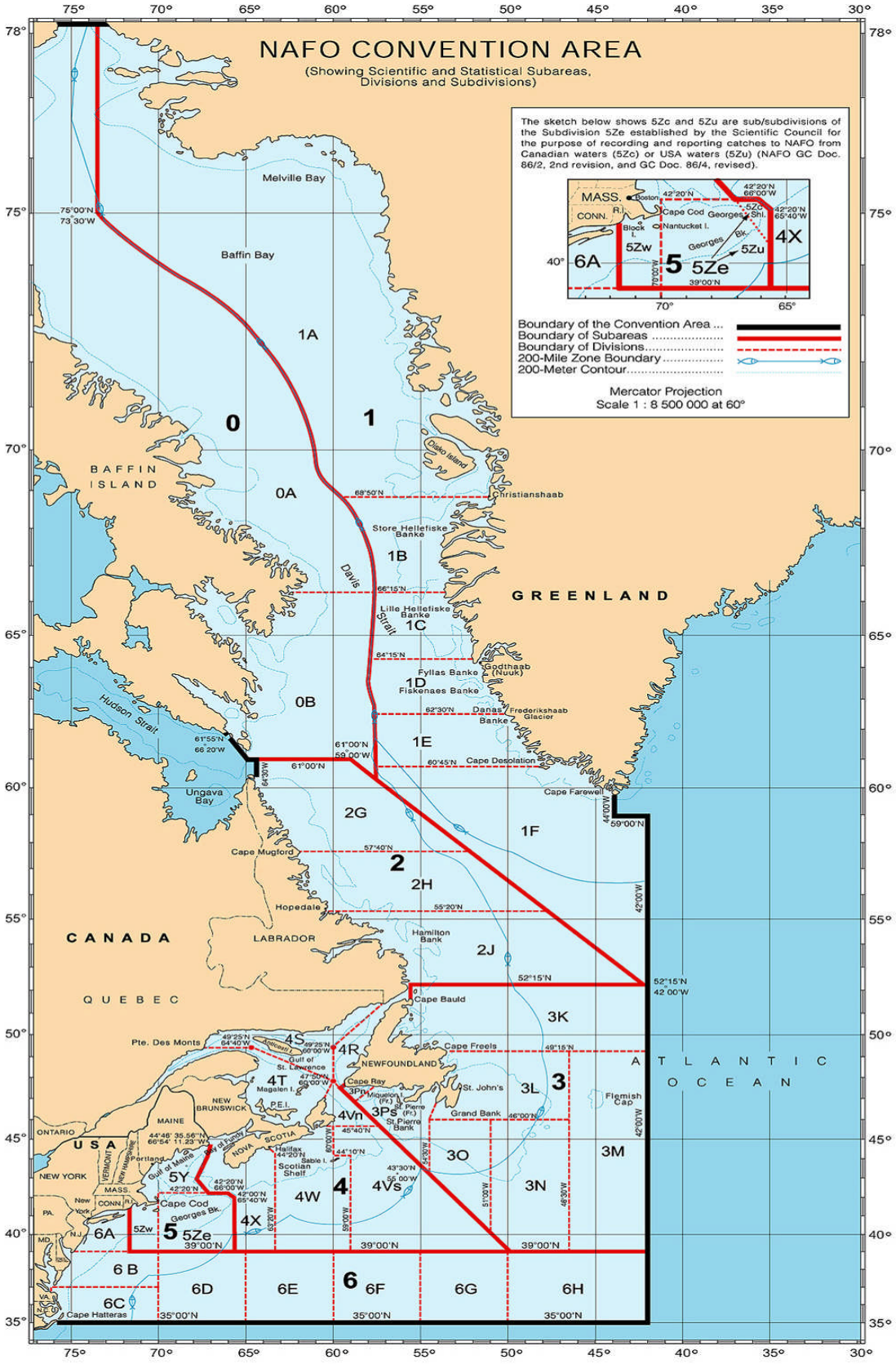

Figure 1: The Northwest Atlantic Fisheries Organisation (NAFO) Convention Area

Source: NAFO website: http://sattrax.ca/marine/map_nafo.html

stock and recruitment seem obvious. Studies using 1-year-old shrimp reveal direct dependence on spawning stock biomass (Aschan and Ingvaldsen 2009, Ouellet et al. 2007). However, the recruitment indices used in the assessments are of 2 and/or 3-year-old shrimp that has been subject to high mortality due to predation before being caught by the survey trawl. Environmental conditions such as temperature, competition with other species and predation by demersal fish influence on the year class size until the shrimp is recruited to the fishery as 3-4 year olds (>15mm carapace length, 6cm total length). Thereby the spawning stock-recruitment relationship weakens from one to three year old recruits.

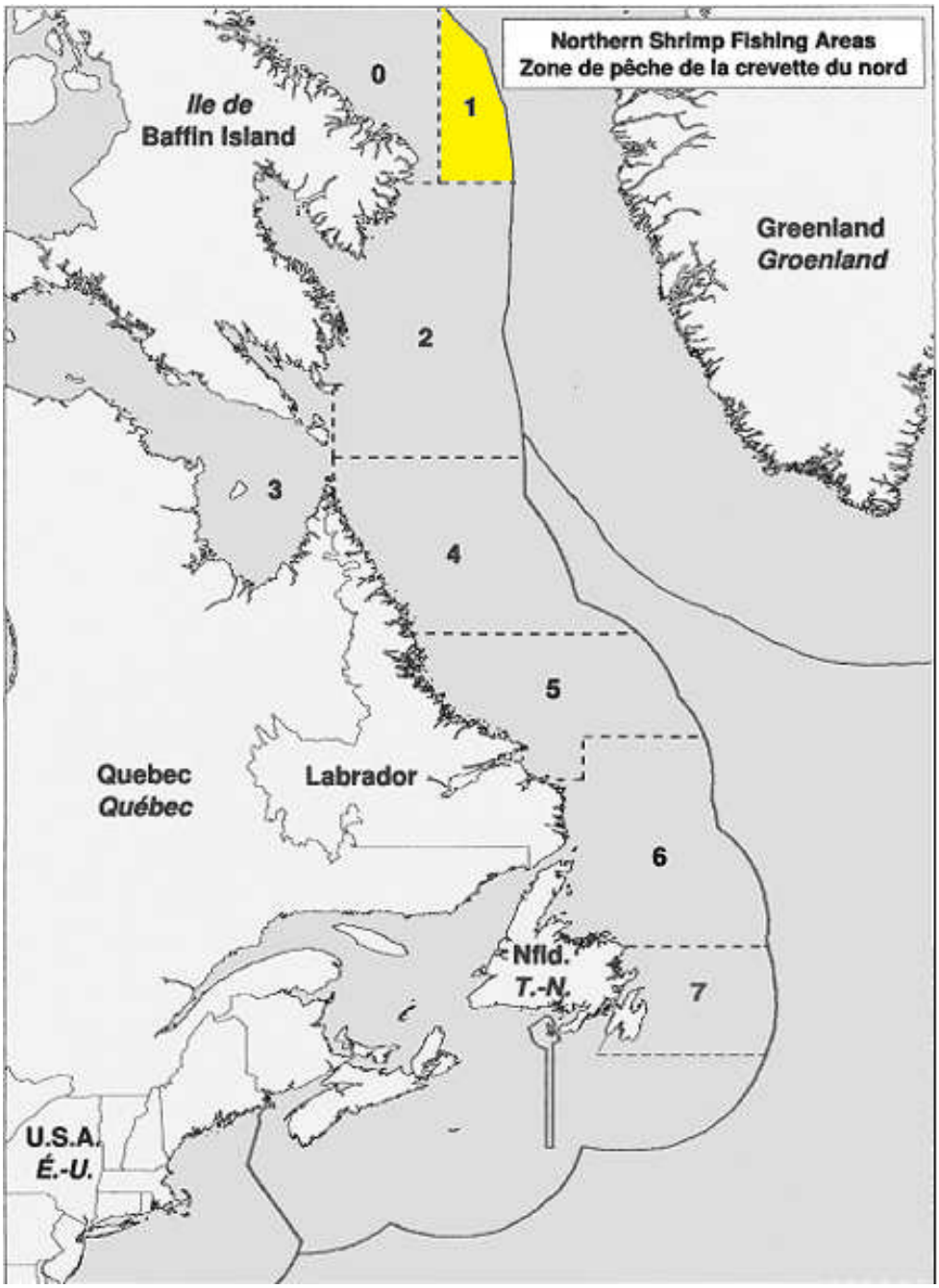

Figure 2: Shrimp Fishing Areas 0-7.

4.3 History of the Fishery

The Northern shrimp fishery commenced in the early 1970s when an exploratory fishing program confirmed the presence of shrimp stocks in the waters stretching southward from Baffin Island to the northeast coast of Newfoundland. Between 1978 and 1991, 17 offshore[1] licences were introduced and quotas established using an Enterprise Allocation regime (see section 6.1). In the 1990s, as the shrimp stocks grew in abundance and the cod moratorium came into effect, temporary inshore[2] licences were introduced throughout Atlantic Canada giving priority access to the under 65 feet fleet and to Aboriginal groups. A three-year plan was announced in 1997 with significant quota increases for both the offshore and temporary inshore licences. The Total Allowable Catch (TAC) has doubled since the late 1990s, rising from 85,000 t in 1998 to over 160,000 t in 2007. In 2006, DFO announced that additional access to the shrimp fishery would be frozen to encourage stability in the short term. Additionally, in 2007, temporary licences were converted to regular licences in an effort to further promote stability in the inshore fleet (DFO 2009a).

In the mid-1990's, a major expansion in the shrimp fishery was facilitated by an increase in shrimp biomass, which appears to have followed the decline in groundfish abundance (Worm & Myers, 2003). TACs were increased stepwise in line with the natural increase in shrimp stocks. The significant scale of the expansion phase is illustrated by the evolution of the TAC and fishery landings for the main SFAs. For example, the total TAC allocated to SFAs 0-7 inclusive increased from 8,200 t in 1978 to 85,000 t by 1998, and to 163,231 t by 2006 (DFO 2007a). Recorded landings increased from 3,630 t in 1978 to 137,528 t in 2006 (DFO, 2007a). Since 2006 a biomass decline has been observed in SFA1, SFA6 and SFA7 (NAFI/ICES 2009, DFO 2010-18)

Following these developments the Canadian fishery for *P borealis* has become one of the primary cold water shrimp resources in the North Atlantic. The following table shows the catch of northern shrimp between 1977 and 2008.

[1& 2] The "offshore" "inshore" distinction refers to processing, i.e. offshore vessels have processing facilities on board whereas inshore vessels do not. As a consequence inshore vessels are smaller (<65') and land fresh shrimp to shore based processors.

Table 1: The landings (t) of *P. borealis* and *P. montagui* (SFAs 2, 3, 4) caught between 1977 and 2008.
(Provided by DFO, 2009).

YEAR					DIV2G	HOPE	CART	HAWKE	DIV3K	DIV3M	DIV3L	TOTAL
	SFA1[4]	SFA2	SFA3[2]	SFA2,3,4[3]	SFA4	SFA5		SFA6		SFA7	SFA7	
1977					-	1,272	1,414	<1	<1	-	-	2,686
1978				0	-	2,109	1,521	-	-	-	-	3,630
1979	1,732			92	3	2,693	1,034	5	-	-	-	5,559
1980	2,726			236	<1	3,938	170	-	-	-	-	7,070
1981	5,284			13	2	3,382	67	135	-	-	-	8,883
1982	2,064			0	5	1,829	154	<1	-	-	-	4,052
1983	5,413			0	30	997	3	-	-	-	-	6,443
1984	2,142			0	-	712	290	-	-	-	-	3,144
1985	3,069			0	-	1,687	2	-	-	-	-	4,758
1986	2,995			476	2	3,498	1,328	-	-	-	-	8,299
1987	6,095			1,069	7	4,538	1,418	1,678	167	-	-	14,972
1988	5,881	2,826		1,125	1,083	6,584	1,254	3,747	4,102	-	-	26,602
1989	7,235	3,039		1,269	3,842	4,329	1,656	1,855	4,807	-	-	28,032
1990	6,177	1,771		1,635	2,945	3,769	1,591	1,929	3,669	-	-	23,486
1991	6,788	1,098		605	2,561	4,501	1,617	1,976	3,524	-	-	22,670
1992	7,493	1,239		0	2,706	4,680	1,635	3,015	3,594	-	-	24,362
1993	5,491	106		0	2,723	4,273	1,446	3,672	4,363	3,724	-	25,798
1994	4,766	475		244	3,982		7,499		10,978	1,041	-	28,985
1995	2,361	2,721		245	5,104		7,616		10,914	970	-	29,931
1996	2,632	3,968		0	5,160		7,383		10,923	906	-	30,972
1997	517	5,235		435	5,217		15,103		21,246	785	-	48,538
1998	933	5,163		2,703	8,051		15,170		46,337	484	82	78,923
1999	2,046	5,132		3,714	7,884		15,109		51,202	477	78	85,642
2000	1,590	4,261		3,005	8,048		14,645		63,175	540	4,229	99,493
2001	3,625	5,829		3,751	7,991		15,036		52,554	295	4,876	93,957
2002	6,247	5,597		3,369	8,516		15,180		60,198	8	5,316	104,431
2003	6,592	5,368		1,053	13,020		30,437		71,227	0	10,008	137,705
2004	7,021	5,231		2,069	9,644		22,690		77,776	0	10,613	135,044
2005	6,921	6,202		1,834	10,247		22,898		75,129	0	11,184	134,415
2006	4,127	5,966	90	2,431	10,084		22,612		75,673		18,271	139,254

YEAR					DIV2G	HOPE	CART	HAWKE	DIV3K	DIV3M	DIV3L	TOTAL
	SFA1[4]	SFA2	SFA3[2]	SFA2,3,4[3]	SFA4	SFA5		SFA6		SFA7	SFA7	
2007	**1,945**	**6,310**	**406**	**947**	**9,839**		**22,637**		**74,437**		**18,312**	**134,833**
2008[1]	**0**	**5,067**	**0**	**752**	9682		20,503	0	74,506	0	21,187	125,878

** In 2003, the offshore licence holders were allowed to change their quota period from Jan 1 – Dec 31 to Apr 1 – Mar 31.

[1] Preliminary data

[2] Includes SFA2 within the NSA

[3] *P montagui* only, all other areas *P borealis*

[4] Catch in SFA 1,2,3 and 4 is by offshore boats only

4.4 The Fleet and Gear

The offshore fleet comprises 13 large factory freezer trawlers operating from ports in Newfoundland and Nova Scotia with occasional landings in Greenland when fishing in far northern waters (SFA 1). Vessels in the present fleet are 49-75 m, with 400 -1,960 cubic metres of hold capacity, purpose built for shrimp trawling and processing, but able to fish and process groundfish if required. The larger vessels make 6 to 8 trips a year averaging between 270 and 320 fishing days, and the smaller ones 8 to 10 trips averaging 200 to250 fishing days. The vessels take crews of between 24 and 28 and operate a double-crewing system, i.e. one trip on, one off, resulting in employment for more than 600 crew members.

Source: DFO 2009a

Figure 3: Typical offshore shrimp fishing vessel (LOA> 100'; >500t)

The offshore fleet fish all year round, starting in SFA 5 & 6 and moving north when ice conditions and quotas allow. Vessels in the inshore fleet are smaller in size, i.e. < 65' and so are more restricted by weather conditions but also the ability to keep fresh shrimp for shore based processing. For these reasons their range is restricted and does not extend North beyond SFA 5.

In SFA 0 and 1 the TAC season operates on a calendar year (Jan – Dec). In SFAs 2 to 6 it runs from April 1 – March 31. The Canadian fishery in SFA 1 takes place off the coast of Baffin Island in Canadian Waters that lie north of latitude 66°15'N and east of longitude 60°30'W and abuts the international dividing line between Canada and Greenland.

Offshore vessels pack their shrimp at sea, either raw-frozen for the Japanese market, or cooked and frozen for the Russian, Chinese and European market. .

Canadian offshore shrimp licence holders are located in Nunavut, Quebec, Newfoundland and Labrador, Nova Scotia and in New Brunswick. All of the 17 offshore shrimp licence holders are party to the assessment, and are listed in section 6.2.

Demersal otter trawls with a minimum mesh size of 40 mm, and fitted with a Nordmore separator grate are used in the shrimp fishery (See Figure 4). Shrimp pass through the grate, but groundfish are directed upwards towards an exit window in the upper panel. The grate is mandatory in all fishing areas. In SFAs 6 and 7 the mandatory grate spacing is 22 mm. In SFAs 1 - 5 and 8 the mandatory spacing is 28 mm. As a rule of thumb the length at which fish are sorted is 10 times the bar space (Roger Larsen pers. comm.). Bobbins or rubber discs are fitted to the ground rope, which is linked to the leading lower edge of the net by vertical toggle chains. The use of the chains is intended to allow the trawl to be towed clear of the bottom to minimise seabed contact and further reduce groundfish bycatch. In recent years various adjustments have been made to trawl doors, bridles, and the net in order to improve hydrodynamics and fuel efficiency (Winger, pers. comm.).

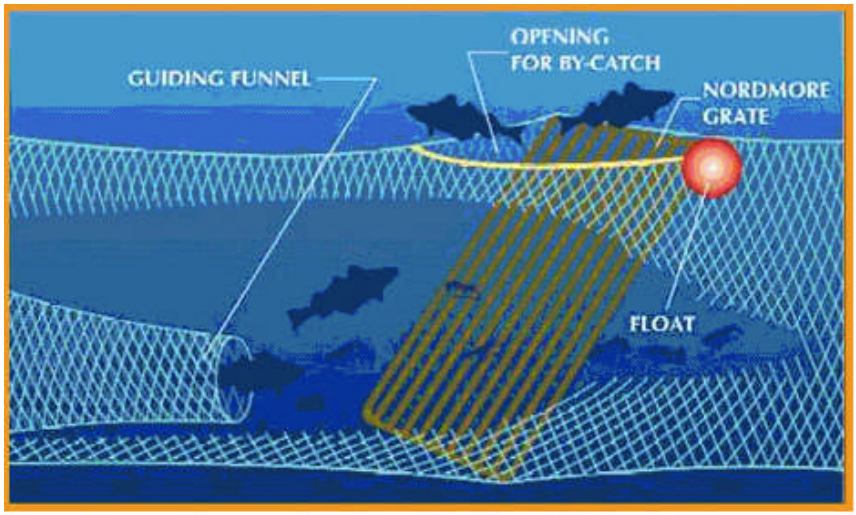

Figure 4: Nordmore Grate
(source: DFO 2009a**)**

5 STOCK ASSESSMENT

5.1 Management Unit

Separate stocks of *P. borealis* have not been clearly defined, however, scientists have observed differences in rates of growth and maturation, which are attributable to different habitat conditions across the geographic range of the species. These differences provide the present basis for delineating assessment and management units into SFAs (see Figure 2). These units also provide the basis for management of the fishery as a whole (DFO 2009a). *P. borealis* may represent a single metapopulation within the Northwest Atlantic, but treating fishery management and ecological relationships at a smaller spatial scale appears consistent with precautionary fishery management.

P. borealis in SFA 1 is a trans-boundary stock being present in both the Canadian and Greenland zones. The stock area for assessment purposes is NAFO Subareas 0+1 and the fishery is prosecuted jointly by Canada and Greenland.

5.2 SFA1 Assessment and Stock Status

SFA 1 is assessed within the Scientific Council (SC) of NAFO. Greenland has conducted stratified random trawl surveys designed primarily to estimate shrimp stock biomass since 1988 (Ziemer and Siegestad 2008). From 1993, the survey was extended southwards into NAFO Division 1E-F (see Figure 1). The Canadian fishery in SFA1 is conducted at the westernmost edge of the west Greenland shelf and the Greenland survey covers this small area during the annual survey with 8 stations of the 200 stations sampled in 2008 (Ziemer and Siegestad 2008).

Catch and effort data from the shrimp fishery are made available from logbooks from Canadian vessels fishing in SFA 1 and from Greenlandic vessel logbooks for NAFO Subarea 1. A Schaefer surplus-production model of population dynamics is used to fit CPUE, catch, and survey biomass indices (Hvingel and Kingsley 2006). The model includes a term for predation by Atlantic cod and a cod biomass series with the input data. CPUE data extends back to 1976, survey data back to 1988. In addition to the absence of recruitment input for the model, the Scientific Council concluded in 2009 that the assessment model may be both optimistic and more uncertain.

Survey biomass increased to an all-time high in 2003 and has since steadily declined. In 2008 and 2009 it was below the series mean (NAFO/ICES 2009). The female spawning stock biomass of *P. borealis* was fairly stable during the 1990s, increased to the highest value in the time series in 2003 and remained at a level considerably higher than the long-term average until 2008 and 2009 when it was assessed as being below the series mean. The increase in female spawning stock biomass was preceded by a couple of years with high recruitment in the late 1990s, but thereafter recruitment has decreased almost continuously (Wieland 2007). The modest increase in the cod stock seen in recent years seems to have reversed. CPUEs are high, but are starting to decline and effort is being directed in a smaller area.

Low recruitment despite relative high female spawning stock biomass means a lower survival of juvenile *P. borealis* before entering the fishery, which is reflected by the drastic decline of the recruit per unit of spawning biomass since 2001. Numbers at age 2 increased slightly in 2008, but were still below the series mean and dropped in 2009 while a second recruitment index (small shrimp in the trawl) remained near its 2006 level until 2010. Prospects for recruitment to the fishable stock in the next few years remain poor as recruitment has been low (NAFO/ICES 2009, NAFO/ICES 2010).

The stock-dynamic model showed a maximum biomass in 2005 with a steepening decline since (Figure 5); the probability that biomass will be below B_{msy} at the end of 2009 with projected catches

at 109,000 t was estimated at 18% and at less than 1% of being below B_{lim}. The mortality caused by fishing and cod predation (Z) has been stable and below Z_{msy} (the upper limit reference) , since 1995. The risk that total mortality would exceed Z_{msy} in 2009 was estimated at about 3.5%. The present stock status is in the precautionary safe zone with biomass above the target level and mortality below Z_{msy} (Figure 6). The risk of the stock falling below B_{msy} at the end of 2010 with a catch of 130.000 t is 18% and the risk of falling below B_{lim} is 0.2 %. With an 'effective' cod stock assumed at 10 000 t in 2010, catches up to 110, 000 t would be associated with risks below 20% of transgressing either precautionary reference point (NAFO/ICES 2009).

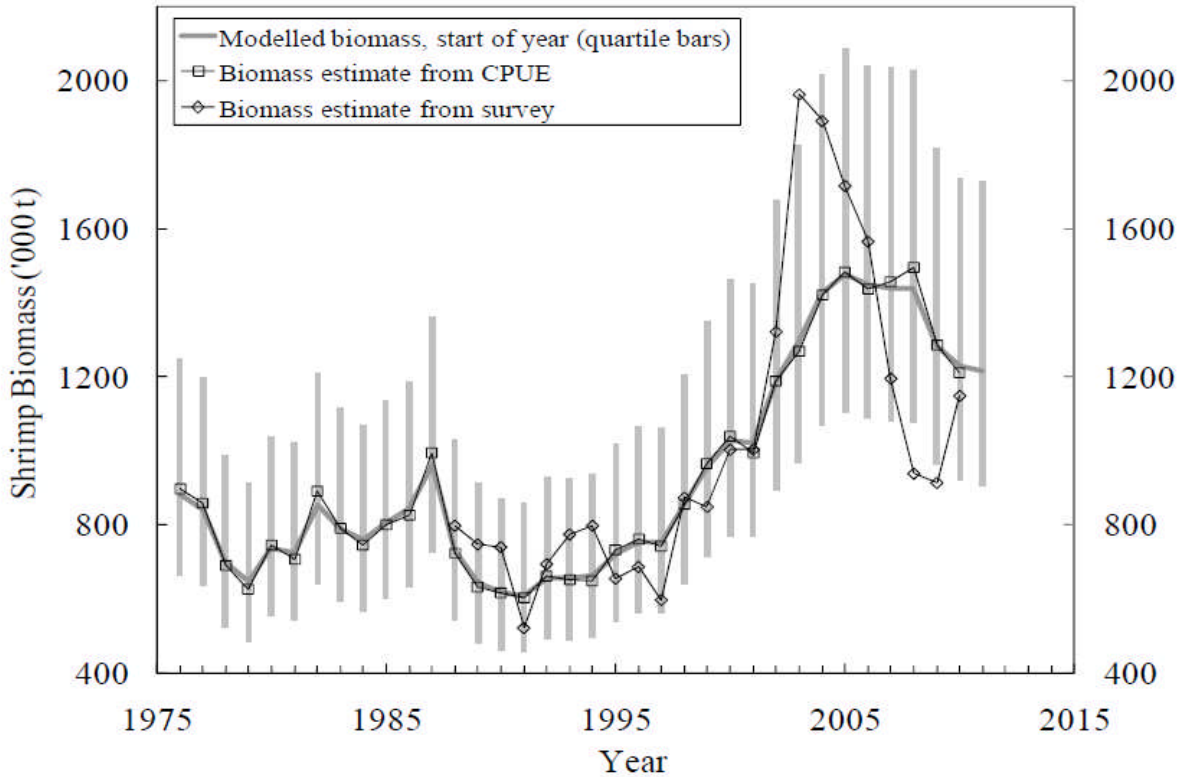

Figure 5. Shrimp in SA 1 and Canadian SFA1: trajectory of the median estimate of stock biomass at start of year, with the year's median CPUE and survey indices (NAFO/ICES 2010).

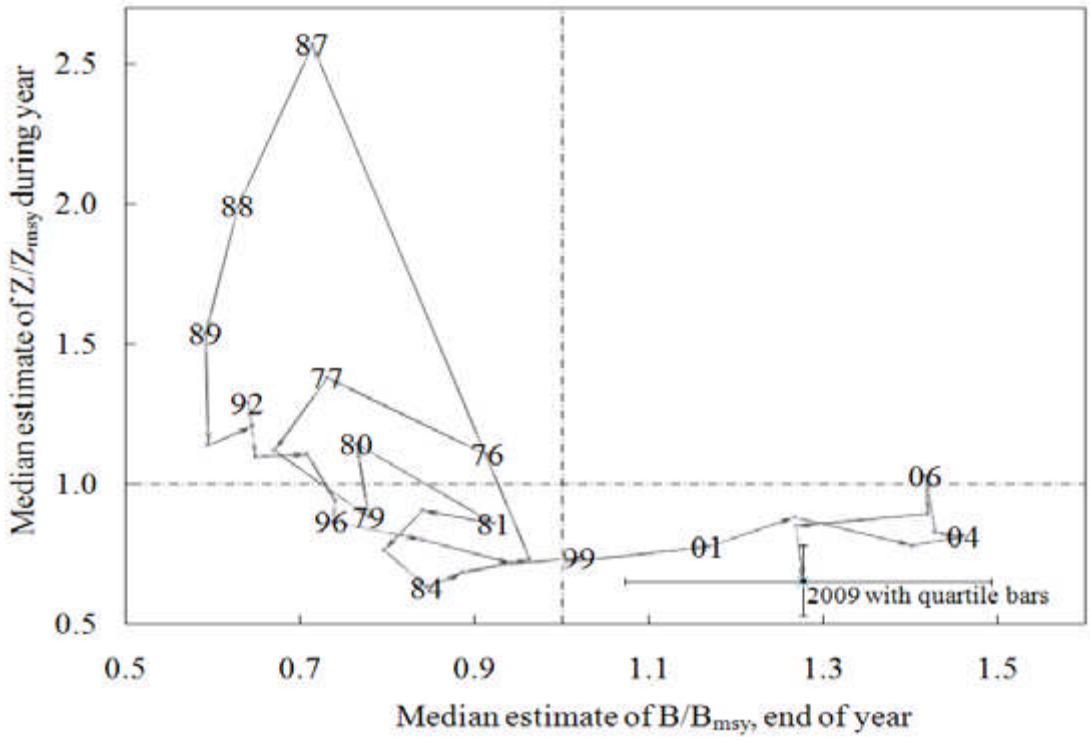

Figure 6. **Shrimp in SA 1 and Canadian SFA1: trajectory of past relative biomass and mortality (NAFO/ICES 2009).**

5.3 SFA 1 Management advice

The shrimp stock is assessed annually and is based on annual surveys conducted by Greenland. There is a harvest strategy in place consisting of a combination of monitoring, stock assessment, harvest control rules and management actions within the Canadian fishery. The Scientific Council of NAFO gives advice on the TAC that is based on maintaining the stock above biological reference points with a level of certainty (B_{msy}>80%). In NAFO Sub Areas 0 and 1 including SFA 1 Canadian and Greenlandic authorities each establish TACs for their EEZ based on advice from NAFO /ICES Pandalus Assessment Group (NIPAG). Canada has historically set a TAC at 17% of the advised TAC (18,417 t in 2007, 2008 and 2009). There is no regular or formal joint TAC setting mechanism. The Greenland Home Rule Government has in recent years set their quota above the NAFO advice (130,000 t in 2007 and 110,000 t in 2008 and 2009).

Since 2002 the TAC has been based on a quantitative assessment using a Bayesian production model. This uses time series of stock survey and fleet CPUE data to calculate stock status and expected catches relative to estimates of B_{msy}, maximum sustainable yield, and the reference points B_{lim} and Z_{lim} (Kingsley, 2007). Since the 1970s, catches have generally risen progressively, reaching an initial peak of 105,000 t in 1992, then decreasing until 1998, but rising again to a peak of 154,600 t in 2006. Since then the model indicates a stock decline.

In recent years, the combined enacted TACs set by Canada, Greenland and EU have exceeded the TACs recommended by NAFO's Scientific Council (Table 2) (NAFO 2008/0-1; NAFO/ICES 2009). Greenland has as a rule caught the enacted TAC or slightly more. Due to lack of revenue (the high cost of fishing in the far north) coupled with better economic alternatives in other areas the annual average Canadian catch in SFA 1over the last decade has been 4,107 and the highest annual reported catch over the last 30 years was in 1999 at 7,493. No fishing took place in SFA1 by Canadian vessels in 2008 and 2009.

The management of a stock that Canadians harvest should not be higher than the 17% Canadian share of the advised TAC. However, there is no bilateral agreement between Greenland and Canada including a regular or formal joint TAC setting mechanism, and management actions are not in place. The strategy that each country uses to determine its quota results in a combined TAC that is approximately 20% above the advised TAC (110,000 t). The risk of falling below B_{msy} is still below 23%. The result of no bilateral agreement in quota setting is that the stock may not be managed on a sustainable basis.

Table 2. Recent catches (2005-2010), recommended and enacted (total and by country) TACs (t) for Northern Shrimp in Div. 0A east of 60°30'W and Subarea 1 are as follows:

	2005	2006	2007	2008	2009
TAC					
Recommended	130 000	130 000	130 000	110 000	110 000
Enacted	152 452	152 380	152 417	145 717	132 987
Greenland			130 000	123 300	110 570
EU			4 000	4 000	4 000
Canada			18 417	18 417	18 417
Catches (NIPAG)	156 899	157 315	144 190	152 749	134 890

6 FISHERY MANAGEMENT FRAMEWORK

Pursuant to the *Constitution Act*, 1867, the legislative authority governing seacoast and inland fisheries falls under the jurisdiction of the Government of Canada. Several pieces of legislation have been enacted to give effect to that responsibility, notably the *Fisheries Act* and regulations and the *Oceans Act*. With *The Fishery (General) Regulations, 1993,* provides a framework for the issue of fishing rights and licences to fish for the commercial fishery.

6.1 Licence Holders

There are seventeen offshore licence holders authorized to fish shrimp in SFAs 1-7. The thirteen offshore vessels that fish these licences do so, either through vessels owned by the licence holder or through joint ventures between the licence holders and vessel owners. The relationship between the licence holders and the vessel owners is displayed in Table 3.

Table 3. Licence Holders and Vessels

Licence Holder (No. of Licences)	Vessel	Vessel Owner
Labrador Fishermen's Union Shrimp Co. Ltd. (2)	Labrador Storm	Labrador Fishermen's Union Shrimp Co. Ltd.
Ocean Choice Intl. Inc. (2)	Newfoundland Lynx/ Katsheshuk II	Ocean Choice International Inc.
Mersey Seafoods Ltd. (2)	Mersey Venture Mersey Phoenix	Mersey Seafoods Ltd.
Lameque Offshore Ltd. (1)	Northern Eagle	M.V. Osprey Ltd.
Crevettes Nordiques Ltee[2] (1)	Atlantic Enterprise	Clearwater Seafoods L. P.
Atlantic Shrimp Co. Ltd. [3] (1)	Atlantic Enterprise Arctic Endurance	Clearwater/Ocean Prawns Canada Joint Venture
Torngat Fish Producers Coop Society Ltd. (1)	Mersey Phoenix Mersey Venture	Mersey Seafoods Ltd.
Caramer Ltd. (1)	Acadienne Gale II	Davis Strait Mgt. Ltd.
Makivik Corp. (1)	Newfound Pioneer	Newfoundland Resources Ltd.
Pikalujak Fisheries Ltd. (1)	Ocean Prawns	Ocean Prawns Canada Ltd.
Qikiqtaaluk Corporation (1)	Saputi	Qikiqtaaluk Corporation
Harbour Grace Shrimp Co. (1)	Ocean Prawns	Ocean Prawns Canada Ltd.
Unaaq Fisheries Inc. (1)	Arctic Endurance	Clearwater Seafoods L. P.
Newfound Resources Ltd. (1)	Newfound Pioneer	Newfound Resources Ltd.,

The fishery is managed on a rights-based system called Enterprise Allocations (EA) with an equal sharing (1/17th each) formula. That percentage is multiplied by the quota assigned to the offshore licence holders for each SFA and allocated to each licence as a maximum tonnage that may be

[2] Wholly owned subsidiary of Clearwater Seafoods Limited Partnership
[3] Ibid

harvested for that fishing year in that particular area. There are further allocations provided to community and aboriginal interests (including some of the 17 licence holders) apart from the offshore licence holder portion *per se*.

6.2 Administrative Arrangements and Boundaries

As noted above SFA 1 is a trans-boundary stock being present in both the Canadian and Greenland EEZ's and fished by both parties. Canada and Greenland have agreed that the Scientific Council (SC) of NAFO should assess the stock and provide advice on harvesting levels. Accordingly, one or both of the parties request scientific advice from the SC on an annual basis. International scientists composed of representatives of Contracting Parties of NAFO review submissions from both coastal states and provide advice in the annual report of the SC.

There is no agreement between Canada and Greenland to jointly or co-manage the stock. Each country sets its own TAC based on its perception of its entitled share. For some years now, Canada's has set its TAC at 17% of the SC recommended catch for the offshore component of the stock (5/6ths of the total). The 17% share claimed by Canada is based on the relative portion of the stock residing in the Canadian zone in the early years of the fishery. Canada and Greenland independently manage the fishery in their respective zones.

Within the Canadian EEZ, the DFO is the main administrative body responsible for the management of the Canadian portion of the catch. The Minister of DFO has the ultimate responsibility for the fishery and his/her authority is delegated to officials through the organizational structure of the department. The SFA 1 fishery falls within the Central and Arctic Region of DFO and the management of the fishery is conducted by the Resource Management Directorate in Ottawa.

Within the Canadian management system, Integrated Fishery Management Plans (IFMP) are developed that outline the fisheries objectives and management measures by stock and area. The Northern Shrimp IFMP is a comprehensive document covering all the SFA's. It has been recently updated and posted on the DFO website (ww.df-mpo.gc.ca, 23rd of September 2009). The IFMP is very detailed containing a number of protocols, some harvest control rules and other measures.

The Northern Shrimp Advisory Committee (NSAC) (see section 6.5) is the main consultative and management body for the fishery. It is a widely representative group composed of all the major stakeholders in the fishery.

6.3 Legislation and Regulation

The legislative authority for the management of seacoast and inland fisheries in Canada falls under the exclusive jurisdiction of the Parliament of Canada. There are several pieces of legislation that apply to the fishing industry, the major one being the *Fisheries Act*. That *Act* grants wide discretionary authority to the Minster of Fisheries and Oceans and provides for the enactment of regulations respecting the management of the fishery. *The Atlantic Fishery Regulations, 1985* and the *Fishery (General) Regulations* are the main regulatory instruments governing the fishery. *The Species at Risk Act, 2002* is important when fishing near populations of designated vulnerable species. *The Oceans Act, 1996* is an overarching piece of legislation of general application. The Coastal *Fisheries Protection Act, 1985* applies to foreign vessels and can come into play in this fishery as the SFA 1 boundary line abuts that of Greenland. The *Fish Inspection Act* governs the processing of shrimp on the factory freezer trawlers which are designated as processing plants for the purposes of the *Act.*

Table 4. Principal Acts and Policy Documents

Principal Acts and Policy Documents	Description
The Fisheries Act, 1985	Provides absolute discretion to the Minister for the management of fisheries and for the establishment of fishing licences, regulations, reporting requirements, powers of fishery officers, protection of fish habitat and pollution prevention.
The Atlantic Fishery Regulations, 1985	Prescribes conditions for the operation of the fishery including seasons, closures, management and conservation measures, etc. Variation Orders are used to alter conditions and to shorten or lengthen the fishing season as appropriate.
The Fishery (General) Regulations 1993	Provides for the issue of licences and the authority to specify conditions in a fishing licence, e.g. allocations, vessel monitoring systems, hail-in/hail-out requirement, observer coverage, dockside monitoring, etc.
The Coastal Fisheries Protection Act, 1985	Prescribes conditions under which foreign vessels are permitted to fish in Canadian waters.
The Species at Risk Act 2002	Authorizes actions aimed at managing species of special concern, preventing the extirpation or extinction of endangered marine species, or promoting their recovery.
The Oceans Act 1996	Prescribes the Canadian oceans management strategy, including sustainable development, the precautionary approach, and the implementation of integrated management of marine activities.
The Fish Inspection Act	Governs fish processing operations on shore and aboard vessels in Canadian waters, notably the processing of shrimp aboard the factory freezer trawlers in the fishery under assessment.

These legislative instruments create the legal framework for the management of fisheries and for the licensing and registration of participants in Canada and more specifically for SFA 1. They also provide a ticketing and court sanction system ranging from low fines to ones in the hundreds of thousands of dollars as well as forfeiture of catch and equipment upon conviction.

6.4 Harvest Controls

Annual Total Allowable Catches (TAC) are the major harvest control measure used for this fishery. As indicated above the SC of NAFO assesses the stock and provides advice on catch limits. The SC uses a Precautionary Approach Framework and has established a precautionary limit reference point for the NAFO Divisions 0 and1 fishery stock biomass at 30% of $B_{msy.}$ Harvest levels are recommended in the form of catch limits, which have a low risk of driving the stock below $B_{msy.}$

Canada then sets its TAC at 17% of the offshore portion of the recommended catch limit, which is divided among the offshore licence holders. The fishery is closely regulated including the presence of on-board observers who track about 70% of tows. Harvest limits are not exceeded and there are severe penalties provided in the *Fisheries Act* should such an event occur. As indicated above the Canadian catch from SFA 1 has been far below the Canadian quota for several years.

There is no minimum size identified in the management of the shrimp stock but a bycatch regulation is in place.

6.5 Monitoring, Control and Surveillance (MCS)

The DFO is the responsible enforcement agency for fishing in Canadian waters. It has a staff of land-based and seagoing Fishery Officers and a complete system of MCS, including:

- At-sea observations by patrol vessels and fixed-wing aircraft
- 100% industry funded on-board observer coverage
- Daily reporting of position and catch and submission of vessel fishing log books
- Random dockside monitoring of landings by 3rd party contractors or Fishery Officers
- Catch and Effort database to track catch against EA's
- Electronic vessel monitoring systems (VMS) on each vessel
- A ticketing system for minor offences
- A court-based system for more serious offences which can result in fines up to $500,000, jail terms and forfeiture of catch and gear
- Conditions of licence covering such things as mandatory sorting grate, mesh size, no shrimp discarding etc.
- On-board observer/vessel protocols to monitor catch, species, package weights, etc.

6.6 Consultation and Dispute Resolution

The major consultative mechanism in the fishery is the NSAC. It is composed of representatives of offshore licence holders, inshore licences holders, and special allocation holders, various processor, fishermen and aboriginal associations and wildlife management boards, a representative from the Nunavut government and provincial government representatives from Newfoundland and Labrador, Nova Scotia, New Brunswick and Prince Edward Island and Quebec. Fishery managers, scientists and enforcement staff from DFO attend the committee and provide advice and assistance. The Director General, Resource Management Operations, DFO, Ottawa, chairs the Committee. Non-members may also attend and can participate in discussions following input from members.

The IFMP outlines the formal structure and detailed terms of reference of the committee covering such things as, the purpose, scope, membership and operating procedures. Its main focus is quota allocations and management measures such as seasons, size limits, gear restrictions, other conservation and compliance issues and licensing policy.

There are additional requirements for the federal government to consult with the Nunavut Wildlife Management Board and consider its opinion concerning fisheries management in the area.

Most disputes are resolved using the representational framework in the NSAC forum. Regional managers of DFO have a particular role to play in brokering solutions on policy related issues. The ultimate appeal of last resort is to the Minister of Fisheries, who is the final authority under Canadian fisheries legislation.

7 ECOSYSTEM CHARACTERISTICS

7.1 Pandalid Shrimp in the Ecosystem

P. borealis occur over very large areas of northwest Atlantic continental shelves, from Greenland through Davis Strait, Hudson Strait, the Labrador and Newfoundland shelves, the Gulf of St. Lawrence, the Scotian Shelf and the Gulf of Maine. Ocean currents in this area are generally from north to south and could act to foster dispersal of shrimp over large continental shelf areas (particularly at the larval stage) (Table 5).

Table 5. Currents in the fishery areas. Source: DFO

Although found over a broad latitudinal range, *P. borealis* concentrate in preferred habitat areas where the bottom is soft and muddy, with a high organic content (although they can be taken on hard bottom areas). Although reviews of continental shelf and slope geology have recently been completed for much of the Newfoundland-Labrador shelf (C-NOPB 2003, 2008), these provide little information on distribution of sediments and habitats in these areas, and little information is available for SFA 1. Soft and hard sediment areas are interspersed in depths where shrimp are found, with channels and

basin areas at the edge of the continental shelf being preferred areas for commercial shrimp concentrations over much of the area. Use of acoustic gear on commercial vessels to map bottom types is currently being explored (Marine Institute 2008) and such bottom typing information would help improve knowledge of benthic habitats in the fishery area.

The distribution of sensitive bottom habitat areas is becoming increasingly well known in the fishery area, based on recent studies of distribution of coldwater corals and sponges. Coldwater corals have been classified into five functional groups based on taxonomy, growth form and size, and all these groups overlap to some extent with the distribution of the shrimp fishery (Edinger et al. 2007). Despite the recent increase in information on distribution of these organisms, information on sensitive bottom habitats, and on bottom habitats in general, must still be considered incomplete.

Coldwater coral distribution in the fishery area has been mapped based on occurrence of corals in commercial and research survey trawls (Edinger et al. 2007; Wareham 2009). Areas of significant occurrence of sponges have been mapped in areas near Flemish Cap and Flemish Pass (Kenchington et al 2009); this study suggests that depths of occurrence of significant sponge concentrations are greater than those at which the shrimp fishery operates.

Shrimp fishing gear operates in several marine communities and habitats:

- the benthic, including the bottom sediments and substrates and organisms which live in direct contact with the substrate. These include infauna such as burrowing worms, and epifauna such as echinoderms (sea and brittle stars, sea cucumbers), molluscs, crustacea, and attached fauna such as coelenterates (hard and soft corals) and sponges. Hard substrates in the fishery area may support anchored epifauna such as hard corals and sponges, while soft substrates may support anchored, mobile or burrowing organisms
- the demersal, organisms which live in the water near bottom and depend on the benthic community for much of their food or habitat. Key members of this community are the demersal fishes, both the commercially important (cod, flatfishes and others) and noncommercial (eelpouts, alligator fishes).
- the benthopelagic, organisms living somewhat further off bottom than those in the demersal community; shrimp and redfishes are members of this community.

Knowledge of the composition and dynamics of communities in which the shrimp fishery operates is sparse, with the exception of commercially-important species (demersal fishes and snow crab) for which population assessments are available. A study of benthic fauna of the northern Labrador Shelf and Davis Strait (Stewart et al 1985) included stations near the fishery area and listed species found, identified major species in each subarea, and explored relations between distribution of benthos and major water masses. Information compiled for a mass balance model of the west Greenland ecosystem summarized available knowledge of trophic interactions in the demersal community (Pedersen and Zeller 2001).

A comprehensive review of available information on benthic communities of the Orphan Basin and adjacent regions of the Grand Banks (C-NPOB 2003), notes that while literature appears extensive, most studies are spatially restricted or species-specific. This review indicates that benthic diversity is high on the Grand Banks, with epifauna dominated by echinoderms (sand dollars, brittle stars, sea urchins, sea cucumbers and asteroids), molluscs, crabs and soft corals. These results are probably applicable to some extent to the fishery area, although one would expect species diversity to decrease toward the north. In general, no studies specific to bottom communities in which the shrimp fishery operates are available.

P. borealis, like other pandalid shrimp, is an opportunistic predator which feeds both near bottom and in the water column during vertical migrations at night (Bergstrom 2000). This species is a key component of the North Atlantic Ocean's food web, between the small organisms that it eats, including the zooplankton and benthos that form the base of the food web, and the top predators that

eat it, like cod and other commercially important finfish (Parsons 2006). As a result, it is an important marine indicator, sensitive to various types of changes in the ecosystem, sometimes even before they are generally evident. Coincident with collapse of groundfish populations in the Canadian Atlantic, pandalid shrimp populations increased substantially (along with other crustacean populations, snow crab and lobster). The increase may have been due to release of groundfish predation and/or to response of the crustacean populations to changes in environmental conditions. Different populations of *P. borealis* have adapted to local temperatures and bloom timing, matching egg hatching to food availability under average conditions. This strategy is vulnerable to inter-annual oceanographic variability and long term climatic (Koeller et al. 2009).

Studies have identified 26 species, which prey on *P.borealis* (Parsons 2005a, b, 2006). Principal predators include Atlantic cod (*Gadus morhua*), Greenland and Atlantic halibut (*Reinhardtius hippoglossoides* and *Hippoglossus hippoglossus*), redfishes (*Sebastes spp*), wolffishes (*Anarhichas spp*), skates (Rajidae) and harp seals (*Pagophilus groenlandicus*). In the northern Gulf of St. Lawrence northern shrimp feed on (in decreasing order of importance) detritus, large zooplankton (principally euphausiids, chaetognaths, hyperiid amphipods), small zooplankton (principally copepods), and phytoplankton (Savenkoff et al 2006) and one would expect a similar prey composition in this fishery area.

The recent increase in abundance and in distribution of fishable concentrations of *P. borealis* over large parts of the Northwest Atlantic has coincided with changes in the marine environment, including cooling of ocean temperatures and substantial declines in populations of some groundfish species, particularly Atlantic cod. Changes in the ocean environment and release of predation pressure are considered potential factors to explain the increases in *P. borealis* abundance, but the relative importance of these factors and others is not well understood (Lilly 2006; Lilly et al. 2000; Parsons and Colbourne 2006; Worm and Myers 2003). Different factors may have predominated at different times during the long-term (1980's to present) increase in shrimp biomass (Lilly 2006). Off Alaska pandalid shrimp, including *P. borealis*, declined rapidly and to low levels in the late 1970s and early 1980s apparently in response to a regime shift in the ocean climate and coincident with changes in abundance of many species in their ecosystem (Anderson 2000).

Since pandalid shrimp populations are sensitive to changes in conditions in the marine environment (Anderson 2000; Clark et al 2000, Parsons and Colbourne 2006), some consideration should be given in establishing fishery management measures to potential future changes in marine conditions. *P. borealis* abundance has recently been very high in relation to the average of observed conditions, apparently in response to favourable environmental conditions including low abundance of some important predators and favourable temperatures. Although future conditions are impossible to forecast accurately, there is potential for *P. borealis* abundance to decrease rapidly and substantially if conditions change.

7.2 Fishery Interactions with the Ecosystem

7.2.1 Endangered, Threatened Protected species

Two species of wolffishes, northern (*Anarhichas denticulatus*, sometimes called broadhead wolffish) and spotted (*Anarhichas minor*), both listed as Threatened on Schedule 1 of Canada's Species at Risk Act, co-occur with *P. borealis* and are taken as bycatch in the fishery. A third species, the striped wolffish (*A. lupus*), is listed as "Special Concern" on SARA Schedule 1 and accordingly is not considered an ETP species for this assessment.

A recovery strategy for the two threatened wolffish species has been published, emphasising the need to avoid targeting these species, and to return any individuals caught to the sea in the best condition possible (Kulka et al 2008). These species are found on a wide range of bottom habitats, although only Spotted Wolffish is found on the soft mud habitats in which the shrimp fishery concentrates (Kulka et al 2008).

Detailed information on bycatch of these two species in the northern shrimp fishery is available for the fishery area (unpublished data compilation, T. Siferd, DFO), indicating that bycatch is low. Between 2002 and 2007, bycatch ranged from 0 to 40 kg/yr for northern wolffish, from 40-245 kg for spotted wolffish. Licence conditions for shrimp fishing vessels, based on requirements in the recovery strategy, require no targeting of wolffishes and live release of any specimens caught in the best condition possible. DFO staff responsible for leading the implementation of the recovery strategy indicate that the shrimp fishery does not appear to have a significant impact on these species (D. Orr/M. Simpson, pers. comm.). A DFO status review for these species is planned for 2009-10 (D. Orr/M. Simpson, pers. comm.).

7.2.2 Bycatch

7.2.2.1 Retained Species

Bycatch in this fishery is well estimated and species are identified to the lowest taxonomic level possible. Observers are carried on 100% of trips, meaning that some 70% of tows are observed. An unpublished compilation of bycatch weights annually since the late 1970s is available for SFAs 0, 1, 2 and 3 (information provided by T. Siferd, DFO).

For the purposes of this assessment, the only "retained" bycatch species is the striped shrimp, *P. montagui*. This species is widely distributed in areas where *P. borealis* is found, from Davis Strait to the eastern Grand Banks (Orr et al 2003), but it is quite rare outside SFAs 2-4, where it is most commonly taken in Hudson Strait and areas on the Labrador Shelf and Davis Strait near the entrance to Hudson Strait. The species generally is found in shallower depths (less than 400 m) than *P. borealis* (200-600 m). Negligible quantities of *P. montagui* are taken in SFA 1 – zero catch was recorded in 9 of 14 years between 1994 and 2007, 1-50 kg in the other five years (unpublished data compilation, T. Siferd, DFO).

7.2.2.2 Discarded Species

All other species taken as bycatch in this fishery are considered "discard" species for this assessment.

The Nordmore grate (see Section 3.4, Figure 4) was introduced into the Canadian shrimp fishery in 1993 in response to concerns about the level of groundfish bycatch in the small-meshed shrimp trawls. Use of the Nordmore grate is currently mandatory in all SFAs in the fishery area. A minimum grate spacing of 28 mm is required in SFA 1.

A recent study (Orr and Cadigan 2009) in SFA 4 comparing shrimp catches and amounts of key commercial bycatch species using 28 mm and 22 mm (as used in more southerly SFAs) grate spacings suggested that more fishes were taken with the 28 mm grate, although the differences were not very large (e.g. +24% for redfishes). Shrimp catch was lower (27% lower in the area with the highest number of comparable tows) in tows with the 22 mm grate. The authors suggested that any advantages in selectivity for fishes might be outweighed by greater time spent fishing to compensate for reduced shrimp catches. There is no current plan to move to the smaller grate spacing in areas where the 28 mm grate is in use.

Trawls are also rigged with toggle chains between footropes and netting, with a view to further decreasing bycatch of near-bottom species such as flatfishes.

Species in the bycatch include finfishes, both commercial and non-commercial species, and mobile and sessile invertebrates. A large number of species and species groups are recorded in the bycatch (unpublished data compilation, T. Siferd, DFO).

Atlantic cod, redfishes and American plaice can be considered "depleted" species, as abundance is

currently at low levels compared to historical levels in parts of the northwest Atlantic where the *P. borealis* fishery operates. Fishery management measures are in place to foster rebuilding of these species, either catch moratoria or strict catch limits, in much of the area between Davis Strait and the Grand Banks.

Bycatch of all discard species combined is in almost all cases below 5% of catch weight of the target species, the notional guideline for identifying "main" bycatch species in MSC assessments. Accordingly, weights of individual species are generally well below the 5% guideline, in most cases an order of magnitude or more below. For most groundfish species, analyses have not been done to compare removals in the shrimp fishery to other sources of mortality. An exception is an analysis indicating that shrimp fishery bycatch of Greenland halibut took less than 5% of an average year-class of Greenland halibut in 1996-2003 on the Newfoundland and Labrador shelves (Bowering and Orr 2004). Bycatch levels can be put in perspective by considering that 100 t of prey biomass (around the level of some of the higher annual single-species bycatch values recorded in individual SFAs) would support 10 t of predator biomass, based on an assumed 10% trophic transfer rate, negligible in ecological terms.

In SFA 1, in the period 1999-2007 total bycatch of all species by weight varied between 34 and 353 t per year, or between 1.8% and 6% of shrimp catch (in years with catches over 1,000 t; percentages were higher in years with low catches but amounts were quite low) (unpublished data compilation, T. Siferd, DFO). Redfish was the most abundant species in the bycatch, with annual catches ranging between 24 t (1.2% of shrimp catch) and 207 t (3% of shrimp bycatch). Next in abundance was Arctic cod at 0.8-120 t/yr. American plaice (0.7-7.1 t/yr) and Greenland halibut (4.2-29.7 t/yr) were important commercial species occurring in the bycatch.

Overall bycatch levels have been very low in this fishery in recent years, and amounts taken do not appear significant in ecological terms. However one reason for low bycatch levels of commercial groundfish species is probably that several of these are currently depleted and at very low abundance compared to historical levels. Rebuilding of populations of these species could lead to greater bycatch, and impact of bycatch mortality on rebuilding might be a concern in a scenario where population recovery was occurring.

7.2.3 Impacts on Habitat

Impacts of bottom fishing gear on habitats can be separated into direct impacts on sediments and substrates, and impacts on sessile organisms which may provide habitat for other organisms (for example erect corals, sponges).

Impacts by the trawl gear used to harvest *P. borealis* on bottom habitats, species, and communities are incompletely known although some information is available which could be used to assess potential impacts. *P. borealis* prefer soft mud and silt bottoms and the fishery concentrates on these to minimise the potential for trawl damage, although occasional presence of hard corals and sponges in trawl bycatch indicates that hard bottoms may be contacted. Gear used is relatively light, and efforts are under way to further lighten gear (doors, foot gear, and netting) in order to reduce fuel costs (see for example a proposal by Newfoundland's Marine Institute, n.d). Trawl doors and footropes would be the only elements of the gear contacting the bottom in most areas. The exception to this overall pattern is use of twin trawls in some northern areas, where a very heavy (4 t) "shoe" is used between the two codends, which would dig into the ground over a narrow band (ca 3 m).

No studies of trawl impacts on habitats typical of *P. borealis* have been conducted in the fishery area. General impacts of trawling on bottom habitats have been reviewed in several studies (summarized in Rice 2006). There is considerable variation between results of the available studies of trawling impacts on soft bottom habitats. In general, it has been concluded that while trawl impacts show more rapidly on soft bottom habitats (mud, sand) than on harder bottom habitats, soft bottom habitats tend to recover more quickly (Rice 2006). A study of impacts of shrimp trawling in the Gulf of Maine

on habitat and community structure of mud bottoms (Simpson and Watling 2006) showed little impact on habitat and relatively short-term (3 months) impacts on community structure. However, a meta-analysis of studies of mobile gear impacts showed that recovery times on mud-sand habitats can be relatively long (Kaiser et al 2006). Hinz et al (2009), in a study of changes in species abundance and community structure in mud-sand habitats along a gradient of trawling intensity in the Irish Sea, concluded that species abundance, biomass and diversity decreased with increased trawling intensity and that changes in community structure were also more marked with increasing trawling intensity. Overall, the results of studies to date depend greatly on methodology, whether the study is of chronic disturbance or of immediate impacts, and on habitat type and community structure (Lokkeborg 2007, Rice 2006).

Information on bycatch of coldwater corals in shrimp gear (Edinger et al. 2007) suggests that a relatively low proportion of shrimp sets takes hard corals (around 2% over the entire Newfoundland-Labrador shelf and Davis Strait), but this probably underestimates the actual impact on habitats and species, since damage may occur even when corals are not taken as bycatch. Given the slow growth rates of coldwater corals these species are probably slow to recover from such impacts. Shrimp trawl fishermen, at least in the offshore fishery, avoid known areas of coral habitat as the likelihood of damage to trawls is high in these areas and cost of repairing trawls is high. Likelihood of damaging gear on hard bottoms is also increasing, as shrimp trawl gear is increasingly light to reduce fuel costs.

Studies of the proportion of bottom impacted by shrimp trawling (Spatialanalysis 2009) suggest that a relatively small proportion of the continental shelf is impacted by this fishery. While encouraging, these studies do not consider the relative sensitivity of the habitats trawled or the specific communities in which the fishery operates.

As noted earlier, information on distribution of coldwater corals and sponges is improving. Several closed areas have been put in place, which could help protect bottom habitats (notably an area voluntarily closed to shrimp fishing off the entrance to Hudson Strait, to protect coldwater corals. DFO's Newfoundland/Labrador region has committed to developing a coral conservation strategy by 2012, and DFO has developed a Policy on Managing Impacts of Fishing on Sensitive Benthic Areas which is intended to provide an overall framework for protecting bottom habitats.

An area was closed by regulation to the Greenland halibut fishery in 2007 SFA 1 to protect narwhal overwintering areas and coral concentrations (Integrated Fisheries Management Plan; DFO 2007ca). While this is outside the main shrimp fishing area in SFA 1, it is a further contribution to benthic habitat conservation in this area.

Excellent information on distribution of fishing effort is available from VMS equipment carried on vessels and logbooks. Compilations of information on distribution of fishing are available (Spatialanalysis 2009; Orr et al MS 2008).

7.2.4 Impacts on Ecosystems

Two potential ecosystem-level impacts of this fishery have been identified: impact of removal of the target species on tropic relationships, and impacts on biological diversity and community structure due to non-catch mortality. The latter does not include impacts on sessile, erect organisms of hard bottoms such as corals and sponges as these have been considered under "habitat" (section 6.2.3).

7.2.4.1 Impact of Removal of *P. borealis* on Trophic Relationships

Given the importance of shrimp as forage for predators in ecosystems in which it occurs, maintenance of adequate biomass to support trophic relationships is an important issue for management. Shrimp abundance is currently high relative to historical levels, although abundance is declining rapidly. Total mortality rates, taking into account cod predation and fishery mortality, have remained below Z_{msy} in recent years, such that adequate amounts of shrimp have been available as forage for

predators. The need to ensure that predator needs are met is explicitly addressed in the stock assessment; total mortality rates which are compared to target and limit rates include terms both for fishing mortality and for mortality due to cod predation (NAFO 2008/0-1). Assessment recommendations are generally followed by management. This approach should help to ensure that an appropriate proportion of shrimp are reserved for predators as part of the fishery management strategy.

7.2.4.2 Impact on Biological Diversity and Community Structure

Overall impact of the shrimp trawl fishery in this area on large parts of ecological communities has not been studied, although information is available on some species groups and some impacts. Shrimp trawl impacts on snow crab populations have been assessed in several studies (Gilkinson et al 2006) but snow crab does not occur in significant numbers in the fishery area.

Non-catch impacts from passage of gear, or extrusion from netting, are not known. Although these might be considered potentially low, because of the use of large rollers on footgear, and relatively light trawl doors, there remains an overall lack of knowledge of the role of individual species in benthic ecosystems and of the specific impacts of shrimp trawl gear on individual species. In addition, use of a heavy shoe on twin trawl gear could increase damage from the trawl over a narrow swathe. Studies of trawl gear on bottom habitats give rather variable results depending on the area and gear (Rice 2006), although decreases in abundance of some taxa following use of shrimp trawls have been observed in some studies (for example, Hansson et al 2000; Tanner 2003). Studies generally show that most reduction in abundance occurs when areas are first trawled (Tanner 2003).

8 OTHER FISHERIES AFFECTING THE TARGET STOCK

No other Canadian fisheries exert significant impact on northern shrimp populations in the fishery area. Groundfish trawl fisheries use mesh sizes that would not retain shrimp and in any case are at low levels or not operating in or near the fishery area at present. Shrimp are not caught in other fisheries in or near the area (i.e. snow crab trap fisheries, gillnet and longline fisheries for finfish).

As noted above, Greenland harvests shrimp from the same NAFO management area, which is treated as a unit for assessment and management purposes. Canada and Greenland do not have an agreed bi-national harvesting policy, each country setting its TAC based on its own policy, following receipt of scientific advice from the NAFO Scientific Council. This has resulted in the recommended TAC being overharvested in recent years. Canada has not harvested its allocated TAC in recent years, and indeed Canadian catches in the fishery area have been relatively low because of economic conditions (high costs of harvesting in the north, good supplies of shrimp from fishery areas to the south). Despite this, the lack of a bi-national fishery management strategy has the potential to lead to unsustainable harvesting of the stock, particularly in a situation where the stock is declining (as appears to be the case at present).

9 STANDARD USED

The MSC Principles and Criteria for Sustainable Fisheries form the standard against which the fishery is assessed and are organised in terms of three principles. Principle 1 addresses the need to maintain the target stock at a sustainable level; Principle 2 addresses the need to maintain the ecosystem in which the target stock exists, and Principle 3 addresses the need for an effective fishery management system to fulfil Principles 1 and 2 and ensure compliance with national and international regulations. The Principles and their supporting Criteria are presented below.

9.1 Principle 1

A fishery must be conducted in a manner that does not lead to over-fishing or depletion of the exploited populations and, for those populations that are depleted, the fishery must be conducted in a manner that demonstrably leads to their recovery. [4]**:**

The intent of this principle is to ensure that the productive capacities of resources are maintained at high levels and are not sacrificed in favour of short term interests. Thus, exploited populations would be maintained at high levels of abundance designed to retain their productivity, provide margins of safety for error and uncertainty, and restore and retain their capacities for yields over the long term.

Criteria:

1. The fishery shall be conducted at catch levels that continually maintain the high productivity of the target population(s) and associated ecological community relative to its potential productivity.
2. Where the exploited populations are depleted, the fishery will be executed such that recovery and rebuilding is allowed to occur to a specified level consistent with the precautionary approach and the ability of the populations to produce long-term potential yields within a specified time frame.
3. Fishing is conducted in a manner that does not alter the age or genetic structure or sex composition to a degree that impairs reproductive capacity.

9.2 Principle 2

Fishing operations should allow for the maintenance of the structure, productivity, function and diversity of the ecosystem (including habitat and associated dependent and ecologically related species) on which the fishery depends.

The intent of this principle is to encourage the management of fisheries from an ecosystem perspective under a system designed to assess and restrain the impacts of the fishery on the ecosystem.

Criteria:

1. The fishery is conducted in a way that maintains natural functional relationships among species and should not lead to trophic cascades or ecosystem state changes.

2. The fishery is conducted in a manner that does not threaten biological diversity at the genetic, species or population levels and avoids or minimises mortality of, or injuries to endangered, threatened or protected species.

[4] The sequence in which the Principles and Criteria appear does not represent a ranking of their significance, but is rather intended to provide a logical guide to certifiers when assessing a fishery. The criteria by which the MSC Principles will be implemented will be reviewed and revised as appropriate in light of relevant new information, technologies and additional consultations

3. Where exploited populations are depleted, the fishery will be executed such that recovery and rebuilding is allowed to occur to a specified level within specified time frames, consistent with the precautionary approach and considering the ability of the population to produce long-term potential yields.

9.3 Principle 3

The fishery is subject to an effective management system that respects local, national and international laws and standards and incorporates institutional and operational frameworks that require use of the resource to be responsible and sustainable.

The intent of this principle is to ensure that there is an institutional and operational framework for implementing Principles 1 and 2, appropriate to the size and scale of the fishery.

A. Management System Criteria:

1. The fishery shall not be conducted under a controversial unilateral exemption to an international agreement.

The management system shall:

2. Demonstrate clear long-term objectives consistent with MSC Principles and Criteria and contain a consultative process that is transparent and involves all interested and affected parties so as to consider all relevant information, including local knowledge. The impact of fishery management decisions on all those who depend on the fishery for their livelihoods, including, but not confined to subsistence, artisanal, and fishing-dependent communities shall be addressed as part of this process.

3. Be appropriate to the cultural context, scale and intensity of the fishery – reflecting specific objectives, incorporating operational criteria, containing procedures for implementation and a process for monitoring and evaluating performance and acting on findings.

4. Observe the legal and customary rights and long term interests of people dependent on fishing for food and livelihood, in a manner consistent with ecological sustainability.

5. Incorporates an appropriate mechanism for the resolution of disputes arising within the system[5].

6. Provide economic and social incentives that contribute to sustainable fishing and shall not operate with subsidies that contribute to unsustainable fishing.

7. Act in a timely and adaptive fashion on the basis of the best available information using a precautionary approach particularly when dealing with scientific uncertainty.

8. Incorporate a research plan – appropriate to the scale and intensity of the fishery – that addresses the information needs of management and provides for the dissemination of research results to all interested parties in a timely fashion.

9. Require that assessments of the biological status of the resource and impacts of the fishery have been and are periodically conducted.

[5] Outstanding disputes of substantial magnitude involving a significant number of interests will normally disqualify a fishery from certification.

10. Specify measures and strategies that demonstrably control the degree of exploitation of the resource, including, but not limited to:

    a) setting catch levels that will maintain the target population and ecological community's high productivity relative to its potential productivity, and account for the non-target species (or size, age, sex) captured and landed in association with, or as a consequence of, fishing for target species;
    b) identifying appropriate fishing methods that minimise adverse impacts on habitat, especially in critical or sensitive zones such as spawning and nursery areas;
    c) providing for the recovery and rebuilding of depleted fish populations to specified levels within specified time frames;
    d) mechanisms in place to limit or close fisheries when designated catch limits are reached;
    e) establishing no-take zones where appropriate.

11. Contains appropriate procedures for effective compliance, monitoring, control, surveillance and enforcement which ensure that established limits to exploitation are not exceeded and specifies corrective actions to be taken in the event that they are.

B. Operational Criteria

Fishing operation shall:

12. Make use of fishing gear and practices designed to avoid the capture of non-target species (and non-target size, age, and/or sex of the target species); minimise mortality of this catch where it cannot be avoided, and reduce discards of what cannot be released alive.

13. Implement appropriate fishing methods designed to minimise adverse impacts on habitat, especially in critical or sensitive zones such as spawning and nursery areas.

14. Not use destructive fishing practices such as fishing with poisons or explosives;

15. Minimise operational waste such as lost fishing gear, oil spills, on-board spoilage of catch etc.

16. Be conducted in compliance with the fishery management system and all legal and administrative requirements.

17. Assist and co-operate with management authorities in the collection of catch, discard, and other information of importance to effective management of the resources and the fishery.

10 BACKGROUND TO THE EVALUATION

10.1 Evaluation Team

Lead Assessor: Paul Knapman
Paul is a lead assessor with Moody Marine and is responsible for Moody Marine operations in North America. He has extensive experience of the fishing industry in North America and Europe. He was previously Head of an inshore fisheries management organization, a senior policy advisor to the UK government on fisheries and environmental issues, a fisheries officer and a fisheries consultant working in Europe and Canada.

Project Coordinator: Don Aldous
Don is a fishery consultant based in Nova Scotia providing fisheries management development services to clients in the fishing industry of Atlantic Canada and to fisheries organizations overseas since 1992. He worked for the Canadian Department of Fisheries and Oceans for 13 years on control of foreign fishing, pelagic and groundfish fisheries management plans. He has extensive experience in the South Pacific Islands as an advisor to island governments and regional organizations concerning tuna fisheries management planning issues.

Expert Advisor P1: Michaela Aschan
Michaela is a Professor in fisheries biology and fisheries management at the Norwegian College of Fishery Science, University of Tromsø in North Norway. As Senior Scientist she was in charge of the Norwegian shrimp research including surveys and shrimp stock assessment in the Barents Sea in the period 1991-2005. She is former chair of the ICES (International Council for Exploration of the Sea) Pandalus Assessment Working Group and has been a member of ICES working groups (WG) including the Arctic Fishery WG, the Pandalus & Nephrops WG and the Benthos Ecology WG. Michaela was a member of the assessment team that undertook the assessment of the Eastern Canadian Northern and Scotian Shelf Shrimp fisheries in 2007.

Expert Advisor P2: Howard Powles
Howard has worked in fishery science, stock assessment, and conservation and management of fishery resources since the mid-1960's, as a working scientist, science manager, program manager, and consultant, with a recurrent focus on crustacean resources. He was a member of the NAFO Working Group on the shrimp resource in NAFO Areas 0 and 1 in 1996-2000, participating in annual assessment meetings with scientists from Canada, Denmark, Greenland and the USA to develop and peer review scientific advice. He also participated in Canadian assessment meetings on the shrimp resource in shrimp fishing areas off Labrador and eastern Newfoundland in the same period. As Director of Fisheries Science and of Biodiversity Science (1998-2004) at Department of Fisheries and Oceans (DFO) Headquarters he was active in developing ecosystem-based approaches to ocean management, in particular approaches based on defining ecosystem objectives and indicators. Howard was also a member of the assessment team that undertook the assessment of the Eastern Canadian Northern and Scotian Shelf Shrimp fisheries in 2007.

Expert Advisor P3: John Angel
John is retired from full time employment having previously worked with the federal Department of Justice before moving to the Department of Fisheries and Oceans as head of legal and regulatory affairs in 1983. His last position in government (1994) was as Regional Director of Fisheries Management for the Scotia-Fundy Region. He then went on to serve as Executive Director of a Canadian fishing industry trade association. John served as a member of the Fisheries Resource Conservation Council (Canada) from 2004 to 2009. He has extensive experience in the development of integrated resource management plans and fishing strategies as well as a background in Canadian fisheries law.

10.2 Previous Certification Evaluations

The shrimp fishery in SFA 1 has not previously been the subject of a MSC main assessment against the MSC Principle and Criteria. The West Greenland *P. borealis* fishery, i.e. prosecuting the same stock, is presently in MSC assessment.

10.3 Inspections of the Fishery

Inspection of the fishery focused on the practicalities of fishing operations, the mechanisms and effectiveness of management agencies and the scientific assessment of the fisheries.

Meetings were held as follows. Some of the key issues discussed have been identified for each meeting.

Name	Affiliation	Date	Key Issues
Bruce Chapman Cecil Bannister Christine Penny Brian MacNamara Rosalind Walsh	Cdn. Assoc. Prawn Prod. “ “ “ Northern Coalition	Sep 2, 2009	The client provided their perspective of the fishery and provided a submission for the team to consider. The client presented the submission in detail.
Tm Siferd Jason Simms David Orr Heather Bishop Bob Lambert Jim Davis Via conference call: Cedric Arseneau Joe Justice Marc Clements Jennifer Buie	DFO Winnipeg DFO Newfoundland “ “ “ “ DFO, Quebec Nun. Wildlife Mgt. Board DFO, Ottawa “	Sep 3, 2009	The stock assessment and supporting scientific ecosystem information were discussed with DFO scientists based in the Central/Arctic Region and the Atlantic Region. Management – including the integrated fisheries management plan, enforcement and DFO policy initiatives including - A Fishery Decision-Making Framework Incorporating the Precautionary Approach; Managing Impacts of Fishing on Benthic Habitat, Communities and Species; and, Policy on New Fisheries for Forage Species.
(Letter) Marine Issues Committee	Ecology Action Centre	Aug 31, 2009	Habitat, corals and bycatch – See Appendix C
(Letter) Fred Winsor	Sierra Club of Canada	Aug 27, 2009	Cold water corals, Vulnerable Marine Ecosystems – See Appendix C

11 STAKEHOLDER CONSULTATION

11.1 Stakeholder Consultation

A total of 10 stakeholders were identified and consulted specifically by Moody Marine. Information was also made publicly available at the following stages of the assessment:

Date	Purpose	Media
25 June 2009	Announcement of assessment	Direct E-mail/letter Notification on MSC website Advertisement in press
17 July 2009	Notification of Assessment Team nominees	Direct E-mail Notification on MSC website
22 July 2009	Notification of intent to use MSC FAM Standard Assessment Tree	Direct E-mail Notification on MSC website
27 July 2009	Notification of assessment visit and call for meeting requests	Direct E-mail Notification on MSC website
2-3 September 2009	Assessment visit	Meetings
21st September 2010	Notification of Proposed Peer Reviewers	Direct E-mail Notification on MSC website
"	Notification of Public Draft Report	Direct E-mail Notification on MSC website
"	Notification of Final Report	Direct E-mail Notification on MSC website

11.2 Stakeholder Issues

Letters and supporting information were received from the Ecology Action Centre (EAC) and the Sierra Club of Canada prior to the site visit. These can be found in Appendix D along with comments from the assessment team. These stakeholders raised concerns relating to habitat impacts of trawls, particularly in areas of vulnerable ecosystems such as cold water corals, the bycatch of fish species, particularly juvenile Greenland halibut and redfish and highlighted the need for caution in directing a fishery toward low tropic level species supporting a food web in Northern latitudes.

The assessment team used these submissions to help in directing their information gathering.

12 OBSERVATIONS AND SCORING

12.1 Introduction to Scoring Methodology

The MSC Principles and Criteria set out the requirements of certified fishery. These Principles and Criteria have been developed into a standard (Fishery Assessment Methodology) assessment tree - Performance Indicators and Scoring Guideposts - by the MSC, which is used in this assessment.

The Performance Indicators (PIs) have been released on the MSC website. In order to make the assessment process as clear and transparent as possible, each PI has three associated Scoring Guideposts (SGs) which identify the level of performance necessary to achieve 100, 80 (a pass score), and 60 scores for each Performance Indicator; 100 represents a theoretically ideal level of performance and 60 a measurable shortfall.

For each Performance Indicators, the performance of the fishery is assessed as a 'score'. In order for the fishery to achieve certification, an overall weighted average score of 80 is necessary for each of the three Principles and no Indicator should score less than 60. As it is not considered possible to allocate precise scores, a scoring interval of five is used in evaluations. As this represents a relatively crude level of scoring, average scores for each Principle are rounded to the nearest whole number.

Weights and scores for the Fishery are presented in the scoring table (Appendix A).

13 LIMIT OF IDENTIFICATION OF LANDINGS FROM THE FISHERY

13.1 Traceability

Traceability of product from the sea to the consumer is vital to ensure that the MSC standard is maintained. There are several aspects to traceability that the MSC require to be evaluated: Traceability within the fishery; at-sea processing; at the point of landing; and subsequently the eligibility of product to enter the chain of custody. These requirements are assessed here.

13.2 Traceability Requirements Within the Fishery

Those companies identified in 1.1 and their vessels fishing with trawl gear will be eligible to sell MSC certified Northern shrimp (*P. borealis*) (as and when the fishery is certified). Existing fisheries management requirements include the clear identification of species, quantity, fishing method and area of capture by all vessels landing fish from the fishery. All catches are reported in logbooks, on landing tickets and through daily radio hail ins.

Cross referencing of logbooks, aerial and at-sea surveillance reports also ensures that fish is reported from the correct area of capture. Dockside monitoring takes place.

13.3 At-Sea Processing

Product is generally landed as IQF product which is bagged and/or boxed.

13.4 Points of Landing

The limit of identification of landings is the landing of *P. borealis* by CAPP and NC member vessels at recognised ports where appropriate recording and monitoring of landings may take place. There are no known risk factors after the point of landing that may influence subsequent chain of custody assessments. Chain of custody should begin from the first point of sale.

13.5 Eligibility to Enter Chain of Custody

Products landed by any of the vessels owned by any of the CAPP and NC member companies are eligible to enter further chains of custody. Companies buying directly from this fishery are required to have chain of custody certification. Any companies buying from the vessels owned by any of the CAPP and NC member companies must also seek chain of custody certification in order to sell product as MSC.

13.6 Target Eligibility Date

In accordance with MSC Technical Advisory Board Directive (TAB D) 021 MSC product eligibility date may be up to a maximum 6 months prior to the publication of the Public Comment Draft Report. The client has indicated their desire to take full advantage of this 6 month period. The target eligibility date will be confirmed in the next draft report.

14 CERTIFICATION RECOMMENDATION

14.1 Certification Recommendation

The Performance of the Fishery in relation to MSC Principles 1, 2 and 3 is summarised below:

MSC Principle	Fishery Performance	
Principle 1: Sustainability of Exploited Stock	Overall: 90.0	Pass
Principle 2: Maintenance of Ecosystem	Overall: 82.0	Pass
Principle 3: Effective Management System	Overall: 87.5	Pass

The fishery attained a score of 80 or more against each of the MSC Principles and did not score less than 60 against any Performance Indicator. It is therefore recommended that the Offshore Canadian Northern Shrimp (*Pandalus borealis*) Trawl Fishery in Shrimp Fishing Area 1 be certified according to the Marine Stewardship Council Principles and Criteria for Sustainable Fisheries.

The scores for the individual Performance Indicators are summarised in Table 4. The scoring commentary and justification for the scores is set out in Appendix A of this report.

Table 6: MSC scoring table for the *Pandalus borealis* Fishery in Shrimp Fishing Area 1 Fishery.

Scores highlighted lie in the 60 - < 80 range and have Conditions associated with them.

Principle	Component	Performance Indicator		Weight	Score
1	Outcome	1.1.1	Stock status	0.5	100
		1.1.2	Reference points	0.5	80
		1.1.3	Stock rebuilding	0	n/a
	Management	1.2.1	Harvest strategy	0.25	80
		1.2.2	Harvest control rules & tools	0.25	100
		1.2.3	Information & monitoring	0.25	90
		1.2.4	Assessment of stock status	0.25	90
2	Retained species	2.1.1	Outcome	0.33	100
		2.1.2	Management	0.33	100
		2.1.3	Information	0.33	90
	Bycatch	2.2.1	Outcome	0.33	80
		2.2.2	Management	0.33	90
		2.2.3	Information	0.33	90
	ETP species	2.3.1	Outcome	0.33	100
		2.3.2	Management	0.33	90
		2.3.3	Information	0.33	90
	Habitats	2.4.1	Outcome	0.33	60
		2.4.2	Management	0.33	60

Principle	Component	Performance Indicator		Weight	Score
		2.4.3	Information	0.33	70
	Trophic function	2.5.1	Outcome	0.33	70
		2.5.2	Management	0.33	70
		2.5.3	Information	0.33	70
3	Governance and policy	3.1.1	Legal & customary framework	0.25	100
		3.1.2	Consultation, roles & responsibilities	0.25	95
		3.1.3	Long term objectives	0.25	100
		3.1.4	Incentives for sustainable fishing	0.25	85
	Fishery specific management system	3.2.1	Fishery specific objectives	0.20	70
		3.2.2	Decision making processes	0.20	80
		3.2.3	Compliance & enforcement	0.20	95
		3.2.4	Research plan	0.20	75
		3.2.5	Management performance evaluation	0.20	80

		Overall Score
Principle 1 – Target Species		**90.0**
Principle 2 – Ecosystem		**82.0**
Principle 3 – Management		**87.5**

14.2 Conditions

As a standard requirement of the MSC certification methodology, the fishery shall be subject to (as a minimum) annual surveillance audits. These audits shall be publicised and reports made publicly available.

The fishery attained a score of below 80 against 8 Performance Indicators. The assessment team has therefore set conditions for continuing certification that the client for certification is required to address. The conditions are applied to improve performance to at least the 80 level within a period set by the certification body but no longer than the term of the certification.

As a standard condition of certification, the client shall develop an 'Action Plan' for Meeting the Conditions for Continued Certification', to be approved by Moody Marine.

The conditions are associated with four key areas (components) of performance of the fishery. The Conditions, associated timescales and relevant Scoring Indicator are set out below.

Condition 1 – Habitat

The client is required by the fourth annual audit to compile and assess information, develop a strategy, and take measures as appropriate such that it can be considered that the fishery is highly unlikely to reduce habitat structure and function to a point where there would be serious or irreversible harm.

It is recommended this could be achieved in a step-wise approach by:

a) compiling available information to provide adequate detail on the nature and distribution of habitat types relative to fishery operations, in relation to vulnerability of habitat types to

Condition 1 – Habitat
impacts from trawl gear; b) developing and implementing a strategy such that the fishery is highly unlikely to reduce habitat structure and function to a point where there would be serious or irreversible harm; c) taking any additional measures identified by the strategy such that the fishery is highly unlikely to reduce habitat structure and function to a point where there would be serious or irreversible harm. Relevant Performance Indicators: 2.4.1, 2.4.2, 2.4.3

Condition 2 – Ecosystem
The client is required by the fourth annual audit, to compile and assess information, develop a strategy, and take measures as appropriate such that the fishery is considered highly unlikely to disrupt key elements of ecosystem structure and function to a point where there would be serious or irreversible harm. It is recommended that this could be achieved in a step-wise approach by: a) compiling available information such that the main consequences of the fishery operations for the ecosystem to be inferred; b) developing and implementing a strategy such that fishery management explicitly addresses the need to maintain adequate shrimp biomass as forage for predators, and a strategy to ensure that the fishery does not cause serious or irreversible harm to benthic ecosystems; c) developing measures such that adequate shrimp biomass is maintained for predator needs, and that the fishery is not causing serious or irreversible harm to benthic ecosystems. Relevant Performance Indicators: 2.5.1, 2.5.2, 2.5.3.

Condition 3 – Short and long term objectives
The client is required by the first annual audit to present evidence that short and long term objectives, which are consistent with achieving the outcomes expressed by MSC's Principles 1 and 2, are explicit within the fishery's management system. It is recommended that the IFMP is amended to take account of the lack of explicit mention that the precautionary approach will be applied in managing the impact of fishing on sensitive habitat, species, and the ecosystem. Relevant Performance Indicator: 3.2.1

Condition 4 – Research Plan
The client is required by the fourth annual audit to present a research plan that assembles current activity, identifies gaps, and provides the management system with a strategic approach to research including reliable and timely information sufficient to achieve the objectives consistent with MSC's Principles 1 and 2. Relevant Performance Indicator: 3.2.4

14.3 Recommendation

The assessment team recommend that the IFMP includes explicit recognition of the ecological role of the species with respect to the target reference point. The assessment team also strongly recommend that an amendment page is included in the IFMP indicating what and when sections are amended.

15 APPENDICES

Appendix A: Scoring Table

Appendix B: Peer Review Reports

1. Peer Reviewer Biographies
2. Peer Review Report A
3. Peer Review Report B

Appendix C: Client Draft Action Plan

Appendix D: Stakeholder Comments

Appendix E: Registered companies / vessels within Unit of Certification: eligible to sell MSC certified product

APPENDIX A

Scoring Table

Principle 1	A fishery must be conducted in a manner that does not lead to over-fishing or depletion of the exploited populations and, for those populations that are depleted, the fishery must be conducted in a manner that demonstrably leads to their recovery.

1.1	Management Outcomes:

1.1.1	**Stock Status**: The stock is at a level which maintains high productivity and has a low probability of recruitment overfishing	It is <u>likely</u> that the stock is above the point where recruitment would be impaired.	It is <u>highly likely</u> that the stock is above the point where recruitment would be impaired. The stock is at or fluctuating around its target reference point.	There is a <u>high</u> <u>degree of certainty</u> that the stock is above the point where recruitment would be impaired. There is a <u>high degree of certainty</u> that the stock has been fluctuating around its target reference point, or has been above its target reference point, <u>over recent years</u>.

Scoring Comments

The most recent NAFO Scientific Council assessment (2010) indicates that the stock is well above the target biological reference point, although biomass has recently shown a declining trend. The population model showed a maximum biomass in 2005 with a decline since, to about 85% of the maximum observed. Recent biomass levels remain about twice the values of the lowest observed. The mortality caused by fishing and cod predation (Z) has been stable and below the upper limit reference Z_{msy}, since 1995. The present stock status is in the precautionary safe zone with biomass above the target level and mortality below Z_{msy}.

Score: 100

Based on a probabilistic model incorporating fishery, survey and biological information, and considering a defined target reference point, there is a high degree of certainty that the stock is above the point where recruitment would be impaired, and that it has been above its target reference point over recent years.

Audit Trace References

NAFO/ICES 2010. NAFO/ICES *Pandalus* assessment group meeting, 20-27 October 2010. NAFO SCS Doc. 10/22, ICES CM 2010/ACOM:14. Northern shrimp (Subareas 0 and 1) – NAFO stock. pp 20-31.

1.1.2	**Reference Points:** Limit and target reference points are appropriate for the stock.	Generic limit and target reference points are based on justifiable and reasonable practice appropriate for the species category.	Reference points are appropriate for the stock and can be estimated. The limit reference point is set above the level at which there is an appreciable risk of impairing reproductive capacity. The target reference point is such that the stock is maintained at a level consistent with B_{MSY} or some measure or surrogate with similar intent or outcome. For low trophic level species, the target reference point takes into account the ecological role of the stock.	The limit reference point is set above the level at which there is an appreciable risk of impairing reproductive capacity following consideration of relevant precautionary issues. The target reference point is such that the stock is maintained at a level consistent with B_{MSY} or some measure or surrogate with similar intent or outcome, or a higher level, and takes into account relevant precautionary issues such as the ecological role of the stock with a high degree of certainty.

Scoring Comments

The stock is assessed using a model that is a stochastic version of a surplus production model including an explicit term for predation by Atlantic cod, stated in a state-space framework and fitted by Bayesian methods. MSY defines maximum production, and B_{msy} is the biomass level when fishing at MSY. A precautionary limit reference point for stock biomass (Blim) is set at 30% of B_{msy} and the limit reference point for mortality (Zlim) is Z_{msy}. The model fits the data well. The assessment model is summarised in Kingsley (2008). The model provides time series of stock biomass, fishing mortality and their uncertainty, and is used to assess stock status and make forecasts.

The assessment evaluates stock status relative to the biological reference points B_{msy}, Z_{msy}, B_{lim} and Zlim. These are used to inform on the consequences of a range of TAC levels. The advice is based on the NAFO Scientific Council precautionary approach taking into account stock biology, exploitation history and the limitations of the available fishery and assessment data.

The limitations of the available fishery and assessment data are included through Bayesian estimation of probabilities for specific biomasses. Uncertainties in the assessment are studied using statistical simulations where different scenarios of cod stock development are presented.

Ecological role of the target species is addressed in setting reference points, since a cod predation mortailty component is added to fishing mortality to create the Z value which is used in forecasting consequences of catch levels.

Score: 80
The fishery meets all elements of the 80 SG: reference points are appropriate and can be estimated, the LRP is set above a level at which there is an appreciable risk of impairing reproductive capacity, the TRP is consistent with B_{msy}, and the ecological role of the stock has been taken into account in setting reference points.
Audit Trace References
Kingsley Michael C.S. 2008c. A Provisional Assessment of the Shrimp Stock off West Greenland in 2008. NAFO SCR Doc. 08/64 NAFO/ICES 2010. NAFO/ICES *Pandalus* assessment group meeting, 20-27 October 2010. NAFO SCS Doc. 10/22, ICES CM 2010/ACOM:14. Northern shrimp (Subareas 0 and 1) – NAFO stock. pp 20-31.

1.1.3	**Stock Rebuilding:** Where the stock is depleted, there is evidence of stock rebuilding.	Where stocks are depleted rebuilding strategies which have a reasonable expectation of success are in place. Monitoring is in place to determine whether they are effective in rebuilding the stock within a specified timeframe.	Where stocks are depleted rebuilding strategies are in place. There is evidence that they are rebuilding stocks, or it is highly likely based on simulation modelling or previous performance that they will be able to rebuild the stock within a specified timeframe.	Where stocks are depleted, strategies are demonstrated to be rebuilding stocks continuously and there is strong evidence that rebuilding will be complete within the shortest practicable timeframe.

Scoring Comments
This Performance Indicator is not applicable to the stock under assessment.
Score: N/A
The stock is not depleted and so this PI is not applicable.
Audit Trace References
N/A

1.2	Harvest Strategy (management)			
1.2.1	Harvest Strategy: There is a robust and precautionary harvest strategy in place	The harvest strategy is expected to achieve stock management objectives reflected in the target and limit reference points. The harvest strategy is likely to work based on prior experience or plausible argument. Monitoring is in place that is expected to determine whether the harvest strategy is working.	The harvest strategy is responsive to the state of the stock and the elements of the harvest strategy work together towards achieving management objectives reflected in the target and limit reference points. The harvest strategy may not have been fully tested but monitoring is in place and evidence exists that it is achieving its objectives.	The harvest strategy is responsive to the state of the stock and is designed to achieve stock management objectives reflected in the target and limit reference points. The performance of the harvest strategy has been fully evaluated and evidence exists to show that it is achieving its objectives including being clearly able to maintain stocks at target levels. The harvest strategy is periodically reviewed and improved as necessary.

Scoring Comments

This stock is harvested by Greenland and by Canada, each with its harvest strategy. There is no bilateral agreement between Greenland and Canada including a formal joint TAC setting mechanism. The strategy that each country uses to determine its quota results in a combined TAC that has been approximately 20% above the advised TAC in recent years.

This report is intended to assess the Canadian harvest strategy. At present, and for the foreseeable future, Canada's claimed share of the total stock TAC is a relatively small fraction of the total (17% of 5/6ths of the advised TAC) and in recent years catches have been substantially below this level. Should the total TAC and other harvest strategy components threaten sustainable management in future, it is expected that MSC performance audits would note this and require corrective action.

The harvest strategy within the Canadian fishery is based on a combination of an effective stock assessment providing sound scientific advice, monitoring (observers on 100% of trips), harvest control rules and management actions operating through effective harvest control tools. The Scientific Council of NAFO gives advice on TAC which is based on maintaining the stock above biological reference points with a level of certainty (B_{msy}>80%). The recommended TAC was 130,000 t in 2005-2007 and was reduced to 110,000 t in 2008 and 2009. Canada has historically set a TAC at 17% of the advised TAC (18,417t in 2007, 2008 and 2009), based on the relative portion of the stock residing in the Canadian zone in the early years of the fishery.

The total TAC adopted by Greenland and Canada has declined from 152,417 t in 2007 to 132,987 t in 2009 (Table 4.3.1).

Due to high harvesting costs in the Canadian fishery in SFA1 and the abundance of shrimp in SFAs further south, the Canadian harvest has been lower than the Canadian-adopted TAC for many years (maximum 2001-2010, 7100 t) and in 2008-2009 a total of 400 t was taken.

Score: 80
The harvest strategy in the Canadian fishery on this stock (Canadian SFA 1) meets all elements of the 80 SG. The harvest strategy is responsive to the state of the stock since TAC decisions are based on the NAFO/ICES annual assessment. All elements of the strategy work together to achieve management objectives reflected in reference points. Excellent monitoring is in place and there is evidence that the strategy is achieving its objectives (ie keeping harvests well below the adopted TAC level). The lack of a stock-wide harvest strategy based on a bilateral agreement between Canada and Greenland remains a potential source of concern. The client is urged to work with Canadian authorities to support development of such a strategy. Should the lack of a joint management framework appear to prejudice sustainability in future, corrective action should be taken.
Audit Trace References
NAFO/ICES 2010. NAFO/ICES *Pandalus* assessment group meeting, 20-27 October 2010. NAFO SCS Doc. 10/22, ICES CM 2010/ACOM:14. Northern shrimp (Subareas 0 and 1) – NAFO stock. pp 20-31.

1.2.2	Harvest control rules and tools: There are well defined and effective harvest control rules in place	Generally understood harvest control rules are in place that are consistent with the harvest strategy and which act to reduce the exploitation rate as limit reference points are approached. There is some evidence that tools used to implement harvest control rules are appropriate and effective in controlling exploitation.	Well defined harvest control rules are in place that are consistent with the harvest strategy and ensure that the exploitation rate is reduced as limit reference points are approached. The selection of the harvest control rules takes into account the main uncertainties. Available evidence indicates that the tools in use are appropriate and effective in achieving the exploitation levels required under the harvest control rules	The design of the harvest control rules take into account a wide range of uncertainties. Evidence clearly shows that the tools in use are effective in achieving the exploitation levels required under the harvest control rules.

Scoring Comments

The NIPAG assessment bases its advice on a rule that harvest level in the next year should not result in a greater than 20% chance of going below B_{msy}. An advised TAC based on this rule is provided through NAFO's Scientific Council. Consequences of other harvest levels, in terms of risk of going below reference levels, are also described. The limitations of the available fishery and assessment data are included through Bayesian estimation of probabilities for specific biomasses. Uncertainties in the assessment are studied using statistical simulations.

The Canadian management approach is to accept the Scientific Council advised TAC, and to allocate a fixed proportion of this to the Canadian fleet (17% of 5/6ths of the total TAC). Accordingly, management of the SFA 1 fishery is based on use of a well-defined control rule.

Harvest control tools (licence limitation, TACs, mesh size restrictions, monitoring by observers on 100% of trips, protection and surveillance) are effective in ensuring that harvest is at or below allowable levels. Catches have been below TACs for many years.

Score: 100

The fishery meets all elements of the 100 SG. Well defined harvest control rules are in place consistent with the harvest strategy, to ensure that exploitation rate is reduced as LRP is approached. Design of the HCRs takes a wide range of uncertainties into account. Evidence clearly shows that tools in use are effective in achieving the exploitation levels required under the HCRs.

Audit Trace References

NAFO/ICES 2010. NAFO/ICES *Pandalus* assessment group meeting, 20-27 October 2010. NAFO SCS Doc. 10/22, ICES CM 2010/ACOM:14. Northern shrimp (Subareas 0 and 1) – NAFO stock. pp 20-31.

1.2.3	**Information / monitoring:** Relevant information is collected to support the harvest strategy	Some relevant information related to stock structure, stock productivity and fleet composition is available to support the harvest strategy. Stock abundance and fishery removals are monitored and at least one indicator is available and monitored with sufficient frequency to support the harvest control rule.	Sufficient relevant information related to stock structure, stock productivity, fleet composition and other data is available to support the harvest strategy. Stock abundance and fishery removals are regularly monitored at a level of accuracy and coverage consistent with the harvest control rule, and one or more indicators are available and monitored with sufficient frequency to support the harvest control rule. There is good information on all other fishery removals from the stock.	A comprehensive range of information (on stock structure, stock productivity, fleet composition, stock abundance, fishery removals and other information such as environmental information), including some that may not be directly relevant to the current harvest strategy, is available. All information required by the harvest control rule is monitored with high frequency and a high degree of certainty, and there is a good understanding of the inherent uncertainties in the information [data] and the robustness of assessment and management to this uncertainty.

Scoring Comments

The life history of *Pandalus borealis* is well known (Bergström 2000). It matures as a male at age 2-5, mates as a male for two or three years before changing sex and spending the rest of its lifespan as a female. The female spawn in fall and carry the eggs until spring when the larvae hatch and live a pelagic life for two months.

With respect to stock structure, excellent information is available on the distribution and geographical range of the stock, relationship of the geographical range to the fishery and to the control of harvests, age, size and sex distribution of the stock. Genetic structure is not well known.

With respect to productivity, the general biology and population dynamics of *P. borealis* are well known. There is good information on maturity, growth, natural mortality and fecundity. Information on density dependent processes and the stock-recruitment relationship is incomplete. Proxy measures for reference points are used in the absence of stock-recruitment information, and the limit reference point is considered to reflect the level below which risks of impaired recruitment would be relatively high.

Fleet composition and fleet characteristics are very well known.

Greenland has conducted stratified random trawl surveys designed primarily to estimate shrimp stock biomass since 1988 in offshore areas and since 1991 also inshore in Subarea 1 (Ziemer and Siegestad 2008). From 1993, the survey was extended southwards into NAFO Div. 1E-F, consistent with changing distribution of the fishery. Catch and effort data from the shrimp fishery were available from logbooks from Canadian vessels fishing in Canadian SFA 1 and from Greenland vessels for NAFO Subarea 1, with excellent coverage. The survey coverage is good and adapts to the distribution of shrimp as the ice withdraws. Information on cod (predator) abundance is from a sound annual assessment. The most recent NAFO/ICES assessment (2010) includes a summary of environmental information relevant to the assessment. Uncertainties are well characterized and are explored in the assessment such that there is a good overall understanding of

how they affect results of the assessment.

With respect to fishery removals, this stock is exploited by the Greenland large vessel and small vessel fleets as well as the Canadian fishery under assessment. Removals by the Greenland fishery are well documented by logbooks, observers and port monitoring and are a source of information for the stock assessment.

Score: 90

This fishery meets most elements of the 100 SG. A comprehensive range of information is available relevant to the harvest strategy, including excellent fishery-independent and fishery-dependent information on abundance trends and productivity, fishery dependent information on fleet composition and removals, and environmental information from a range of sources. All information required by the HCR is monitored at high frequency and with a high degree of certainty and there is a good understanding of the uncertainties in the information and robustness of the assessment and management to uncertainty.

Fishery removals by the Greenland fleets harvesting this stock are very well documented.

Comprehensive information on stock structure (genetic structure) and productivity (stock-recruitment relationship) is not available, thus a score of 90 is assigned.

Audit Trace References

Bergström, B. 2000. Biology of Pandalus. Advances in Marine Biology, 38:55-256.
Hvingel, C. and Kingsley, M. C. S. 2006. A framework to model shrimp (*Pandalus borealis)* stock dynamics and to quantify the risk associated with alternative management options, using Bayesian methods. ICES Journal of Marine Science, 63: 68-82.
Ziemer, N. and H. Siegestad. 2008. Results of the Greenland bottom trawl survey for Northern Shrimp (*Pandalus borealis*) off West Greenland (NAFO Sub area 1 and Division 0A), 1988–2008. NAFO SCR Doc. 08/71, 34 pp.

1.2.4	**Assessment of stock status:** There is an adequate assessment of the stock status	The assessment estimates stock status relative to reference points. The major sources of uncertainty are identified.	The assessment is appropriate for the stock and for the harvest control rule, and is evaluating stock status relative to reference points. The assessment takes uncertainty into account. The stock assessment is subject to peer review.	The assessment is appropriate for the stock and for the harvest control rule and takes into account the major features relevant to the biology of the species and the nature of the fishery. The assessment takes into account uncertainty and is evaluating stock status relative to reference points in a probabilistic way. The assessment has been tested and shown to be robust. Alternative hypotheses and assessment approaches have been rigorously explored. The assessment has been internally and externally peer reviewed.

Scoring Comments
Uncertainties in stock abundance estimates are recognised and incorporated in the assessment approach (Hvingel, 2006). This approach is a Bayesian framework with uninformative priors and the analysis includes a detailed analysis of the uncertainties. Predation is included as a time series in the assessment model but recruitment is included as an error term. There are studies of the uncertainty associated with the abundance survey and with the CPUE series. There are studies comparing the trends in the CPUE and survey abundance series and the uncertainties associated with having two different abundance series are discussed in the advice and in the background documents. The management advice is based on this analysis. An international peer review is performed annually in the NAFO/ICES *Pandalus* Assessment Group. No formal internal evaluation of the assessment is conducted but information and results are reviewed as the assessment working paper is produced.
Score: 90
The assessment is appropriate for the stock and for the harvest control rule and takes into account the major features relevant to the biology of the species and the nature of the fishery. The assessment also takes account of uncertainties relative to reference points appropriately and is subject to annual peer review in the NAFO/ICES Pandalus Assessment Group. The fishery therefore meets all of the SG80 scoring indicators and two of the four SG100 indicators, justifying a score of 90. Alternative assessment approaches/ models have not been explored and the NAFO Scientific Council have expressed some concern that the stock model used model may be too optimistic.
Audit Trace References
NAFO/ICES 2008. Report of the NAFO/ICES Pandalus assessment group 23-30 October 2006. NAFO SCS Doc. 08/58. Hvingel, C. and Kingsley, M. C. S. 2006. A framework to model shrimp (*Pandalus borealis*) stock dynamics and to quantify the risk associated with alternative management options, using

Bayesian methods. ICES Journal of Marine Science, 63: 68-82.

Principle 2	Fishing operations should allow for the maintenance of the structure, productivity, function and diversity of the ecosystem (including habitat and associated dependent and ecologically related species) on which the fishery depends

2.1	Retained non-target species

2.1.1	***Status:*** The fishery does not pose a risk of serious or irreversible harm to the retained species and does not hinder recovery of depleted retained species.	Main retained species are <u>likely</u> to be within biologically based limits or if outside the limits there are <u>measures</u> in place that are <u>expected</u> to ensure that the fishery does not hinder recovery and rebuilding of the depleted species. If the status is poorly known there are measures or practices in place that are expected to result in the fishery not causing the retained species to be outside biologically based limits or hindering recovery.	Main retained species are <u>highly likely</u> to be within biologically based limits, or if outside the limits there is a <u>partial strategy</u> of <u>demonstrably effective</u> management measures in place such that the fishery does not hinder recovery and rebuilding.	There is a <u>high degree of certainty</u> that retained species are within biologically based limits. Target reference points are defined and retained species are at or fluctuating around their target reference points.

Scoring Comments
Pandalus montagui is the only potential retained species in this area. Bycatches from observer records are extremely low, zero in most years, and maximum of 0.05 t in one year from 1999 to 2007 (T. Siferd compilation). Surveys indicate that *P. montagui* biomass is typically less than 2% of *P. borealis* biomass in the entire NAFO 0+1 area surveyed, and that this species occurs at shallower depths than *P. borealis* (as in other areas) (Kanneworff 2003).
Score: 100
Catches are rare and negligible in impact thus achieving the 100 SG.
Audit Trace References
Kanneworff 2003; unpublished data compilation provided by T. Siferd, DFO

2.1.2	***Management strategy:*** There is a strategy in place for managing retained species that is designed to ensure the fishery does not pose a risk of serious or irreversible harm to retained species.	There are measures in place, if necessary, that are expected to maintain the main retained species at levels which are highly likely to be within biologically based limits, or to ensure the fishery does not hinder their recovery and rebuilding. The measures are considered likely to work, based on plausible argument (e.g., general experience, theory or comparison with similar fisheries/species).	There is a partial strategy in place, if necessary that is expected to maintain the main retained species at levels which are highly likely to be within biologically based limits, or to ensure the fishery does not hinder their recovery and rebuilding. There is some objective basis for confidence that the partial strategy will work, based on some information directly about the fishery and/or species involved. There is some evidence that the partial strategy is being implemented successfully.	There is a strategy in place for managing retained species. The strategy is mainly based on information directly about the fishery and/or species involved, and testing supports high confidence that the strategy will work. There is clear evidence that the strategy is being implemented successfully, and intended changes are occurring. There is some evidence that the strategy is achieving its overall objective.

Scoring Comments
The only retained species is at negligible levels, justifying a 100 score; fishing strategies are likely to continue to maintain negligible impact on the retained species and monitoring will continue.
Score: 100
Fishing strategies are likely to continue to maintain negligible impact on the retained species and monitoring will continue.
Audit Trace References
Kanneworff 2003; T. Siferd, DFO unpublished data compilation

2.1.3	***Information / monitoring:*** Information on the nature and extent of retained species is adequate to determine the risk posed by the fishery and the effectiveness of the strategy to manage retained species.	Qualitative information is available on the amount of main retained species taken by the fishery. Information is adequate to qualitatively assess outcome status with respect to biologically based limits. Information is adequate to support measures to manage main retained species.	Qualitative information and some quantitative information are available on the amount of main retained species taken by the fishery. Information is sufficient to estimate outcome status with respect to biologically based limits. Information is adequate to support a partial strategy to manage main retained species. Sufficient data continue to be collected to detect any increase in risk level (e.g. due to changes in the outcome indicator scores or the operation of the fishery or the effectiveness of the strategy).	Accurate and verifiable information is available on the catch of all retained species and the consequences for the status of affected populations. Information is sufficient to quantitatively estimate outcome status with a high degree of certainty. Information is adequate to support a comprehensive strategy to manage retained species, and evaluate with a high degree of certainty whether the strategy is achieving its objective. Monitoring of retained species is conducted in sufficient detail to assess ongoing mortalities to all retained species.

Scoring Comments
Observers are carried on 100% of trips in this fishery and observe some 70% of tows, so information is considered accurate. The only retained species, *P. montagui*, in this fishery area, occurs in very small amounts. In most years from 1999 to 2007, 0 catches were recorded by observers, and a maximum annual catch of 0.05 t was recorded in one year during this period (unpublished observer information, T. Siferd). Surveys indicate that *P. montagui* biomass is typically less than 2% of *P. borealis* biomass in the entire NAFO 0+1 area surveyed, and that this species occurs at shallower depths than *P. borealis* (as in other areas). The SFA 1 fishery occurs in relatively deep waters where *P. montagui* is relatively less abundant.
Score: 90
Accurate information is available indicating very low, essentially negligible, catches; however this has not been published or peer reviewed so cannot be considered “verifiable”
Audit Trace References
Kanneworff 2003; unpublished compilation of observer information provided by T. Siferd, DFO

2.2	**Discarded species (also known as “bycatch” or “discards”)**			
2.2.1	***Status*** The fishery does not pose a risk of serious or irreversible harm to the bycatch species or species groups and does not hinder recovery of depleted bycatch species or species groups.	Main bycatch species are <u>likely</u> to be within biologically based limits, or if outside such limits there are mitigation <u>measures</u> in place that are <u>expected</u> to ensure that the fishery does not hinder recovery and rebuilding. If the status is poorly known there are measures or practices in place that are expected result in the fishery not causing the bycatch species to be biologically based limits or hindering recovery.	Main bycatch species are <u>highly likely</u> to be within biologically based limits or if outside such limits there is a <u>partial strategy</u> of <u>demonstrably effective</u> mitigation measures in place such that the fishery does not hinder recovery and rebuilding.	There is a <u>high degree of certainty</u> that bycatch species are within biologically based limits.

Scoring Comments

Although several key groundfish species which occur in the bycatch are currently considered to be depleted or outside safe biological limits (Atlantic cod, American plaice, redfishes), the amounts of bycatch taken are so small as to be ecologically negligible, well below the levels at which they would be considered a “main” bycatch species (5% of the shrimp catch). Bycatches of the order of 200 t/yr (around the maximum observed for commercial or non-commercial species in this fishery area) are equivalent to an amount required to develop 20 t of predator biomass, assuming a simple 10% conversion factor between trophic levels, negligible in ecological terms.

The principal management measure in place, use of the Nordmore grate with a grate spacing of 28 mm is effective in maintaining bycatch levels of all species far below the 5% level which notionally would indicate a “main” bycatch species. Trawls are rigged with toggle chains designed to reduce bycatch of bottom-living species such as flatfishes. Taken together, and considering their widespread impact in reducing bycatch, these measures are considered a strategy. Their use is based on knowledge of the fishery and species, and there is an awareness of the need to adjust measures if necessary.

Bycatch management strategies do not consider potential issues if depleted groundfish populations were to recover. Current low bycatch levels may partly be due to low groundfish abundance, and some consideration of potential impacts should populations recover would help to complete the existing bycatch management approach. This could include decreasing Nordmore grate spacing.

Score: 80

Most bycatch species are considered to be within safe limits, but several are not. A strategy based on use of the Nordmore grate and toggle chains is demonstrably effective, associated with very low bycatch levels that are essentially negligible in ecological terms.

Audit Trace References

See 2.2.2, 2.2.3

2.2.2	***Management strategy:*** There is a strategy in place for managing bycatch that is designed to ensure the fishery does not pose a risk of serious or irreversible harm to bycatch populations.	There are measures in place, if necessary, which are expected to maintain main bycatch species at levels which are highly likely to be within biologically based limits or to ensure that the fishery does not hinder their recovery. The measures are considered likely to work, based on plausible argument (e.g general experience, theory or comparison with similar fisheries/species).	There is a partial strategy in place, if necessary, for managing bycatch that is expected to maintain main bycatch species at levels which are highly likely to be within biologically based limits or to ensure that the fishery does not hinder their recovery. There is some objective basis for confidence that the partial strategy will work, based on some information directly about the fishery and/or the species involved. There is some evidence that the partial strategy is being implemented successfully.	There is a strategy in place for managing and minimising bycatch. The strategy is mainly based on information directly about the fishery and/or species involved, and testing supports high confidence that the strategy will work. There is clear evidence that the strategy is being implemented successfully, and intended changes are occurring. There is some evidence that the strategy is achieving its objective.

Scoring Comments

Use of the Nordmore grate with a grate spacing of 28 mm, and use of toggle chains designed to reduce bycatch of bottom-living species such as flatfishes, together are considered a strategy for reducing bycatch which is demonstrably effective. This meets the definition of a strategy in that it is based on knowledge of the fishery and species, has been designed specifically do deal with this Component (bycatch), and there is an awareness of the need to make further adjustments should this become necessary (a study on moving from 28 mm to 22 mm spacing has been done, Orr and Cadigan 2009).

There is clear evidence that the strategy is being implemented successfully and that bycatch levels are being maintained very low. Amounts taken are very small in ecological terms: for example a bycatch of 200 t, about the maximum observed for the most commonly taken bycatch species, redfishes, in this fishery area, is equivalent to the amount needed to develop 20 t of predator biomass based on a notional 10% conversion factor between tropic levels.

The bycatch management strategy does not consider potential issues if depleted groundfish populations were to recover. Current low bycatch levels may partly be due to low groundfish abundance, and some consideration of potential impacts should populations recover would help to complete the existing bycatch management approach. This could include consideration of any potentially positive impact of decreasing Nordmore grate spacing.

Score: 90

A strategy based on use of the Nordmore grate and toggle chains is associated with very low bycatch levels, essentially negligible in ecological terms. This is based on information directly about the fishery and species involved, and testing supports high confidence that the strategy will work; there is clear evidence that it is being implemented successfully and that it is achieving its objectives.

The fishery meets all elements of the 100 SG, however, a score of 90 is given because the strategy does not consider the potential need for future modifications if groundfish populations should recover
Audit Trace References
Unpublished data compilation provided by T. Siferd, DFO; Orr and Cadigan 2009.

2.2.3	***Information / monitoring*** Information on the nature and amount of bycatch is adequate to determine the risk posed by the fishery and the effectiveness of the strategy to manage bycatch.	Qualitative information is available on the amount of main bycatch species affected by the fishery. Information is adequate to broadly understand outcome status with respect to biologically based limits. Information is adequate to support measures to manage bycatch.	Qualitative information and some quantitative information are available on the amount of main bycatch species affected by the fishery. Information is sufficient to estimate outcome status with respect to biologically based limits. Information is adequate to support a partial strategy to manage main bycatch species. Sufficient data continue to be collected to detect any increase in risk to main bycatch species (e.g. due to changes in the outcome indicator scores or the operation of the fishery or the effectiveness of the strategy).	Accurate and verifiable information is available on the amount of all bycatch and the consequences for the status of affected populations. Information is sufficient to quantitatively estimate outcome status with respect to biologically based limits with a high degree of certainty. Information is adequate to support a comprehensive strategy to manage bycatch, and evaluate with a high degree of certainty whether a strategy is achieving its objective. Monitoring of bycatch data is conducted in sufficient detail to assess ongoing mortalities to all bycatch species.

Scoring Comments

Observers are carried on 100% of trips and observe some 70% of tows (the maximum that can be achieved), and as such, coverage is excellent. All species in the bycatch are identified to the lowest level possible.

Information on total bycatch by weight is available in unpublished tabular form from 1979-2007. In the ten-year period 1998-2007 total bycatch of all species by weight varied between 34 and 353 t, or between 1.8 and 6% of shrimp catch (in years with catches over 1000t; percentages were higher in years with low catches but amounts were quite low). Redfish was the most abundant species in the bycatch, with annual catches ranging between 24 t (1.2% of shrimp catch) and 207 t (3% of shrimp bycatch). Next in abundance was Arctic cod at 0.8-120 t/yr. American plaice (0.7-7.1 t/yr) and Greenland halibut (4.2-29.7 t/yr) were key commercial species occurring in the bycatch.

Numbers at length are also available for the important groundfish species for the period 1997-2007.

Bycatch monitoring by observers, funded by industry as a condition of licence, will continue in future.

A study comparing selectivity and catches with Nordmore grate spacings of 22 and 28 mm has been conducted in SFA 4 (Orr and Cadigan 2009), whose results would be applicable in this

area. Based on that study, fishery managers have concluded that there is no strong justification to reduce the grate spacing at this time. Should groundfish populations begin to recover, the results of this study might be used to consider whether reducing the grate spacing would be effective in providing additional protection to recruiting year-classes.

Score: 90

Accurate information on weights of all bycatch species is available over a long period, as is information on numbers at length for important groundfish species; given the very low amounts taken, the information can be considered sufficient to estimate outcome status with a high degree of certainty. information is adequate to support a strategy to manage bycatch and evaluate with a high degree of certainty whether the strategy is meeting its objective. Monitoring is continuing at an adequate level of detail to assess ongoing mortalities to all bycatch species.

The fishery meets all elements of the 80 SG; the only element missing for the 100 SG is "verifiable" as the bycatch information has not been published or peer reviewed.

Audit Trace References

Unpublished data compilation provided by T. Siferd, DFO; Orr and Cadigan 2009

2.3	Endangered, Threatened and Protected (ETP) species			
2.3.1	***Status:*** The fishery meets national and international requirements for protection of ETP species. The fishery does not pose a risk of serious or irreversible harm to ETP species and does not hinder recovery of ETP species.	Known effects of the fishery are likely to be within limits of national and international requirements for protection of ETP species. Known direct effects are unlikely to create unacceptable impacts to ETP species.	The effects of the fishery are known and are highly likely to be within limits of national and international requirements for protection of ETP species. Direct effects are highly unlikely to create unacceptable impacts to ETP species. Indirect effects have been considered and are thought to be unlikely to create unacceptable impacts.	There is a high degree of certainty that the effects of the fishery are within limits of national and international requirements for protection of ETP species. There is a high degree of confidence that there are no significant detrimental effects (direct and indirect) of the fishery on ETP species.

Scoring Comments
Two ETP species occur in the area and could be impacted by the fishery: spotted wolffish and northern wolffish, both listed as threatened on Schedule 1 of the *Species at Risk Act*. Bycatch of both species was negligible, based on observer coverage on 100% of trips. The recovery strategy for these species concluded that recent and current levels of fishing mortality are such as to allow for population rebuilding (Kulka et al 2008).
Score: 100
This fishery exceeds requirements in terms of impact on ETP species, and is not having a detrimental effect on these species.
Audit Trace References
Kulka et al. 2008; unpublished data compilation from T. Siferd, DFO

2.3.2	***Management strategy*** The fishery has in place precautionary management strategies designed to: - meet national and international requirements; - ensure the fishery does not pose a risk of serious or irreversible harm to ETP species; - ensure the fishery does not hinder recovery of ETP species; and - minimise mortality of ETP species.	There are measures in place that minimise mortality, and are expected to be highly likely to achieve national and international requirements for the protection of ETP species. The measures are considered likely to work, based on plausible argument (eg general experience, theory or comparison with similar fisheries/species).	There is a strategy in place for managing the fishery's impact on ETP species, including measures to minimise mortality, that is designed to be highly likely to achieve national and international requirements for the protection of ETP species. There is an objective basis for confidence that the strategy will work, based on some information directly about the fishery and/or the species involved. There is evidence that the strategy is being implemented successfully.	There is a comprehensive strategy in place for managing the fishery's impact on ETP species, including measures to minimise mortality, that is designed to achieve above national and international requirements for the protection of ETP species. The strategy is mainly based on information directly about the fishery and/or species involved, and a quantitative analysis supports high confidence that the strategy will work. There is clear evidence that the strategy is being implemented successfully, and intended changes are occurring. There is evidence that the strategy is achieving its objective.

Scoring Comments

A recovery strategy for northern and spotted wolffish was published in February 2008 (Kulka et al 2008), identifying threats and mitigating measures for these species. Fishing was identified as a potential threat, although areas of greatest decline in these species (inshore shelf areas) are areas where trawling rarely occurs (Kulka et al 2008). Population trends of the listed species have been stable or increasing under recent fisheries, thus recent and current levels of fisheries are considered consistent with allowing these species to rebuild (Kulka et al 2008).

Currently retention of spotted and northern wolffishes is prohibited by licence conditions for all fisheries, including the shrimp fishery in this area, and wolffishes if caught must be released in good condition. These measures, the requirement to protect these two species, and the general need to fish in ways which will reduce impacts on species at risk, are noted in the Integrated Fishery Management Plan for northern shrimp.

Under the current strategy for managing bycatch in this fishery area (mandatory use of the Nordmore grate with a 28 mm grate spacing, , use of toggle chains) bycatch of spotted wolffish and northern wolffish is extremely low, essentially ecologically negligible.

Modification of the strategy should abundance of the two ETP species begin to increase, and bycatch levels increase, has not been given explicit consideration. Increases in bycatch would likely be local and short-term, affecting only small individuals.

Score: 90

There is a strategy in place, designed to achieve above national and international requirements for the protection of the identified ETP species under recent and current conditions. Quantitative analysis (analysis of recent population trends under fishery conditions) indicates that the strategy will work. There is clear evidence that the strategy is being implemented successfully, and that it is achieving its objective.

The fishery meets most elements of the 100 SG, however, the maximum score is not achieved because potential strategies to be implemented should these species increase in abundance are not given explicit consideration.
Audit Trace References
Kulka et al 2008; IFMP

2.3.3	***Information / monitoring*** Relevant information is collected to support the management of fishery impacts on ETP species, including: - information for the development of the management strategy; - information to assess the effectiveness of the management strategy; and - information to determine the outcome status of ETP species.	Information is adequate to broadly understand the impact of the fishery on ETP species. Information is adequate to support measures to manage the impacts on ETP species Information is sufficient to qualitatively estimate the fishery related mortality of ETP species.	Information is sufficient to determine whether the fishery may be a threat to protection and recovery of the ETP species, and if so, to measure trends and support a full strategy to manage impacts. Sufficient data are available to allow fishery related mortality and the impact of fishing to be quantitatively estimated for ETP species.	Information is sufficient to quantitatively estimate outcome status with a high degree of certainty. Information is adequate to support a comprehensive strategy to manage impacts, minimize mortality and injury of ETP species, and evaluate with a high degree of certainty whether a strategy is achieving its objectives. Accurate and verifiable information is available on the magnitude of all impacts, mortalities and injuries and the consequences for the status of ETP species

Scoring Comments
Observers are carried on 100% of trips and observe some 70% of tows (the maximum that can be achieved), and as such, coverage is excellent. Information on weights caught for 25+ years, and information on numbers at length caught for 2002-2007, are available in an unpublished compilation of observer data. Estimated annual catches are 1-281 individual northern wolffish in 2002-7, 97-819 individual spotted wolffish 2002-7. Although information on wolffish population status is incomplete and does not allow formal assessment of shrimp fishery impacts, recent population trends for the two identified ETP species have been stable or positive (Kulka et al 2008). The extremely low bycatch amounts suggest a negligible ecological impact. A specialists in wolffish biology has indicated that impact of the shrimp fishery on these species is negligible (M. Simpson, pers. comm.). An assessment of northern and spotted wolffishes is planned for fall 2010.
Score: 90
Information is sufficient to quantitatively estimate outcome status with a high degree of certainty, and is adequate to support a comprehensive strategy to manage impacts, and to evaluate with a high degree of certainty whether the strategy is achieving its objectives (the current strategy is not considered fully "comprehensive", PI 2.3.2, but the information is adequate to support a comprehensive strategy). Accurate information is available on magnitude of all impacts and their consequences for the status of the ETP species. The fishery meets most elements of the 100 SG but the information on impacts has not been published or peer reviewed so is not considered "verifiable".
Audit Trace References
Kulka et al. 2008; unpublished data compilation from T. Siferd, DFO

2.4	Habitat

2.4.1	***Status*** The fishery does not cause serious or irreversible harm to habitat structure, considered on a regional or bioregional basis, and function.	The fishery is unlikely to reduce habitat structure and function to a point where there would be serious or irreversible harm.	The fishery is highly unlikely to reduce habitat structure and function to a point where there would be serious or irreversible harm.	There is evidence that the fishery is highly unlikely to reduce habitat structure and function to a point where there would be serious or irreversible harm.

Scoring Comments

The fishery concentrates on mud bottoms (or sand, or mixed mud-sand), and vessels avoid hard bottoms to minimise the risk of damage to trawls. Trawl gear is relatively light and efforts are underway to further reduce gear contact with the bottom in order to reduce fuel costs. Bottom rollers and trawl doors are the principal parts of the trawl contacting the bottom in most areas. A heavy "shoe" is used on some tows with twin trawls, which would have a greater impact on the bottom but over a narrow swathe (around 3 m).

Studies are unavailable on the impacts of shrimp gear on mud and mud-sand bottoms in this area, but some inferences can be made from studies on sand bottoms, recognising that impacts are to some extent site specific and that inference leaves some uncertainty about conclusions. In a 3-year study of impacts of trawl gear on the Grand Banks, there was no alteration to benthic communities and recovery of the sand habitat occurred within a year (results summarised in Gordon et al 2009). Soft bottoms are impacted relatively rapidly by trawling gear but recover relatively quickly (DFO 2006benthic).

The fishery probably produces occasional impacts on hard-bottom areas with erect sessile fauna which may be important as habitat. Coral bycatch is low, suggesting that contact with such areas is relatively rare, but bycatch information probably under represents interactions with such sensitive areas since impacts may occur when coral is not retained. Such habitats probably recover relatively slowly as growth rates of hard corals are low (Gilkinson and Edinger eds 2009).

Score: 60

Given its mode of operation, this fishery is unlikely to reduce habitat structure and function to a point where there would be serious or irreversible harm.

Audit Trace References

Gordon et al 2009; DFO 2006benthic; interviews (see 2.4.2); Gilkinson and Edinger eds 2009; Simpson and Watling 2006; Hinz et al 2009

2.4.2	***Management strategy*** There is a strategy in place that is designed to ensure the fishery does not pose a risk of serious or irreversible harm to habitat types.	There are measures in place, if necessary, that are expected to achieve the Habitat Outcome 80 level of performance. The measures are considered likely to work, based on plausible argument (e.g general experience, theory or comparison with similar fisheries/habitats).	There is a partial strategy in place, if necessary, that is expected to achieve the Habitat Outcome 80 level of performance or above. There is some objective basis for confidence that the partial strategy will work, based on some information directly about the fishery and/or habitats involved. There is some evidence that the partial strategy is being implemented successfully.	There is a strategy in place for managing the impact of the fishery on habitat types. The strategy is mainly based on information directly about the fishery and/or habitats involved, and testing supports high confidence that the strategy will work. There is clear evidence that the strategy is being implemented successfully, and intended changes are occurring. There is some evidence that the strategy is achieving its objective.

Scoring Comments
Several measures are in place which would help to reduce impacts of the fishery on habitats. The fishery is concentrated on soft bottoms (mud and/or sand), preferred habitat for shrimp and with less risk of damage to trawls, and these types of habitats are generally considered relatively resilient to trawl impact (Rice 2006; Gordon et al 2006). Trawls and doors used are relatively low-impact, and work is under way to further lighten the gear in the interests of saving fuel (interviews at *Newfound Pioneer*, 2009; Marine Institute, 2007; Marine Institute n.d.). The relatively low proportion of trawl sets with corals as bycatch suggests that impacts on these habitats may be low, although presence in sets would underestimate impact since trawls may impact corals without retaining them. Steps are being taken toward developing a strategy for managing potential habitat impacts. A Closed Areas Working Group of the Northern Shrimp Advisory Committee has been established to consider closed areas and other ecosystem impacts of the fishery. DFO Newfoundland/Labrador Region has committed to developing a coral/sponge conservation strategy for the Newfoundland/Labrador continental shelf, and this is expected to be complete by 2012; this may not include areas of the Davis Strait in the fishery area, however. DFO has developed a national policy for Managing the Impacts of Fishing on Sensitive Benthic Habitats (April 2009) (http://www.dfo-mpo.gc.ca/fm-gp/peches-fisheries/fish-ren-peche/sff-cpd/benthi-eng.htm), which is expected to provide an overall framework for actions to improve protection of sensitive habitats and species.
Score: 60
Measures are in place that are likely to ensure that the fishery does not cause serious or irreversible harm to habitats,
Audit Trace References
Interviews at *Newfound Pioneer*, Marine Institute, DFO, CAPP; DFO web site; Integrated Fisheries Management Plan; GEAC et al 2007

2.4.3	***Information / monitoring*** Information is adequate to determine the risk posed to habitat types by the fishery and the effectiveness of the strategy to manage impacts on habitat types.	There is a basic understanding of the types and distribution of main habitats in the area of the fishery. Information is adequate to broadly understand the main impacts of gear use on the main habitats, including spatial extent of interaction.	The nature, distribution and vulnerability of all main habitat types in the fishery area are known at a level of detail relevant to the scale and intensity of the fishery. Sufficient data are available to allow the nature of the impacts of the fishery on habitat types to be identified and there is reliable information on the spatial extent, timing and location of use of the fishing gear. Sufficient data continue to be collected to detect any increase in risk to habitat (e.g. due to changes in the outcome indicator scores or the operation of the fishery or the effectiveness of the measures).	The distribution of habitat types is known over their range, with particular attention to the occurrence of vulnerable habitat types. Changes in habitat distributions over time are measured. The physical impacts of the gear on the habitat types have been quantified fully.

Scoring Comments

No mapping of bottom sediments in the fishery area has been done, although some information is available and fishermen are aware of bottom type distribution and concentrate on preferred bottom types (mud and sand bottoms). Information on bottom types may be improved through a project to use acoustic equipment on commercial shrimp vessels to type bottoms in the fishery area (Marine Institute, School of Ocean Technology 2008).

Information on distribution of particularly sensitive habitat areas, coral concentration areas, is available and level of detail of this information continues to improve (Edinger et al 2007; Wareham and Edinger 2007; Wareham 2009). This information in mainly based on observations of corals in commercial trawl sets (observer program) and trawl survey programs. Observations have been mapped separately for the various groups of corals, including hard and branching corals (mainly associated with hard-bottom areas) and soft corals (often found on soft bottoms). Distribution maps suggest that relatively few sets recorded corals in this fishery area (Edinger et al 2007), although formal analyses of bycatches by fishing area are not available. Preliminary investigation of areas of concentration of sponges, another type of sensitive habitat area, based on trawl survey and observer data from areas similar to this fishery area (Kenchington et al 2009) suggest that sponge concentration areas are at depths greater than those at which the shrimp fishery operates.

Distribution of fishing operations is very well known from VMS and logbook information and is compiled (Spatialanalysis 2009; Orr et al MS 2008). Corals were recorded in 1.8% of shrimp trawl sets in shrimp fishery areas to the south of SFA 1, most of these being soft corals (Edinger et al. 2007).

Vulnerability of habitat types in the fishery area to bottom trawl gear is generally known (e.g. Rice 2006; Gordon et al 2006; Simpson and Watling 2006).

Available information has not been compiled into an overall summary that would provide adequate detail on the nature and distribution of habitat types relative to fishery operations, in relation to vulnerability of habitat types to impacts from trawl gear.

Score: 70
The fishery meets all elements of the 60 SG in that there is a basic understanding of types and distribution of habitats in the fishery, and of the impacts of the fishery on habitats. The fishery is assigned a score above 60 because there is detailed information on nature and distribution of sensitive habitats (coral and sponge areas) and reliable information on spatial extent, timing and location of the fishery.
Audit Trace References
C-NPOPB 2008; Marine Institute, School of Ocean Technology 2008; Edinger et al 2007; Wareham and Edinger 2007; Wareham 2009; Kenchington et al 2009; Rice 2006; Gordon et al 2006; Spatialanalysis 2009; Orr et al MS 2008; Simpson and Watling 2006.

2.5	Ecosystem

2.5.1	***Status*** The fishery does not cause serious or irreversible harm to the key elements of ecosystem structure and function.	The fishery is unlikely to disrupt the key elements underlying ecosystem structure and function to a point where there would be a serious or irreversible harm.	The fishery is highly unlikely to disrupt the key elements underlying ecosystem structure and function to a point where there would be a serious or irreversible harm.	There is evidence that the fishery is highly unlikely to disrupt the key elements underlying ecosystem structure and function to a point where there would be a serious or irreversible harm.

Scoring Comments

The principal issues identified to be addressed here are (a) impact of removal of the target species, which are forage for a wide range of predator species, on trophic relationships (b) non-catch impacts on biological diversity and community structure, particularly for benthic species. . In addition, overall impact on ecosystems is considered consistent with the MSC FAM.

Impact of removal of target species on trophic relationships. Shrimp abundance is currently high relative to historical levels, although it is declining rapidly. Need to allocate shrimp as forage to predators is explicitly addressed in assessment and management, as cod predation is considered in the stock assessment and in determining sustainable TACs. Given that shrimp abundance is quantitatively monitored and that a quantitative assessement of predator requirements is considered, information on this component can be considered quantitative.

Non-catch impact on benthic species and communities. This fishery is unlikely to be having serious or irreversible impacts on benthic species but no assessment has been done. An assessment of spatial distribution of the fishery has been done, suggesting that a low proportion of the continental shelf has been affected by shrimp trawling; this is a good initial step but additional analyses of communities and their sensitivity would be needed to assess impact. Information on this component can be considered qualitative.

The fishery is unlikely to be affecting size spectra of caught species to an extent that there would be serious or irreversible harm. Shrimp size compositions are monitored regularly and indicate no truncation which would cause serious harm. Only small individuals of bycatch species are taken in the bycatch. Information is quantitative.

There is no indication that serious or irreversible harm such as described in the MSC FAM (extinctions, trophic cascades, gross changes in species or community composition) is being caused. Information is qualitative.

Score: 70

The fishery is unlikely to be causing serious or irreversible harm through non-catch impacts on benthic communities,

The fishery is highly unlikely to disrupt trophic relationships by reducing shrimp abundance to levels which would impact predators, as the need to maintain shrimp biomass as forage for predators is addressed in assessment and management.

There is no indication of serious or irreversible harm being caused at the levels described in the MSC FAM.

Audit Trace References

See 2.5.2, 2.5.3

2.5.2	***Management strategy*** There are measures in place to ensure the fishery does not pose a risk of serious or irreversible harm to ecosystem structure and function.	There are measures in place, if necessary, that take into account potential impacts of the fishery on key elements of the ecosystem. The measures are considered likely to work, based on plausible argument (eg, general experience, theory or comparison with similar fisheries/ ecosystems).	There is a partial strategy in place, if necessary, that takes into account available information and is expected to restrain impacts of the fishery on the ecosystem so as to achieve the Ecosystem Outcome 80 level of performance. The partial strategy is considered likely to work, based on plausible argument (eg, general experience, theory or comparison with similar fisheries/ ecosystems). There is some evidence that the measures comprising the partial strategy are being implemented successfully.	There is a strategy that consists of a plan, containing measures to address all main impacts of the fishery on the ecosystem, and at least some of these measures are in place. The plan and measures are based on well-understood functional relationships between the fishery and the Components and elements of the ecosystem. This plan provides for development of a full strategy that restrains impacts on the ecosystem to ensure the fishery does not cause serious or irreversible harm. The measures are considered likely to work based on prior experience, plausible argument or information directly from the fishery/ecosystems involved. There is evidence that the measures are being implemented successfully.

Scoring Comments

Shrimp as a forage species. The need to ensure that predator needs for shrimp prey are met is explicitly addressed in the stock assessment; total mortality rates which are compared to target and limit rates include terms both for fishing mortality and for mortality due to cod predation (NAFO 2008/0-1). Scientific advice is considered in setting TACs and Canada has been harvesting at a low level in this area in recent years. This approach has ensured that an appropriate proportion of shrimp are reserved for predators.

Non-catch impacts on biological diversity and benthic communities. The mode of operation of the fishery is for the most part consistent with reducing potential impacts on biological diversity and on benthic communities. Fishing operations are concentrated on soft bottom areas, which have shorter recovery times than harder bottoms and whose mobile or infauna is generally less vulnerable to damage than the erect, sessile, long-lived fauna of hard bottoms. Trawls are relatively light and fitted with rollers which should roll over the bottom; however a heavy shoe which digs into bottom is used on some tows with twin trawls.

Score: 70

For non-catch and other ecosystem impacts, measures are in place to reduce ecosystem impacts and it can be inferred that these are working to ensure that serious or irreversible harm is not resulting, meeting the 60 SG.

Predator requirements are explicitly addressed in assessment and management, and there is evidence that shrimp abundance is being maintained at a level which will meet the needs of

predators, meeting the 80 SG.
Audit Trace References
IFMP; interviews *Newfound Pioneer*, DFO, CAPP; NAFO 2008/0-1

2.5.3	***Information / monitoring*** There is adequate knowledge of the impacts of the fishery on the ecosystem.	Information is adequate to identify the key elements of the ecosystem (e.g. trophic structure and function, community composition, productivity pattern and biodiversity). Main impacts of the fishery on these key ecosystem elements can be inferred from existing information, but have not been investigated in detail.	Information is adequate to broadly understand the functions of the key elements of the ecosystem. Main impacts of the fishery on these key ecosystem elements can be inferred from existing information, but may not have been investigated in detail. The main functions of the Components (i.e. target, Bycatch, Retained and ETP species and Habitats) in the ecosystem are known. Sufficient information is available on the impacts of the fishery on these Components to allow some of the main consequences for the ecosystem to be inferred. Sufficient data continue to be collected to detect any increase in risk level (e.g. due to changes in the outcome indicator scores or the operation of the fishery or the effectiveness of the measures).	Information is adequate to broadly understand the key elements of the ecosystem. Main interactions between the fishery and these ecosystem elements can be inferred from existing information, and have been investigated. The impacts of the fishery on target, Bycatch, Retained and ETP species and Habitats are identified and the main functions of these Components in the ecosystem are understood. Sufficient information is available on the impacts of the fishery on the Components and elements to allow the main consequences for the ecosystem to be inferred. Information is sufficient to support the development of strategies to manage ecosystem impacts.

Scoring Comments
The ecological role of the target species is relatively well known. *Pandalus* shrimps prey on, and are prey for a variety of species (Parsons 2005a, 2005b, 2006; Savenkoff et al 2006), although other species (such as capelin for cod, fishes for seals) may be preferred prey. Trophic structures related to northern shrimp have not been studied in this area, but studies in continental shelf areas with generally similar conditions (e.g. Savenkoff et al 2004) probably provide a general picture of trophic relationships in the fishery area. Trophic relationships in demersal communities in this area have been outlined (Pedersen and Zeller 2001). Information on benthic and demersal communities in which the fishery operates is relatively general, with the exception of exploited groundfishes for which detailed stock assessments are available. Basic life history information is available on non-commercial demersal fishes (eg Scott and Scott 1988; Fishbase). Species composition of benthos, major species, and relations of

distributions to environmental conditions are known for stations in and near SFA 1 (Stewart et al 1985). Bycatch information from the shrimp trawls also provides a qualititative, and incomplete, picture of benthic species composition in the fishery area (T. Siferd, unpublished compilation).

Non-catch impacts on these species and others in the benthic community could result from gear passage, i.e. impact of rockhopper gear rollers or trawl doors; these impacts may be low, given that the gear is relatively light and large rollers are used, but have not been assessed. In this area, a heavy shoe is used on tows with twin trawls, and this is likely to damage sessile invertebrate species in the path of the gear over a swathe of some 3 m.

Ability of potentially impacted communities to recover from impacts is not known for the area, with the exception of commercial groundfishes (although there is some uncertainty about ability to recover from current low abundance levels). Inferences on recovery ability of other groups can be made from work in other areas. Ability to recover generally varies with lifespan; slow-growing, long-lived species (such as some species of hard corals) will recover more slowly than short-lived species (eg tube-dwelling worms). A 3-year study of trawl impacts on sand bottoms on the Grand Banks suggested that benthic communities were little altered over this period (summarised by Gordon et al 2009). Simpson and Watling (2006) found little evidence of long-term impacts of shrimp trawling on benthos or habitat structure in the Gulf of Maine.

Score: 70

Information is adequate to broadly understand the key elements of the ecosystem, and the main functions of the components in the ecosystem is known. Main impacts of the fishery on some ecosystem elements are known such that ecosystem impacts can be inferred; the key unknown is non-catch impact of the fishery on benthic communities and species. Some relevant ongoing data collection is occurring (distribution of fishing) but risk level cannot be assessed for non-catch impacts on benthic communities and species.

The fishery clearly meets the 60 SG and meets at least the first three scoring issues of the 80 SG.

Audit Trace References

Pedersen and Zeller 2001; Parsons 2005a, 2005b, 2006; Savenkoff 2006; Scott and Scott 1988; Fishbase; Stewart et al 1985; unpublished compilation of observer data provided by T. Siferd, DFO; Gordon et al 2009.

Principle 3	The fishery is subject to an effective management system that respects local, national and international laws and standards and incorporates institutional and operational frameworks that require use of the resource to be responsible and sustainable

3.1	Governance and Policy

3.1.1	**Legal and/or customary framework** The management system exists within an appropriate and effective legal and/or customary framework which ensures that it: - Is capable of delivering sustainable fisheries in accordance with MSC Principles 1 and 2; - Observes the legal rights created explicitly or established by custom of people dependent on fishing for food or livelihood; and - Incorporates an appropriate dispute resolution framework.	The management system is generally consistent with local, national or international laws or standards that are aimed at achieving sustainable fisheries in accordance with MSC Principles 1 and 2. The management system incorporates or is subject by law to a mechanism for the resolution of legal disputes arising within the system. Although the management authority or fishery may be subject to continuing court challenges, it is not indicating a disrespect or defiance of the law by repeatedly violating the same law or regulation necessary for the sustainability for the fishery. The management system has a mechanism to generally respect the legal rights created explicitly or established by custom of people dependent on fishing for food or livelihood in a manner consistent with the objectives of MSC Principles 1 and 2.	The management system is generally consistent with local, national or international laws or standards that are aimed at achieving sustainable fisheries in accordance with MSC Principles 1 and 2. The management system incorporates or is subject by law to a transparent mechanism for the resolution of legal disputes which is considered to be effective in dealing with most issues and that is appropriate to the context of the fishery. The management system or fishery is attempting to comply in a timely fashion with binding judicial decisions arising from any legal challenges. The management system has a mechanism to observe the legal rights created explicitly or established by custom of people dependent on fishing for food or livelihood in a manner consistent with the objectives of MSC Principles 1 and 2.	The management system incorporates or is subject by law to a transparent mechanism for the resolution of legal disputes that is appropriate to the context of the fishery and has been tested and proven to be effective. The management system or fishery acts proactively to avoid legal disputes or rapidly implements binding judicial decisions arising from legal challenges. The management system has a mechanism to formally commit to the legal rights created explicitly or established by custom on people dependent on fishing for food and livelihood in a manner consistent with the objectives of MSC Principles 1 and 2.

Scoring Comments
Canadian fisheries management has a well-established legislative and policy framework. As noted Section 6.1 above, the federal government has jurisdiction for seacoast and inland fisheries in Canada, and Parliament has enacted several pieces of legislation that govern fisheries, notably the *Fisheries Act*. That *Act* grants authority for fisheries management to the Minster

of Fisheries and Oceans as well as providing the power to enact regulations governing a wide variety of management measures of which the *Atlantic Fishery Regulations*, 1985 and the *Fishery (General) Regulations* are the main legal instruments governing the fishery. Management measures are developed under the authority of the *Act* and the regulations and ministerial powers are delegated to officials of the DFO.

In addition, legislation has been enacted by the Parliament of Canada to give effect to the Nunavut land claim. The *Nunavut Land Claims Agreement Act* contains provisions for the access, allocation and management of fisheries in the Nunavut Settlement Area (NSA. The Nunavut Wildlife Management Board exercises jurisdiction over fisheries matters in the NSA including harvesting and licencing to fish.

Several policy initiatives have been developed to guide decision-making in the management of fisheries in Canada, three of which are important for this assessment. The *"Policy Framework for the Management of Fisheries on Canada's Atlantic Coast"* envisions robust fisheries that include all stakeholders and which are biologically and economically sustainable. The *"Sustainable Fisheries Framework"* incorporates the precautionary and ecosystem approaches into fisheries management decisions. Finally, the "*Aboriginal Fisheries Strategy"* is aimed at ensuring that aboriginal entitlements are respected in the development of stable fisheries management regimes for aboriginal peoples.

Legal disputes respecting fishing are adjudicated quickly and fairly in a public forum through the Canadian judicial process and have been shown to be effective. For example, disputes regarding aboriginal fishing rights have been fairly resolved (*R.v Sparrow, R.v Marshall*) and have led to current legislation and policy that ensures the protection of aboriginal rights. Native people participate in the offshore shrimp fishery through licences and allocations and their representatives are members of the advisory process. The legal and policy framework has been otherwise tested on several occasions in such areas as licencing (Saulnier v The Royal Bank), fishing rights and allocation practices {Larocque v. Canada (Minister of Fisheries and Oceans)} and through numerous prosecutions in an open and transparent process. The system has quickly reacted to implement binding legal decisions.

Many disputes, legal and otherwise, are avoided through a proactive co-management advisory process and frequent communication between the regulator and the fishery participants.

All areas of management responsibilities and roles are clearly defined within the department and fishery management programs are delivered in an organized and controlled manner. There is an elaborate sanction and penalty structure in the *Act* and regulations and a ticketing and court based program for the resolution of legal disputes. Government legislation and policy ensures the protection of aboriginal rights and Inuit people do participate in the fishery through licences and allocations in SFA 1.

Both the Canadian and Nunavut management regimes described are consistent with the UN Convention on the Law of the Sea (United Nations, 1982) as well as with the main principles of the 1995 United Nations Code of Conduct for Responsible Fishing.

Score: 100

The Canadian and Nunavut management systems are consistent with local, national or international laws or standards that are aimed at achieving sustainable fisheries. The Canadian system for the settlement of legal disputes is fair and transparent and proven to be effective. Both systems seek to avoid disputes and both systems respect legal and customary rights of participants.

Audit Trace References

Fisheries Act (R.S. 1985, c. F-14C) and regulations; *Territorial Sea Geographic Co-ordinates (Area 7) Order (S.O.R./85-872); UN Convention on the Law of the Sea* (United Nations, 1982), *UN Code of Conduct for Responsible Fishing*; *Agreement between The Inuit of the Nunavut Settlement Area and Her Majesty The Queen in Right of Canada*, 1993

3.1.2	**Consultation, roles and responsibilities** The management system has effective consultation processes that are open to interested and affected parties. The roles and responsibilities of organisations and individuals who are involved in the management process are clear and understood by all relevant parties.	Organisations and individuals involved in the management process have been identified. Functions, roles and responsibilities are generally understood. The management system includes consultation processes that obtain relevant information from the main affected parties, including local knowledge, to inform the management system.	Organisations and individuals involved in the management process have been identified. Functions, roles and responsibilities are explicitly defined and well understood for key areas of responsibility and interaction. The management system includes consultation processes that regularly seek and accept relevant information, including local knowledge. The management system demonstrates consideration of the information obtained. The consultation process provides opportunity for all interested and affected parties to be involved.	Organisations and individuals involved in the management process have been identified. Functions, roles and responsibilities are explicitly defined and well understood for all areas of responsibility and interaction. The management system includes consultation processes that regularly seek and accept relevant information, including local knowledge. The management system demonstrates consideration of the information and explains how it is used or not used. The consultation process provides opportunity and encouragement for all interested and affected parties to be involved, and facilitates their effective engagement.

Scoring Comments
The Northern Shrimp Advisory Committee (NSAC) is the major consultative mechanism for the fishery. It is a structured body with terms of reference and rules of procedure outlined in the Annex B of the Integrated Fisheries Management Plan. The committee is composed of representatives of the northern shrimp industry, including offshore licence holders, inshore licences holders, and special allocation holders, Fisheries and Oceans Canada staff, representatives of the Nunavut Wildlife Management Board, as well as provincial and territorial governments. NSAC meetings are held at least annually to review updated scientific advice for the NAFO area 0+1 stock of *Pandalus borealis* and to develop recommendations for the TAC's for SFA 1 in the Canadian zone. The committee also meets to develop advice to the Minister when government or industry puts new proposals or new management regulations forward. Members make presentations to the committee for consideration and debate. DFO managers and scientists also attend and present information and advice to guide the committee's deliberations. Non-members may attend NSAC meetings but they may not sit at the table. They can participate in discussions following input from members. There is a collaborative agreement between DFO and one non-governmental organization, the World Wildlife Fund that aims to *"to achieve shared objectives for the conservation, protection, and sustainable development of Canada's oceans as mandated by the Oceans Act."* through a collaborative and constructive partnership.
Score: 95
All stakeholders have been identified and roles and responsibilities have been defined in the NSAC terms of reference. The consultative process has a built-in procedure for seeking and accepting relevant information, including local knowledge from fishermen, aboriginal peoples, and other stakeholders. The information is reviewed and discussed and participants are aware

of how it is used and how decisions are made.

The score would have been higher if the official membership of NSAC included Non Government Organisations.

Audit Trace References

Annex B of the IFMP - Northern Shrimp Advisory Committee Membership And Terms Of Reference; Collaborative Agreement Between Fisheries and Oceans Canada (DFO) and World Wildlife Fund, October 2008;

3.1.3	**Long term objectives** The management policy has clear long-term objectives to guide decision-making that are consistent with MSC Principles and Criteria, and incorporates the precautionary approach.	Long-term objectives to guide decision-making, consistent with MSC Principles and Criteria and the precautionary approach, are implicit within management policy.	Clear long-term objectives that guide decision-making, consistent with MSC Principles and Criteria and the precautionary approach, are explicit within management policy.	Clear long-term objectives that guide decision-making, consistent with MSC Principles and Criteria and the precautionary approach, are explicit within and required by management policy.

Scoring Comments

With respect to the establishment of scientific advice on stock status and catch recommendations, the NAFO Scientific Council operates under formal R*ules of Procedure.* The SC uses the precautionary approach as its basis for recommendations.

Canadian fisheries management has a hierarchy of broad policy measures beginning with a solid legislative foundation through the *Fisheries Act* and several sets of associated regulations (see 6.4 above). From that legal framework flows an elaborate outline of policy goals, objectives, processes and procedures for the shrimp fishery. The following outline the broad policy objectives that are the most relevant to this assessment.

Four overarching objectives for fisheries management are outlined in the *Atlantic Fisheries Policy Framework* - conservation and sustainable use of marine resources and habitat; self-reliant fisheries contributing to the well-being of coastal communities; shared stewardship involving participants in fisheries management and a stable and transparent rules-based access and allocation approach.

The *"Sustainable Fisheries Framework"* focuses on the incorporation of the precautionary and ecosystem approaches to fishery management decisions while protecting biodiversity and fisheries habitat. This policy requires that the precautionary approach be used in the management of all fisheries and includes a specific policy paper entitled "A fishery decision-making framework incorporating the Precautionary Approach". This policy paper requires that management action be taken depending on whether the stock status is deemed to be in a healthy, cautious or critical zone. The policy requires that uncertainty be incorporated in the calculation of the stock status. Under the framework, fishery management decision rules must be established to respond to these various scenarios which has been done for the fishery under assessment.

The "*Policy to Manage the Impacts of Fishing on Sensitive Benthic Areas"* deals with the mitigation of the impacts of fishing on sensitive benthic areas or avoidance of impacts of fishing that are likely to cause serious or irreversible harm to sensitive marine habitat, communities and species.

The *Emerging Species Policy* sets out the requirements and procedures or new fisheries. A cornerstone of the policy is the establishment of a scientific base with which stock responses to new fishing pressures can be assessed.

The *Aboriginal Fisheries Strategy* was developed to implement the Supreme Court of Canada decision that aboriginal people have a right to fish for food, social and ceremonial purposes, a right that takes priority, after conservation, over other users of the resource. The policy seeks to provide stability where DFO manages the fishery and where land claims settlements have not already put a fisheries management regime in place.

These broad policy guidelines are implemented through fisheries specific objectives that are outlined in species management plans.

Score: 100

There is a clearly articulated legislative and policy framework consistent with MSC Principles and Criteria that guides decision-making including guidelines for the precautionary approach. The long-term objectives are clear, explicit and required by management policy.

Audit Trace References

Fisheries Act and regulations; DFO *A Policy Framework for the Management of Fisheries on Canada's Atlantic Coast;* DFO *Sustainable Fisheries Framework; DFO Emerging Fisheries Policy; DFO Aboriginal Fisheries Strategy; DFO "Policy to Manage the Impacts of Fishing on Sensitive Benthic Areas"; NAFO Rules of Procedure and Financial Regulations*

3.1.4	**Incentives for sustainable fishing** The management system provides economic and social incentives for sustainable fishing and does not operate with subsidies that contribute to unsustainable fishing.	The management system provides for incentives that are consistent with achieving the outcomes expressed by MSC Principles 1 and 2.	The management system provides for incentives that are consistent with achieving the outcomes expressed by MSC Principles 1 and 2, and seeks to ensure that negative incentives do not arise.	The management system provides for incentives that are consistent with achieving the outcomes expressed by MSC Principles 1 and 2, and explicitly considers incentives in a regular review of management policy or procedures to ensure that they do not contribute to unsustainable fishing practices.

Scoring Comments

The Enterprise Allocation system of fishing provides a quasi property right to each offshore licence holder. Such stability and security of access provide strong economic incentives to harvest for the long-term maximize value and not volume and minimize negative impacts on the stock and its ecosystem. A sense of stewardship is evident in the attitude of the licence holders.

Attention by NGO's to bottom contact fishing gear has led to initiatives to minimize impacts. There are extensive resources and infrastructure at the Marine Institute of Memorial University where developments in gear technology are encouraged and jointly funded by governments, industry and university organizations through gear trials, experiments etc.

The cost of labour to separate high quantities of by-catch provides an incentive to avoid catching these species in the first place. This led to the voluntary use of the nordmore grate by the offshore shrimp before it became a legal requirement.

Fishing vessels also contribute data on the commercial fishery that is used by the NAFO Scientific Council in the stock assessment process.

There is also a detailed legislative penalty structure with significant financial penalties to deter negative behaviour.

Score: 85

The EA approach encourages good fishing practices and avoids overharvesting and waste. The licence holder and its Captains take part in surveys, trials and gather information for the biannual assessments. There are neither negative incentives nor subsidies in the fishery.

The score on this indicator would have been higher if the management system explicitly considered incentives in a regular review of management policy or procedures to ensure that they do not contribute to unsustainable fishing practices as required by the scoring guidepost for 100.

Audit Trace References

Annex E of the IFMP - *Northern Shrimp Enterprise Allocation Program: MSC Certification of the Offshore Shrimp Fisheries (>100') in areas 1,2,3,4,5,6 and 7. Submission for the Main Assessment by the 17 Offshore Licence Holders* September 2, 2009; licence conditions for offshore shrimp vessels.

3.2	Fishery- specific management system			
3.2.1	**Fishery- specific objectives** The fishery has clear, specific objectives designed to achieve the outcomes expressed by MSC's Principles 1 and 2.	Objectives, which are broadly consistent with achieving the outcomes expressed by MSC's Principles 1 and 2, are implicit within the fishery's management system.	Short and long term objectives, which are consistent with achieving the outcomes expressed by MSC's Principles 1 and 2, are explicit within the fishery's management system.	Well defined and measurable short and long term objectives, which are demonstrably consistent with achieving the outcomes expressed by MSC's Principles 1 and 2, are explicit within the fishery's management system.

Scoring Comments

The IFMP contains a detailed matrix of goals and objectives beginning with the following three principles:

- Conservation and Sustainable Harvest: ecosystem based approach; cost-effective harvesting strategies; mitigate the impacts on other species an ecosystem; and stabilize industry infrastructure
- Benefits to Stakeholders: commercially viable and self-sustaining fishery.
- Co-management of the Shrimp Resource: provide licence holders with an effective sharing of responsibility; accountability and decision making

Detailed strategies and management measures are outlined under each of these three principles under in 1.1 of the IFMP – *Fishery Objectives*. Long and short-term objectives covering major components of MSC Principle 2 are explicitly included in the management plan, but several components could be addressed more directly.

A general performance review of the fishery takes place at the annual NSAC meeting but does not include an assessment of whether the enumerated objectives are being met and key management issues are being addressed. A Fishery Checklist is in the process of being developed which will also be useful in identifying areas for improvement in the management of the fishery. The Conservation and Enforcement Working Group, a joint DFO-Industry group, focuses on conservation measures but does not conduct a performance review against stated objectives.

Score: 70

Short and long-term objectives in the domestic fishery are well described in the management system. The lack of specific measurement indicators makes evaluation of some of the objectives difficult and keeps this indicator from achieving a higher score. The lack of explicit mention of application of the precautionary approach to Principle 2 related issues and specific measurement indicators makes evaluation of some of the objectives difficult and keeps this indicator from achieving a higher score. The score would have also been higher if maintenance of biodiversity and maintenance of shrimp biomass to support predators had been included in the objectives.

Audit Trace References

Integrated Fisheries Management Plan - *Northern Shrimp - Shrimp Fishing Areas (SFAs) 0-7 and the Flemish Cap, 2007;* Pers. Com. - *Fishery Checklist; NSAC minutes*

3.2.2	**Decision-making processes** The fishery-specific management system includes effective decision-making processes that result in measures and strategies to achieve the objectives.	There are informal decision-making processes that result in measures and strategies to achieve the fishery-specific objectives. Decision-making processes respond to serious issues identified in relevant research, monitoring, evaluation and consultation, in a transparent, timely and adaptive manner and take some account of the wider implications of decisions.	There are established decision-making processes that result in measures and strategies to achieve the fishery-specific objectives. Decision-making processes respond to serious and other important issues identified in relevant research, monitoring, evaluation and consultation, in a transparent, timely and adaptive manner and take account of the wider implications of decisions. Decision-making processes use the precautionary approach and are based on best available information. Explanations are provided for any actions or lack of action associated with findings and relevant recommendations emerging from research, monitoring, evaluation and review activity.	Decision-making processes respond to all issues identified in relevant research, monitoring, evaluation and consultation, in a transparent, timely and adaptive manner and take account of the wider implications of decisions. Formal reporting to all interested stakeholders describes how the management system responded to findings and relevant recommendations emerging from research, monitoring, evaluation and review activity.

Scoring Comments
Decision-making in the Scientific Council is based on the *Rules of Procedure for the Scientific* Council that is part of the *NAFO Rules of Procedure and Financial Regulations*. The document outlines guidelines for representation, voting, order of business, committees and records and reports. The IFMP sets out the decision making process for the management of the fishery. The Northern Shrimp Advisory Committee (NSAC) serves as a forum for the discussion of issues on the management and development of the northern shrimp fishery providing advice and recommendations to the Minister of Fisheries and Oceans. NSAC provides input for the content of the Integrated Fisheries Management Plan, including but not limited to advice on quota allocations and regulatory measures such as seasons, size limits, gear restrictions, conservation, compliance issues and licencing policy. Advice to the Minister is analyzed by the DFO after which decisions are made and incorporated into the IFMP.
Score: 80
There is a well-established decision making process that results in measures and strategies to achieve the fishery objectives. Explanations regarding findings recommendations, etc are usually outlined or are evident in the IFMP and in fishery management decisions issued prior to the annual fishery. The provision of a formal reporting process to all stakeholders outlining explanations for action of the lack thereof would enhance the score on this indicator.

The NAFO Scientific Council evaluates all sources of information in an open manner, uses the precautionary approach as an operating principle and produces a stock status report and catch recommendations in an open, transparent forum. NSAC has established terms of reference and its decision-making processes respond to all issues identified in relevant research, monitoring, evaluation and consultation. The system is transparent and all meetings are open to the public.

For the fishery under assessment, a framework based on reference points along with the use of harvest control rules is being brought into management of this stock and the management regime follows the precautionary approach.

Audit Trace References

Integrated Fisheries Management Plan - *Northern Shrimp - Shrimp Fishing Areas (SFAs) 0-7 and the Flemish Cap 2007; Nunavut Land Claims Agreement; NAFO Rules of Procedure and Financial Regulations*

3.2.3	**Compliance and enforcement** Monitoring, control and surveillance mechanisms ensure the fishery's management measures are enforced and complied with.	Monitoring, control and surveillance mechanisms exist, are implemented in the fishery under assessment and there is a reasonable expectation that they are effective. Sanctions to deal with non-compliance exist and there is some evidence that they are applied. Fishers are generally thought to comply with the management system for the fishery under assessment, including, when required, providing information of importance to the effective management of the fishery.	A monitoring, control and surveillance system has been implemented in the fishery under assessment and has demonstrated an ability to enforce relevant management measures, strategies and/or rules. Sanctions to deal with non-compliance exist, are consistently applied and thought to provide effective deterrence. Some evidence exists to demonstrate fishers comply with the management system under assessment, including, when required, providing information of importance to the effective management of the fishery. There is no evidence of systematic non-compliance.	A comprehensive monitoring, control and surveillance system has been implemented in the fishery under assessment and has demonstrated a consistent ability to enforce relevant management measures, strategies and/or rules. Sanctions to deal with non-compliance exist, are consistently applied and demonstrably provide effective deterrence. There is a high degree of confidence that fishers comply with the management system under assessment, including, providing information of importance to the effective management of the fishery.

Scoring Comments
There is a comprehensive monitoring and surveillance system in place for the SFA 1 fishery. All vessels are issued a licence containing an extensive list of licence conditions and which is to be on board the vessel at all times for the information of the Captain and crew. Measures such as VMS, hail-in/out requirements, daily hails of position, catch and other information, 100% on-board industry funded observer coverage, aircraft surveillance, at-sea boardings, and spot-checks of landings ensure good coverage of the fishery. A ticket and court-based sanction framework is outlined in the *Fisheries Act* and regulations with court based prosecution for serious offences through the procedures provided in the *Criminal Code of Canada*. Upon conviction maximum penalties of $500,000 and up to two years in jail may be imposed along with forfeiture of catch and equipment at the discretion of the court.
Score: 95
The Canadian monitoring, control and surveillance system in place for the offshore shrimp fishery is very elaborate and has been shown to be effective in enforcing the requirements and rules of the fishery. Offenders are regularly pursued and the sanctions under the *Fisheries Act* are strong deterrents. The offshore shrimp fleet has not had any serious compliance issues.(pers.com DFO). There is a high degree of confidence that fishers comply with the management system and provide necessary information through the observer program and through the submission of logbooks. There is no evidence of systematic non-compliance. The score would have been higher on this performance indicator if there had been evidence of a regular review mechanism with data to support the conclusion of effective deterrence.

Audit Trace References
Integrated Fisheries Management Plan - *Northern Shrimp - Shrimp Fishing Areas (SFAs) 0-7 and the Flemish Cap, 2007*

3.2.4	**Research plan** The fishery has a research plan that addresses the information needs of management.	Research is undertaken, as required, to achieve the objectives consistent with MSC's Principles 1 and 2. Research results are available to interested parties.	A research plan provides the management system with a strategic approach to research and reliable and timely information sufficient to achieve the objectives consistent with MSC's Principles 1 and 2. Research results are disseminated to all interested parties in a timely fashion.	A comprehensive research plan provides the management system with a coherent and strategic approach to research across P1, P2 and P3, and reliable and timely information sufficient to achieve the objectives consistent with MSC's Principles 1 and 2. Research plan and results are disseminated to all interested parties in a timely fashion and are widely and publicly available.

Scoring Comments

Ongoing stock assessment research is described in detail in Annex D of the IFMP. For the purposes of stock assessment, the O+1 shrimp stock is monitored through Canadian and Greenlandic research surveys and sampling of the commercial catch. Catch rates of shrimp and fish species are recorded, and detailed observations are made on shrimp size distribution, sex, maturity and egg production. These data provide useful information on the distribution and abundance of the resource, the effects of fishing, changes in the environment, and potential for the fishery in the near future.

Other research, although not conducted in SFA 1 specifically, includes work directed towards age determination, estimation of mortality rates, effects of environmental parameters (e.g., temperature, currents) and relationships with major predators, especially Greenland halibut and cod.

A 5 year $5 million research proposal by the Marine Institute of Memorial University has been developed and submitted for funding that has the objective of reducing the bottom impact of various trawls currently used in the industry. The approach for this project is to complete design and simulation using various trawl configurations, complete physical modeling using the flume tank, and then evaluate prototypes under commercial conditions.

A study is currently being undertaken by the Marine Institute to develop a methodology to use industry single beam sounders to collect bottom type data and compile these data to create an acoustic classification map for fishing grounds off Newfoundland and Labrador. The study will focus in particular on northern shrimp, although the results will be applicable to other benthic species. The study will help to guide more detailed investigation of sensitive habitats and the correlation between shrimp abundance and seabed habitat.

Additional research is being conducted at the DFO Maurice Lamontagne Institute in Mont Joli, Quebec in tank rooms designed to simulate the natural living conditions of *Pandalus borealis*. The studies are exploring the effect of water temperature on the various stages in their life cycle.

NIPAG provides research recommendations in their regular stock assessments.

The research being conducted is circulated to all interested parties in a timely fashion, either directly to stakeholders, at advisory committee meetings or via the Canadian Science Advisory

Secretariat (CSAS) system on the DFO website.

Score: 75

While there is significant ongoing research activity to support the fishery, there is no actual research plan that provides the management system with a strategic approach to research as is required by the 80 scoring guidepost.

The research survey and assessment program is described and published as part of the IFMP (Annex D) and provides management with necessary information. However it is not comprehensive, as it does not address all issues identified in the stock assessments as requiring resolution through research. In addition, although ecosystem issues are addressed in ongoing research and in the research plan, there is not a comprehensive range of research topics identified to resolve issues related to ecosystem impacts of fishing"

Audit Trace References

Integrated Fisheries Management Plan - *Northern Shrimp - Shrimp Fishing Areas (SFAs) 0-7 and the Flemish Cap, 2007; MSC Certification of the Offshore Shrimp Fisheries (>100') in areas 1, 2 ,3, 4, 5, 6 and 7. Submission for the Main Assessment by the 17 Offshore Licence Holders* September 2, 2009

3.2.5	**Monitoring and management performance evaluation** There is a system for monitoring and evaluating the performance of the fishery-specific management system against its objectives. There is effective and timely review of the fishery-specific management system.	The fishery has in place mechanisms to evaluate some parts of the management system and is subject to occasional internal review.	The fishery has in place mechanisms to evaluate key parts of the management system and is subject to regular internal and occasional external review.	The fishery has in place mechanisms to evaluate all parts of the management system and is subject to regular internal and external review.

Scoring Comments

Ongoing monitoring and evaluation mechanisms include an extensive reporting system on the commercial fishery through logbooks, VMS, dockside monitoring and 100% observer coverage. Research surveys supply additional data and full scientific reviews of the performance of the fishery are conducted and annual assessments produced.

A review as to whether the objectives are being met and key management issues are being addressed is conducted at annual NSAC meetings, attended by licence holders, provincial and federal government representatives First Nations' representatives. Meetings are open to the public. DFO has also created a " Fishery Checklist"- an internal diagnostic tool containing more than a 100 questions designed to assess a fishery's status against necessary elements of a sustainable fishery. The checklist is a complement to the annual review of a fishery against the specific objectives.

With respect to external review, the Canadian Auditor General has the authority to and has in the past conducted reviews of the fisheries management regime on an *ad-hoc* basis - see Auditor General of Canada, 1999 Report (updated in 2000) - *Managing Atlantic Shellfish in a Sustainable Manner;* Spring 2009 Report - Chapter 1- *Protecting Fish Habitat*; October 2004 Report -Chapter 5—Fisheries and Oceans Canada—*Salmon Stocks, Habitat, and Aquaculture*; December 2000 Report - Chapter 31—Fisheries and Oceans—*Fleet Management*; March 2008 Status Report - Chapter 6—*Ecosystems—Control of Aquatic Invasive Species.*

Occasionally the Fisheries and Oceans committees from the Parliament and Senate of Canada conduct reviews of specific issues in the fishery and require the Minister or officials of DFO and the industry to appear as witnesses to the review.

With respect to the advice provided by the Scientific Council of NAFO, the stock assessments process consists of peer review by international scientists of Contracting Parties who are members of NAFO at Scientific Council. All proceedings, scientific advice and reports are available through annual reports posted on the NAFO website.

Score: 80
The annual NSAC meeting and the stock assessment process are regular review mechanisms in place to evaluate key parts of the management system, and may include external participants. The score on this indicator would have been higher if there was a regular review mechanism for the review of the management system against its objectives and if there was a provision for regular external review.
Audit Trace References
Integrated Fisheries Management Plan - *Northern Shrimp - Shrimp Fishing Areas (SFAs) 0-7 and the Flemish Cap 2007; MSC Certification of the Offshore Shrimp Fisheries (>100') in areas 1, 2, 3, 4, 5, 6 and 7. Submission for the Main Assessment by the 17 Offshore Licence Holders* September 2, 2009; Auditor General of Canada annual reports

APPENDIX B

Peer Review Reports

PEER REVIEWERS BIOGRAPHIES

Don Parsons

Don is a retired shrimp population biologist having worked with the Department of Fisheries and Oceans Canada, Newfoundland Region, for over 25 years. Don has represented Canada at several international fora on *Pandalus* species and has published extensively on the biology and population dynamics of northern shrimp. He has been an expert team member of the Oregon Pink Shrimp and Gulf of St. Lawrence Northern Shrimp fisheries and is a member of the team presently assessing the Scotian Shelf *Pandalus* fishery.

Sean Cox

Sean holds a Doctorate in Resource Management and Environmental Studies. He is Assistant Professor of Fisheries Science in the School of Resource and Environmental Management at Simon Fraser University. He has undertaken significant work in the field of design and evaluation of stock assessment and management procedures for commercial fisheries. His collaborative work on groundfish has involved stakeholders, groundfish managers, scientists, and academics in the collaborative development of precautionary fishery management policies that meet conservation and economic objectives

Peer Reviewer 1

Background
Need a very close inspection of all sections and appendices to this report for numerous typographical and spelling errors.

MML Assessment Team Response – The report has been reviewed and typographical and spelling errors corrected.

Some elements of the Glossary do not appear in this report (e.g., ASPIC), perhaps because they appear in one of the other reports?

MML Assessment Team Response – The Glossary has been amended.

P 21: "In SFA 0 and 1 the TAC season runs from 1 January. In SFAs 2 to 6 it runs from April 1." This should also state when the season closes.

MML Assessment Team Response – The length of the season is dependent on ice conditions, economics, etc. The text has been amended.

P 23: "…with projected catches at 132,000 t …" should more specifically state, e.g., "…with projected combined trans-boundary catches of 132,000 t …". It would be even better to also state what the UoC catch would be.

MML Assessment Team Response – The text has been amended.

P 23/24: The text on the Bayesian production model should be removed if it is the same model described in the previous section.

MML Assessment Team Response – We think the reviewer has made a mistake as this is the first time that the Bayesian production model has been mentioned

Principle 1

Stock status (P50): The scoring comments seem to contradict the score. "Prospects for recruitment to the fishable stock remain poor.", "age-2 abundance reached a record low", "…concerns about future recruitment remain grave". If any of these statements are accurate, then how can there be a high likelihood that recruitment is not being impaired?

MML Assessment Team Response – The text has been amended. Concerns about recruitment in the most recent NAFO/ICES assessment, which we have cited in the current draft, are somewhat less than in previous assessments and in any case do not contradict the fact that the stock has been above reference points for some years and is demonstrably healthy.

There is no reference here to the probability of being below Z_{lim} and B_{lim} either, which are the more appropriate reference points for the recruitment elements of this indicator. For the target reference point element, the comments should provide the actual probabilities to justify the score (this is done for Z_{msy}, but should be done for B_{msy} as well)

MML Assessment Team Response –We have added text to indicate that the stock is well above the target biological reference point and below the target fishing mortality, so well above B_{lim}. The risk of the stock falling below B_{msy} at the end of 2010 with a catch of 130.000 t is 18% and the risk of falling below B_{lim} is 0.2 %

Reference points (P52): most of the scoring comments have nothing to do with the actual scoring guidepost elements, so one cannot tell where the 95 score comes from.

MML Assessment Team Response – We have revised the text and the score to try to ensure that the score is well justified.

Harvest strategy (P55): What is the evidence that the strategy is achieving its objectives? The Stock Status section was pretty grim on the outlook for this stock and the probability of being below B_{msy} (23%) is approaching the limit value of 30%. Do those projections also take into consideration that Greenland will exceed its TAC by 20%?

The comments below the score are not clearly related to the actual score.

MML Assessment Team Response – We have revised the text and reviewed the score to try to ensure clarity. The strategy is achieving its objectives within the Canadian fishing zone and under the Canadian management strategy, i.e. the harvests are well below the adopted TAC. Our approach to the Canada-Greenland bilateral management issue is outlined under this PI.

Harvest control rules and tools P(57): How can the harvest control tools be effective when they are irrelevant to the Canadian fishery and they are consistently exceeded by the larger fishery in Greenland? To what extent can this fishery be certified independent of what the Greenland fishery is doing?

MML Assessment Team Response – Our approach to assessing the Canadian management framework is outlined under PI 1.2.1, and revised text is provided to support our scoring of this PI.

Information/monitoring P(59): the lack of genetic information cannot be used to support the single-stock assumption. It is also hard to argue that an assumption is "very likely" in the absence of specific information.

MML Assessment Team Response – Text has been modified to take this comment into account.

Assessment of stock status P(61):
Replace "uninformed" with "uninformative", although the Hvingel and Kingsley (2006) analyses use several informative priors as well.

How does a logistic population dynamics model that aggregates all biomass into one category account for the major biological feature of a hermaphroditic shrimp?

Recruitment is included in the assessment implicitly in the process error term as described in Hvingel and Kingsley (2006).

MML Assessment Team Response – The text errors are corrected in the revised draft. The population model deals with exploitable biomass and does not explicitly take the hermaphrodism of the shrimp into account, while pre-recruits (males) are used for two different recruitment indices not yet included in the model.

Principle 2

This section is reasonably well organized and documented; however, like other sections, there is no obvious connection between the scoring guideposts, the comments, and the scores.

Status (P66): In the scoring comments: "Bycatches of the order of 200 t/yr…". Is this bycatch of

groundfish, as implied by the preceding text, or shrimp as implied by the text that follows?

MML Assessment Team Response - This is groundfish bycatch --- shrimp bycatch is covered in the "retained species" 2.1 series.

Principle 3

This section seems to be well-organized, although like the others, there is a lack of clear relationships between the scores and the individual elements within each scoring guidepost.

Long term objectives (P86): I don't see where most of these policies are relevant to this indicator. The MSC FAM Section 8.2.24 indicates that this section should explain how management policy is consistent with the precautionary approach (and there is a specific definition therein for use in scoring). Yet, there are no specific examples of high-level policy objectives.

MML Assessment Team Response - The MSC FAM for PI 3.1.3 Long Term Objectives requires that this PI deal with management policy at a high level and within a broad context and outside the specific fishery under assessment. The PI should deal with overarching legislation, policies and custom that applies within a broader management system.

To that end, the report outlines several broad fishery management legislative and regulatory instruments along with policy documents that form a high-level policy framework. Four of these specific high-level policy documents are dealt with in some detail in the report that applies to all fisheries. One of those, the *"Sustainable Fisheries Framework"* deals with the implementation of the precautionary approach through a decision-making framework that requires that action is taken when the status of the stock indicates a cautious or critical state. The narrative under Scoring Comments of PI 3.1.3 in the report has been amended to clarify the use of the PA through these policy objectives.

Fishery-specific objectives (P89): there is no discussion of "measurable" objectives. The objectives presented are all aspirational rather than operational as required under this PI.

MML Assessment Team Response - While the team does not agree that the objectives are all aspirational, they do lack a degree of specificity such that the score should be lowered. This PI is now scored at 70 with additional comments in the scoring table as well as the addition of a condition.

Stakeholder comments

1. Some of the comments made by EAC with respect to Principle 1 have been cutoff at the bottom of page 103.

MML Assessment Team Response – The EAC comments on Principle 1 were limited and were not cut off.

2. The comments for Principle 1 are also duplicated under concerns for Principle 2.

MML Assessment Team Response – This has been amended

3. The figure referenced on page 105 (Figure 1) is missing.

MML Assessment Team Response – The figure was not included in the submission

Suitability of conditions of certification: Conditions, where established seem appropriate to meet the requisite standard and also seem fair to the client; that is, they can be accomplished in the time given and with the expected data that will accumulate. The recommendations for meeting conditions seem prescriptive. I expected a list of evidence required to demonstrate that conditions are met, not a step-wise approach since the UoC may have other ways of meeting the conditions.

MML Assessment Team Response – Our recommendations are in-line with those that were made in a separate certification of the northern shrimp fishery in SFA 5-7 in 2008 and are intended to provide some guidance and a joined up approach with that assessment. The MSC have clearly stated that Conditions should not be too prescriptive and it is for the client to set out how they intend to demonstrate that conditions are met. The client's action plan has to be agreed with the assessment team.

Peer Reviewer 2

Review of MSC Assessment Report for
The Canadian Offshore Northern Shrimp (*Pandalus borealis*)
Trawl Fishery - Shrimp Fishing Area 1

Version: Client Draft

Part A - General Comment:

Reviews of four MSC draft Assessment Reports were performed:

1. The Canadian Offshore Northern Shrimp (*Pandalus borealis*) Trawl Fishery - Shrimp Fishing Areas 2, 3, 4, 5 and 6,
2. The Canadian Offshore Northern Shrimp (*Pandalus borealis*) Trawl Fishery - Shrimp Fishing Area 1 (this review),
3. The Canadian Offshore Northern Shrimp (*Pandalus borealis*) Trawl Fishery - Shrimp Fishing Area 7, and
4. The Canadian Offshore Striped Shrimp (*Pandalus montagui*) Trawl Fishery - Shrimp Fishing Areas 2, 3 and 4.

All reviews include both editorial changes/corrections and comments of substance. The former is not exhaustive. There were numerous errors which, in some cases, were quite minor, whereas, in others, they had impact on the meaning and/or understanding of the text.

More substantial comments are given for both the reports and the scoring tables, and are relevant to the interpretation of information for the purpose of scoring the performance indicators. Some editorial changes are also suggested for the tables.

When considering their merit, the assessment team should ensure that any resulting changes, minor or substantial, are applied across all assessment reports where it is deemed appropriate. Moreover, much of the information in the report sections was identical or similar. The SFA 2 – 6 assessment for *P. borealis* was reviewed first and comments provided on the report (Part B) of that review can apply to the other three. Consequently, most of the comments for the other three reports relate to the rationale provided in the scoring tables.

Part B – Comments on the Report:

1- Introduction:

1. Page 5, Section 1.4 Other Information Sources – As noted for the other reports, this section is generic for all SFA reports. A statement explaining that this is by design (i.e. a template for all reports) would be useful.

MML Assessment Team Response – Text has been added to this effect

2 - Glossary:

1. Page 13, General comment – Several of the acronyms, terms and abbreviations (e.g. ASPIC, B_{BUF}, F_{LIM}, IUCN) do not appear in this or any report. These should be fleshed out and removed.

MML Assessment Team Response – This section has been amended.

4 –Stock Assessment:

1. Page 23, Section 4.2, para. 2, last sentence – “with the input data”, not “win”.

MML Assessment Team Response – The correction has been made.

2. Page 23, Section 4.2, General comment – As for the other SFA reports, it would be useful to include the 2009 assessment findings. An update, in this case, should not lead to major changes elsewhere in the text because the changes in stock status were detected earlier.

MML Assessment Team Response – This section now includes findings of 2009. The risk of the stock falling below *Bmsy* at the end of 2010 with a catch of 130.000 t is 18% and the risk of falling below *Blim* is 0.2 %

3. Page 23, Section 4.3, first sentence – Define NIPAG in glossary.

MML Assessment Team Response – NAFO/ICES Pandalus Asessment Working Group has been defined

4. Page 24, last sentence – It is worth noting that Canada did not fish in 2008 and 2009.

MML Assessment Team Response – These points have been taken into account within the revised report

6 - Ecosystem Characteristics:

1. Page 33, Section 6.2.2.2, para. 2 – Is there a reference to the source of the details on bycatch for the 1999 – 2007 period?

MML Assessment Team Response –The reference has been added.

9 - Background to the Evaluation:

1. Section 9.2 – It might be worth noting that the West Greenland shrimp fishery is listed as “in assessment” on the MSC website.

MML Assessment Team Response – Agreed. The text has been added.

11 - Observations and Scoring:

1. Section 11.1 – As noted for other reports, scores were presented to the first decimal and there are no weights recorded in the scoring table.

MML Assessment Team Response – The MSC FAM V2 requires Principle scores to be to 1 decimal place. Weighting in the assessment scoring table are not required to be shown.

13 - Certification Recommendation:

See comments on Conditions below (Part D – Concluding Remarks)

Part C – Comments on the Scoring Tables:

1. PI 1.1.1 – Within Scoring Comments, first para., last sentence – > 15 mm, not < ; and "predatory" not "predating". An update on the state of the stock based on the 2009 NAFO assessment is suggested. Also, there should be an explanation of why the grave concerns about future recruitment do not reflect impairment. Otherwise, the rationale is confusing.

MML Assessment Team Response – The text has been amended. We have based the current draft on the 2010 NAFO assessment which is the most recent – we did not have access to this information for the client draft report. Although this assessment expresses some concerns about pre-recruits being in decline, these are somewhat less than in previous assessments and in any case do not contradict the fact that the stock has been well above reference points for some time, and is demonstrably healthy.

PI 1.1.2 – In addition to the absence of recruitment input for the model, the Scientific Council

MML Assessment Team Response – A sentence about the registration of fishery removals has been included in the scoring justification – there are no other fisheries in which there are removals.

2. concluded in 2009 that the assessment model may be both optimistic and more uncertain.

MML Assessment Team Response – This has been added to text under PI 1.2.4.

3. PI 1.2.1 – As the first bullet of SG 80 is not met, a score higher than 70 seems excessive.

MML Assessment Team Response – We have provided additional detail on our approach to evaluating this PI, which is to assess the Canadian management framework rather than the bilateral Canada-Greenland situation. The Canadian TAC is responsive to the state of the stock, and we feel that overall the 80 SG is met for this PI.

4. PI 1.2 2 – A score of 100 is difficult to justify if the independent TAC setting processes could result in unsustainable exploitation.

MML Assessment Team Response – We believe that the Canadian fishery management framework does meet the 100 SG, based on revised text we have provided.

5. PI 1.2.3 – A brief statement about other fishery removals is needed to support a score >80.

MML Assessment Team Response – The text has been amended.

6. PI 1.2.4 – A higher score could be awarded as there is some evidence that the last two elements of SG 100 have also been met to some extent (i.e. robust assessment, international peer review).

MML Assessment Team Response – We have adjusted the score and text in line with this comment.

7. PI 2.2.2 – All elements of SG 100 specify a strategy, not a partial one. An explanation of the additional 5 points should be given.

MML Assessment Team Response – We have provided further explanation for the scoring (and on further consideration have increased the score on this PI).

8. PI 2.2.3 – The score is appropriate but what seems to be deficient here, with respect to SG 100 requirements, is a comprehensive strategy to manage bycatch.

MML Assessment Team Response – We have provided further explanation of the scoring here, including reasons for not meeting the 100. Whether the strategy is comprehensive is scored in PI 2.2.2, but the information is not considered "verifiable" thus not meeting the 100.

9. PI 2.3.2 – A 100 score was not awarded "because potential strategies to be implemented should these species increase in abundance are not given explicit consideration ". This is more relevant for this fishery because the grate spacings can be reduced from 28 mm. Moreover, the strategy is not comprehensive and, therefore, the score should be less than 100.

MML Assessment Team Response – We have clarified these points in the revised text.

10. PI 2.3.3 – Comparing the rationale with that for the same PI in SFA 7, the score here should be lower than 90, given the lack of verifiable information.

MML Assessment Team Response – We have increased the score on this PI for SFA 7 and provide some further clarification for the basis for the score in text here.

11. PI 2.4.1 – The impact of the "shoe" used during twin trawling should be mentioned here.

MML Assessment Team Response – We have done this and also reduced the score to 60 consistent with the SG.

12. PI 2.4.2 – As there is no partial strategy, what is the basis for the intermediate score of 70?

MML Assessment Team Response – We agree and have revised the score to 60.

13. PI 2.4.3 – The score implies most of the elements of SG 80 are met when, in fact, only the third is supported by the rationale.

MML Assessment Team Response – We agree and have clarified the text and revised the scored.

14. PI 2.5.1 –There is only qualitative assessment and expert judgment, nothing quantitative, which satisfies SG 60. Some added value is warranted for considering predator forage but a score of 75 appears excessive.

MML Assessment Team Response – We agree and have revised the score to 70 and provided further detail on the justification.

15. PI 2.5.2 – Need to mention the additional twin-trawling impact. Also, there is no partial strategy, only measures, requiring a score lower than 80. However, the reasons for awarding a high intermediate score of 75 are not clear.

MML Assessment Team Response – We agree and have revised the score to 70 and provided further detail on the justification.

16. PI 2.5.3 – The impact of the "shoe" used during twin trawling should again be mentioned.

MML Assessment Team Response – We agree and have revised the score to 70 and provided further detail on the justification.

17. PI 3.1.1 – Evidence that the mechanism for resolving legal disputes has been tested and proven effective is lacking.

MML Assessment Team Response – The text in the Scoring Comments of the PI has been amended to better address the issue noted.

18. PI 3.1.3 – If the objectives are required by management policy, then the score should meet the SG 100 requirements.

MML Assessment Team Response – The team has reviewed the scoring of this PI and find that it meets all the requirements of the 100 scoring guidepost. The score has been changed accordingly.

19. PI 3.1.4 – Is there a regular review of policy to justify the extra 5 points?

MML Assessment Team Response - Five (5) extra points were awarded as the fishery meets the first part of the first sentence of PI 100 but not the second (the explicit and regular review).

20. PI 3.2.1 – Scoring Comments, second bullet point: "commercially viable and self-sustaining fishery" appears twice. In Score section, it could be noted that, although predator requirements are not included in objectives, the stock assessment explicitly does.

MML Assessment Team Response - The text has been corrected with respect to the first point. With respect to the second, we believe the current wording is adequate.

21. PI 3.2.4 – The rationale requires a statement about the timely dissemination of research results to support a score >60.

MML Assessment Team Response - The text under Score in this PI has been amended to reflect how research results are disseminated.

22. PI 3.2.5 – Scoring Comments, second para., last sentence: delete "in the" or complete the thought.

MML Assessment Team Response - The sentence has been corrected.

Part D – Concluding Remarks:

Instructions for the review stated that "comments should concentrate on the following, as far as is appropriate:

i) The accuracy of information quoted in the report
ii) Whether this information has been applied appropriately to the scoring indicators used in the table
iii) Whether the interpretation of this information justifies the decision made on whether to certify the fishery
iv) The suitability of the conditions attached to certification."

These instructions were followed and are further commented below.

The accuracy of the information quoted in the report appears to be sufficient for the MSC assessment process. The evidence for scoring was well documented and traceable within the references.

As stated above in Part B, Section 4 (Stock Assessment), the report lacks the most recent stock assessment. Information from the 2009 NAFO assessment could be included without requiring significant changes throughout the report or affecting the scoring.

MML Assessment Team Response – This has been added.

The information provided has been appropriately applied to the scoring indicators in most instances (see Part C, above). However, at times, it was difficult to identify the rationale for intermediate scores. Some intermediate scores were explained by how they were deficient from the higher SG but, for those where added value was given to the lower SG, the reasons were not clearly stated.

MML Assessment Team Response – These points have been taken into account and either additional information has been added to the rational or cores have been revised.

The outcome of the assessment might need revision should some Performance Indicator scores change in response to comments and suggestions provided herein.

The conditions designed to improve the scores for harvest strategy (1.2.1), habitat (2.4.1, 2.4.2, 2.4.3), ecosystem (2.5.1, 2.5.2, 2.5.3) and research plan (3.2.4) performance indicators appear suitable for achieving scores of 80 or more under the DAT. The timescales suggested to meet the conditions also appear reasonable.

APPENDIX C

Client Draft Action Plan

Pandalus Borealis SFA1

Condition 1 **Habitat** Relevant Performance Indicators: 2.4.1, 2.4.2, 2.4.3

The client is required by the fourth annual audit to compile and assess information, develop a strategy, and take measures as appropriate such that it can be considered on a regional or bioregional basis that the fishery is highly unlikely to reduce habitat structure and function to a point where there would be serious or irreversible harm.
This will be achieved by the following:

- CAPP and NC will collaborate with other stakeholders and the Department of Fisheries & Oceans Canada (DFO), towards development of a program (a) to enhance the collection of information, and (b) to conduct an evaluation of the nature and distribution of habitat types, their vulnerability, and the related impact of otter trawl fishing for shrimp in this area. A "project team" will be assembled for this purpose, which more generally will also ensure implementation of DFO's Sustainable Fisheries Framework Policies, including with respect to Sensitive Benthic Areas as it applies to the conduct of shrimp fishing in this area.
- By the first annual audit there will documented evidence that a plan for the assembly of available information and a program for evaluation has been developed by the "project team", and data collection and assembly for this purpose has commenced.
- By the second annual audit there will documented evidence showing the information that has been assembled and the results of analysis to date.
- By the third annual audit there will be documented evidence showing that at least a provisional evaluation has been completed.
- By the fourth annual audit there will be documented evidence that at least a partial strategy is in place, and incremental mitigation measures have been identified and are being implemented as appropriate for this fishing activity.

Condition 2 **Ecosystem** Relevant Performance Indicators: 2.5.1, 2.5.2, 2.5.3

The client is required by the fourth annual audit, to compile and assess information, develop a strategy, and take measures as appropriate such that the fishery is considered highly unlikely to disrupt key elements of ecosystem structure and function to a point where there would be serious or irreversible harm.
This will be achieved by the following:

- CAPP and NC will collaborate with other stakeholders and the Department of Fisheries & Oceans Canada (DFO), towards development of a program (a) to enhance the collection of information, and (b) to conduct an evaluation of the vulnerability of ecosystem components and the inferred impact of otter trawl fishing for shrimp in this area. A "project team" will be assembled for this purpose, which more generally will also ensure implementation of DFO's Sustainable Fisheries Framework Policies as they applies to the conduct of shrimp fishing in this area.
- By the first annual audit there will documented evidence that a plan for the assembly of available information and a program for evaluation has been developed by the "project team", and data collection and assembly for this purpose has commenced.
- By the second annual audit there will documented evidence showing the information that has been assembled and the results of analysis to date.
- By the third annual audit there will documented evidence showing that at least a provisional evaluation has been completed.
- By the fourth annual audit there will be documented evidence that at least a partial strategy is in place, and incremental mitigation measures have been identified and are being implemented as appropriate for this fishing activity.

Condition 3 **Short and long term objectives** Relevant Performance Indicator: 3.2.1

The client is required by the first annual audit to present evidence that short and long-term objectives, which are consistent with achieving the outcomes expressed by MSC's Principles 1 and 2, are explicit within the fishery's management system.
This will be achieved by the following:

- CAPP and NC will collaborate with other stakeholders and the Department of Fisheries & Oceans Canada (DFO), to amend the IFMP with explicit references to the precautionary approach being applicable to managing the impact of fishing on sensitive habitat, species and the ecosystem.

Condition 4 **Research Plan** Relevant Performance Indicator: 3.2.4

The client is required by the fourth annual audit to present a research plan that assembles current activity, identifies gaps, and provides the management system with a strategic approach to research including reliable and timely information sufficient to achieve the objectives consistent with MSC's Principles 1 and 2.
This will be achieved by the following:

- CAPP and NC will collaborate with other stakeholders and the Department of Fisheries & Oceans Canada (DFO) in assembling a working group to codify existing activity and develop a Research Plan for the short-to-mid term, that are linked to the objectives established for the fishery and for MSC Principles 1 and 2.
- By the first annual audit there will be documented evidence that a plan to conduct gap analysis has been developed by the working group.
- By the second annual audit there will be documented evidence that a gap analysis has been completed.
- By the fourth annual audit there will be documented evidence that a research plan is in place.

Note: Timelines associated with action planning to address Conditions 1 through 4 above are subject to special processes required through Land Claims Agreements.

General Recommendations

The assessment team recommends that the IFMP include explicit recognition of the ecological role of the species with respect to the target reference point. The assessment team also strongly recommends that an amendment page is included in the IFMP indicating what and when sections are amended.

- CAPP and NC will collaborate with other stakeholders and the Department of Fisheries & Oceans Canada (DFO), to implement these recommendations.

APPENDIX D

STAKEHOLDER COMMENTS

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August 31, 2009

Moody Marine Ltd.
Moody International Certification
28 Fleming Drive
Halifax, Nova Scotia
Canada B3P 1A9

RE: Stakeholder Input for Assessment Team Site Visit,
Canada Offshore Northern and Striped Shrimp Full MSC Assessment

Atlantic Canadian Waters, FAO Statistical Area 21

'Striped Shrimp Fishery', Shrimp Fishing Areas (SFAs) 2,3,4.
'Northern Shrimp Fishery', Shrimp Fishing Areas (SFAs) 1,2,3,4,5,6,7.

Attn: Paul Knapman and Canada Offshore Northern and Striped Shrimp Assessment Team

The Ecology Action Centre has been an active stakeholder in the MSC assessment processes for Atlantic Canadian fisheries. We appreciate the opportunity to participate in third party assessments, and as such we submit the following comments for your review and incorporation into your fishery site visit process. We respect the significant amount of work required to gather the data needed to assess the Striped and Northern Shrimp fisheries. We assert that **Nature of Bycatch** and **Habitat Effects** (both areas of Principle II concern) are areas of most critical concern in this fishery.

Principle I: Health of Fish Stock

Comments and Concerns:

Assessment should include a significant consideration of the consequences of removing vast biomass of a species from the food web that play an important role in the lower levels of the marine food chain.

Principle II: Impact on Ecosystem

Comments and Concerns:

BYCATCH/ DISCARDS:

Because of the high volume of shrimp being landed, low bycatch percentages nonetheless amount to a high bycatch volume for finfish and invertebrates. Even higher are the overall numbers of fish that are incidentally caught, since all bycatch consists of small or juvenile fish. Bycatch numbers are particularly concerning for Greenland halibut and redfish.

Finfish bycatch

The Canadian Northern Shrimp Trawl Fishery is the largest fishery by volume in Atlantic Canada. In 2005, shrimp catches in Atlantic Canada totaled 167,386 tons, with the majority of the catch coming from Newfoundland and Labrador. In comparison, all groundfish catches of Atlantic Canada combined, totaled 134,193 tons in 2005 (USDA 2007). As a result of this, the total finfish bycatch of the shrimp fishery is high, even if the percentage bycatch rates are low. All finfish bycatch in the northern shrimp fishery is discarded (Koeller et al. 2007).
The Nordmore grate did reduce finfish bycatches in the shrimp fishery. However, small and juvenile fish continue to be caught and the total number of groundfish bycatch is still high. Total fish bycatch in 2005 by the shrimp fishery in SFAs 5,6 & 7 was 186.78 tons.

Particularly concerning are the high catch numbers for juvenile Greenland halibut and redfish. On the Grand Banks (NAVO div. 3LNO), shrimp fishing vessels caught an estimated 143, 728 juvenile Greenland halibut in 2006, most of which were of age 1 (Orr et al. 2006). In the divisions 2GH, 2J3K and 3L combined, the shrimp fishery caught an estimated 4,722,274 Greenland halibut as bycatch in 2003 (Bowering and Orr 2006). Greenland halibut stocks off Newfoundland are at an all time low and recruitment is below average. Targeted fishing effort for Greenland halibut has been high and has exceeded rebuilding targets by more than 22% (Healey and Mahe 2007). Because Greenland halibut is one of the last remaining commercially significant groundfish stocks in the Northwest Atlantic (Shelton 2005) and its stock status is alarming, the high Greenland halibut bycatch in the prawn fishery is a cause for concern. Bowering and Orr (2006) attempted to estimate the impact of Greenland halibut bycatch on the overall Greenland halibut population and were not able to demonstrate a severe impact. However, the study pooled all data for the entire NAFO subarea 2 and divisions 3KL, thereby making it difficult to elucidate the effect of bycatch on Greenland halibut in different areas. This is particularly relevant given the cod collapse, and the past assumption that all cod were from the same stock. Further research is needed to separate out the effect of Greenland halibut bycatch in smaller arrears of the shrimp fishery. Furthermore, an estimated 326, 793 juvenile redfish

(*Sebastes spp.*) were caught as bycatch in 2005 in shrimp trawls on the Grand banks (Orr et al. 2006). On part of the Grand Banks (NAFO div. 3LN), there is a moratorium against directed fishing of redfish (Avila de Melo et al. 2007) while on the remainder (NAFO div. 3O) there is a small redfish fishery (Parsons and Power 2007). The impact of this bycatch on the redfish population is unclear. Considering the low abundance of redfish, however, it is possible that the shrimp fishery is having a detrimental impact on redfish stocks. Further research is needed to address this concern.

Due to the above, EAC recommends that Moody Marine require a complete assessment of the impact of shrimp trawling on the populations of Greenland halibut, redfish and other affected groundfish.

Coral bycatch

Cold water corals are an important component of benthic habitats (Henry and Roberts 2007; Hargrave et al. 2004). However, information on coral bycatch in the Canadian Northern Shrimp trawl fishery is incomplete. Fisheries observers only note presence or absence of corals in shrimp sets (Edinger, personal communication). In addition to that, corals that are dangling from the net are often removed and discarded by fishing crews before the corals can make it to the sorting tables on the ship, where fisheries observers are working (Edinger, personal communication). This incomplete observer data makes it very difficult to determine the actual impact of shrimp trawling on cold water corals. A shrimp set with corals can contain anything from a few fragments of a coral, to several hundred kilograms of coral. It is therefore impossible to tell when large coral patches are trawled for the first time and just how severe the coral bycatch problem is. For this reason EAC urges Moody Marine to require coral bycatch to be quantified by fisheries observers as a condition for MSC certification. Despite the inaccuracies in observer data, there is evidence that shrimp trawls do catch coral, and are second only to the Greenland halibut fishery (Figure1).

Furthermore, a large proportion of invertebrates that are destroyed by trawl nets never show up as bycatch in the first place. Invertebrate mortality from trawling is more likely to occur from disturbance to the seabed and the passage of the net, rather than from being taken as bycatch (Ball et al. 2000). In addition to that, shrimp trawls in this area have 70cm+ toggle chains (Moody Marine 2008a). It can therefore be assumed that a large quantity of the corals that are destroyed by the footgear never make it into the net. For this reason, EAC recommends a field study be completed where a retainer bag is placed behind the footgear of the shrimp trawl to quantify coral mortality. A similar study has already been completed to assess snowcrab bycatch (Gilkinson et al. 2006).

Finally, areas with little or no coral bycatch might historically have been important coral habitats. Cold water corals are slow growing and it may take from decades to centuries for a damaged coral patch to recover (Roberts and Hirshfield 2004). Therefore, if a large coral patch has been destroyed, subsequent shrimp trawls in the same area may have little to no coral bycatch. There is no information on the damage to corals that has

already been done by the shrimp fishery. While it may prove to be impossible to distinguish historical coral habitat that has been destroyed, it is at least possible to freeze the footprint of the shrimp fishery on corals.

EAC therefore recommends that the Canadian Offshore Northern and Striped Shrimp Fisheries not be allowed to expand into any new areas, as a requirement for MSC certification.

Damage to snowcrab

The impact of the shrimp fisheries on the snowcrab resource is less well understood than is assumed. The snowcrab industry has for some time argued that shrimp trawling is damaging snowcrabs and that an unusually large number of crabs with missing limbs are caught in areas that are being trawled for shrimp. Three DFO research studies (summarized by Gilkinson et al. 2006) attempted to demonstrate an impact of shrimp trawling on snowcrab. All three studies were not able to show any substantial snowcrab mortality or damage from shrimp trawling. However, the second study, in which retainer bags were attached right behind the footgear of the trawl, showed that large numbers of snowcrabs did encounter the footgear of the shrimp trawl. Legg loss in this study was 4% (Gilkinson et al. 2006). All three studies were conducted in summer and fall. Snowcrabs tend to molt in the spring (DFO 2003), and are most sensitive to loosing their limbs during that time. It can therefore be inferred that during molting season, substantially higher leg loss of snow crabs occurs than these three DFO studies demonstrated. Furthermore, when the high volume of the prawn fishery is taken into consideration, 4% of snow crabs loosing limbs might be a considerable number of crabs.

EAC recommends that a study on damage to snowcrabs be carried out in the spring, during molting season, when crabs are most sensitive.

HABITAT:

Damage to benthic habitat

The research on the impact of shrimp trawling on sandy and muddy bottom habitats remains inconclusive. Studying the impact of bottom trawling is challenging and costly and there are only a handful of studies that specifically investigated the impact of shrimp trawls. Of those, Hansson et al. (2000) showed a reduction of the abundance of echinoderms, particularly ophiuroids as a result of shrimp trawling in soft sediment communities in Sweden. Tanner (2003) investigated the impacts of shrimp trawling in Australia and observed a decline in the abundance of sessile epifauna as well as a decreased persistence for all taxa exposed to trawling, in particular sponges and bryozoans. Tanner pointed out that the impact from the experimental trawls used in his study was remarkably lower than the impact that is to be expected from larger, heavier commercial shrimp trawls (Tanner 2003). Sparks McConkey and Watling (2001) studied

the effects of trawling on soft sediment communities in Maine, and observed a significant decrease in the number of individuals, the abundance of species and diversity at trawled sites. Video camera observations of shrimp trawling by Gilkinson et al. (2006) did observe extensive furrows being drawn into the sediment that lasted for 4 days. Sediment remained suspended in the water column for one day after trawling. A number of studies also showed little to no impact by shrimp trawling on soft sediment communities (summarized by Rice 2006). The impact of groundfish otter trawls have been studied more in depth and sometimes with large and expensive studies (Freese et al. 1999). The damaging impact of the groundfish otter trawl fishery is well established in the literature (Freese et al. 1999; Sparks-McConkey and Watling 2001; Gordon et al. 2006; Rice 2006). There are no explicit spatial closures associated with this fishery that adequately protect representative seafloor habitat.

Principle III: Management System

Comments and Concerns:

The Ecology Action Centre strongly advocates for the implementation of an Ecosystem Approach that applies the precautionary principle and resilience thinking to the management of natural marine resources and social-ecological systems. We assert that it is at least as important to manage systems to enhance their resilience, as it is to manage for the optimization of specific species stocks. Resilience is the capacity of a system to absorb disturbance and still retain its basic function and structure. A fishery that is deemed to be sustainable and well managed must demonstrate high priority to the need to manage the environment to reduce risks and buffer against uncertainty and surprise.

Recommendations to Moody Marine Ltd.:

- Require the completion of a full assessment on the impact of shrimp trawling on the populations of Greenland halibut, redfish and other groundfish.
- Require fisheries observers to quantify coral bycatch in the shrimp fishery.
- Require the completion of a field study on the impact of shrimp trawling on corals, using a grab bag behind the footgear.
- Freeze the footprint of shrimp trawling on benthic habitats by not allowing the fishery to expand into new coral areas.
- Require the completion of a study on damage to snowcrabs during the springtime when crabs are molting.

Yours sincerely,

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References

Ball, B.J., Fox, G., Munday, B.W. (2000) Long- and short-term consequences of a Nephrops trawl fishery on the benthos and environment of the Irish Sea. *ICES Journal of Marine Science 57: 1315-1320.*

Bowering, W.R. and Orr, D.C. (2004) By-Catch of Greenland Halibut (Reinhardtius hippoglossoides, Walbaum) in the Canadian Fishery for Northern Prawn (Pandalus borealis, Koyer) in NAFO Subarea 2 and Divisions 3KL. *NAFO SCR Doc. 04/67.*

DeMelo, A., Duarte, R., Power, D., and Alpoim, R. (2007) An ASPIC Based Assessment of Redfish in NAFO Divisions 3LN. *NAFO SCR Doc. 07/38*

Freese, L. Auster, P.J., Heifetz, J., Wing, B.L. (1999) Effects of trawling on seafloor habitat and associated invertebrate taxa in the Gulf of Alaska. *Marine Ecology Progress Series 182: 119-126.*

Gass, S.E. (2002) An assessment of the distribution and status of seep sea corals in Atlantic Canada using both scientific and local forms of knowledge. *School for Resource and Environmental Studies. Halifax, Dalhousie University: 176.*

Gordon, D.C. Jr., Kenchington, E.L.R. and Gilkinson, K.D. (2006) A review of Maritimes Region research on the effects of mobile fishing gear on benthic habitat and communities. *Can. Sci. Advis. Sec. Res. Doc. 2006/056*

Hansson, M., Lindegarth, M., Valentinsson, D., Ulmestrand, M. (2000) Effects of prawntrawling on abundance of benthic macrofauna in Gullmarsfjorden, Sweden. *Marine Ecology Progress Series 198: 191-201.*

Hargrave, B.T., Kostylev, V.E., Hawkins, C.M. (2004) Benthic epifauna assemblages, biomass and respiration in The Gully region on the Scotian Shelf, NW Atlantic Ocean. *Marine Ecology Progress Series 270: 55-70.*

Healey, B.P. (2007) Greenland Halibut (*Reinhardtius hippoglossoides*) in NAFO Subarea 2 and divisions 3KLMNO: Stock trends based on annual Canadian Research Vessel survey results during 1978-2006. *NAFO SCR Doc. 07/45*

Healey, B.P. and Mahe, J.C. (2007) An Assessment of Greenland Halibut (*Reinhardtius hippoglossoides*) in NAFO Subarea 2 and Divisions 3KLMNO. *NAFO SCR Doc. 07/53*

Henry, L.A. and Roberts, J.M. (2007) Biodiversity and ecological composition of macrobenthos on cold-water coral mounds and adjacent off-mound habitat in the bathyal Porcupine Seabight, NE Atlantic. *Deep-Sea Research I 54: 654-672.*

Koeller, P., Covey, M. and King, M. (2007) An assessment of the Eastern Scotian Shelf prawn stock and fishery in 2006 and outlook for 2007, including estimate of bycatch and evaluation of alternative fishery independent abundance indicators. *Can. Sci. Advis. Sec. Res. Doc. 2006/090.*

Moody Marine (2008a) Certification Report for Canadian Northern Prawn Trawl Fishery Prawn Fishing Areas 5,6,7/v2

Moody Marine (2008b) Certification Report for Canadian Northern Prawn Trawl Fishery Prawn Fishing Areas 13,14,15v/2

Orr, D.C., Veitch, P.J., and Sullivan, D.J. (2006) An update on information pertaining to Northern Prawn (*pandalus borealis,* Kroyer) and Groundfish in NAFO divisions 3LNO. *NAFO SCR Doc. 06/73*

Orr, D.C., P.J. Veitch, and D.J. Sullivan. (2004) An Update of Information Pertaining to Northern Prawn (Pandalus borealis, Kroyer) And Groundfish in NAFO divisions 3LNO. *NAFO SCR Doc. 04/86*

Parsons, D.M. and Power, D. (2007) An Assessment of the Status of Redfish in NAFO division 3O. *NAFO SCR. Doc. 07/55*

Rice, J. (2006) Impacts of Moblie Bottom Gears on Seafloor Habitats, Species and Communities: A Review and Synthesis of Selected International Reviews. *Can. Sci. Advis. Sec. 2006/057*

Roberts, S. and Hirshfield, M. (2004) Deep-sea corals: Out of sight, but no longer out of mind. *Frontiers in Ecology and the Environment 2(3):123-130.*

Shelton, P.A. (2005) Does the Rebuilding Plan for Greenland Halibut in Subarea 2 and Divisions 3KLMNO have a Scientific Basis and is it on Track? *NAFO SCR Doc. 05/10*
Sparks-McConkey, P.J. and Watling, L. (2001) Effects on the ecological integrity of a soft-bottom habitat from a trawling disturbance. *Hydrobiologica 456: 73-85.*

Tanner, J.E. (2003) The influence of prawn trawling on sessile benthic assemblages in Gulf of St. Vincent, South Australia. *Can. J. Fish. Aquat. Sci. 60: 517-526.*
USDA (2007) Canada Fisheries Products, Annual 2007. *Global Agriculture Information Network (GAIN) report CA7047*

15.1 Moody Marine Assessment Team Response to EAC Recommendations

The EAC made a number of recommendations in their submission and the following represents the team's response:

Recommendation 1 - Require the completion of a full assessment on the impact of shrimp trawling on the populations of Greenland halibut, redfish and other groundfish.

The assessment team did gather information on the bycatch of groundfish species – section 6.2.2 – Performance Indicators 2.2.1, 2.2.2 and 2.2.3 specifically deal with the issue of bycatch:

- PI 2.2.1 is an 'Outcome' Performance Indicator that considers the status of the impact or the risk that the fishery poses to bycatch species;
- PI 2.2.2 is a 'Management Strategy' Performance Indicator that considers the basis, reliability and implementation of the management strategy for bycatch species; and
- PI 2.2.3 is an 'Information' Performance Indicator that considers the nature, extent, quality and reliability of the monitoring and information that is relevant to bycatch in: (i) developing and implementing the management strategy and (ii) measuring the outcomes of the strategy.

The assessment team concluded that most bycatch species are considered to be within safe limits, but several are not. A partial strategy based on use of the Nordmore grate and toggle chains is demonstrably effective, associated with very low bycatch levels that are essentially negligible in ecological terms. As a result the fishery attained scores above the 80 Scoring Guidepost for each of the aforementioned Performance Indicators. The assessment team also recognised that low bycatch levels may be partly due to current low groundfish abundance levels and some consideration of bycatch management strategies under a groundfish recovery scenario would be necessary to increase the score including moving to smaller grate spacing.

It should be noted, if it is determined that that the fishery is certified against the MSC standard the issues such as this will be reviewed at annual surveillance audits.

Recommendation 2 - Require fisheries observers to quantify coral bycatch in the shrimp fishery.

The assessment team understands that the observer programme does record coral bycatch.

Recommendation 3 - Require the completion of a field study on the impact of shrimp trawling on corals, using a grab bag behind the footgear.

The assessment team considered corals in the habitat related Performance Indicators. Deficiencies in all three habitat related Performance Indicators were identified and were combined in a single Condition of Certification - the client is required to ensure by the fourth annual audit information is compiled and assessed, a strategy developed, and measures taken, such that it can be confirmed that the fishery is highly unlikely to reduce habitat structure and function to a point where there would be serious or irreversible harm.

Recommendation 4 - Freeze the footprint of shrimp trawling on benthic habitats by not allowing the fishery to expand into new coral areas.

The assessment team set the aforementioned Condition related to habitat. It should be noted that the MSC require that Conditions follow the narrative or metric of the Performance Indicators and Scoring Guideposts and do not prescribe how the client shall achieve the Condition. On occasions however, the assessment team may provide an indication or recommendation to the client on how they may meet the Condition.

Recommendation 5 - Require the completion of a study on damage to snowcrabs during the springtime when crabs are molting.

Snowcrab does not commonly occur in the area of this fishery and it is assumed that this recommendation refers to the shrimp fishery that is conducted to the south of this fishery area.

Atlantic Canada Chapter
Sierra Club of Canada
53 Warbury Street
St. John's, Newfoundland
A1E 1N9

27 August 2009

Paul Knapman
Moody Marine Limited
28 Fleming Drive
Halifax, Nova Scotia
B3P 1A9

Dear Sir:

We write in response to your advertisement appearing in *The Telegram* August 22, 2009 re: Marine Stewardship Council Assessment, Canadian Association of Prawn Producers and the Northern Coalition, Northern and Striped Shrimp Fishery.

Our organization, the Sierra Club of Canada has a long standing policy to conserve and protect marine environments. Following from that position we consult and work with independent ocean scientists based in Canada and elsewhere, using the best scientific information available to advocate for healthy, abundant, and bio-diverse marine environments. We see these as the foundation for maintaining healthy sustainable fisheries.

Over the past few years we have worked with Dr. Richard Haedrich (deep-sea ocean habitat specialist) and Dr. Evan Edinger (cold-water corals specialist) and their teams of graduate students based at Memorial University in St. John's. Through a collaborative process they were able to identify certain Vulnerable Marine Ecosystems(VMEs) situated along the eastern edge of the North-west Atlantic Continental Shelf. These VMEs contain high concentrations of cold-water corals and from historical data have been identified as areas of abundance and bio-diversity for both commercial and non-commercial species.

Protection for these areas, ie. no human activity aside from baseline scientific monitoring would permit rejuvenation and restoration of abundance and bio-diversity. Elsewhere in the planet's oceans such protections have often led to significant recoveries resulting in upwellings of species into other areas of the shelf and restoration of migration patterns for mobile fish stocks.

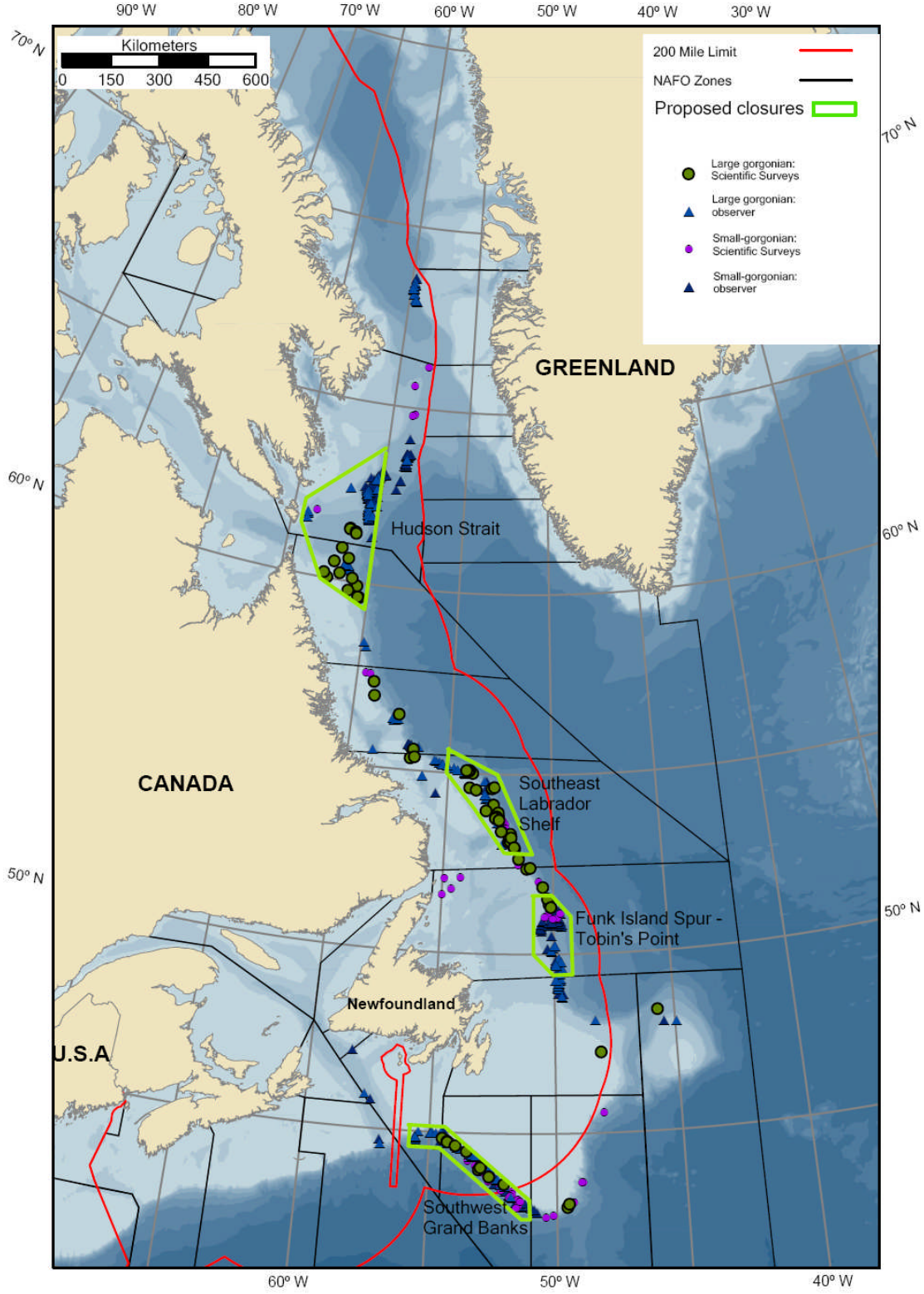
The Sierra Club would like to see similar recovery occur off Labrador and Newfoundland. We recommend that the areas identified through the scientific research be closed. Small, specific, well known and recognized shrimp trawling areas outside the aforementioned zones should be set aside for shrimp trawling. These can be identified from examining fishing log books and fisheries observer records and should be much easier to manage. Fishing technologies other than mid-water trawling should be investigated for fishing shrimp as in some areas of the North-west Atlantic using traps or pots to catch shrimp has enjoyed some success.

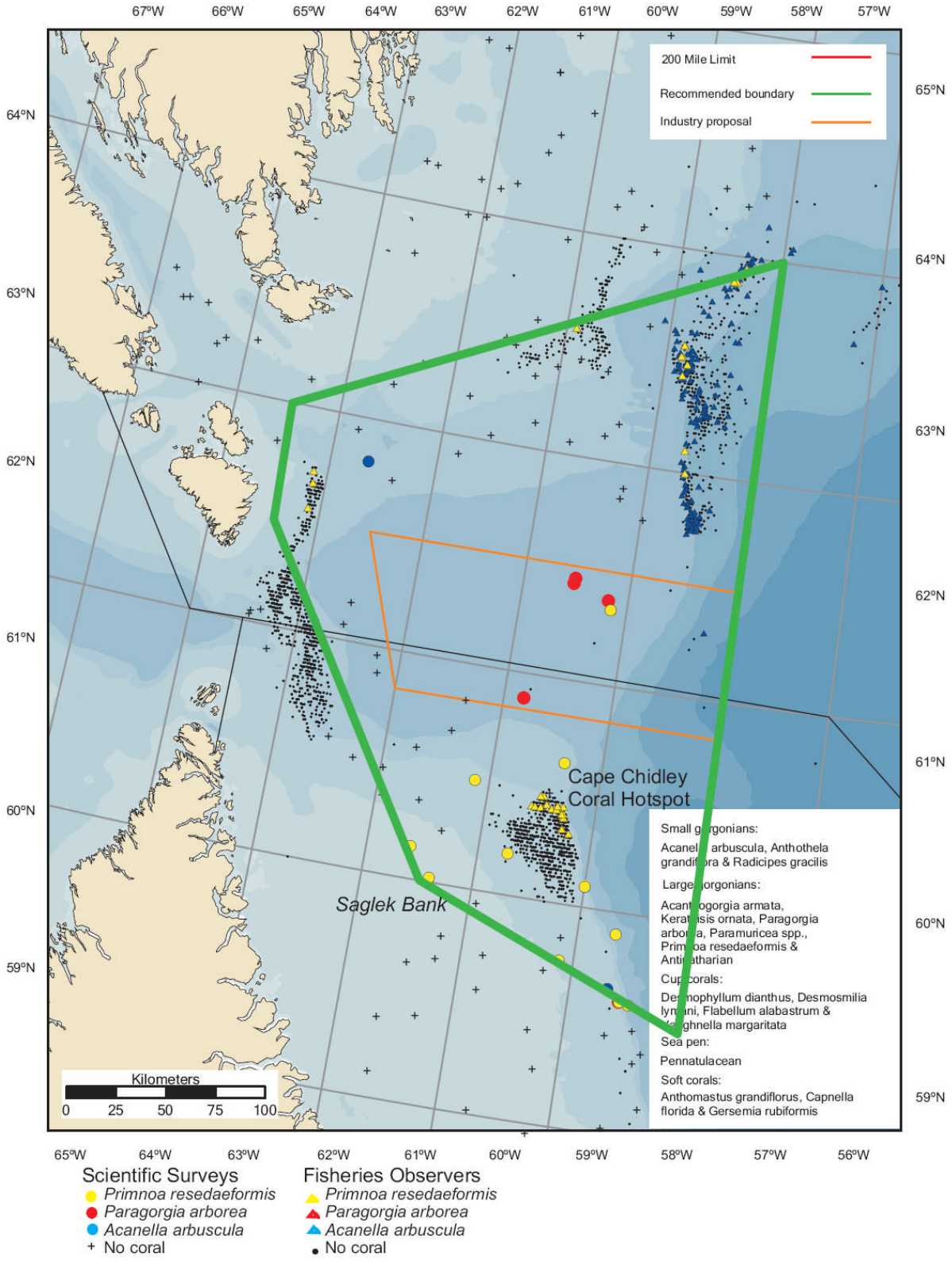
Please find attached maps outlining areas identified as being Vulnerable Marine Ecosystems. If you wish further supporting data please feel free to contact myself or Gretchen Fitzgerald, Director , Atlantic Canada Chapter, Sierra Club Canada, Halifax, Nova Scotia; tel. 1-902- 444-3113.

Sincerely

Fred Winsor PhD. (Northwest Atlantic fisheries history)
St. John's, Newfoundland

Proposed closures to protect Vulnerable Marine Ecosystems: Deep-sea Corals in the Newfoundland and Labrador Region

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61°N
60°N
59°N
65°N
200 Mile Limit
Recommended boundary
Industry proposal
Cape Chidley
Coral Hotspot
Saglek Bank
Small gorgonians:
Acanella arbuscula, Anthothela grandiflora & Radicipes gracilis
Large gorgonians:
Acanthogorgia armata, Keratoisis ornata, Paragorgia arborea, Paramuricea spp., Primnoa resedaeformis & Antipatharian
Cup corals:
Desmophyllum dianthus, Desmosmilia lymani, Flabellum alabastrum & Caryophyllia margaritata
Sea pen:
Pennatulacean
Soft corals:
Anthomastus grandiflorus, Capnella florida & Gersemia rubiformis
Kilometers
0 25 50 75 100
65°W
64°W
63°W
62°W
61°W
60°W
59°W
58°W
57°W
56°W
Scientific Surveys
Primnoa resedaeformis
Paragorgia arborea
Acanella arbuscula
No coral
Fisheries Observers
Primnoa resedaeformis
Paragorgia arborea
Acanella arbuscula
No coral

15.2 Moody Marine Assessment Team Response to the Sierra Club of Canada Recommendations

In their submission the Sierra Club recommend that, "*...the areas identified through the scientific research* [concentrations of cold water corals] *be closed. Small, specific, well known and recognized shrimp trawling areas outside the aforementioned zones should be set aside for shrimp trawling. These can be identified from examining fishing log books and fisheries observer records and should be much easier to manage. Fishing technologies other than mid-water trawling should be investigated for fishing shrimp as in some areas of the North-west Atlantic using traps or pots to catch shrimp has enjoyed some success.*"

The assessment team considered cold water corals under the three Performance Indicators associated with habitat:

- PI 2.4.1 is an 'Outcome' Performance Indicator that considers the status of the impact or the risk that the fishery poses to habitat;
- PI 2.4.2 is a 'Management Strategy' Performance Indicator that considers the basis, reliability and implementation of the management strategy for habitat; and
- PI 2.4.3 is an 'Information' Performance Indicator that considers the nature, extent, quality and reliability of the monitoring and information that is relevant to habitat in: (i) developing and implementing the management strategy and (ii) measuring the outcomes of the strategy.

All three Indicators were scored below 80. As a result the assessment team set a single Condition that covers each of the scoring issues that were considered to be deficient. This Condition requires the client to ensure by the fourth annual audit information is compiled and assessed, a strategy developed, and measures taken, such that it can be confirmed that the fishery is highly unlikely to reduce habitat structure and function to a point where there would be serious or irreversible harm.

APPENDIX E

Registered companies / vessels within Unit of Certification: eligible to sell MSC certified product

Licence Holder (No. of Licences)	Vessel	Vessel Owner
Labrador Fishermen's Union Shrimp Co. Ltd. (2)	Labrador Storm	Labrador Fishermen's Union Shrimp Co. Ltd.
Ocean Choice Intl. Inc. (2)	Newfoundland Lynx/ Katsheshuk II	Ocean Choice International Inc.
Mersey Seafoods Ltd. (2)	Mersey Venture Mersey Phoenix	Mersey Seafoods Ltd.
Lameque Offshore Ltd. (1)	Northern Eagle	M.V. Osprey Ltd.
Crevettes Nordiques Ltee[6] (1)	Atlantic Enterprise	Clearwater Seafoods L. P.
Atlantic Shrimp Co. Ltd. [7] (1)	Atlantic Enterprise Arctic Endurance	Clearwater/Ocean Prawns Canada Joint Venture
Torngat Fish Producers Coop Society Ltd. (1)	Mersey Phoenix Mersey Venture	Mersey Seafoods Ltd.
Caramer Ltd. (1)	Acadienne Gale II	Davis Strait Mgt. Ltd.
Makivik Corp. (1)	Newfound Pioneer	Newfoundland Resources Ltd.
Pikalujak Fisheries Ltd. (1)	Ocean Prawns	Ocean Prawns Canada Ltd.
Qikiqtaaluk Corporation (1)	Saputi	Qikiqtaaluk Corporation
Harbour Grace Shrimp Co. (1)	Ocean Prawns	Ocean Prawns Canada Ltd.
Unaaq Fisheries Inc. (1)	Arctic Endurance	Clearwater Seafoods L. P.
Newfound Resources Ltd. (1)	Newfound Pioneer	Newfound Resources Ltd.,

[6] Wholly owned subsidiary of Clearwater Seafoods Limited Partnership
[7] Ibid