MOODY MARINE LTD

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Public Comment Draft Report for

EASTERN CANADA OFFSHORE SCALLOP FISHERY

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CONTENTS

TABLES

FIGURES

PHOTOS

1 INTRODUCTION

This report sets out the results of the assessment of the Eastern Canada Offshore Scallop Fishery against the Marine Stewardship Council (MSC) Principles and Criteria for Sustainable Fishing.

1.1 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) and management framework." The fishery proposed for certification is therefore defined as:

Species:	Scallop (*Placopecten magellanicus*)
Geographical Area:	St Pierre Bank (Scallop Fishing Areas 10, 11, & 12) The Eastern Scotian Shelf (Scallop Fishing Area 25) Browns and German Bank (Scallop Fishing Area 26) Georges Bank (Scallop Fishing Area 27)
Method of Capture:	New Bedford scallop rakes / dredge
Stock:	The "Eastern Canada Offshore Sea Scallop Fishery" in Scallop Fishing Areas 10, 11, 12, 25, 26 & 27.
Management System:	Department of Fisheries and Oceans (DFO) led management, through their Maritime Region.
Client Group:	Successful certification of the fishery will apply to the following companies and their vessels: • Adams and Knickle Limited • Clearwater Seafoods Limited Partnership • Comeau's Sea Foods Limited • LaHave Seafoods Limited • Ocean Choice International Limited Partnership

The Seafood Producers Association of Nova Scotia (SPANS) is acting as coordinator for the five companies. In the course of the certification it is possible that further clients 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.

1.2 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 scallops (*Placopecten magellanicus*) are 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 Conditions and Recommendations.

Once the client has agreed the client draft report it will be subject to critical review by appropriate, independent, scientists ('peer review'). The comments of these scientists will be appended to this report. The response of the assessment team will also be appended.

The report will then be posted on the MSC website for 30 days allowing for stakeholder comment. The comments that are received will be appended to the report along with the response of the assessment team. The report and the certification recommendation are 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 a further 21 days for stakeholder scrutiny.

1.3 Information sources used

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

- The client group;
- The fishing industry;
- The Department of Fisheries and Oceans (DFO); and
- Environmental Non Government Organisations

Other information sources

Published information and unpublished reports used during the assessment are listed below as direct references (list A) and background source material (list B):

A. Literature cited

Anderson, J.T., J.E. Simon, D.C. Gordon Jr. and P.C. Hurley. 2005. Linking fisheries to benthic habitat at multiple scales: eastern Scotian Shelf haddock. American Fisheries Society Symposium 41: 251-264.

Aoyama, S., 1989. The Mutsu Bay scallop fisheries: scallop culture, stock enhancement, and resource management. In: J.F. Caddy (Editor), Marine invertebrates fisheries: Their assessment and management, John Wiley & Sons. Inc., pp. 525-539.

Bakus, R.H. (ed.). 1987. Georges Bank. MIT Press, 593 p.

Barbeau, M.A., R.E. Scheibling, B.G. Hatcher, L.H. Taylor and A.W. Hennigar. 1994. Survival analysis of tethered juvenile sea scallops *Placopecten megellanicus* in field experiments: effects of predators, scallop size and density, site and season. Mar. Ecol. Prog. Ser. 115: 243-256.

Barnes, P.W. and J.P. Thomas (eds.). 2005. Benthic habitats and the effects of fishing. American Fisheries Society Symposium 41, 890 p.

Beaumont, A.R. and Zouros, E. 1991 Genetics of scallops. IN: Scallops: Biology, Ecology and Aquaculture, S.E. Shumway editor. Elsevier, New York: 585-623.

Black, G.A.P., R.K. Mohn, G. Robert, and M.J. Tremblay. 1993. Atlas of the biology and distribution of the sea scallop *Placopecten magellanicus* and Iceland scallop *Chlamys islandica* in the Northwest Atlantic. Can. Tech. Rep. Fish. Aquat. Sci. No 1915.

Bourne, N. 1964. Scallops and the offshore fishery of the Maritimes. Bull. Fish. Res. Bd. Canada, No. 145; 60p.

Bourne, N. 1965. Relative efficiency of catches by 4- and 5-inch rings on offshore scallop drags. J. Fish. Res. Bd. Canada, Vol 22(2), pp 313-333.

Bousfield,E.L., 1960. Canadian Atlantic Sea Shells. Department of Northern Affairs and National Resources, National Museum of Canada Ottawa.

Bradshaw. C., L.O. Veale and A.R. Brand. 2002. The role of scallop-dredge disturbance in long-term changes in Irish Sea benthic communities: a re-analysis of an historical dataset. Journal of Sea Research 47: 161-184.

Breeze, H., D.G. Fenton, R.J. Rutherford and M.A. Silva. 2002. The Scotian Shelf: and ecological overview for ocean planning. Can. Tech. Rept. Fish. Aquat. Sci. 2393.

Brown, B.E., M. Parrack, and D.D. Flescher. 1972. Review of the current status of the scallop fishery in ICNAF division 5Z. Int. Comm. Northw. Atl. Fish. (ICNAF) Res. Doc. 72/113: 1-13

Caddy, J.F., 1973. Underwater observations on tracks of dredges and trawls and some effects of dredging on a scallop ground. J. Fish. Res. Bd. Canada, 30: 173-180.

Caddy, J.F. 1975. Spatial model for an exploited population, and its application to the Georges Bank scallop fishery. J. Fish. Res. Bd. Canada, 32 (8): 1305-1328.

Caddy, J.F., 1978. Underwater observation on scallop *Placopecten magellanicus* behaviour and drag efficiency. J. Fish. Res. Board Can. 25: 2123-2141.

Caddy, J.F. 1989. A perspective on the population dynamics and assessment of scallop fisheries, with special reference to the sea scallop *Placopecten magellanicus* Gmelin. In: J.F. Caddy (Editor), Marine Invertebrate Fisheries: their Assessment and Management, John Wiley & Sons, pp. 559-574.

Caddy, J.F. and Gulland, J.A. 1983. Historical patterns of fish stocks. Mar. Pol., Oct. 1983: 267-278.

Chuenpagdee, R., L.E. Morgan, S.M. Maxwell, E.A. Norse and D. Pauly. 2003. Shifting gears: assessing collateral impacts of fishing methods in US waters. Frontiers in Ecology and Environment 1: 517-524.

Clearwater 2008. Bycatch avoidance protocol

Collie, J.S., J.M. Hermsen, P.C. Valentine and F.P. Almeida. 2005. Effects of fishing on gravel habitats: assessment and recovery of benthic megafauna on Georges Bank. American Fisheries Society Symposium 41: 325-343.

Cranford, P.J. and D.C. Gordon, Jr. 1992. The influence of dilute clay suspensions on sea scallop (*Placopecten magellanicus*) feeding activity and tissue growth. Neth. J. Sea Res. 30: 107-120.

Cranford, P.J., D.C. Gordon Jr., C.G. Hannah, J.W. Loder, T.G. Milligan, D.K. Muschenheim and V. Shen. 2003. Modelling the potential effects of petroleum exploration drilling on northeastern Georges Bank scallop stocks. Ecological Modelling 166: 19-39.

Currie, D.R. and G.D. Parry. 1999. Impacts and efficiency of scallop dredging on different soft substrates. Can. J. Fish. Aquat. Sci. 56: 539-550.

DFO. 2000. Scotia-Fundy Offshore Scallop Integrated Fisheries Management Plan Maritimes Region.

DFO. 2002. Proceedings of a benthic habitat classification workshop; a framework for the conservation of benthic communities of the Scotian-Fundy area of the Maritimes Region. Canadian Science Advisory Secretariat Proceedings Series 2002/023.

DFO. 2003. State of the eastern Scotian Shelf ecosystem. Maritimes Region Ecosystem Status Report 2003/004.

DFO. 2004a. Proceedings of a benthic habitat classification workshop; benthic classification and usage guidelines for the Scotia-Fundy area of the Maritimes Region. Canadian Science Advisory Secretariat Proceedings Series 2004/004.

DFO. 2004b. Workshop on the maintenance of the diversity of ecosystem types: benthic community distributions of the Scotia-Fundy Area. Canadian Science Advisory Secretariat Proceedings Series 2004/048.

DFO. 2004c. Identification of ecologically and biologically significant areas. National Capital Region Ecosystem Status Report 2004/006.

DFO. 2005. Framework for classification and characterization of Scotia-Fundy benthic habitats. Canadian Science Advisory Secretariat Science Advisory Report 2005/071.

DFO. 2006a. Haddock on the southern Scotian Shelf and in the Bay of Fundy (Div. 4X/5Y). Canadian Science Advisory Secretariat Science Advisory Report 2006/047.

DFO. 2006b. Cod on the southern Scotian Shelf and in the Bay of Fundy (Div. 4X/5Y). Canadian Science Advisory Secretariat Science Advisory Report 2006/046.

DFO. 2006c. Impacts of trawl gears and scallop dredges on benthic habitats, populations and communities. Canadian Science Advisory Secretariat Science Advisory Report 2006/025.

DFO. 2006d. Science expert opinion on scallop fishery area/time closure – 2006. Maritimes Region Expert Opinion 2006/05.

DFO. 2006e, Assessment of Georges Bank Scallops (*Placopecten magellanicus*). DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2006/032.

DFO. 2006f, 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. Eastern Scotian Shelf Integrated Ocean Management Plan. Oceans and Habitat Branch, BIO.

DFO. 2007b. Scallop fishery area/time closure to reduce yellowtail flounder bycatch on Georges Bank in 2007. Canadian Science Advisory Secretariat Science Response 2007/001.

DFO. 2008a. Review of scallop gear modification report. Canadian Science Advisory Secretariat Science Response 2008/014.

DFO. 2008b. Recovery potential assessment for cusk (*Brosme brosme*). Canadian Science Advisory Secretariat Science Advisory Report 2008/024.

DFO. 2008c. Assessment of Georges Bank scallops (*Placopecten magellanicus*). Canadian Science Advisory Secretariat Science Advisory Report 2008/045.

DiBacco, C., G. Robert and J. Grant. 1995. Reproductive cycle of the sea scallop, *Placopecten magellanicus* (Gmelin, 1791) on northeastern Georges Bank. J. Shellfish Res. 14: 59-69.

Dickie, L.M. and P.C. Smith. 1989. Fisheries Ecology Program (FEP): general introduction. Can. J. Fish. Aquat. Sci. 46: 538.

Doherty, P. and T. Horsman. 2007. Ecologically and biologically significant areas of the Scotian Shelf and environs: a compilation of scientific expert opinion. Can. Tech. Rept. Fish. Aquat. Sci. 2774.

DuPaul W.D. and D.B. Rudders. 2007. An assessment of sea scallop distribution and abundance in the Georges Bank closed area II – preliminary results. VIMS Marine Resources Report No 2007-3.

Duplisea, D.E., S. Jennings, K.J. Warr and T.A. Dinmore. 2002. A size-based model of the impact of bottom trawling on benthic community structure. Can. J. Fish. Aquat. Sci. 59:1785-1795.

Fisher, J.A.D. and K.T. Frank. 2002. Changes in finfish community structure associated with an offshore fishery closed area on the Scotian Shelf. Mar. Ecol. Prog. Ser. 240: 249-265.

Foltz, D.W. and Zouros, E., 1984 Enzyme heterozygosity in the scallop *Placopecten magellanicus* (Gmelin) in relation to age and size. Marine Biological Letters 5:255-263.

Frank, K.T., N.L. Shackell and J.E. Simon. 2000. An evaluation of the Emerald/Western Bank juvenile haddock closed area. ICES J. Mar. Sci. 57: 1023-1034.

Fuller, S.D., C. Picco, J. Ford, C.-F. Tsao, L.E. Morgan, D. Hangaard and R, Chuenagdee. 2008. How we fish matters: addressing the ecological impacts of Canadian fishing gear. Ecology Action Centre, Living Oceans Society and Marine Conservation Biology Institute.

Gavaris, S., G. Robert and L. Van Eeckhaute. 2007. Discards of Atlantic cod, haddock and yellowtail flounder from the 2005 and 2006 Canadian scallop fishery on Georges Bank. Transboundary Resource Assessment Committee Reference Document 2007/03.

Gavaris, S., J.M. Porter, R.L. Stephenson, G. Robert and D.S. Pezzack. 2005. Review of management plan conservation strategies for Canadian fisheries on Georges Bank: a test of a practical ecosystem-based framework. ICES CM 2005/BB:05.

Gilkinson, K.D., G.B.J. Fader, D.C. Gordon Jr., R. Charron, D.L. McKeown, D. Roddick, E.L.R. Kenchington, K.G. MacIsaac, C. Bourbonnais, W.P. Vass and Q. Liu. 2003. Immediate and longer-term impacts of hydraulic clam dredging on an offshore sandy seabed: effects on physical habitat and processes of recovery. Continental Shelf Research 23: 1315-1336.

Gordon, D.C. Jr. and E.L.R. Kenchington. 2007. Deep-water corals in Atlantic Canada: a review of DFO research (2001-2003). Proc. N.S. Inst. Sci. 44: 27-50.

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.

Gordon, D.C. Jr., K.D. Gilkinson, E.L.R. Kenchington, C. Bourbonnais, K.G. MacIsaac, D.L. McKeown, and W.P. Vass. 2005. Summary of the Grand Banks otter trawling experiment (1993-1995): effects on benthic habitat and communities. American Fisheries Society Symposium 41: 411-424.

Gordon, D.C., 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. National Review and Advisory Meeting on a Science Basis for Policy and Management Plans for Addressing Impacts of Otter Trawls and Bivalve Dredges on Benthic Habitats and Communities. DFO Can. Sci. Advis. Sec. Res. Doc. 2006/056: ii + 41 p.

Goudey, C., M. Pol, O. Free, L. Williams and P. Tasha. 2006. Sea scallop harvest using flow control. ICES Symposium on Fishing Technology in the 21st Century: integrating fishing and ecosystem conservation.

Henry, L.-A. and E.L.R. .Kenchington. 2004. Differences between epilithic and epizoic hydroid assemblages from commerical scallop grounds in the Bay of Fundy, northwest Atlantic. Mar. Ecol. Prog. Ser. 266: 123-134.

Hermsen, J. M., J.S. Collie and P.C. Valentine. 2003. Mobile fishing gear reduces benthic megafauna production on Georges Bank. Mar. Ecol. Prog. Ser. 260: 97-108.

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

Kenchington, E.L., M. Patwary, E. Zouros and C.J. Bird. 2006. Genetic differentiation in relation to marine landscape in a broadcast spawning bivalve mollusc (*Placopecten magellanicus*). Mol. Ecol. 15: 1781-1796.

Kenchington, E.L., T.J. Kenchington, L.-A. Henry, S. Fuller and P. Gonzalez. 2007. Multi-decadal changes in the megabenthos of the Bay of Fundy: the effects of fishing. J. Sea Res. 58: 220-240.

Kostylev, V. and C.G. Hannah. 2007. Process-driven characterization and mapping of seabed habitats. In Todd, B.J. and H.G. Greene (eds.) Mapping the seafloor for habitat characterization. Geological Association of Canada Special Publication 47, pp-.171-184.

Kostylev, V. E., B.J. Todd, O. Longva and P.C. Valentine. 2005. Characterization of benthic habitats on northeastern Georges Bank, Canada. American Fisheries Society Symposium 41: 141-152.

Kostylev, V.E., B.J. Todd, G.B.J. Fader, R.C. Courtney, G.D.M. Cameron and R.A. Pickrill. 2001. Benthic habitat mapping on the Scotian Shelf based on multibeam bathymetry, surficial geology and sea floor photographs. Mar. Ecol. Prog. Ser. 219: 121-137.

Kostylev, V.E., RW.C. Courtney, G. Robert and B.J. Todd. 2003. Stock evaluation of giant scallop (*Placopecten megallanicus*) using high-resolution acoustics for seabed mapping. Fish. Res. 60: 479-492.

Larsen,P.F., and Lee, R.M., 1978. Observations on the abundance, distribution and growth of post larval sea scallop Placopecten magellanicus, on Georges Bank. Nautilus 92: 112-116.

Lindholm, J.B., P.J. Auster and L.S. Kaufman. 1999. Habitat-mediated survivorship of juvenile (0-year) Atlantic cod *Gadus morhua*. Mar. Ecol. Prog. Ser. 180: 247-255.

Lindholm, J.B., P. Auster and P.C. Valentine 2004. Role of a large marine protected area for conserving landscape attributes of sand habitats on Georges Bank (NW Atlantic). Mar. Ecol. Prog. Ser. 269: 61-68.

Linehan, J. 2004. Annotated bibliography of habitat associations of juvenile demersal fish in offshore shelf waters from Newfoundland, the Gulf of St. Lawrence and the Maritimes Region. Can. Tech. Rept. Fish. Aquat. Sci. No. 2526.

Løkkeborg, S. 2005. Impacts of trawling and scallop dredging on benthic habitats and communities. FAO Fisheries Technical Paper 472, 59 p.

Lough, R.G., P.C. Valentine, P.C. Potter, P.J. Auditore, G.R. Bolty, J.D. Neilson and R.I. Perry. 1989. Ecology and distribution of juvenile cod and haddock in relation to sediment type and bottom currents on eastern Georges Bank. Mar. Ecol. Prog. Ser. 56: 1-12.

McGarvey, R., F.M. Serchuk, I.A. McLaren. 1993. Spatial and parent-age analysis of stock-recruitment in the Georges Bank sea scallop (*Placopecten magellanicus*) population, Can. Journ. Fish. Aquat. Sci.,50: 564-574.

McIntyre, T.M., R. Cunningham, G. Robert and R. Branton. 2006. Gear trial experiment to reduce groundfish bycatch in the offshore scallop fishery on Georges Bank. Can. M.S. Rep. Fish. Aquat.

Sci. No 2745; 37p.

Medcof, J.C. and Bourne, N. 1964. Causes of mortality of the sea scallop (*Placopecten magellanicus*) proceedings of the National Shellfisheries Association. 53:33-50.

Merrick, R. and H. Haas. 2008. Analysis of Atlantic sea scallop (*Placopecten magellanicus*) fishery impacts on the North Atlantic population of loggerhead sea turtles (*Caretta caretta*). NOAA Tech Memo NMFS NE 207.

Merrill, A.S. and J.A. Posgay. 1964. Estimating the natural mortality rate of sea scallops. Res. Bull. Int. Comm. N.W. Atlantic Fish. 1:88-106.

Murawski, S.A. and F.M. Serchuk. 1989. Environmental effects of offshore dredge fisheries for bivalves. ICES C.M. 1989/K:27.

Naidu, K.S. 1970. Reproduction and breeding cycle of the giant scallop *Placopecten magellanicus* Gmelin in Port au Port Bay, Newfoundland. Can. J. Zool. 48: pp pp 1003-1012.

Naidu, K.S., and G. Robert. 2006. Fisheries sea scallop, *Placopecten magellanicus*. Pgs. 869-905 in S. Shumway and J. Parsons (eds.), Scallops: Biology, Ecology and Aquaculture, 2nd ed. Elsevier.

Pickrill, R.A. and B.J. Todd. 2000. The multiple roles of acoustic mapping in integrated ocean management, Scotian Shelf, Canada. In B. Cicin-Sain and E. Rivera-Arriaga (eds.) Proceedings of the International Conference on Coastal and Ocean Space Utilization, Vol.1, pp. 109-113.

Pilditch, C.A. & J. Grant (1999). The effects of variations in flow velocity and phytoplankton concentration on sea scallop (*Placopecten magellanics*) grazing rates. J. Exp. Mar. Biol. Ecol. 240: 111-136

Rago, P.J., S.E.Wigley and M.J. Fogarty. 2005. NEFSC bycatch estimation methodology: allocation, precision and accuracy. NEFSC Ref Doc. 05-09; 44 p.

Repetto, R. 2001.The Atlantic Sea Scallop Fishery in the US and Canada: A Natural Experiment in Fisheries Management Regimes. Yale School of Forestry & Environmental Studies. Mar. Policy 25: 251-264.

Robert, G., Black, G.A.P., Butler, M.A.E., and Smith, S.J.. 2000. Georges Bank Scallop Stock Assessment. DFO Stock Assess. Sec. Res. Doc 2000/016.

Robert, G., M.J. Lundy and M.A.E. Butler-Connolly. 1986. Scallop fishing grounds on the Scotia Shelf. CAFSAC Res. Doc. 86/41; 43p.

Robinson, S.M.C., S. Bernier and A. MacIntyre. 2001. The impact of scallop drags on sea urchin populations and benthos in the Bay of Fundy, Canada. Hydrobiologia 465:103-114.

Shepard, S, C.A Goudey, A. Read and M.J. Kaiser. 2009. Hydrodredge: reducing the negative impacts of scallop dredging. Fish. Res. 95:206-209.

Shumway, S.E., R. Selvin, and D.F. Schick. 1987. Food resources related to habitat in the scallop *Placopecten magellanicus* (Gmelin, 1791): a qualitative study. J. Shellfish Res. 6: 89-95.

Sinclair, M., R.K. Mohn, G. Robert, and D.L. Roddick. 1985. Considerations for the effective management of Atlantic scallops. Can. Tech. Rep. Fish. Aquat. Sci. 1382; 113p.

Smith, S.J., J. Black, B.J. Todd, V. E. Kostylev and M.J. Lundy. (submitted). The impact of commercial fishing on the determination of habitat associations of sea scallops. ICES J. Mar. Sci.

Smolowitz, R., W. DuPaul and R. Enoksen. 2006. Turtle-excluder dredge for the sea scallop fishery. Performance Report No. 2. National Marine Fisheries Service, Northeast Region Office,

Gloucester, MA.

Stevens, G., G. Robert, L. Burke, E. Poullioux, D. Roussel, J.R. Wilson. 2008. The evolution of management in Canada's offshore scallop fishery. In: Case Studies on Fisheries Self-governance. FAO Technical Paper 504.

Stewart, P.L. and S.H. Arnold. 1994. Environmental requirements of the sea scallop (*Placopecten magellanicus*) in eastern Canada and its response to human impacts. Can. Tech. Rept. Fish. Aquat. Sci. 2005.

Stokesbury, K.D.E. 2000. Physical and biological variables influencing the spatial distribution of the giant scallop *Placopecten magellanicus*. Special Publication 14, Alaska Department of Fish and Game, pp. 13-19.

Stokesbury, K.D.E. and B.P. Harris. 2006. Impact of limited short-term sea scallop fishery on epibenthic community of Georges Bank closed areas. Mar. Ecol. Prog. Ser. 307: 85-100.

Stokesbury, K.D.E. and J.H. Himmelman. 1995. Biological and physical variables associated with aggregations of the giant scallop Placopecten magellanicus. Can. J. Fish. Aquat. Sci. 52:743 - 753.

Thouzeau, G., G. Robert and R. Ugarte. 1991. Faunal assemblages of benthic magainvertebrates inhabiting sea scallop grounds from eastern Georges Bank, in relation to environmental factors. Mar. Ecol. Prog. Ser. 74: 61-82.

TRAC 2008a. Eastern Georges Bank haddock. Transboundary Resources Assessment Committee Status Report 2008/02.

TRAC 2008b. Eastern Georges Bank cod. Transboundary Resources Assessment Committee Status Report 2008/01.

TRAC 2008c. Georges Bank yellowtail flounder. Transboundary Resources Assessment Committee Status Report 2008/03.

Tremblay, M.J. and Sinclair, M.M., 1992. Planktonic sea scallop larvae (*Placopecten magellanicus*) in the Georges Bank region: broadscale distribution in relation to physical oceanography. Can. J. Fish. Aquat. Sci., 49: 1597-1615.

Tremblay, M.J., W. Loder, F.E. Werner, C.E. Naimie, F.H. Page and M.N. Sinclair. 1994. Drift of sea scallop larvae *Placopecten magellanicus* on Georges Bank: a model study of roles of mean advection, larval behaviour and larval origin. Deep Sea Research Part II: Topical Studies in Oceanography, 41(1), pp 7-49.

Wallace, G.T. and E.F. Braasch. 1997. Proceedings of the Gulf of Maine Ecosystem Dynamics Scientific Symposium and Workshop. Regional Association for Research on the Gulf of Maine Report 97-1.

Walsh, S.J. 2008. A review of current studies on scallop rake modifications to reduce groundfish bycatch in the Canadian offshore scallop fishery on Georges Bank. Canadian Science Advisory Secretariat Research Document 2008/050.

Zwanenburg, K.C.T., D. Bowen, A. Bundy, K. Drinkwater, K. Frank, R.O'Boyle, D. Sameoto and M. Sinclair. 2002. Decadal changes in the Scotian Shelf ecosystem. In K. Sherman and H.R. Skjoldal (eds.) Large marine ecosystems of the North Atlantic, pp.105-150.

Zwanenburg, K.C.T., A. Bundy, P. Strain, W.D. Bowen, H. Breeze, S.E. Campana, E. Head, D. Gordon and B. Petrie. 2006. Implications of ecosystem dynamics for intergrated management of the Eastern Scotian Shelf. Can. Tech. Rept. of Fish and Aquat. Sci. 2652.

2 GLOSSARY OF ACRONYMS AND ABBREVIATIONS USED IN THE REPORT

CPUE	Catch Per Unit Effort
DFO	Department of Fisheries and Oceans or Fisheries and Oceans Canada
EA	Enterprise Allocation
EEZ	Exclusive Economic Zone
FAO	Food and Agriculture Organisation
F_{max}	The rate of fishing mortality for a given exploitation pattern rate of growth and natural mortality, that results in the maximum level of yield per recruit. This is the point that defines growth overfishing.
FRCC	Fisheries Resource Conservation Council
IFMP	Integrated Fisheries Management Plan
MSC	Marine Stewardship Council
MSY	Maximum Sustainable Yield
NAFO	Northwest Atlantic Fisheries Organisation
OSAC	Offshore Scallop Advisory Committee
PI	Performance Indicator
SAR	Scientific Advisory Report
SFA	Scallop Fishing Area
SG	Scoring Guidepost
SPA	Sequential Population Analysis
TAB	Technical Advisory Board (for the MSC)
TAC	Total Allowable Catch
TRAC	Transboundary Resource Assessment Committee
VDC	Virtual Data Centre
VMS	Vessels Monitoring System

3 BACKGROUND TO THE FISHERY

3.1 Introduction

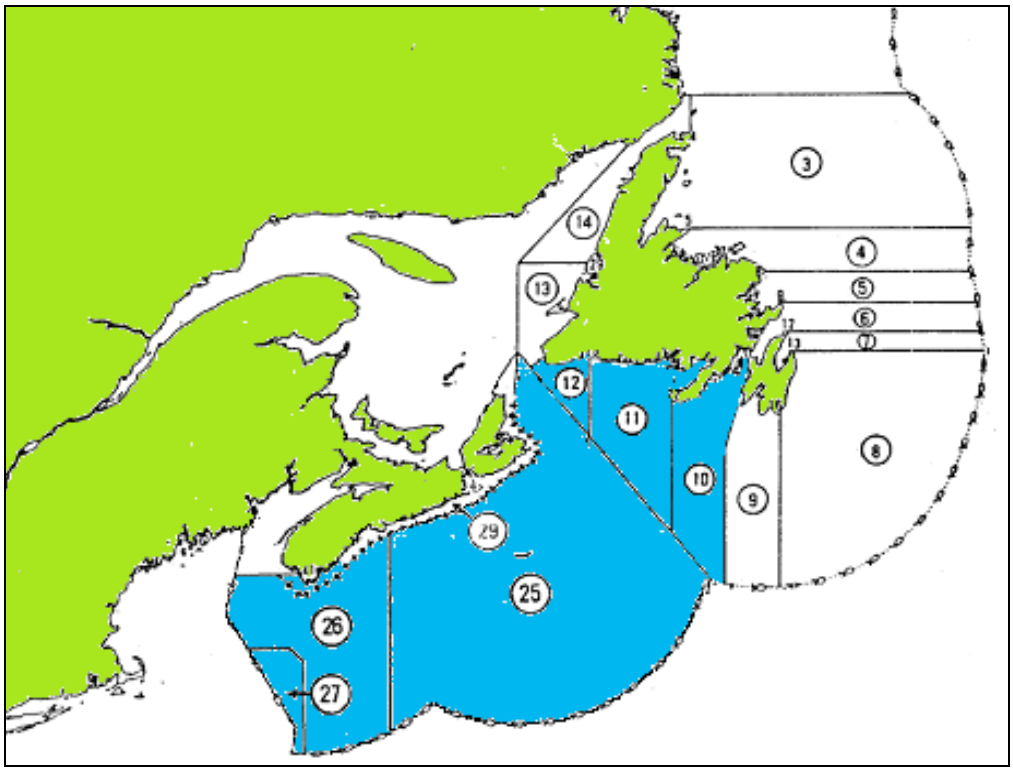
The offshore scallop fishery of Atlantic Canada is managed through the use of geographical zones called Scallop Fishing Areas (SFA) ranging from north east Newfoundland to Georges Bank off south west Nova Scotia. The offshore scallop fishery occurs entirely within Canada's 200 mile limit and is managed by federal legislation, policies and practices. Scientific and management advice is provided by staff of the Department of Fisheries and Oceans (DFO). The association of scallop beds with the offshore 'Banks' provides the basis for a geographical demarcation of the stocks. The fishery is focused on George's Bank (SFA 27), Browns and German Banks (SFA 26), the Eastern Scotian Shelf (SFA 25), and St. Pierre Bank (SFA 10, 11, 12). Figure 1 shows the scallop fishing areas and Figure 2 shows the concentration of scallop fishing on the beds.

3.2 Biology of the target species

An excellent review of the sea scallop was prepared by Stewart and Arnold (1994). The scallop (*Placopecten magellanicus*) is found in the North Atlantic between Cape Hatteras and Labrador. It is found from just below tide level to depths of 100 m or more. Offshore commercial fisheries focus on banks found on the continental shelf which have depths less than 100 m. In Canadian waters these are Georges, Browns, German, Western, Sable Island, Banquereau and St. Pierre Banks. Scallops in the northern parts of the range tend to occur shallower because of temperature.

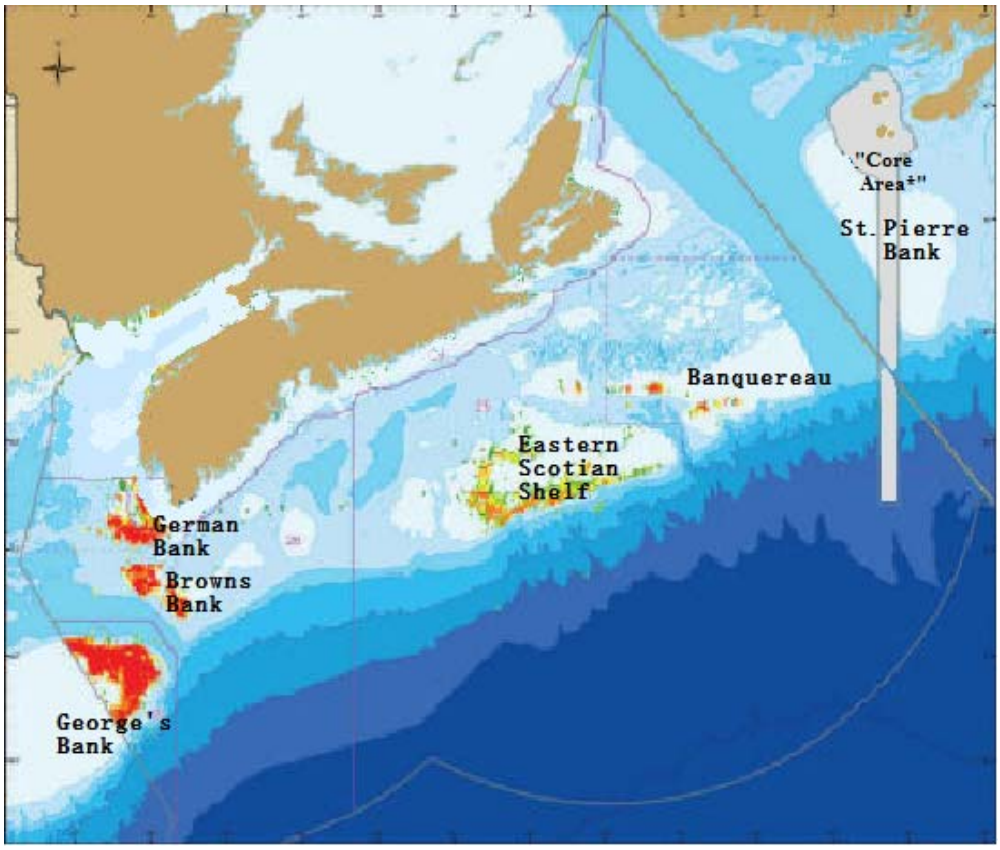
Scallops are highly clumped (i.e. contagious) in their spatial distribution and occur most abundantly on gravel bottoms. Localized, dense aggregations are referred to as beds. Some beds occur sporadically while others are essentially permanent. More permanent beds appear to be in areas with suitable larval supply, temperature, current, food availability and substrate. Not all gravel bottoms support high densities of scallops.

Figure 1. Department of Fisheries and Oceans (DFO) Scallop Fishing Areas (SFA). The blue shaded areas represent the SFAs under assessment.



Source: DFO

Figure 2. Shows the offshore areas where fishing for scallops was concentrated between 1999 and 2003 (except for St Pierre Bank). The red shading indicates the areas where the highest landings were taken. *The "core area" indicates French Maritime Waters.



Source: adapted from http://www.mar.dfo-mpo.gc.ca/oceans/e/essim/atlas/fisheries-e.html#FMA

Scallops may reach sexual maturity as early as Age 2 and sex can be differentiated by their gonads, as the female gonad is red in colour and the male gonad is creamy white. The major spawning period in Canadian waters is from August to October. Eggs and sperm are released into the water column where fertilization takes place. Fertilized eggs develop into a ciliated larval stage (known as *veliger*) within a few days and continue to develop while swimming in the water column for 30 to 60 days before they settle to the seafloor. Settlement can be delayed if appropriate substrate is not found.

Attachment by byssal threads to substrate or epibenthic organisms appears to be important, especially in areas with high currents. Spat attach predominately on the underside of gravel and shell fragments, a behavioural pattern which may provide protection from predation. Nevertheless, their survival rate is low. They undergo a series of morphological changes before becoming juvenile scallops. As young scallops age, they become less mobile and show less tendency to attach.

The age of a scallop can be estimated from the number of annual rings on the shell, although a first ring is not always clearly distinct. Growth rates are influenced by season, depth and temperature and so vary from area to area. A scallop recruits to the fishery around year 4 but is first detected in surveys at Age 2.

Sea scallops live on the surface of the seabed, often in a slight depression that they make themselves. While they do have some swimming ability, once settled they tend to stay in the same area. Swimming is rarely seen in scallops larger than 110 mm shell height. They are suspension feeders that filter plankton and organic detritus from the bottom of the water column, hence their preference for areas with high current velocities. They prefer water with low suspended sediment concentrations as fine sediment can interfere with feeding (Cranford and Gordon 1992).

When abundant, sea scallops can dominate the benthic biomass. Species groups with similar environmental requirements include other molluscs, crustaceans, annelids and echinoderms (Thouzeau et al. 1991). A species of sea snail (*Liparis inquilinus*) and juvenile red hake (*Urophycis chuss*) can live inside the shells of sea scallops, apparently without harm to the hosts (Stewart and Arnold 1994). The gravel areas which commonly contain scallop beds are also important habitat for demersal fish such as haddock and cod (Lough et al. 1989).

Sea scallops have numerous predators. During their pelagic phase, they can be eaten by larger zooplankton as well as planktivorous fish. Once settled, principle predators are starfish, predatory snails, crabs, lobsters and various bottom fish species (e.g. winter flounder, cod, wolffish and American plaice). In general, predation pressure decreases with increasing size.

3.3 History of the fishery

The offshore scallop fishery was established around 1945 in response to the growing demand for scallops. For the next 40 years the fishery was focused almost exclusively on Georges Bank by fleets operating from ports in south western Nova Scotia as well as vessels from the New England states. Over the past 25 years the fishery has been expanded to Browns, German and St. Pierre Banks as well as in areas of the eastern Scotian Shelf. In 1973 limited entry was introduced to cap fishing capacity. In 1977, Canada declared a 200 mile fishing zone which resulted in a dispute over access to Georges Bank between Canada and the United States. In 1984 the International Court of Justice (ICJ) confirmed and established an international boundary in the Gulf of Maine (known as the “ICJ line” or “Hague line” after the name of the Dutch city where the ICJ resides). The north eastern portion of the Georges Bank (acknowledged to be the most productive area of the Bank for scallops) was awarded to Canada.

Prior to the ICJ decision, fishing interests from both countries conducted intensive fishing on a competitive basis. The result was a severe drop in abundance with Canadian scallop landings falling to less than 2,500 t of meats. This provided the incentive for the Canadian government and the fishing industry to develop a management strategy to rebuild and maintain scallop stocks and address fleet replacement.

Perhaps the most important turning point for the offshore scallop fishery after the establishment of the

Hague line was the introduction of an enterprise allocation (EA)[1] program in 1986. Owing to concerns from those employed within the industry that this would compromise their jobs, a trial period was incorporated into the program. Following a review in 1989, the participants considered the trial to be a success and the program was made permanent. Since then there has been a rationalization of the fleet with the number of active vessels having been decreased from 68 to 18 and the number of enterprises holding licences from 9 to 6. Today, traditional "wetfish" vessels land fresh scallop meats and a modern fleet of freezer trawlers capable of shucking and individually quick freezing (IQF) scallops within 1 hour of being caught has been introduced.

Arguably, the second most important event in the fishery was the agreement of the inshore and offshore fleets in 1986 to separate their fisheries by a line drawn at latitude 43° 40' north in the Bay of Fundy (see Figure 3). This allowed both fleets to manage their fisheries separately for the benefit of its participants. By 1998, the offshore fleet had expanded its EA program to include all banks on which offshore scallop fishing occurred.

3.4 Fishing and fleets

3.4.1 Scallop fishing

The fishery is conducted by towing steel scallop dredge (locally known as the New Bedford rake) along the seabed. Each vessel typically employs two dredges, each varying in width from 15 -17 feet (~ 4.5 to 5.2 m) (see Photo1). The forward opening of the standard dredge, supported by shoes that skid along the bottom, has a cutting bar on bottom and a pressure plate on top (Photo 2).

Photo 1. A 17 foot (5.2 m) dredge, showing the diving plate and the front end of the dredge that is attached to a towing warp and two wheels designed to stop the dredge from digging into the substrate.

Behind this frame is mounted a bag consisting of steel rings, which normally have an internal diameter of 3 inches (Photo 3). On the top of the bag, immediately behind the pressure plate, is the rope back, an area of large mesh netting (generally 5-6 inches, 12-15 cm) to allow the escape of fish (Photo 3). The bottom of the bag does not start until well back from the cutting bar. Sometimes, a pair of rollers is used up front to keep the nose from digging into the substrate (Photo 1). Towing speed ranges from 3 to 5.5 knots and tow duration commonly ranges from 20 to 30 minutes depending on conditions. There are no regulations on scallop dredges in Canada while the mesh size of the rope back and bag ring size are regulated in the U.S. Walsh (2008) says the efficiency (i.e. percentage of available scallop caught) of the current east coast USA New Bedford scallop dredges is estimated to range from 20-55%, with an average of 46%. Seabed type and weather conditions (the seabed contact of the gear is reduced in rougher seas) can affect gear efficiency too.

[1] A term used to describe the allocation of property rights, in this instance, individual quotas

Photo 2. Showing the shoe of the dredge and the diving plate.

Photo 3. Shows the rear of the dredge with the catching bag made up of 3 inch (7.62 cm) steel rings and the 5 inch (12.7 cm) square mesh rope back panel to allow groundfish to escape.

Walsh (2008) provided a summary of how the dredge works: The capture process is thought to be initiated when scallops swim up in reaction to, or are lifted vertically by, the hydrodynamic effect of the cutting bar. The cutting bar of the dredge usually rides at or just above the sea floor depending on substrate. Scallops can pass under the bar, collide with the bar and tumble over, or swim over it. Some of the scallops entrained in the water turbulence may pass out of the dredge through the overhead rope back. The sweep chain, which forms the leading edge of the ring bag, passes beneath the scallops when they rise and the scallops fall into the bag and are captured. Tickler chains mounted ahead of the sweep chain or in front of the cutting bar may also cause some vertical swimming reaction and thereby increase catch. Scallops smaller than the inside diameter of the rings that comprise the bag may pass through, unless the rings are clogged. Scallops have also been observed

swimming over the dredge's pressure plate.

While the bottom contact by any wheels, shoes and the cutting bar may be limited, the bottom of the chain bag (on the order of 3-4 m long) is in contact with the seabed bed for much of the tow and extends the full width of the gear. Its weight also increases as a tow progresses as it picks up rocks and other substrate material as well as scallops. The disturbance caused to the seabed includes displacement of sediment clasts, flattening out of microhabitat features and resuspension of fine sediment. Organisms are impacted as well, especially the larger and attached forms of epifauna that may be present. This type of seabed disturbance is readily detected by acoustic tools such as sidescan sonar (Gordon et al 2006).

3.4.2 The fleet

The Canadian offshore scallop fleet consists of 12 wetfish vessels landing iced product and 6 freezer vessels landing frozen product. All vessels are greater than 27.4m (90') with the freezer vessels reaching lengths of up to 40 m (130'). Vessels replacement is restricted to 44.8 M (147') by licensing policy and industry guidelines for the EA program. Crew complement ranges from 10-17 on wetfish trawlers and up to 32 on freezer vessels, depending on size. The total complement for the fleet is around 350, mostly full-time, year-round jobs (freezer vessels are double-crewed, one trip on, one off).

Trips by wetfish vessels typically last up to 12 days port to port with freezer vessels staying at sea for approximately 20 days. Fishing is conducted year round with the duration of the season limited by the EA and the overall TAC. Fishing on some of the smaller banks is adjusted by the fleet depending on production and catch rates in any given year and German Bank is closed for the six-month lobster season to avoid gear conflict. Winter fishing is somewhat curtailed on St. Pierre Bank due to extreme weather conditions.

4 FISHERY LOCATION, ADMINISTRATIVE BOUNDARIES, AND RESPONSIBILITIES

4.1 Administrative context and legislation

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, 1985*. That *Act* grants wide discretionary authority to the Minster of Fisheries and Oceans and provides the authority for the enactment of regulations respecting the management of the fishery. The *Atlantic Fishery Regulations*, 1985 and the *Fishery (General) Regulations, 1993* are the main regulations governing the management of 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 George's Bank abuts the Canada-US jurisdictional line. The *Fish Inspection Act* governs the processing of scallops on the factory freezer trawlers which are designated as processing plants for the purposes of the *Act*.

Table 1. Principal acts and policy documents relevant to the Canadian offshore scallop fishery.

Principal Acts and Policy Documents	Description
The Fisheries Act, 1985	Provides for the absolute authority of the Minister and for the establishment of fishing licences, fishery 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 meat counts and seasons. Variation Orders are used to increase or decrease the meat counts and to shorten or lengthen the fishing season as appropriate.

Principal Acts and Policy Documents	Description
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	Authorises 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 processing operations aboard vessels in Canadian waters.

These regulations outline a legal framework for the management of fisheries and for the licensing and registration of participants. Under the authority of the Fisheries Act, 1985 and the Atlantic Fishery Regulations, 1985, the DFO develops Integrated Fishery Management Plans (IFMP) in consultation with the industry. These plans outline the fisheries management objectives and management measures by stock and area. Advisory Committees composed of the major stakeholders serve as the forum for the formulation of management measures and recommendations to the regulator (DFO). The main management body for the offshore scallop fishery is the Offshore Scallop Advisory Committee (OSAC). The committee is supported by the advice of regional DFO managers and scientists.

The Minister of Fisheries and Oceans has ultimate responsibility and wide discretion for the management of these fisheries. The powers of the Minister are delegated to officials through the organizational structure of the department. The Atlantic region is divided into four regional management areas, each with scientific, management and enforcement staff. The offshore scallop fishery is administered by the Maritimes Region of the DFO [DFO NL provides some science assessment for St. Pierre but management is in Maritimes]. While most decisions concerning the management of the fishery are made in the regions, there is some oversight and referral of some matters to the department at the national level in Ottawa.

4.2 National waters

The offshore scallop fishery takes place entirely inside Canada's 200 mile economic zone although a part of St. Pierre Bank has been designated by Canada and France to be a joint zone, called the Core area (Fig. 2). Following the June 10, 1992 decision of the Court of Arbitration for the Delimitation of Maritime Areas between Canada and The Republic of France, the two countries entered a *Process Verbal* governing their mutual fishing relations in part of NAFO subdivision 3Ps in which are found both Canadian and French maritime waters. That area contains part of St. Pierre Bank where offshore scallop fishing takes place. The document sets out a cooperative approach to conservation, science and consultation. Pursuant to that agreement, offshore scallop vessels are not permitted to retain Iceland scallops in the Core area.

5 STOCK ASSESSMENT

5.1 Management unit

The offshore scallop fishery is managed through the use of geographical zones called Scallop Fishing Areas (SFA) (Fig. 1) which are associated with:

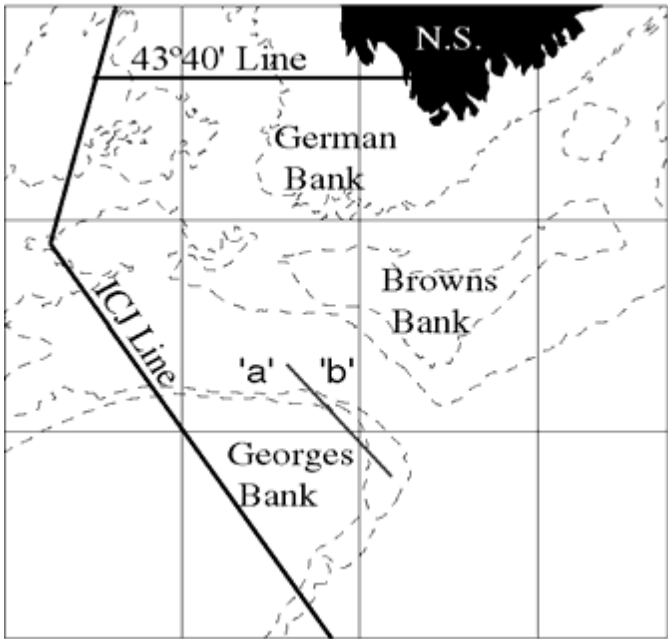
- St Pierre Bank (SFA 10, 11, and 12);
- Eastern Scotian Shelf (SFA 25);
- Browns and German Banks (SFA 26); and
- Georges Bank (SFA 27).

Genetic study of scallops in the region (Beaumont and Zouros 1991) suggested that the populations could not be considered as a single randomly mating unit although genetic differentiation was weak due to gene flow. New data (Kenchington et al 2006) seem to confirm this conclusion but provide more detail. Genetic differentiation was significantly different for some populations and the model of panmixia (random mating within a breeding population) was rejected. Overall, it was concluded that the geographic patterns of genetic variation are primarily due to currents promoting either retention or mixing of larvae and the available data seem to indicate some genetic differences in the area of the assessment (Georges to St. Pierre).

Because of regional recruitment, growth and management differences, and also practical considerations, the beds are assessed and managed separately, with the major research effort dedicated to the main productive population on Georges Bank Zone 'a'.

On Georges Bank, two subareas are distinguished – the shallower and more productive Zone 'a' and a deeper Zone 'b' (see Figure 3).

Figure 3. Zones 'a' and 'b' on Georges Bank, the international boundary between Canada and the US indicated by the ICJ Line and the 43º40' north latitude inshore-offshore separation line.



Source: (CSAS 2008).

The stock in Canadian waters shares the Bank with similarly productive grounds on the U.S. side of the international boundary, which are managed separately using a different research and management strategy from the Canadian fishery, but one that has also been successful in restoring stocks to previous levels. It seems unlikely that the national stock components on Georges Bank, though divided by the boundary, are completely distinct, but neither is it reasonable to assume that either is dependent to a major extent on the reproduction of stocks on the other side of the boundary, though the occurrence of this to a certain extent cannot be excluded. Fortunately, the U.S. management approach to stock recovery appears to be complementary to the one used in Canadian waters[2]. The Canadian management system was compared favourably to the U.S. regime in a paper by Repetto (2001), with the author concluding that the Canadian resource has been better maintained with lower fishing effort and that the Canadian fishing industry has become more prosperous and innovative relative to that in the U.S.

[2] (see, e.g.:*http://wwmfs.nooa.gov/fishwatch/species/atl_sea_scallop.htm).*

5.2 Assessments and stock status

With the exception of the Banquereau and St Pierre Banks the offshore scallop beds are surveyed annually by DFO with collaboration and funding from the fishing industry. Banquereau and St Pierre are considered to be marginal fisheries subject to sporadic pulse recruitment. As a result they are only exploited periodically and subsequently surveys on these banks are less frequent. Surveys are completed for Browns, German and the Scotian Shelf in May. Two annual surveys are funded by the fishing industry for Georges Bank, in May and August, which provide direct indices of abundance for the commercial stock. The first survey in May provides a preliminary indication of stock size, before the major survey in August. Surveys are used to provide in-season advice, and to estimate the abundance and distribution of commercial and pre-recruits (ages 3+). Surveys cover Georges Bank Zones 'a' and 'b', but an assessment is only conducted using data from Zone 'a'.

In addition to surveys, the status of the resource is evaluated from trends in catch per unit effort (CPUE) from logbook and observer data, a meat weight index derived for standard 100 mm size scallops, and from meat counts and 100% landings coverage by dockside observers. In addition, since VMS systems are now installed on each vessel, accurate information on positions fished is also available.

Information on stock status for the various banks is presented to the DFO Regional Advisory Process (RAP) enabling peer review and opportunity for fishery managers and industry representatives to provide their information and knowledge (while RAP is typically internal review it can also include external review depending on the circumstances). For Georges Bank, this information is the output of the quantitative stock assessment. The outcome of the RAP is presented to the Offshore Scallop Advisory Committee (OSAC) and their informed views are taken into account.

DFO publishes its survey results through Science Advisory Reports (SAR), e.g. DFO 2008c.

DFO undertakes "framework assessment reviews", commonly on a five yearly basis, within which they review, among other things, stock assessment methodology and data as well as ecosystem management considerations (e.g. Robert et al. 2000). Within this process external peer review is used to help ensure rigour, transparency and impartiality. A framework assessment review was undertaken in February 2009 (i.e. after the site visit associated with this assessment).

Evidence suggests that the fishery may be entering a favourable period of recruitment. Survey catch rates from Georges Bank Zone 'a' for pre-recruits, recruits, and commercial size scallops rose between 1998 and 2001 and reached historically high levels during 2000 to 2002, before declining to near average levels between 2003 and 2006. Size distributions in the 2007 survey data showed two cohorts of pre-recruits. The older cohort (60 mm shell size) was not evident in the 2006 survey, and the younger cohort (10 - 15 mm) was probably 1 year old scallops. Although these juveniles are infrequently captured in surveys, these results suggest recent, higher than average settlement success in 2006 along the edge of Georges Bank Zone 'a', and on the eastern border of Zone 'b', which may translate into good catches from 2010 onwards.

The abundance of scallops on Browns Bank remains above the long term average, and this also applies to beds on the Eastern Scotian Shelf. Naidu (1970) noted that recruitment was intermittent on St Pierre Bank, and this seems to apply to most Scotian Shelf and Browns Bank scalloping areas, (and even on Georges Bank, less pronounced recruitment fluctuations also apply). This is one reason why research effort devoted to less productive, or intermittently productive areas has been limited. The success of fisheries on most of the Scotian Shelf beds seems to have depended on occasional good year classes in a temperature and current regime that is apparently less favourable for scallop reproduction than more southerly grounds.

The scientific advice and suggestions on levels of TAC for each scalloping ground are based on the abundant quantitative resource information, which is evaluated following a nominal adaptive approach with strong reference to previous years' data. The main analytical assessment currently available is cohort analysis, carried out for Georges Bank Zone 'a' stock only, and standard reference points are confined to those provided by early yield per recruit analyses. This is considered a prudent strategy, and managers can use at least 45 years of experience and accumulated data from logbooks

and resource surveys in reacting to scallop stock changes.

It has not been found appropriate to apply standard groundfish assessment approaches to sea scallops, as this is a largely sedentary species which shows non-random, aggregated distribution patterns, both of biomass and age composition, and because fishing effort is also aggregated while part of the stock is now protected by closures. The recent advent of accurate mapping by multibeam sonar of bottom characteristics important to scallops has made the fishing effort exerted more efficient, but has also made the assumption of a dynamic pool, namely that all members of a population have an equal chance of being fished in a given year, increasingly unrealistic. Instead, improved technology means that the fleet can focus more tightly on productive grounds so that scallops in marginal areas are unlikely to be exposed to fishing. It is important that the onset of multibeam technology will allow the stratification of stock surveys based on maps of surface sediments, since it has been confirmed that scallop distribution is largely influenced by bottom type (Kostylev et al 2003, Smith et al in press).

The assessment approach employed does not rely heavily on a specific population model. Assessments have used Sequential Population Analysis (SPA) or cohort analysis with a quarterly time-step to estimate age-structured abundance, biomass, and fishing mortality, using a combination of the survey abundance index, commercial catch rates, and the age composition in the catch. This approach was also used to provide 2008 stock projections and catch scenarios. Two variants of this model were presented at the assessment meeting described in Scientific Advisory Report (SAR) (2008) (DFO 2008c), tuned to both survey and commercial catch rate indices (as in the past), and a second model tuned only to the survey index. Neither of these was found to be completely satisfactory, and the 2008 SAR report mentioned two problems contributing uncertainty to these assessments:

1) A potential lack of proportionality between the commercial catch rate index and stock biomass has arisen due to changes in fishing practices;
2) There is a lack of recent ageing data;

Thus, the SPA used in this and previous assessments was deemed inadequate by SAR (2008) due to a poor fit to the data in recent years and to projections that were inconsistent with scientific understanding of the resource. Another issue not taken into account by the SPA analysis was the spatial heterogeneity in distribution of ages, and the targeting by the fleet of particular size classes. This results in a spatial aggregation of fishing effort. This non-proportionality will be further accentuated in future as bottom sediment maps are more widely used, and now that effort is excluded from voluntary closures. Aggregation of biomass and effort means that the commercial catch rate index may not be proportional to population abundance or biomass, and calls for a more specific modelling approach taking into account spatial considerations. DFO has recognised this to be the case and has suggested an update of the formal assessment procedures (pers. comm. Ian Jonsen, DFO).

Exploitation rates have been low since EA's were introduced, and it is reasonable to conclude that stock abundance is not currently threatened by overfishing. An empirically based, adaptive management approach, without formal population models or management rules, seems to have been effective in restoring stock biomass and keeping stock size at a healthy level. Scientists, managers and industry are aware that a return to overexploitation would erode the profitability of the fishery. The biomass trend is actively monitored; a conservative and adaptive approach to setting harvesting levels is pursued, and caution is exercised when increases in the TAC are called for. Thus the offshore scallop plan is adaptive, and fine-tuning occurs on a regular basis, as harvesting strategies change seasonally in response to markets, weather conditions, meat sizes, etc. (An economic optimum compatible with harvesting at a lower rate than is required for targeting a maximum sustainable yield).

5.3 Management advice

The current approach to stock assessment and resource management is largely empirical and, given the deficiencies in applying standard assessment methods used for finfish, the actual management approach used depends heavily on abundance data from surveys, log books, and meat count monitoring, plus a long historical record. These sources are used to track the status of the stock and make precautionary decisions.

Management takes account of earlier research which, based on an estimate of the natural mortality rate of adult scallops (assumed at M = 0.1) (Merrill and Posgay, 1964), suggested that optimal ages at first capture should be delayed to at least 5-6 years. This has been recognised, and in 2004 a dense area of Age 2 juvenile scallops that was observed in the research survey in Zone 'a' was protected by a voluntary closure of 95 km^2. This industry initiative remained in place for two years with the objective of improving scallop yield. Since then, after discussion of survey results by the enterprises, such dense seed areas are enclosed in voluntary 'seed boxes'. The fleet abstains from fishing them until the recruits reach at least Age 4, when they are opened to harvesting with the current catch quota applying. [For example, offshore freezer trawlers were reported in SAR (2008) to have landed 68% (2,739 t) of their catches from Zone 'a', and 57% (1,571 t) of these catches came from within a voluntary closure area opened to fishing]. Catch rates from these closed areas were reported to be about 17% higher than for the rest of Zone 'a'.

The fishing mortality rate which gives the maximum yield per recruit is in the vicinity of F_{MAX} = 0.4-0.6, but given the economic motive underlying the EA approach, management has aimed at an exploitation rate lower than this. Thus, after a significant period in the 1960's to 1980's when younger scallops (Ages 3-4) were taken under competitive fishing unrestrained by a quota, the fishery now operates under a precautionary quota with restrictions on the area fished, and other regulations listed in Stevens et al. (2008). Mean ages captured are now reported to approach age five or greater, i.e. the fishery is approaching the age compositions once taken in the newly exploited population.

The fishery is managed by an overall annual quota divided up into enterprise allocations. The 2008 interim TAC was set at 5,000 t, but a minor increase could have been supported given the recent steady increase in the stock and above-average recruitment, especially since voluntary closures of two large aggregations of juveniles have reduced the risk of subsequent recruitment failure.

As noted by Robert et al. (2000), catch sampling has been sporadic on some Scotian Shelf grounds. Under these conditions, assessments may have been restricted to estimates of standing stock from surveys, perhaps supplemented by growth and mortality estimates and yield/recruit calculations. However, assessments have always included analysis of fishery data including CPUE, size distribution and spatial distribution of the fishery.

One precautionary approach for poorly-documented grounds has been the use in the past of rolling quotas: effectively the quota is divided into sequential small aliquots of around 200 t. This allowed precautionary closure before the full quota was taken if there was evidence that an overestimate of stock abundance had occurred.

The changes that occurred through the EA programme have resulted in a management approach that places priority on attaining an economic optimum; this will inevitably result in fishing occurring at levels of effort less than those providing MSY – the commonly accepted optimum by the United Nations Convention on the Law of the Sea (UNCLOS). This must be the principal reason, (in contrast to applying physical reference points in a top-down government management plan), why the offshore scallop fishery managed to restore Georges Bank scallop stocks to a productive level. Despite recruitment failures on Georges Bank in 1990 and 1991, the rapid response of the industry in reducing TAC levels contributed to the recovery of stocks. Modifying the exploitation strategy based on the detailed bottom maps provided by industry investment in multi-beam mapping is expected to further reduce fishing effort for the same quota, by concentrating effort on productive areas (Stevens et al. 2008).

6 FISHERIES MANAGEMENT FRAMEWORK, PROCESSES AND INTERACTIONS

6.1 Management objectives

Long-term Integrated Fishery Management Plans are created and published by DFO describing the fishery, its management objectives, and processes (DFO 2000). These plans are comprehensive documents outlining all aspects of the fishery including an overview, stock status, long-term

objectives, management objectives, current management issues and management measures employed in the fishery. The current plan has been in effect since 2000 and is undergoing a review in 2009.

In addition there are annual fishing plans that outline specific measures to achieve short and medium term objectives. These plans are developed by the DFO in close cooperation with the Offshore Scallop Advisory Committee (OSAC) (see 6.2).

The goals of the offshore scallop fishery are to achieve biological sustainability and economic viability through the proper administration of the EA program. The management objectives outlined in the IFMP are:

- to ensure the conservation and restoration of the resource;
- to the degree possible, stabilize landings over time; and,
- to provide increased economic benefits for crews, vessel owners, shore workers and the people of Canada.

Main management measures include quotas (EA's), closed areas and meat counts. Meat counts vary according to area from 33/500g on Georges Bank 'a' to 100/500g on Banquereau Bank.

Short to medium-term objectives are not outlined in specific documents although several seem to be implicit in annual fishing plans:

- limit exploitation rate (quotas/EAs)
- protect juvenile stock and maximize value (meat counts)
- protect incoming recruitment (juvenile scallop closed areas)
- reduce bycatch (bycatch reserves/recording of catch, area/time closures)
- data collection (logbooks/monitoring documents)
- bycatch protocols

6.2 Advisory committee roles and consultations

The Offshore Scallop Advisory Committee (OSAC) is the major consultative and management body for the fishery. The committee is composed of the major stakeholders - licence holders, crew representatives, some fishing associations, Aboriginal Organisations and First Nations along with representatives of DFO science and management and the provincial governments of Newfoundland and Labrador and Nova Scotia. OSAC provides input and advice to DFO on the conservation, protection and management of the offshore scallop resource, including annual fishing plans, regulatory measures, fishing seasons, licensing policies, size limitations and gear restrictions. OSAC makes recommendations on annual total allowable catches, the administration of the EA program and the introduction of new fishing technologies that may affect existing management measures.

OSAC is chaired by a DFO official. An industry co-chairman may be appointed at the discretion of Committee members. Regular meetings are held throughout the fishing season to discuss the performance of the fishery and to make necessary adjustments. The Committee is supported by a working group of DFO officials who consolidate scientific, economic and management advice into draft fishing plans for the Committee's consideration. Unless a majority of Committee members say otherwise before a meeting starts, the proceedings of the advisory committee are open to the public and to media representatives.

6.3 Fisheries management methodology

The offshore scallop fishery is managed by:

- limited entry to licensed operators
- total allowable catches (TAC) for each SFA
- an Enterprise Allocation style of access and allocation
- a meat-count measure
- seasons and closed areas
- conservation and protection measures, and compliance strategies

Limited entry to the offshore scallop fishery was implemented in 1973 at 76 licensed vessels in order

to cap what was acknowledged to be excessive fishing capacity for the available resource. Through the implementation of an Enterprise Allocation program in 1986, that capacity has been reduced to 18 vessels in 2009.

6.3.1 Harvest restrictions

The scallop harvest is restricted by setting TACs for each SFA. Following a consideration of the scientific advice, marketing and other information, OSAC forwards a recommendation for annual TACS for each SFA to DFO for consideration and final approval or adjustment. OSAC has proven to be very conservative with respect to setting harvest levels and has even recommended TACs lower than that allowed by annual assessments. As its recommendations are always within limits provided by the scientific advice, approval usually follows as a matter of course. Table 2 shows the TACs and actual landings from the offshore between 1990 and 2008,

Table 2. TACs and landings for the period 1990-2008. (* 2008 landings are preliminary)

Year	Georges Bank				Browns Bank				German Bank	
	TAC	Landed			TAC	Landed			TAC	Landed
1990	5,200	5,219			200	207				
1991	5,800	5,800			220	215				
1992	6,200	6,151			450	454				
1993	6,200	6,191			600	575			200	200
1994	5,000	5,003			1,400	1,403			600	600
1995	2,000	1,984			2,000	2,002			400	399
1996	3,000	2,995			750	743			100	91
1997	4,250	4,259			500	500			100	100
	Georges Bank 'a'		Georges Bank 'b'		Browns Bank (North)		Browns Bank (South)			
	TAC	Landed	TAC	Landed	TAC	Landed	TAC	Landed		
1998	3,200	3,191	800	800	500	500	100	99	300	301
1999	2,500	2,503	1,200	1,196	200	200	300	293	600	597
2000	6,200	6,212	600	601	750	748	200	200	600	599
2001	6,500	6,480	400	395	1,000	999	100	99	600	599
2002	6,500	6,469	200	192	650	649	100	98	800	797
2003	6,000	5,985	200	199	1,000	1,003	100	97	400	399
2004	3,500	3,518	200	200	2,000	2,007	200	185	400	401
2005	2,500	2,484	200	201	1,075	1,068	100	38	200	199
2006	4,000	3,931	200	162	1,050	912	100	14	600	601
2007	4,000	4,000	400	400	1,200	1,198	50	1	600	599
2008*	5,500	5,496	400	359	400	389	0	0	400	394

Year	East Scotian Shelf				St. Pierre Bank		Totals for all SFAs	
	TAC	Landed			TAC	Landed	TAC	Landed
1990		434			150	152	5,550	6,012
1991		389			150	134	6,150	6,538
1992		524			150	67	6,800	7,196
1993		250			150	115	7,150	7,331
1994	150	116			150	49	7,300	7,171
1995	150	150			150	68	4,700	4,603
1996	175	175			50	18	4,075	4,022
1997	175	174			50	3	5,075	5,036
	East SS excluding Banquereau		Banquereau					
	TAC	Landed	TAC	Landed				
1998	355	265	50	51	50	0	5,355	5,207
1999	350	277	150	148	50	0	5,350	5,214
2000	200	195	150	147	50	4	8,750	8,706
2001	200	199	100	89	50	0	8,950	8,860
2002	250	178	100	5	50	0	8,650	8,388
2003	250	229	50	0	50	0	8,050	7,912
2004	250	246	50	0	250	251	6,850	6,808
2005	250	235	100	10	250	42	4,675	4,278
2006	150	140	100	0	195	5	6,395	5,766
2007	150	150	50	25	0	0	6,450	6,372
2008*	125	87	50	0	0	0	6,875	6,725

6.3.2 Access and allocation

An enterprise allocation (EA) program of management of the offshore scallop fishery was made permanent in 1989 at which time the percentage shares for each of the enterprises was negotiated and fixed by the participants. The companies agreed among themselves and with DFO that the original percentage shares negotiated in 1986 would continue and would apply to new stock areas which may be managed by TACs unless otherwise negotiated through OSAC. Since that time, new areas have been developed and access and allocations to those areas has followed the EA formula agreed in 1989. Over time six of the original participant companies have been bought by others and two new companies have entered. As a result, the original shares have shifted among the group. The number of companies has decreased from 9 to 6, see Table 3.

Table 3. Offshore scallop fishery – Enterprise Allocation shares of client companies (January 2008) for SFAs 10, 11, 12, 25, 26, 27.

COMPANY NAME	PERCENT SHARE OF TAC
LaHave Seafoods Limited	5.92
Adams and Knickle Limited	9.77
Comeau's Sea Foods Limited	16.68
Ocean Choice International	16.77
Clearwater Seafoods Limited Partnership	43.86

No one fishing enterprise may hold more than 50% of any specific scallop stock. For the purposes of this section, enterprise includes any subsidiaries under one corporate structure. Permanent transfers of a portion of a company's EA are not permitted under the plan, except in the event of the sale of a company. Temporary transfers within the fishing year are permitted between EA parties with the prior approval of DFO but (barring catastrophic events) an enterprise will not be authorized to transfer in excess of 25% of its EA for more than two consecutive years.

6.4.4 Fishing seasons

With the exception of German Bank which is closed to scallop fishing during the 6 month lobster season (Dec-May) to avoid gear conflicts, the operating premise for the offshore scallop fishery is that the season is open year-round, subject to the quota being caught. Closures do occur from time to time during the season but are usually industry driven and based on an assessment of fishing conditions and the state of the stock at the time. Weather on St. Pierre Bank makes winter fishing rare.

There are a number of voluntary "seed box" closures that have been put in place by industry to protect juvenile scallops. In 2004, the annual survey identified an aggregation of juvenile scallops and a voluntary closure of some 95 km^2 was enacted to avoid catching the small scallops. In 2006, the survey confirmed that the scallops in this closed area had or would reach commercial size by the start of the 2007 season. The concept has been continued in 2007 and 2008 with more seed boxes as the industry continues to identify beds of immature scallops through industry grid surveys. Currently, there are three such closures on Georges 'a' and three on Browns North for a total of over 200 square kilometres on each bank.

6.5 Conservation, protection, and compliance

There are a variety of monitoring and enforcement measures in place in the offshore scallop fishery, including:

- licence conditions, quotas and individual EA limits on catch
- bycatch reserves and bycatch protocols
- a hail-in/hail-out requirement
- mandatory satellite vessel monitoring equipment (VMS) on all vessels

- on-board observers at choice of DFO (two trips per month for Georges for the fleet)
- an industry funded 100% dockside monitoring to weigh all scallop meats landed
- an industry-funded port sampling program to monitor the meat count regulation
- daily hailing of catch
- random at-sea boarding by Fishery Officers
- aerial surveillance
- mandatory completion of logbooks and an extensive Scallop Monitoring Document

The compliance record in the offshore scallop fishery is excellent. There is very little incentive to cheat as the licence holders focus on the long-term economic return from the fishery. The economic incentives have led to a suite of voluntary compliance measures and a peer pressure system that has been effective in making infractions almost non-existent. Few reports of non-compliance have been reported since the inception of the enterprise allocation program in 1986 and even fewer over the past decade.

In the event of breaches, sanctions in the form of heavy fines and forfeiture of catch provided in the *Fisheries Act* and regulations serve to deter non-compliance with licence conditions and fishery regulations. Tickets are issued by enforcement officers for low level infractions, and formal court proceedings are pursued for major offences.

DFO rates the potential for illegal behaviour for all of its fisheries in the region. The offshore scallop fishery is deemed to be at a very low risk for non-compliance with regulations and management measures.

6.6 Representation and consultation

As noted above, OSAC, with a broad membership, is the main consultative body in this fishery. Meetings are open to the public and DFO informs that nobody has ever been refused entry to meetings. The Seafood Producers Association of Nova Scotia (SPANS) represents all of the licence holders and there is a very close working relationship with DFO with many research, data collection and monitoring programs being funded by the industry.

7 ECOSYSTEM CHARACTERISTICS

7.1 Introduction

The ecosystem of the Bay of Fundy, Georges Bank and the Scotian Shelf is relatively well-known as a result of extensive studies of seabed geology, physical oceanography, chemical oceanography, plankton ecology, benthic ecology, fisheries, seabirds and marine mammals by government and university scientists in Atlantic Canada. Reviews of current understanding of the Scotian Shelf ecosystem are provided by Breeze et al. (2002) and Zwanenberg et al. (2006). A thorough review of the Georges Bank ecosystem was prepared by Backus (1987) while a comprehensive study of the Browns Bank ecosystem was conducted by DFO (Dickie and Smith 1989). There also have been a large number of scientific studies carried out by Canadian and US scientists in the Gulf of Maine, including Georges Bank, and many of these are reported by Wallace and Braasch (1997). Therefore, the geographic area addressed by this assessment is data rich.

Since Canada's Ocean Act was passed in 1997, the DFO has undertaken various initiatives to implement an ecosystem approach to management. One of these has been the Eastern Scotian Shelf Integrated Management (ESSIM) program which is a collaborative ocean planning process led by DFO under the Canada Oceans Act (DFO 2007a).

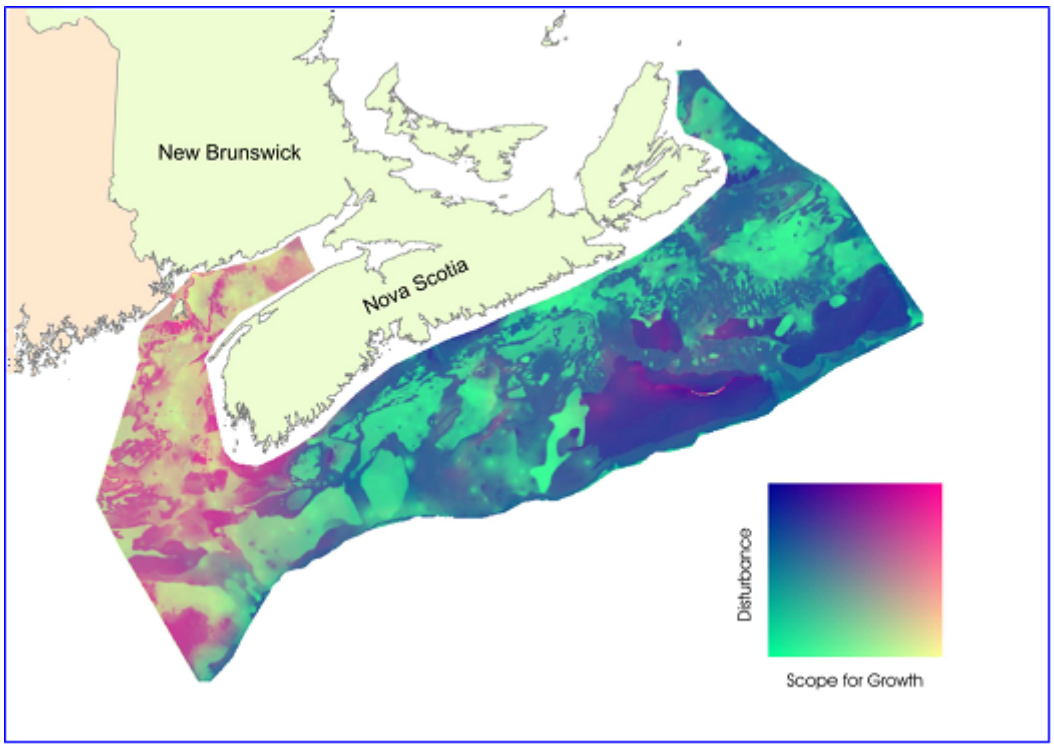
One of the many projects is the development of a benthic classification scheme for the Scotia-Fundy Region through a series of regional advisory process (RAP) meetings (DFO 2002, DFO 2004a and b, DFO 2005). After reviewing different classification schemes, it was decided to develop a general benthic classification scheme using a habitat template approach (Kostylev and Hannah 2007). This approach is based on ecological theory that relates the life history traits of different species to the properties of the environment. The geographic area covered extends from Georges Bank to the

Laurentian Channel and includes the Bay of Fundy, and the model uses a 500 m grid. Two indices are derived: disturbance (physical) and scope for growth (biological). Disturbance reflects the physical stress imparted on the seabed by natural processes such as waves and currents. Scope for growth estimates the energy available to organisms for growth and reproduction. These indices are calculated from regional data bases of variables that include bathymetry, stratification, chlorophyll, oxygen saturation, bottom temperature, sediment grain size and bottom stress (Kostylev and Hannah 2007).

The distribution of disturbance is complex and heavily influenced by depth while scope for growth shows a broad-scale gradient increasing from east to west. The two indices are combined to create a multicoloured habitat map (see Figure 4). This map is a continuum where gradients arise naturally from the data layers and show the distribution of habitats where organisms with particular life history traits are likely to be found. It compares well with existing data but more refinement is needed. The habitat template map does not provide a precise distribution of benthic communities but rather provides a systematic overview of expected life history traits and community structures. This approach has also been used to characterize the benthic habitat on the Canadian sector of Georges Bank (Kostylev et al. 2005). The habitat map constructed from the two indices was a good predictor of benthic communities as assessed by optical means (i.e. video and photos). Mostly mobile or burrowing fauna were dominant in more disturbed habitat on the bank while sessile species represented stable areas. Suspension feeders were extremely common in benign areas while scavengers or predatory animals dominated adverse environments.

These same parameters of disturbance and scope for growth can also be used to characterize the sensitivity and predicted response of benthic communities to human impact (DFO 2005). Sensitivity can be defined as a function of vulnerability and recoverability. Communities found in areas of low natural disturbance and with low scope for growth will be highly vulnerable to physical disturbance and have slow recovery times. Such communities would be highly sensitive; an example is deep water corals. Communities found in areas of high natural disturbance and with high scope for growth will be less vulnerable to physical disturbance and have faster recovery times. Such communities would be less sensitive; a good example would be those in shallow waters on Georges Bank.

Figure 4. Habitat template map for the Scotian Shelf. Red indicates high natural disturbance and high scope for growth while green indicates low natural disturbance and low scope for growth.



(Source Kostylev et al. 2007)

Commercial concentrations of sea scallops are most abundant on gravel substrates on the top of offshore fishing banks. These are areas of high physical disturbance and therefore the resident

benthic communities should be less vulnerable to fishing disturbance. However, due to the pronounced east-west gradient in scope for growth, it is predicted that recovery from fishing disturbance would be much faster on Georges Bank than it would be on St. Pierre Bank.

Another initiative being taken by DFO has been the identification of ecologically and biologically significant areas (EBSAs) (DFO 2004). While the habitat template map described above is based on theory, the identification of EBSAs to date has been based on several sources of information including expert scientific opinion. The results of a scientific workshop are presented by Doherty and Horsman (2007). The criteria considered included uniqueness, aggregation, fitness consequences, resilience and naturalness. The EBSAs identified at this workshop included Georges Bank, German Bank, Browns Bank, Western Bank and Sable Island Bank, which are all sites where commercial scallop fisheries take place. Concluding that an area is ecologically significant does not give it any legal status but provides guidance on the standard of management considered to be appropriate.

Deep-water corals occur in Atlantic Canada and are highly sensitive to fishing disturbance (see review of research by Gordon and Kenchington, 2007). Two areas of high coral abundance have been established as coral conservation areas and closed to bottom fishing activity. These are in the Northeast Channel (424 km^2) and at the Stone Fence in the mouth of the Laurentian Channel (15 km^2). The presence of deep-water corals also played a role in the establishment of the Gully MPA (2364 km^2) (DFO Maritimes Region Coral Conservation Plan[3]). These important coral habitats are much deeper than scallop beds, and no deep-water corals have been reported in the observer program for the Canadian sea scallop fishery. Deep water corals are therefore not considered an issue in this fishery.

Marine ecosystems are not static but change due to the influence of both natural and human factors. Analysis of over 60 data sets, most of which extend back to at least 1970, shows that many features of the Scotian Shelf ecosystem have changed dramatically during the past thirty years (Zwanenburg et al. 2002, DFO 2003). Some of these documented changes may have affected scallop stocks:

- A major cooling event in bottom waters in the northeast region started in the mid-1980s and reached a minimum in the early 1990s. By the late 1990, bottom temperature was back above normal.
- Phytoplankton during the period of 1991-2001 were more abundant and more variable than seen in the 1960s and early 1970s. However, the important zooplankton species *Calanus finmarchicus* showed the opposite trend.
- Groundfish have declined while small pelagic species and commercially exploited invertebrate species have increased.
- Reductions in average body size of groundfish have occurred and there are currently very few large fish.
- Condition and growth of several groundfish species has remained low during the past decade.
- The abundance of grey seals has risen steadily.
- The fishery is increasingly targeting species at lower trophic levels in the food web because there now exists a lack of availability of groundfish at the higher trophic levels.

DFO continues to monitor the continental shelf ecosystem off Atlantic Canada through the Atlantic Zone Monitoring Program (AZMP). The AZMP was implemented in 1998 to collect and analyze biological, chemical and physical field data that are needed to characterize and understand the causes of oceanic variability over different time scales, provide data sets that can be used to establish relationships among biological, chemical and physical variables and provide adequate data to support the sound development of ocean activities. Seven stations and 13 sections are sampled several times a year and variables measured include temperature, salinity, dissolved oxygen, chlorophyll, nutrients and plankton. The results of these surveys are posted regularly on the DFO website.

A review of management plan conservation strategies for Canadian fisheries on Georges Bank was conducted by Gavaris et al. (2005). They considered the fisheries management plans for groundfish, herring, scallop and lobster/Jonah crab. These plans have focussed on strategies aimed at sustaining population productivity for the utilized resources. Community productivity is considered to have

[3] http://www.dfo-mpo.gc.ca/Library/322312.pdf)

been adequately addressed by moderating exploitation on the utilized species, while biodiversity concerns have been addressed through bycatch limitations for incidental mortality and through restricted fishing zones. Habitat considerations, other than those related to preserving biotope, have not featured prominently. For most of the 20th century, the focus was on population productivity studies. Incidental mortality started to receive more attention in the past few decades and habitat considerations are now emerging as the most recent concern. The conservation objectives of maintaining productivity, preserving biodiversity and protecting habitat are important for securing viable and sustainable fisheries into the future.

From the above it is clear that the understanding of the Georges Bank and Scotian Shelf ecosystems is much advanced compared with many other fisheries around the world. However, the data base is much more limited for St. Pierre Bank. With the exception of the latter area, there is therefore a sound environmental information base that can be used in making management decisions.

7.1.1 Ecosystem considerations

There is an extensive scientific literature of research papers and reviews on fishing gear impacts, most of which have been published in the last 20 years. Studies have included a wide range of gear types (e.g. otter trawls, scallop dredges, clam dredges, beam trawls, etc.) and habitat types (e.g. mud, sand, gravel, etc.). Recent overviews include Barnes and Thomas (2005), Løkkeborg (2005) and Kaiser et al. 2006).

Different experimental approaches have been used to study gear impacts. These include laboratory studies, manipulative field experiments (including adequate control areas), comparing similar nearby areas with different fishing histories and collecting observations at same site at different time periods. Each approach has its own strengths and weaknesses and a combination of approaches is recommended. Understanding natural variability, both spatial and temporal, is a critical component to gear impact research.

The results of Canadian and international research on impacts of trawl gears and scallop dredges on benthic habitat and communities were reviewed at a national RAP that included government scientists and managers, the fishing industry, conservation organizations and the university community (DFO 2006c). It was concluded that mobile bottom-contacting fishing gears do have impacts on benthic populations, communities and habitats. The effects are not uniform and depend upon:

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

There is an emerging generalization that the effects of fishing gear dragged along the seafloor depend largely on the amount of epifauna in the area being trawled or dragged. Immediate impacts are large where epifauna form a habitat that is vulnerable to fishing gear because it is fragile, inflexible and large enough to be retained by the gear. Longer term impacts will depend on the frequency of disturbance and the recovery rate of the habitat and biota.

Several studies have compared the relative impacts of different fishing gears (Chuenpagdee et al. 2003, Kaiser et al. 2006, Fuller et al. 2008). All of these studies place scallop dredges near the top of list for severity of impacts. Therefore, this issue needs to be carefully considered in this assessment.

As stated above, scallops are found primarily in gravel habitats on the top of offshore banks. These tend to be high energy environments influenced by waves and currents. Because of the relative stability of gravel substrates (composed of pebble, cobble and boulders), these habitats have a larger percentage of attached, structure-forming epifauna than mud or sand habitats. Therefore they can be expected to be potentially more sensitive to mobile gear disturbance than softer bottoms.

Numerous studies of scallop dredge impacts have been conducted, both in Atlantic Canada and other places around the world. Those considered most appropriate for this assessment are summarized in

Appendix F. More details on specific Canadian research can be found in Gordon et al. (2006). Of particular note is the recent paper by Kenchington et al. (2007). They compared the composition of the megabenthos community as collected by commercial scallop dredges during two surveys conducted 30 years apart on the Digby scallop beds in the Bay of Fundy. Significant changes were observed. The community became more homogeneous with time and the frequencies of occurrence of dominant taxa changed markedly. Over the 30-year period, there was a relative decline in fragile, sessile, permanently-attached and colonial taxa and an increase in robust, mobile grazers and scavengers. While the megabenthic communities are somewhat different, similar results can be expected for offshore scallop beds but such data sets are not available. Similar long-term changes over 60 years in the composition of benthic communities as a result of scallop dredging have been reported in the Irish Sea (Bradshaw et al. 2002).

The results of these experiments examining the impacts of scallop dredges on benthic habitat and communities can be summarized as follows:

- Habitat is clearly disturbed.
- Sediment is displaced and re-suspended.
- Clasts larger than the mesh size of the dredge (i.e. cobbles and boulders) are removed from the seabed (but dumped nearby).
- Microhabitat features, including those that provide structure, are destroyed and habitat becomes less complex.
- Recovery times are at least several years, especially on gravel bottoms.
- Scallop dredges also have an immediate and direct effect on benthic communities.
- The most susceptible organisms to damage are large, attached epibenthic forms.
- There is incidental mortality of the target species (i.e. scallops that are not caught but come into contact with the gear causing mortality or damage such that the likelihood of predation is increased).
- Repetitive commercial dredging over decades affects the relative composition of megabenthic communities with vulnerable species becoming less abundant. However, there is no evidence of any species being extirpated.
- Benthic communities can recover once the disturbance ceases but recovery rates appear to be on the order of a decade.

There are no direct experiments on impacts of the scallop fishery under assessment on benthic habitats and communities, although Collie et al (2005) did conduct an indirect experiment (spatial comparison) in the scallop fishing beds in the Canadian sector of Georges Bank (funded by US agencies). However, the likely impacts of current fishing effort on the banks in question can be estimated with the data on hand.

With respect to incidental mortality (scallops that are not caught but come into contact with the gear causing mortality or damage such that the likelihood of predation is increased) Caddy (1973) and Murawski and Sherchuk (1989) showed that this can be quite variable depending upon the type of dredge, how it is deployed and seabed properties. It is also influenced by the efficiency of the dredge which is estimated to be between 20-55% (Walsh 2008). Available evidence indicates that incidental mortality can be as high as 25%.

Industry has been very progressive in investing in multibeam mapping through joint research with the Canadian Hydrographic Service (CHS) and Natural Resources Canada (NRCan) and is making full use of recent advances in seabed mapping. Using data collected by a joint project of the Scallop Industry Mapping Group (the five Client companies) and the CHS on Browns Bank, Kostylev et al. (2001) demonstrated that multibeam bathymetry is an excellent tool for benthic habitat mapping. As demonstrated above, sea scallops are strongly associated with gravel lag deposits and these in turn were readily identified on Browns Bank using multibeam backscatter data (Kostylev et al. 2003). There was a highly significant correlation between scallop survey catch rates and backscatter intensity which could be used to predict scallop abundance and distribution. Subsequently, the industry conducted multibeam surveys of its own on Georges Bank and German Bank. These proprietary data are now used to direct fishing operations and the results are striking (Pickrill and Todd 2000). Vessels are now able to target specific areas of gravel habitat where scallops are most likely to be abundant. Individual dredge sets (on the order of a few kilometres long) are oriented to keep the

dredges in the best habitat and avoid seabed structures that could interfere with fishing. For a fixed TAC, the time spent fishing can be cut in half and time dredging the bottom can be reduced by as much as 75%. Not only does this result in highly significant savings in time and fuel but it also leads to a substantial reduction in the total spatial footprint of the dredge disturbance. Where multibeam data are available, only habitats with the highest densities of large scallops are being disturbed, not less suitable habitats nearby. The spatial heterogeneity of the dredging disturbance is increased, especially at small spatial scales (tens to hundreds of meters).

It should be noted though that this improvement is taking place only on those banks where multibeam data are available (i.e. Georges, Browns and German Banks) and not on Western, Sable Island, Banquereau and St. Pierre Banks. These three banks represent 80-90% of the historical landings on an annual basis. From a habitat perspective, it is preferable to keep fishing effort patchy (Duplisea et al. 2002).

Even the most intensely dredged areas are probably not completely disturbed. For example, concentrated dredging in the Banquereau hydraulic clam dredge experiment only covered between 53 to 68% of a 100 x 500 m box (Gilkinson et al. 2003). The undisturbed patches leave abundant organisms that can aid in recovery.

There also are temporal aspects of the dredging disturbance that must be considered in assessing overall impacts. Due to the benthic nature of the scallop population (i.e. they don't move much as adults) and thoroughness of the annual stock surveys (conducted jointly by industry and DFO), it is possible to plan the distribution of future fishing effort with a high degree of confidence. Areas with a high concentration of juveniles are identified and these are often closed by agreement within the industry until the scallops reach ideal size for harvesting (e.g. the seed boxes established on Georges Bank). Once an area of high abundance is located, it is fished at a high level of effort until catches decline. Then fishing effort is directed to a new area with an abundance of harvestable scallops. Because of these practices, there seems to be a self-regulated pattern of rotational fishing without formally-designated closed areas. This will give habitat and benthic communities some chance to recover before scallops reach marketable size but this may be limited to just a few years in the case of seed boxes. Despite appreciable rates of recovery, especially on Georges Bank, it appears that the time needed for full recovery of benthic communities is on the order of 5-10 years (Bradshaw et al 2000, Collie et al. 2005).

In conclusion, although no direct observations are available, on the basis of other studies it is speculated that scallop dredging does have an impact on benthic habitat and benthic communities that can be discerned above natural variability with habitat structure and complexity likely being reduced. Despite rotational fishing, the recovery period may be greater than the return period of the dredging disturbance (5–10 years). Kenchington et al (2007) documented a change in the epibenthic communities on the Digby scallop grounds over a 30 year period that is believed to be attributed to dredging disturbance of both the scallop and groundfish fishery. The species composition of the epibenthic community in offshore scallop grounds could be changing with taxa vulnerable to disturbance decreasing in relative abundance.

More detailed predictions could be made if a detailed analysis of the spatial and temporal distribution of fishing effort on an annual basis was carried at a fine scale (tens of meters) for the entire fishery (i.e. 18 vessels). The VMS data and GIS software are available to do this. This would allow areas subjected to the heaviest disturbance to be identified and the return period of disturbance determined.

7.1.2 Bycatch and discarding

The impacts of scallop dredges extend beyond those documented above for benthic habitat and communities. The most obvious of these impacts concerns the bycatch. Organisms caught in the dredge and brought on board are subjected to damage and possible mortality. After removal of harvestable scallops (100 mm +) by hand, bycatch (after sub-sampling if observers are on board), undersized scallops and rocks are discarded back over the side of the vessel. The survival of bycatch organisms is not well understood and is most likely quite variable by species. There appears to be limited data the amount of undersized scallops that are discarded. In addition, there is little data on the discard mortality of undersized scallops. Tagging experiments in the US indicate that a

substantial percentage of discarded scallops can survive if they are handled properly and returned to the water quickly (pers. comm. Deborah Hart, Northeast Fisheries Science Center, Woods Hole, MA, 2009).

All vessels shuck their catch by hand on board and all offal and shells are promptly dumped back overboard. This practice does not appear to cause any environmental concern. The shells serve as important substrate for numerous organisms including juvenile scallops and important structure-forming epibenthos. The offal is a valuable food source for numerous fish and scavenging benthic organisms which are attracted into the fished area.

Bycatch data are collected by the industry-funded observer program. Observers are requested to record all species caught (but in actuality many small taxa are missed). Weights are recorded for all species of fish and larger invertebrates observed. Number and length are also measured for some groundfish species. All observer reports are filed with DFO and data are entered into the DFO Virtual Data Centre (VDC). The observer program is currently limited to Georges Bank which has approximately 60-80% of the TAC. There was limited observer coverage between 1991 and 2004. Beginning in 2005, one scallop trip per month was observed (about 5% of the effort) and this coverage was increased to two trips per month in July 2007 (about 10% of the effort).

A preliminary analysis of scallop dredge bycatch data from Georges Bank, extracted from the VDC, was conducted in the course of this assessment. On average, 27% of the dredge contents are composed of rocks, sand, foreign articles, garbage and shells while 73% is composed of organisms. Scallops account for 94% by weight of the organisms captured by the dredges. The weight of fish bycatch was 5.4% of the total while that of all invertebrate taxa was 0.6%. Approximately 150 taxa have been collected in total. The most common fish caught, in decreasing abundance, are: monkfish, winter skate, little skate, yellowtail, longhorn sculpin, sea raven, winter flounder, cod, thorny skate, haddock, barndoor skate, spiny dogfish, ocean pout and American plaice. The most common invertebrates caught, in decreasing abundance, are: starfish, hermit crabs, lobster, razor clams, crabs, sponges, sea urchins, gastropods and shrimp.

Walsh (2008) summarized information on how different organisms react to scallop dredges. Skate often sit on the bottom until the last moment before reacting to the cutting bar. Either the cutting bar will pass over them or they turn and swim under the bar and into the bag. Sometimes they are caught on the cutting bar for several minutes before passing under the bar or over the pressure plate. Large skate can out swim the approaching dredge or swim up or laterally away from the tow path. It is thought that flounders will react similarly. No observations of the behavioural reactions of cod or haddock to scallop dredges have been made but it is speculated that they may be similar to their responses to trawls. Small and medium-sized cod, haddock and other groundfish are likely to pass underneath the cutting bar or swim through the space between the pressure plate and cutting bar, or over the top of the dredge. The speed of the tow and bottom substrate will influence the behavioural reactions of fish to the gear. Reactions are also often size and density dependent.

The New Bedford scallop rake/dredge, as currently used in the Canadian fishery, appears to be quite selective. Excluding rocks, sand, foreign articles, garbage and shells, scallops make up 94% of the catch. This high efficiency presumably reflects the steps taken by industry in recent years to reduce bycatch and use multibeam bathymetry to target specific areas of high scallop abundance.

To date, only the bycatch data for yellowtail flounder, cod and haddock have been processed by DFO. These three mobile species are managed jointly by Canada and the US under the Transboundary Resource Assessment Committee (TRAC). Scaling up the observer data to the entire scallop fishery on Georges Bank provides estimates of bycatch (see Table 4).

With the exception of monkfish (also known as goosefish or angler fish), all the bycatch is required to be discarded. In the absence of reliable survival estimates, it assumed that all discards are dead for the purpose of stock assessment computations (Gavaris et al. 2007). The TRAC agreement stipulates that estimates of bycatch by scallop fishery must be subtracted from the individual TACs assigned for these species.

In summary, the finfish bycatch of New Bedford scallop rake/dredge, while relatively small, is still

significant. The only available quantitative data that can be used to assess its importance comes from the observer program. This program is restricted to Georges Bank. The other five banks fished are not sampled. To date only the data for yellowtail, cod and haddock have been processed. The possibility exists that there could be other important bycatch issues on other banks that have not yet been identified.

Table 4. Estimated bycatch of yellowtail flounder, cod and haddock by the offshore scallop fleet on Georges Bank between 2005 and 2008.

Species	Year			
	2005	2006	2007	2008
	Tonnes			
Yellowtail Flounder	255	565	105	117
Cod	87	117	124	36
Haddock	50	67	61	33

Source: DFO 2008c

Given the poor status of some groundfish stocks, notably yellowtail flounder and cod, fishery managers and the scallop industry are exploring ways to reduce this bycatch by the offshore scallop fleet. Three different approaches are being utilized: gear modification, area/time closures and bycatch restrictions.

7.1.3 Gear modification

The entire scallop fleet uses the New Bedford style scallop rake /dredge. There are no regulations on scallop dredges in Canada while the mesh size of the rope back and bag ring size are regulated in the US. Each vessel often rigs their dredges slightly differently depending upon experience and the type of bottom being fished.

Gear modification experiments have been conducted by the Seafood Producers of Nova Scotia (SPANS) and DFO (McIntyre et al. 2006) and gear development continues by some enterprises. These tested an experimental dredge with a deflector to force fish upwards through an escape route as well as high intensity lights, strobe lights and sound pingers on a standard dredge. These were meant to startle and elicit an escape response in groundfish ahead of the dredge. The experimental deflector dredge did not significantly reduce bycatch. The light and sound devices did produce statistically significant reductions in bycatch for some species. However, no one single modification produced a reduction in bycatch for all species concerned.

A review of scallop dredge modification studies to reduce groundfish bycatch was conducted by Walsh (2008). These included two Canadian studies and nine from the US. It also considered initiatives to reduce bycatch in scallop dredges in Europe, the west coast of the US, Argentina and Australia. The review concluded that increasing the mesh size of the rope back top panel and ring size of the dredge bags have potential for reducing bycatch. However, it was recognized that the effectiveness of these modifications would differ depending on the fishing area. The review was subjected to a peer review (DFO 2008a) and the recommendations were supported.

Some of the benthic impacts from scallop dredges are caused by the cutting bar used to dig scallops from the sediment. A novel hydrodredge has been designed at the Massachusetts Institute of Technology (MIT) (Goudey et al. 2006) and has the potential to exert far less impact on the seabed and biota. A prototype is illustrated in Walsh (1980). Four precisely oriented cups deflect water downward which in turn lifts scallops into the water column where they can be captured by the bag. This passive process is based on the hydrodynamics of the gear and does not require mechanical pumping of water. This gear is supported by wheels and not shoes which also lessens bottom disturbance. Gear trials in the UK indicated that use of the hydrodredge reduced bycatch and the number of dead scallops (Shepard et al. 2009). This dredge is currently being evaluated locally by Adams and Knickle (i.e. members of the client group). US scientists have also been investigating ways to exclude turtles from scallop dredges (e.g. Smolowitz et al. 2006).

In summary, there still seem to be further opportunities to improve dredge designs to reduce bycatch and benthic disturbance.

7.1.4 Area/time closures

An expert opinion on scallop fishery area/time closures to reduce cod bycatch on Georges Bank was held in 2006 (DFO 2006d). It concluded that some areas of high cod density could be closed to scallop fishing for a period of two months to reduce cod bycatch. The onset of the closed period could be coincident with the cessation of the experimental winter groundfish fishery when 30% of the cod are in spawning and post-spawning stages. Subsequently, annual closures during February and March were enacted for specific areas on the northeast portion on Georges Bank starting in 2006 and these have continued up to the present. These closures have been effective in reducing the cod bycatch in the scallop fishery. DFO also examined if a similar area/time approach could be used to reduce the bycatch of yellowtail flounder (DFO 2007b). It was found that the bycatch of this species did vary seasonally and peaked in June. It also tended to be higher in the western part of the study area. Subsequently, starting in 2007, specific areas of the northeast portion of Georges Bank are closed annually to reduce the bycatch of yellowtail flounder. There also is a voluntary seasonal closure on German Bank from December to the end of May to eliminate gear conflicts with the lobster fishery.

7.1.5 Bycatch restrictions

Several years ago, DFO Fisheries Management established bycatch reserves in the groundfish management plan for yellowtail, cod and haddock on Georges Bank to account for the discards by the offshore scallop fleet. These are expressed as a percentage of the total TACs. These are 30%, 12 % and 1.03 % for yellowtail, cod and haddock, respectively. Even though shares are identified to account for discard mortality, this does not provide a quota to the scallop fleet as they are not permitted to retain any of these species (and 100% mortality is assumed). There is currently no directed fishery for yellowtail flounder at this time. It is landed only as bycatch.

Clearwater has developed a non-discretionary bycatch protocol for its entire fleet (Clearwater 2008). This includes the following provisions

- All groundfish bycatch will be returned to the water in a manner that causes least harm to the fish. No vessel is to leave any tows on deck awaiting processing. No more than one tow will be permitted in the hopper, rail, dump table, deck, etc. at a time.
- In order to facilitate communication of bycatch areas among the fleet, a grid system will be used to identify catch location. This grid is labelled, numbered and provided to all vessels in the fleet.
- It is the responsibility of the Captain to ensure yellowtail flounder, cod and haddock bycatch (#s of fish) is monitored on a tow-by-tow basis 24 hours/day. Fish will be accounted for in the grid of the greatest % of the tow.
- Avoidance measures will be taken if a vessel encounters a yellowtail flounder catch that exceeds 25 lbs per watch, or a maximum 100 lbs per day, and or a cod catch of 15 lbs per watch, or a maximum 60 lbs per day. Avoidance measures are stipulated.

It is not known whether other licence holders have a similar protocol.

7.2 Species at risk

Procedures to protect wildlife species in Canada have recently been established. The Species at Risk Act (SARA) was enacted in 2003 with the purpose of protecting wildlife at risk. Species of concern are evaluated by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC). If a species is judged to be at risk it is listed under one of the following categories: extinct, extirpated, endangered, threatened, or, of special concern. It is then referred to the appropriate Federal Authority for consideration of legal protection under SARA. If a species is listed under SARA, a recovery strategy or management plan is developed.

Of these species, two are reported in the observer data base: the Atlantic wolffish (a total of 838 kgs)

and the spotted wolffish (a total of 35 kgs). The larger bycatch of Atlantic wolffish may be a potential concern for Georges Bank. It might also be an issue on other banks but data are not available.

According to the captain of the vessel we visited, in his experience turtles have never been accidentally caught. However, turtle bycatch appears to be an issue in US waters where loggerhead turtles are apparently frequently caught (Merrick and Haas 2008) and attempts are being made to exclude turtles from scallop dredges (Smolowitz et al. 2006). There appears to be no evidence of scallop dredges directly impacting marine mammals. However, vessel noise could affect their behaviour. There also is a remote chance of collision between vessels and whales, especially while vessels are underway.

Several species of skate are currently being considered for listing under SARA. Winter skate has been assessed by COSEWIC and is currently under review by DFO but no listing decision under SARA has been made to date. Since skates are common in the scallop bycatch, they may become more of an issue in the near future. Management and recovery plans have been developed for all three wolffish species combined[4]. Observer data indicate that cusk have been caught by scallop dredges on a few occasions. This species has been assessed by COSEWIC as threatened and is currently being considered for listing by SARA. Its recovery potential has been assessed (DFO 2008b).

7.2.1 Other fisheries relevant to this assessment

Scallop bycatch in other fisheries appears to be negligible and therefore not an issue in this assessment. However, as described above, there is a bycatch of demersal fish in the scallop fishery which includes monkfish, various skates, yellowtail, cod and haddock. The bycatch of yellowtail, cod and haddock (Table 4) is carefully monitored through the Transboundary Resources Assessment Committee (TRAC). For the past two decades, these three stocks have been depressed and management actions have been taken to rebuild them. Haddock appear to be doing well on both Georges Bank (TRAC 2008a) and the western Scotian Shelf (DFO 2006a). The fishery on the eastern Scotian Shelf is still closed but there has been some good recruitment recently. However, stocks of both yellowtail flounder and cod have remained depressed with low recruitment and productivity (TRAC 2008b, TRAC 2008c, DFO 2006b). That the bycatch of these species by scallop dredges led to their decline seems doubtful since scalloping effort is much lower now than a decade ago. It seems probable that directed trawl fishing and environmental change (e.g. Zwanenberg et al. 2002) played the major roles. The extent to which scalloping might be preventing recovery of these stocks is unknown.

Habitat disturbance by scallop dredges also has the potential to impact fisheries. Various commercial species also use gravel habitats for spawning, nursery areas and feeding areas. These include groundfish such as haddock and cod (Linehan 2004) as well as pelagic species such as herring. The spatial overlap of scalloping with yellowtail habitat appears to be less since yellowtail prefers a sandy seabed (Linehan 2004). Reducing habitat complexity and structure through scallop dredging could have negative impacts on these species. For example, Lindholm et al. (1999) have demonstrated that seabed habitat disturbance can reduce the survivorship of juvenile cod. Recent research on the Scotian Shelf has indicated that juvenile haddock prefer seabed habitats that are more rugged and complex (Anderson et al. 2005). The extent to which habitat alteration by scalloping might affect the survival of juvenile fish is unknown at present. It should be noted that a large area (~4,000 nm^2) on Emerald and Western Banks was closed to all groundfish fishing in 1987 to protect juvenile haddock (Frank et al. 2000). However, this area has remained open to scalloping. An increase in the abundance of herring, winter flounder and redfish has been observed (Fisher and Frank 2002).

8 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

[4] [available online @ http://www.sararegistry.gc.ca/document/default_e.cfm?documentID=1579]

system to fulfil Principles 1 and 2 and ensure compliance with national and international regulations. The Principles and their supporting Criteria are presented below.

8.1 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. [5]:

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.

8.2 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.

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.

8.3 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.

[5] 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

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[6].

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.

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.

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

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.

9 BACKGROUND TO THE EVALUATION

9.1 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 organisation, 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.

Expert advisor: John Caddy: John is an independent consultant with a long experience of marine resource and environmental research management issues nationally during his appointment with the Department of Fisheries and Oceans Canada (DFO), and globally during 20 years of work with the United Nation's Food and Agriculture Organisation (FAO), (including his former post as Chief of Marine Resources in the Fisheries Department). An early emphasis in his career was on management of marine invertebrate fisheries, in particular as a researcher on offshore from 1966-74, but has since worked on management of a wide variety of other resources.

Expert Advisor: Don Gordon: Don has led numerous multidisciplinary projects investigating the effects of human activities on the marine environment, including oil spills, tidal barrages, hydrocarbon drilling wastes and mobile fishing gear. Focus of his research has been on benthic habitat and community studies with a strong field component. He also has experience in benthic habitat mapping, identification of important fish habitat and deep-water corals and has been involved in applying the research results to marine management issues. He retired from Fisheries and Oceans Canada in 2005 but remains an Emeritus Scientist within the Ecosystem Research Division.

Expert Advisor: John Angel: John 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 served as Executive Director of the Canadian Association of Prawn Producers, a trade association representing offshore northern shrimp interests in Eastern Canada until 2004. He has extensive experience in the development of integrated resource management plans and fishing strategies as well as a background in Canadian fisheries law and is currently a member of the

Fisheries Resource Conservation Council (FRCC), an independent advisory body to the Canadian Minister of Fisheries and Oceans.

9.2 Previous certification evaluations

The fishery has not been previously assessed against the MSC standard.

9.3 Fishery site visit

The fishery site visit focused on the practicalities of fishing operations, the impact of the gear on seabed habitat, communities and other commercial species, 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.

Table 5. A list of individuals and/or organisations that were interviewed or provided information in the course of the site visit to the fishery.

Name	Affiliation	Date	Key Issues
Brian Giroux	Scotia Fundy Mobile Gear Fishermen's Association	16/12/08	Bycatch of groundfish
Susanna Fuller	Ecology Action Centre (EAC)	16&19/12 /08	Habitat and species interactions, observer coverage, transparency
Rob Johnson	EAC	16/12/08	Habitat and species interactions, observer coverage
Marty King	World Wildlife Fund (WWF)	16/12/08	Habitat and bycatch, transparency, protected species
Susan Fudge	WWF	16/12/08	Habitat and bycatch, transparency, protected species
Stefan Leslie	DFO, Resource Management	17/12/08	Fisheries management & science, environmental interactions.
Greg Stevens	DFO, Resource Management	17/12/08 18/3/09	Fisheries management & science, environmental interactions. Area time closures
Allan MacLean	DFO, Conservation and Protection	17/12/08	Fisheries Regulations and enforcement
Melanie MacLean	DFO, Oceans, Habitat and Species at Risk Branch	17/12/08	Environmental legislation, protected species and habitats
Kerri Graham	DFO, Policy and Economic Branch	17/12/08	Management policy, certification process.
Ian Jonsen	DFO, Population Ecology Division	17/12/08 18/3/09	Stock assessment and monitoring Bycatch, discards and scallop mortality
Amy Glass	DFO, Population Ecology Division	17/12/08	Stock Assessment and monitoring
Christine Penney	Clearwater Seafoods Limited Partnership	17 & 18/12/08	Fisheries management & science, environmental interactions, operational aspects.
Catherine Boyd	Clearwater Seafoods Limited Partnership	18/12/08	Fisheries management & science, environmental interactions,

Name	Affiliation	Date	Key Issues
			operational aspects.
Roger Stirling	Seafood Producers of Nova Scotia (SPANS)	17/12/08	Fisheries management & science, environmental interactions, operational aspects.
David Knickle	Adams and Knickle Limited	17/12/08	Fisheries management, operational aspects, gear design
Jim Mosher	Clearwater Seafoods Partnerships Limited	18/12/08	Fishery operation, management and gear /vessel operation
Mike Pitman	Clearwater Seafoods Partnerships Limited	18/12/08	Fishery operation and gear development
Capt. Tom Skinner	Clearwater Seafoods Partnerships Limited	18/12/08	Vessel and fishery operation
David Lowery	Clearwater Seafoods Partnerships Limited	18/12/08	Vessel and fishery operation
Todd Keizer	Clearwater Seafoods Partnerships Limited	18/12/08	Vessel and fishery operation
Tana Worcester	DFO, Centre for Science Advice	5/1/09	Scallop gear
Vladimir Kostylev,	Geological Survey of Canada, Atlantic	7/1/09	Seabed habitat mapping
Brian Todd,	Geological Survey of Canada, Atlantic,	7/1/09	Seabed habitat mapping
Jessica Sameoto	DFO, Population Ecology Division	12/1/09	Observer data base
Jim Simon	DFO, Population Ecology Division	12/1/09	Observer data base
Tracy Horsman	DFO, Oceans, Habitat and Species at Risk Branch	12/1/09	Ecologically and biologically significant areas
Peter Hurley	DFO, Population Ecology Division	13/1/09	Groundfish stocks
Stratus Gavaris	DFO, St. Andrews Biological Station	17/3/09	Bycatch
Jorgen Hansen	DFO, Resource Management,	18/3/09	Bycatch
Deborah Hart	Northeast Fisheries Science Center	18/3/09	Scallop Mortality

10 STAKEHOLDER CONSULTATION

10.1 Stakeholder consultation

A total of 14 stakeholders / groups/ organisations were identified and consulted specifically by Moody Marine in the course of the assessment. Information was also made publicly available at the following stages of the assessment:

Table 6. Stakeholder consultations held

Date	Purpose	Media
5/08/08	Notification of confirmation of assessment	Direct E-mail/letter Notification on MSC website
1-31/11/08	Notification of confirmation of assessment	Advertisement in press - November '08 edition of "The Navigator"
29/08/08	Notification of Assessment Team nominees	Direct E-mail Notification on MSC website
18/09/08	Confirmation of Assessment Team	Direct E-mail Notification on MSC website
29/09/08	Consultation on draft Performance Indicators and Scoring Guideposts	Direct E-mail Notification on MSC website
6/11/08	Release of final Performance Indicators and Scoring Guideposts	Direct E-mail Notification on MSC website
27/10/08	Notification of assessment visit and call for meeting requests	Direct E-mail Notification on MSC website
15-19/12/08	Assessment visit	Meetings
18/08/09	Notification of Proposed Peer Reviewers	Direct E-mail Notification on MSC website

10.2 Stakeholder issues

Feedback from stakeholders has assisted in the selection of the assessment team and refinement of the Performance Indicators and Scoring Guideposts.

NB. The remainder of this section will be completed following the 30 day public consultation period and receipt of any comments. These will be copied into the table along with the assessment team's response.

The following tables identify the general and specific points that were made by each stakeholder, the associated PI and score (where applicable or relevant) and the assessment team's response.

Table 7. Stakeholder feedback on the public comment draft report

Organisation/Individual:		
PI	**Stakeholder Comments**	**Moody Marine Limited (MML) Response**

11 OBSERVATIONS AND SCORING

11.1 Introduction to scoring methodology

Information was posted on the MSC website on the 27th September describing the application of the MSC Principles and Criteria and the scoring methodology (see http://www.msc.org/track-a-fishery/in-assessment/north-west-atlantic/Eastern-Canada-offshore-scallop/assessment-downloads).

The MSC Principles and Criteria set out the requirements of certified fishery. The certification methodology adopted by the MSC involves the interpretation of these Principles and Criteria into specific Performance Indicators against which the performance of fishery can be measured according to pre-specified guideposts.

The Performance Indicators developed by the Moody Marine assessment team have been identified on the MSC website (Performance Indicators and Scoring Guideposts). In order to make the assessment process as clear and transparent as possible, these guideposts identify the level of performance necessary to achieve 100, 80 (a pass score), and 60 scores for each Performance Indicator.

These generic Performance Indicators and Scoring Guideposts have been the subject of stakeholder consultation and have been confirmed or modified following this process based on the judgement of the assessment team. Prior to scoring, the Indicators are also 'weighted' in relative importance according to the nature of the fishery undergoing certification.

At the top level, no weightings are assigned in terms of each MSC Principle; a fishery must 'pass' each of Principles 1, 2 and 3 in order to achieve certification and these are of equal importance.

Within each Principle, and related to each MSC Criterion, Sub-criteria and Performance Indicators are grouped in a hierarchy. Each level represents separate areas of important information (e.g. Indicator 1.1 requires a sufficient level of information on the target species and stock, 1.2 requires information on the effects of the fishery on the stock and so on).

At the level of the 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. Accordingly, 100 represents a theoretically ideal level of performance and 60 a measurable shortfall. 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, weighted average scores are rounded to the nearest whole number.

Weights and scores for the Fishery are presented in the scoring table. Weights for criteria, sub-criteria and Performance Indicators add to a total of 100 at each level of the hierarchy. Scores are allocated relative to the Scoring Guideposts.

11.2 Evaluation results

Observations are presented in the scoring table, together with any weighting applied to the Fishery and the scores allocated.

12 LIMIT OF IDENTIFICATION OF LANDINGS FROM THE EASTERN CANADA OFFSHORE SCALLOP FISHERY

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.

12.1 Traceability within the fishery

Those companies identified in 1.1 and their vessels fishing with New Bedford scallop rakes / dredge gear will be eligible to sell MSC certified scallop (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 of scallop are reported in logbooks and on landing tickets. On board observers also monitor, cross check and verify their reports with the vessels logbook. Random landing and processing plant inspections by enforcement officers are also conducted to ensure that administrative details associated with species, area and capture and quantity are in order.

Cross referencing of VMS data with logbooks, observer and aerial and at-sea surveillance reports also ensures that fish is reported from the correct area of capture. 100% of the landings are monitored by dockside sampling

12.2 At-sea processing

Scallops are shucked and either individually quick frozen (IQF) or chilled and landed as fresh scallop meats.

12.3 Point of landing

Various points of landing are used throughout Nova Scotia. Prior to landing 'hail-ins' are required and landing cannot take place until dockside monitoring is ready.

12.4 Eligibility to enter chains of custody

The scope of this certification ends at the points of landing. For product to be eligible to carry the MSC logo, separate chain of custody certification will be required for storage, handling and outlet facilities downstream of the point of landing.

12.5 Target eligibility date

The client has chosen the target eligibility date to be 6 months prior to the date of publication of Public Consultation Draft Report. Therefore it is estimated that this will be 20th June 2009.

13 CERTIFICATION RECOMMENDATION

13.1 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 : 87	**Pass**
Principle 2: Maintenance of Ecosystem	Overall : 82	**Pass**
Principle 3: Effective Management System	Overall : 89	**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 Eastern Canada Offshore Scallop Fishery be certified according to the Marine Stewardship Council Principles and Criteria for Sustainable Fisheries.

13.2 Scope of certification

This assessment relates only to the fishery defined in Section 1.1 up to the point of landing as defined in Section 12.

Monitoring and control of fishing locations and methods is considered sufficient to ensure fish and fish products invoiced as such by the fishery originate from within the evaluated fishery:

- 100% satellite tracking based on mandatory VMS transponders, plus aerial surveillance;
- At-sea inspections;
- Completion and submission of vessel log books and landing declarations allowing cross-referencing of position with the VMS, aerial surveillance and at-sea inspection reports;
- Observer coverage two trips per month of vessels fishing on Georges Bank;
- 100% Port Sampling
- 100% Dockside Monitoring Program; and,
- Random landing and processing plant inspections by enforcement officers.

This will allow fish and fish products from this fishery to enter into further chains of custody subject to appropriate assessment and certification.

The client group has confirmed that the following plants will be receiving scallop from named vessels and these will be eligible to chain of custody certification.

Table 8. Client group member companies and their associated processing plants.

Company	Processing Plants
To be completed with the assistance of the client at the final certification report stage	

13.3 Conditions and recommendations associated with certification

13.3.1 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 eight Performance Indicators. The assessment team has therefore set conditions for continuing certification that the client group is required to address. 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'. This Action Plan is required to be approved by Moody Marine.

The Conditions, associated timescale and relevant Performance Indicator are set out below.

Condition 1 – Incidental and Discard Mortality
The incidental and discard mortality of scallops is not well known for this fishery as a result the following Condition has been set: The client is required to ensure that by the fourth annual audit all major sources of fishery related mortality, including landings, fishing effort, discards, incidental mortality and mortality of juveniles are accurately recorded/estimated for most fleets and most parts of the stock. To achieve this outcome, it is recommended that: a) By the second annual audit a program is developed to assess the incidental and discard

Condition 1 – Incidental and Discard Mortality

mortality of scallops.

b) By the fourth annual audit information from this program is formally taken onto account within the management of the fishery.

This Condition relates to Performance Indicator 1.1.2.3.

Condition 2 – Bycatch and Discards

Information and assessment of discards and by-catch is not gathered from all of the Banks. As a result the following Condition has been set:

The client is required to ensure that by the second annual audit sufficient information on discarded scallops and non target species is gathered in order to evaluate the impact of the fishery on the scallop stock, non target species and/or ecological systems.

To achieve this outcome, it is recommended that:

a) By the first annual audit, bycatch monitoring is expanded to cover all of the Banks that are fished. The same level of bycatch monitoring should be maintained on Georges Bank and at least one trip per season should be monitored on the other named Banks that are fished in the Unit of Certification.
b) By the first annual audit, methods for collecting under-sized scallop discard data are reviewed and improvements implemented where warranted.
c) By the second annual audit, all bycatch and under-sized scallop discard data are processed and reported on an annual basis.

This Condition relates to Performance Indicators: 2.1.2.1, 2.1.2.2 and 2.1.4.2

Condition 3 – Biological Diversity, Community Structure and Productivity

Analysis has not been complete to judge whether the observed impacts of scalloping on habitat and biological diversity, community structure and productivity are within acceptable limits. For this reason the following Condition has been set:

The client is required to ensure that by the third annual audit sufficient information is available on the consequence of the fishery to suggest it is not having unacceptable impacts on habitat and biological diversity, community structure and productivity. If any unacceptable impacts are identified by the fourth annual audit the client shall implement measures to ensure they are addressed.

To achieve this outcome, it is recommended that:

a) By the second annual audit determine the spatial distribution of fishing disturbance of the seabed for all banks fished on an annual basis. This analysis should be done for as many past years as possible. Compare the spatial distributions of fishing disturbance for successive years to determine the time intervals between disturbances for all areas fished.
b) By the second annual audit, use existing information to map the seabed habitats, and, where possible, communities of the scalloping areas for which multibeam data are not available.
c) By the third annual audit, based on (a) and (b) above, develop a program to fill key knowledge gaps.
d) By the third annual audit, review existing information on the sensitivity of the identified seabed habitats and associated species and the expected rates of recovery from disturbance by scallop fishing.
e) By the third annual audit, use the above information to evaluate the likely impacts of the fishing disturbance on habitat and community structure, biological diversity and productivity as well as the risk of creating irreversible changes.
f) Assess the acceptability of likely impacts that are identified.
g) If unacceptable impacts are identified, by the fourth annual audit, new management strategies should be outlined and measures implemented to detect and manage the ecosystem impacts of the fishery and ensure that key elements of the ecosystem are protected.

Condition 3 – Biological Diversity, Community Structure and Productivity

This Condition relates to Performance Indicators: 2.1.4.3 and 2.1.4.4

Condition 4 - Management Objectives

The management system does not contain clear short and long term resource and environment objectives or evaluated procedures for measuring performance relative to the objectives. For this reason the following Condition has been set:

The client is required to ensure that by the first annual audit explicit short and long-term resource and environment objectives and procedures for measuring performance relative to the objectives are incorporated into the management system.

To achieve this outcome, it is recommended that:

a) By the first annual audit explicit short and long-term resource and environment objectives and review of milestones are incorporated into the management system.
b) By the first annual audit appropriate procedures are implemented for measuring performance relative to the objectives

This Condition relates to Performance Indicators: 3A.3.1 and 3A.3.4

Condition 5 – Formalisation and Implementation of a Precautionary Approach

A formalized commitment to the application of the precautionary approach is missing within the management system. For this reason the following Condition has been set:

The client will ensure that by the first annual audit formalised measures are implemented to apply a precautionary approach in the development and application of operational procedures in the absence of sufficient information.

To achieve this outcome, it is recommended that:

a) By the first annual audit formalised measures are described and implemented to show how the precautionary approach is applied in the management system.

This Condition relates to Performance Indicator: 3A.3.3.

13.3.2 Recommendations

It is recommended that:

- A research program associated with the seed boxes could provide useful information on the natural mortality rate of juvenile scallops as well as help to estimate an order of magnitude for incidental mortalities due to fishing. Estimating growth rate and the mortality rates of juveniles warrants further investigation.
- Future Framework Reviews for the offshore fishery should consider:
  - The current exploitation strategy into the stock assessment procedure;
  - Incorporate the seed boxes into assessments, quota setting and forecasting;
  - Establish a series of limit reference points to mark unfavourable changes in stock abundance;
  - Examine Biological Reference Points based on biomass/catch rate, meat count, mortality rate, or on other relevant historical indicators of importance to the industry.
- There is exchange of information with U.S. counterparts on management measures as they affect Georges Bank.
- All companies continue to experiment with ways to reduce the seabed disturbance and bycatch of scallop dredges.
- Precautionary rolling quotas are kept as a management option if, for some reason, annual

surveys cannot be performed before setting quotas.

- Improvements are made in the capability for ageing scallops.

14 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 Action Plan

Appendix D: Stakeholder Comments

Appendix E: Summary review of relevant fishing impacts research.

APPENDIX A

Scoring Table

SCORING INDICATORS	Comments	Weight	Score

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.**	**33.3**	**87**
1.1 *(MSC Criterion 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.**	**33.3**	**88**
1.1.1		There should be sufficient information on the target species and stock separation to allow the effects of the fishery on the stock to be evaluated.	**16.7**	**85**
Weighting Commentary		No weighting is applied to the MSC Principles – these are equally weighted and each must attain a weighted score of 80 or more for certification to be granted. The three MSC criteria are considered of equal importance. The four sub-criteria under 1.1 (MSC Criterion 1) and the Performance Indicators under sub-criterion 1.1.1 are also considered of equal importance; essentially representing a 'logical sequence' of issues.		
1.1.1.1		Is the species readily identified as adults and juveniles?	**14.3**	**100**
60	Misidentification is possible and increases recording errors of catches, but this does not compromise monitoring to unacceptable levels.	The sea scallop (*Placopecten magellanicus*) is found in harvestable concentrations on beds of sandy gravel in depths of 35 – 120 m. It is readily identified by scientists at all key life stages and by fishers, observers, regulators, etc. when recruited into the fishery. There are only 2 commercial pectinid bivalves in the area of interest (Bousfield, 1960) the other being the Icelandic scallop (*Chalmys islandica*).		
80	The target species are unlikely to be confused with any other species and/or any misidentification is demonstrably insignificant in the monitoring of catches.			
100	The species is readily identified by fishers and by regulators and is recorded appropriately.			

SCORING INDICATORS		Comments	Weight	Score
1.1.1.2		Is the life history of the species understood and the spawning and nursery areas well described?	**14.3**	**85**
60	There are gaps in information but the basis of the life history is understood sufficient to support a comprehensive qualitative evaluation of the effects of the fishery. Spawning and nursery areas/times are well established.	Significant information exists on the biology and ecology of sea scallop. Key life history characteristics have been well described. A synoptic biological overview of the life history was provided by the Science Advisory Reports (SAR), and an assessment overview was conducted by DFO in 2006. Scallops may reach sexual maturity as early as Age 2 and have separate sexes. The female gonad is red in colour and the male gonad is creamy white. The major spawning period is from August to October; eggs and sperm are released into the sea and fertilization is external. Fertilized eggs develop into the larval stage (veliger) in a few days, and will continue to develop while swimming in the water column for 30 to 60 days before settlement to the bottom (Tremblay et al 1994). Newly settled larvae undergo a series of morphological changes before becoming a juvenile scallop. The species is filter-feeding on phytoplankton and organic detritus. There are a few gaps in information that call for further research on settlement and early life stages on bottom, but these are not critical to safe management. For example, the implications of epidemic spawning and the need to maintain adequate spawning densities have not been considered explicitly, but experts indicate that the clumped distribution of scallops on the bank favours egg fertilization. Ensuring that some areas are set aside as a spawning refuge appears to have been a successful strategy on the US side of the line, designed to ensure local high spawning densities of large scallops, and could be usefully introduced within the Canadian zone. The early post-larval life needs further study to elucidate the role of juvenile nursery habitat, migration and dispersal. Spawning stock and juvenile (Age 2-3) distributions are regularly mapped through stock and seed surveys. (See the 2008 SAR - DFO 2008C.). Concentrations of ‘seed scallops’, where concentrations of juveniles are abundant, are voluntarily closed to exploitation until commercial size/age (4+ years) is reached.		
80	Critical factors in the life history of the species are clearly documented and understood, sufficient to support a comprehensive qualitative evaluation of the effects of the fishery. Spawning and nursery areas/times are well established.			
100	The life history of the species is clearly documented and well understood including behaviour and ecological interactions. Spawning and nursery areas are sufficiently well documented to support closed area / seasons where this is deemed necessary.			

SCORING INDICATORS	Comments	Weight	Score

1.1.1.3		Is the geographical range of the target stock(s) known and any seasonal movements described?	14.3	100
60	A management unit approximating the stock(s) is used with some biological justification. This is based upon a sufficiently robust estimation of the geographical range and biological characteristics of the target stock.	The stock distribution pattern is well understood, and habitat mapping is significantly enhancing the level of fine-scale understanding as to where the stock is likely to occur in fishable densities. The scallop, *Placopecten magellanicus*, is found only in the Northwest Atlantic, from Cape Hatteras to Labrador. Scallops are aggregated in patches and harvestable concentrations are called beds. Major areas of offshore fishing activity are Georges Bank, the Eastern Scotian Shelf (Banquereau, Middle Bank, Sable and Western Banks), Browns Bank, German Bank, and St. Pierre Bank (south of Newfoundland). Scallops prefer a sandy, gravel bottom and occur in depths of 35 to 120m on the offshore banks. (Black et al. 1993, Bourne,1964) Most biological research on scallops has been carried out on inshore grounds and on Georges Bank – the populations on the Scotian Shelf are less well described, but well defined, and appear to show more intermittent recruitment (occasional good year classes) than on Georges Bank. More recent research using multibeam sounder equipment (Kostylev et al. 2001) has identified the preferred scallop microhabitat and scallop centres of distribution appear to be on gravel bottom. This result could be used by all fleet members to avoid fishing habitat types that may be less favourable for scallops.		
80	A reliable estimate of the geographic range and biological characteristics of the target stock(s) is available including seasonal patterns of movement and availability.			
100	The complete geographic range and biological characteristics of the stock(s), including seasonal patterns of movement / availability, are demonstrably understood and verified.			

SCORING INDICATORS		Comments	Weight	Score
1.1.1.4		Is information collected on the abundance/density of the stock(s)?	**14.3**	**95**
60	Either fishery dependent or fishery independent indices are available on the abundance/density of the stock biomass. Qualitative information exists on the appropriateness of the indices as proportional indicators of stock status.	With the exception of the Banquereau and St Pierre Banks the offshore scallop beds are surveyed annually by DFO with collaboration and funding from the fishing industry. Banquereau and St Pierre are considered to be marginal fisheries subject to sporadic pulse recruitment. As a result they are only exploited periodically and subsequently surveys on these banks are less frequent. Stock indices are well documented based on DFO twice-yearly surveys on Georges Bank, industry seed surveys, meat sampling of every trip in port, log book data and a VMS control every hour by independent co-monitors (vessels have 2 transponders). Stock status is estimated annually using stock surveys, landings, landed sizes, and an analysis of fishery performance. Recent examples of reports are: DFO, 2007, and the offshore Scallop Advisory Committee presentation on the offshore scallop stock status, December 11, 2007. (See also: copies of DFO 2006e & 2008c; OSAC presentations 2008,2007, 2006; and Survey Result presentations 2008, 2007). More recently, surveys of seed scallops provide an indication of the areas of the bank where concentrations of 2+ age groups are particularly abundant and need protection. Logbooks provide catch and effort data from which catch rates (CPUE) are estimated – these data are cross checked with VMS, dockside monitoring, and limited observer coverage (two trips per month but only on vessels fishing on Georges Bank). Catch in numbers at age is estimated from port samples. Relative biomass indices are provided by research surveys on all the Banks. Using this data a sequential population analysis model is used to estimate population abundance.		
80	Fishery dependent and/or fishery independent indices are available on the abundance/density of the stock. Uncertainties have been analysed and those uncertainties are such that trends can be determined from indices.			
100	Fishery dependent and fishery independent indices are available on the abundance/density of the stock. Indices are consistent and there is clear evidence that they are proportional to the stock status.			

SCORING INDICATORS		Comments	Weight	Score
1.1.1.5		Is there information on fecundity, size at maturity, recruitment, growth and factors causing natural mortality?	**14.3**	**85**
60	There is sufficient information available, for key areas of the stock distribution, on the fecundity, size at maturity, growth and natural mortality to support a basic assessment.	Data are available on adult maturity, and fecundity is known for Georges Bank. The natural mortality of commercial-sized sea scallops was estimated to be 0.1 y^{-1}. Little information is available on scallop populations on Browns and the Scotian Shelf, though the population parameter values may be presumed similar to those of the Georges Bank. Natural predators of scallops include, but are not limited to, cod (*Gadus callarias*), American plaice (*Hippoglossoides platessoides*), wolf fish (*Anarhichas lupus*) and starfish (*Asterias vulgaris* and *Crossaster papposus*). Other causes of natural mortality include unfavourable water temperature and salinity changes, and parasites. The natural mortality rate of juveniles in seed boxes, and the incidental mortality rates exerted on them elsewhere due to fishing, are less well documented, but may be significant. A research focus on this aspect will make forecasting future yields more accurate. In summary: • Comprehensive and reliable quantitative information exists on the fecundity/size at maturity/recruitment, sex ratio, growth rates and factors causing natural mortality of adult scallops, and can be incorporated into assessment models. • Data on fecundity/size at maturity/or recruitment comes from Dibacco et al. (1995) and on growth rate from Brown et al. (1972);Robert, et al. (1985); Larsen and Lee (1978); • Estimates of natural mortality for adults come from Medcof and Bourne (1964) and Merrill and Posgay (1964). A problem in routinely estimating growth rates is due to poorly visible growth rings on the shells of Georges Bank scallops. This needs a research focus, and we were made aware by DFO that ageing information is limited and could be improved with enhanced, “age reading” skills or through the development and use of a size-structured model. While the overall quality and level of data for the fishery appear to be good and are sufficient to score at least above the minimum requirements, however improvements in the quality of age data and juvenile mortality rates are needed. The score would be higher on this item if there had been more detailed studies of the natural mortality rate of juvenile scallops in seed boxes. This important information would permit a semi-quantitative forecast of the potential yield from a seed box when it is eventually opened to fishing after several years of closure. Similarly, the indirect mortality to juveniles escaping through the dredge rings, or after discarding from deck, are implied to be of significance by the presence of shell breakage marks (Caddy 1989) for the unknown proportion of animals that recover the selection and escapement process. Estimates of indirect losses due to fishing should ideally be incorporated in an improved stock assessment.		
80	Quantitative estimates are available of fecundity and maturity at size, growth rates and natural mortality, for most parts of the stock distribution, sufficient to inform a robust evaluation of stock status.			
100	There is comprehensive and reliable quantitative information on the fecundity/size at maturity/recruitment, growth rates and factors causing natural mortality, for all parts of the stock distribution, which can be incorporated into assessment models.			

SCORING INDICATORS		Comments	Weight	Score
1.1.1.6		Is information available on environmental influences on the stock dynamics?	**14.3**	**95**
60	Some relevant studies have been undertaken to identify the most important environmental influences on the stock. Research is encouraged and ongoing..	Evidence suggests that recruitment fluctuates in response to some environmental signal related to the oceanic gyre that typically occurs over Georges Bank. Although good year class recruitment does not appear to be dependent on the existence of a large spawning populations, ensuring that densities of adult spawners are prevented from falling too low in poor recruitment years is likely to be an appropriate management measure. This could be achieved by incorporating a proportion of the spawning stock inside spawning refugia as a precautionary measure that could play an important role in years when stock size is low. • A knowledge of environmental factors affecting distribution, survival, and year class strength allows detailed estimation of their effects on stock dynamics; (Stokesbury, 2000); • Substantial stocks are primarily associated with gravel substrates, that can now be identified using high-resolution acoustics for seabed mapping; (Kostylev, et al. 2003; Thouzeau, et al. 1991), and thus reduce significantly the impact of dredging on other bottom types and benthic ecosystems; • The effects of currents on adult behaviour and larval life in the plankton have now been studied: (e.g., Pilditch and Grant 1999; and Stokesbury and Himmelman 1995; Tremblay and Sinclair 1992).		
80	There is sufficient knowledge of the main environmental factors affecting distribution, survival and year class strength to allow an estimation of effects on stock dynamics.			
100	There is sufficient knowledge of environmental factors affecting distribution, survival and year class strength to allow detailed estimation of effects on stock dynamics.			

SCORING INDICATORS		Comments	Weight	Score
1.1.1.7		Is there information on the variability in recruitment and can this be used to predict recruitment to the fishery?	**14.3**	**90**
60	There is some information on recruitment variability and its causes, including some time-series data.	Time series information of biomass and catches going back to the early 1980's show no clear predictive stock-recruitment relationship for the offshore stock, although MacGarvey et al. (1993) does postulate such a mechanism. It is documented that long term environmental fluctuations influence recruitment, but the precise mechanism, probably acting during the larval stages, is as for most other fisheries; namely variations in the strength and degree of closure of the current gyre over Georges Bank during the larval stages. Historical data for this and other adjacent fisheries (e.g. the Bay of Fundy fishery which has a longer time series), suggests that long term production fluctuations occur on a roughly 18-20 year cycle. Whether the causes for temporal variation in recruitment are entirely environmental or are partly influenced by density-dependent factors (such as a low densities of spawners in some years), needs further elucidation. It would not be precautionary to fish out all dense patches of adult scallops, since there is evidence that spawning can be epidemic, and that fertilization success drops off with wider spacing of spawners. Experience elsewhere with Japanese scallops (Aoyama 1989) shows that recruitment tends to become more regular when significant biomasses of adults were being held locally in suspended culture. This supports the idea that a positive effect may occur if small, high density patches of adult scallops are allowed to persist as small permanent spawning refugia, and recent US experience with closed areas (e.g., DuPaul and Rudders 2007) supports this contention. Nonetheless, it is highly probable that long-term environmental fluctuations do influence recruitment, and that the mechanism acts at the larval stages in response to the degree to which a current gyre keeps larvae over Georges Bank during larval life: (see Naidu and Robert 2006; Sinclair et al. 1985). The more detailed information collected recently on Age 1-2 scallops (seed surveys) will allow a better forecast of eventual recruitment to the fishery once juvenile mortality rates have been established.		
80	There is an appropriate measurement of recruitment and/or ongoing research into the factors generating recruitment variability so as to estimate likely future recruitment. Time series data are available, sufficient for short-term forecasts.			
100	There is reliable monitoring of recruitment and/or strong evidence of ongoing research projects to study recruitment variability factors with some evidence of an understanding of those factors. Information, built up over a long time series exists and can be reliably used to predict recruitment for medium term stock projections.			

SCORING INDICATORS		Comments	Weight	Score
1.1.2		**There should be sufficient information on the fishery to allow its effects on the target stock to be evaluated**	**16.7**	**85**
Weighting Commentary		All Performance Indicators within this sub-criterion are considered of equal significance.		
1.1.2.1		Are fleet descriptions, fishing methods and gear types known throughout the fishery?	**33.3**	**100**
60	Main fishing methods and gear types are known for the fishery with some information on geographical areas of use. Information is available on the size and composition of the fleet, but is not regularly updated.	The fleet, vessels, and gear characteristics are well known, and detailed statistics on fleet operations, catches and fishing effort are available by area of operation. The fishery is prosecuted by New Bedford rakes/dredges only, but gear design and methods of deployment have been subject to industry experimentation in recent years.		
80	Main fishing methods and gear types are known and information is available on the geographical areas of use. Recorded information is available on the size and composition of the fleet. This is updated at appropriate intervals. Seasonal and geographical variations are known.			
100	All fishing methods and gear types employed in the fishery are known. In-situ observations are made of fishing practices. Information on the size and composition of the fleet, and seasonal and geographical variability, is recorded and regularly reviewed.			

SCORING INDICATORS		Comments	Weight	Score
1.1.2.2		Is gear selectivity and composition of landing known for the fishery?	**33.3**	**85**
60	Appropriate information is available on selectivity and qualitative changes in selectivity. Data on the composition of catches are sufficient to support a rudimentary evaluation of the fishery.	At present, there is one gear type used in the offshore fishery, though experimentation is now leading to individual modifications in gear design and deployment, principally to reduce fuel consumption, damage to benthic fauna and to reduce groundfish bycatch. In the past, gear selectivity has been well studied both in Canada and the US (Bourne 1965, Caddy 1968). The selectivity of scallop sizes captured by the offshore dredge is not knife-edged, and especially on substrates with mix boulder/gravel sediments, it partially retains a wide range of sizes. Walsh (2008) says the efficiency (i.e. percentage of available scallop caught) of the current east coast USA New Bedford scallop dredges is estimated to range from 20-55%, with an average of 46%. Analysis of catch data indicates that 94% by weight of the catch is scallops and 6% fish and inverts. Seabed type and weather conditions (the seabed contact of the gear is reduced in rougher seas) can affect this figure considerably. (For a review of selectivity studies, see Naidu and Robert 2006). The conventional New Bedford rake/dredge used in the offshore fishery has 3 ½ inch metal rings in its catch retaining bag. We were told that some fishermen were using 4 inch rings on a seasonal or area basis. (4 inch rings are mandatory in the US sea scallop fishery). Research in the US fishery indicates that 4 inch rings provide greater selectivity of larger scallops with only a limited reduction in the catch of optimal sized scallops (100 mm+), and improved efficiency in catching larger scallops. The number of links between rings also appears to influence selectivity. It is probable that the use of chafing gear also affects selectivity. All landings are recorded through an industry-financed dockside monitoring programme. Landings are subject to 100% dockside monitoring to confirm total weights landed. The detailed size distribution of every landing is covered in Port Sampling records (summarized bi-weekly by DFO and distributed to all licence holders) - 100% of offshore scallop landings are subject to this mandatory dockside monitoring program. The areas of capture are also known for all scallops harvested. Licence conditions permit fishing only on one bank per trip, and VMS confirms the hourly location of all vessels, and would detect infringements of seed boxes or other closed areas. Other approaches to increasing dredge selectivity are being tested by industry, comparing paired tows during commercial trips with standard and modified dredges. The approaches currently being tested include: - Wider spacing in the dredge rope back; - Rubber wheels on the tow bar and dump bar to reduce damage to the bottom and escaping scallops; - Slower and shorter tows, using the winch for retrieval; - Using multibeam mapping to avoid, where possible, bottom types other than the gravel bottom favoured by scallops; However, scientific or formal reports detailing the gear or the results from these trials have not been produced. Furthermore, the extent to which the above modifications have been adopted by the whole fleet were not made clear to the team in the course of the site visit.		
80	Selectivity of gear types are well estimated for key locations and times. Data on the composition of catches in the main fisheries affecting the target stock are adequate to support confidence in the evaluation of the fishery.			
100	Full selectivity have been accurately estimated for all gears, locations and times of fishing over a suitable time period. There is comprehensive and reliable data on the size structure and sex ratio of all significant catches; sufficient to support a high degree of confidence in the evaluation of the fishery.			

SCORING INDICATORS		Comments	Weight	Score
1.1.2.3		Are all major sources of fishery related mortality recorded/estimated, including landings, fishing effort, discards, incidental mortality and mortality of juveniles?	**33.3**	**75**
60	Sufficient information is recorded to allow accurate estimates to be made of landings and effort. Estimates of discards and incidental mortality are available for key fleets.	Trends in landings and fishing effort are well documented, as are discards (e.g. Rago 2005), but incidental mortalities must occur as a result of fishing. Although the extent of incidental mortality of escapees from the dredge is unknown, judging from the shock marks on scallop shells (which Caddy (1989) showed coincide closely in size with the ring diameters and inter-ring spaces), this mortality component is not negligible, and deserves further investigation. Indirect impacts of the gear on small scallops, especially on the first three year classes prior to commercial size, occur while passing through the dredge (e.g., Caddy 1973; 1989). Some incidental mortality of escapees must take place judging from shell shock marks caused to an unknown proportion of small scallops damaged during escapement through the dredge rings, but which recover subsequently. Monitoring shock mark frequency at size could help provide indicative estimates of the indirect mortality rate. Since the fishing strategy is usually to tow repeatedly over the same area until catch rates decline, multiplicative impacts are to be expected if small scallops are present in the tow area, and groundfish that accumulate to feed in the dredge track are liable to incidental damage. These effects have been reduced compared with the last 30 years or more, since some areas of dense young scallop aggregations are now protected from fishing within seed boxes until they reach commercial sizes, and fishing effort is more narrowly concentrated on productive bottom than previously. All vessels have VMS and 100% logbook completion. Effort exerted, and fishing locations, are well recorded and are used in determining CPUE, extent of fishing area, and other indices. There are two observed trips per month on Georges Bank only on a fleet of 18 vessels. Discard data are collected by observers, and since the time on deck of small scallops is reduced in the modern fishery, the efforts made to reduce this cause of mortality must be at least partially effective. Discard mortality of scallops is thought to be low unless they are left on deck for long periods during summer or winter. The move to freezer trawlers and covered decks with conveyor belts rapidly returning discards to the sea is likely to have reduced this mortality component even further. Undersized scallops are thought to have a high survival rate if rapidly returned to the water (Gavaris et al. 2005).		
80	Landings and effort are accurately recorded. Discards and incidental mortality are well estimated for most fleets and most parts of the stock.			
100	Landings, effort, discards and incidental mortality are accurately monitored for all fleets and parts of the stock.			

SCORING INDICATORS		Comments	Weight	Score
1.1.3	**There is a well-defined and effective stock assessment procedure and harvest strategy for managing the target stock.**		**16.7**	**84**
Weighting Commentary		All Performance Indicators within this sub-criterion are considered of equal significance.		
1.1.3.1		Is there an effective stock assessment for all relevant parts of the stock?	**12.5**	**80**
60	Stock biomass, fishing mortality and recruitment, or their proxies, are estimated periodically for management purposes, using indicators, analytical and/or survey-based methods, for relevant parts of the stock.	With the exception of the Banquereau and St Pierre Banks the offshore scallop beds are surveyed annually by DFO with collaboration and funding from the fishing industry. Banquereau and St Pierre are considered to be marginal fisheries subject to sporadic pulse recruitment. As a result they are only exploited periodically and subsequently surveys on these banks are less frequent. Two annual surveys take place on Georges Bank, in May and August, which provide direct indices of abundance for the commercial stock. The first survey in May provides a preliminary indication of stock size, before the major survey in August. Surveys are used to provide in-season advice, and to identify areas where Age 2 seed scallops are concentrated. Surveys cover Georges Bank Zones 'a' and 'b' but an assessment is only conducted using data from Zone 'a'. In addition to annual surveys, the status of the resource is evaluated from trends in catch per unit effort (CPUE) from logbook and observer data, a meat weight index derived for standard 100mm size scallops, and from meat counts and 100% landings coverage by dockside observers. In addition, since VMS systems are now installed on each vessel, accurate information on positions fished is also available. Although the assessment procedure is effective, ideally it should reflect more closely the spatial harvesting strategy followed. Caddy (1975) showed that in the absence of local closures and a rigorously enforced meat count regulation, fishing effort becomes focussed onto high density patches where young scallops are common. Now that a more discriminatory fishing pattern is made possible by bottom mapping, spatial management has become a reality, and places this fishery ahead of most contemporary offshore harvests. The assessment approach currently used needs updating however, to incorporate the fact that only a portion of the whole stock area is harvested in a given year, and to follow survival within the seed boxes which are closed It is recommended that an update of the current stock assessment procedure be implemented in cooperation with DFO as part of the Framework Review to incorporate new features of the current exploitation strategy into the assessment.		
80	Appropriate time series of stock biomass, fishing mortality and recruitment estimates, and their uncertainty, are available from analytical and/or survey-based methodology for most parts of the stock, and are used to assess stock status and make forecasts.			
100	Appropriate time series of stock biomass, fishing mortality and recruitment estimates, and their uncertainty, are available from analytical and/or survey based methodology for all parts of the stock, and are used to assess stock status and make forecasts.			

SCORING INDICATORS		Comments	Weight	Score
1.1.3.2		Are there appropriate reference points based on stock biomass and/or fishing mortality?	**12.5**	**85**
60	Appropriate limit and precautionary reference points or proxy measures with similar intent or outcome, have been chosen and are justified and are appropriate to achieve long-term sustainability.	Biological reference points (BRPs) in the traditional sense are not used in the evaluation and management of this fishery. Instead a number of indices provide proxy measures with similar intent to BRPs. These include survey biomass, recruitment, CPUE, meat counts, and size structure of scallops in the survey. These are all used and evaluated to obtain a holistic view of the health of the stock. In addition to the regulated minimum meat count which is carefully enforced by DFO, industry has put in place a voluntary meat count tolerance supported by the Port Sampling program and effectively self-enforced by industry. Although some incidental mortality due to fishing may occur, the fishery has reduced harvesting of Age 3 scallops to a low level. Evidently the meat counts currently landed support the contention that the fishery is close to a maximum for the yield per recruit, and this seems to be a function both of avoiding areas of small scallops, and the significant reduction in fishing effort brought about by the EA strategy, which minimizes unnecessary harvest costs in vessels and sea time. Further reference points could easily be derived from the extensive data on other indicators collected, such as mean catch rate, total mortality rate, discards and biomass. These indicators might be incorporated within a traffic light approach such as used in other fisheries (e.g. snow crab Caddy et al 2005). Safe maxima for the intensity of fishing by subarea, and minima for biomasses and annual recruitment, could also be easily derived from the historical data collected on research cruises and commercial samplings. As an alternative to a traffic light approach, reference points (RPs) could be established within a fisheries control law which would determine the overall management measures taken in a given year. These RPs could reflect, for example, the empirical values of indicators in past years when scallop biomasses were low, in order to avoid a repetition of unfavourable conditions for spawning. It is recommended that the Framework Review for the offshore fishery should seek to: • Incorporate the seed boxes into assessments, quota setting and forecasting; • Establish a series of limit reference points to mark unfavourable changes in stock abundance. These could be based on biomass/catch rate, meat count, mortality rate, or on other relevant historical indicators of importance to the industry.		
80	Appropriate limit and precautionary reference points or proxy measures with similar intent or outcome are determined and implemented taking into account stock biology, exploitation history and the limitations of the available fishery and assessment data.			
100	Appropriate limit and precautionary reference points are determined and implemented taking into account stock biology and statistical simulations of the variability and uncertainty of fishery and assessment data.			

SCORING INDICATORS		Comments	Weight	Score
1.1.3.3		Is the stock status and harvest strategy evaluated relative to reference points?	**12.5**	**90**
60	An approximated evaluation is made of the stock status and an appropriate harvest strategy is implemented relative to reference points or measures with similar intent or outcome.	Annual advice is generated for each bank: (see SAR and/or reports of OSAC science advice). As noted, the meat count regulations were originally based on a yield/recruit reference point, and meat counts are rigorously enforced. A number of indices including survey biomass, recruitment, CPUE, meat counts, and size structure of scallops in the survey, are used as proxies for reference points and are evaluated to obtain a holistic view of the health of the stock. The industry and DFO do not believe that a formal reference point approach with pre-determined harvest control rules, will add value to the management of this fishery, since the adaptive management system currently in place has been successful in reducing fishing when stock levels have been low, and has led to stock recovery. Nonetheless, a degree of formalization of decision rules would help should a downturn in recruitment occur for any reason. In the offshore scallop fishery, decisions to reduce harvest levels when stock levels are declining have been taken by the industry and independently of DFO to reduce harvest and incorporate sophisticated spatial mechanisms which are not easily dealt with using the simple, dynamic pool type of assessment commonly used for finfish stocks. Proposed changes in exploitation strategy suggested by multiple indicators have not been disputed by industry, nor their implementation delayed. Rapid action is taken without the delays that are commonly the case where a new annual assessment has to be incorporated into an annual governmental management cycle. The EA program has demonstrably aligned the interests of the licence holders with the long term conservation of the resource. In partnership with DFO, the industry has demonstrated a history of reducing harvest levels when resource status is low, with the aim of rebuilding depleted stocks to healthy levels. There is no formal reference level for setting TACs. However, for the main traditional scallop fishing area on Georges Bank the mean exploitation rate of the adult stock has remained around 20% for the last 14 years. Furthermore, over the same period, the adult stock (ages 4-7+) has been maintained at between 20-30,000 tonnes. A yield per recruit based reference is used for all scallop fishing areas, setting an upper limit to the number of meat counts per 500 grammes landed. On banks other than Georges, precautionary rolling TACs, commonly 100-200 tonnes, were each set for 6 or 12 week durations, along with specified meat counts. If meat counts and catch rates were maintained during these periods, the TAC was kept the same or increased by increments of 100 or 200 tonnes for a further 6-12 week period. If counts increased above the prescribed limit, the fishing area was closed. There still appears to be a degree of self policing, as vessels move out of fishing areas before they are closed if catch rates fall or meat counts increase above the prescribed levels so overexploitation of smaller grounds is minimized. Nonetheless, precautionary rolling quotas – i.e., quotas divided into small aliquots, were used when the scallop biomass present was uncertain or unknown. Although this management tool is not currently employed, it should be kept as a management option if, for some reason, annual surveys cannot be performed before setting quotas.		
80	At appropriate intervals an adequate evaluation of stock status is made, and an appropriate harvest strategy identified and implemented relative to the reference points or measures with similar intent or outcome.			
100	There is an ongoing and appropriate evaluation of stock status relative to reference points or measures with similar intent or outcome using probabilistic methods that facilitate short and longer term forecasts that determine an appropriate harvest strategy.			

SCORING INDICATORS	Comments	Weight	Score

1.1.3.4		Does the evaluation take into account major uncertainties in data and have assumptions been assessed?	12.5	80
60	Major uncertainties are identified. Some attempt has been made to evaluate these.	Scallop populations were described as ‘resources showing fluctuations with irregular periodicity’ by Caddy and Gulland (1983), and such uncertainties require annual recruitment surveys which are implemented for all major offshore beds. ‘Uncertainty’ here mainly relates to uncertainties as to the number of seed scallops on the banks, and the survival to commercial sizes of the proportion of the total recruitment which is conserved within seed boxes. The score given to this Performance Indicator does not necessarily reflect inadequate monitoring, but rather the fact that the seed box role and the changing exploitation strategy made possible by using multibeam mapping, need to be more closely incorporated into the annual assessment. (This of course, is an original application of technology in the field of fisheries and adds to the confidence that overfishing is being kept under control). Especially for the smaller beds on the Scotian Shelf which provide a small proportion of offshore landings, there will always be irregularities in production, and exploitation will not occur every year. As noted earlier, ensuring observer coverage of trips to these beds by single vessels in scouting mode with observers on board to collect data should precede opening the area to full exploitation, and will ensure that accidental overfishing does not occur.		
80	The evaluation takes into account major uncertainties in the data and functional relationships. The most important assumptions have been assessed and the consequences are known.			
100	The evaluation addresses all significant uncertainties in the data and functional relationships and evaluates the assumptions in terms of scope, direction and bias relative to management-related quantities.			

SCORING INDICATORS		Comments	Weight	Score
1.1.3.5		Are uncertainties and assumptions explored and reflected in management advice?	**12.5**	**85**
60	Major uncertainties are recognised and are reported in management advice and their possible management implications identified.	Uncertainties are described in the "Uncertainty" section in the SAR. The estimation of uncertainty in the assessment approach currently used by DFO will be improved (e.g., DFO 2008c) once the assessment approach has been updated to take into account new features such as the seed boxes and bottom mapping information. That efforts are being made in this direction is shown by Kostylev et al. (2003) and by Smith et al. (submitted) which demonstrate that scallop distribution is predominantly determined by sediment type. This was confirmed by a 2005 survey, and a survey stratification based on the multibeam bottom mapping and geology ground-truthing project in this area confirmed a higher precision in biomass estimation was possible by this method. Since the stratification schemes for comparable groundfish surveys are unlikely to be so precise, such a survey stratified by accurate bottom type should significantly reduce uncertainties in survey data for scallops		
80	Major uncertainties and assumptions are reflected in the management advice and limitations addressed through the appropriate management advice and decisions.			
100	All significant uncertainties and assumptions are addressed and reflected in the management advice, including appropriate decision.			

SCORING INDICATORS		Comments	Weight	Score
1.1.3.6		Does the stock evaluation include the consequences of current harvest strategies?	**12.5**	**85**
60	The evaluation makes an appropriate initial approximation of the consequences of current harvest strategies.	Biomass projections are provided for by the evaluation for the Georges Bank stock (e.g., DFO 2008c), and provide the basis for TAC setting. In 2008, some difficulties were raised with the cohort assessment model used in earlier assessments, largely as a result of the change in exploitation patterns resulting from more directed effort (closing seed boxes and using detailed bottom charts). This modifies one the assumptions of the cohort method, namely that all individuals in the stock are equally vulnerable to exploitation. Although this prevented projections from being made in 2008, survey data are still available for forecasting abundances, and it is expected that after incorporating new features of the fishery in the assessment approach, biomass projections will be possible in the near future. Management is provided with control scenarios on the main traditional fishing grounds (zone 'a') on George's Bank, i.e. a TAC of *x* corresponds to an exploitation rate of *y* which means that the exploitation rate for age 3+ (the recruiting stock biomass) and age 4-7 (target biomass) are specified by the gear selection curve. Adequate controls of possible quota overruns are readily demonstrated for all scallop fishing areas.		
80	The evaluation includes a robust approximation of the consequences of current harvest strategies. Uncertainties are considered in harvest strategy evaluations.			
100	The evaluation includes the consequences of current harvest strategies, forecasts future consequences of these and evaluates stock trajectories under decision rules.			

SCORING INDICATORS		Comments	Weight	Score
1.1.3.7		Are clear and tested decision rules set out for effective management of the stock(s)?	**12.5**	**80**
60	Decision-making is logical and appropriate but decision rules have not necessarily been formally documented or tested.	Industry and DFO decisions are well coordinated, and effectively used to protect the long term sustainability of the stock. Decision rules are discussed within the Offshore Scallop Advisory Committee (OSAC) and confirmed by DFO and reported in annual management plans. The safety margin provided by the established harvest shares is incorporated into the enterprise allocation scheme and provides little incentive to exert excess effort and overexploit the stock. The TAC is reduced when stock biomass is low, hence the TAC fluctuates with stock abundance. For example, Browns South has been closed due to low adult abundance. Significant juvenile abundance there will see this part of the Bank re-open when these scallops grow to commercial size. The survey measures the abundance of Age 2 and 3 scallops, and provides a two-year window allowing the industry to react in advance of fluctuations of incoming recruitment. Voluntary seed boxes, a strategy developed in this fishery whereby the industry agrees to close areas with high concentrations of juvenile scallops (refer to Seed Box Presentations), provides protection for juvenile scallops and eventually provides the industry with higher yields for a given level of recruitment, at a lower harvesting cost.		
80	Clear decision making rules are used, are fully documented, but may not have been fully tested. Decision rules are reconciled with reference points and with data and assessment limitations.			
100	Clear, documented and tested decision rules are fully implemented, are fully consistent with reference levels and with data and assessment limitations. The decision rules are evaluated periodically.			

SCORING INDICATORS		Comments	Weight	Score
1.1.3.8		Are appropriate management tools specified to implement input and/or output controls?	**12.5**	**95**
60	Management tools exist to implement input and/or output controls. Some evidence exists to show that tools are implemented and are effective in achieving management goals.	Input control is through a rigorous limitation on fleet size, fleet capacity and days on the grounds. Output control is through TACs, rolling TACs, and meat counts and the voluntary tolerance levels imposed on these. Landings are 100% DMP monitored, and overruns are deducted from following year's allocation. An effective transfer system is in place. The status of the stock indicates that this fishery is being successfully managed.		
80	Management tools have been specified to implement input and/or output controls. These are generic although some attempt has been made to relate them to the specific fishery OR tools are lacking in some details but are specifically related to the fishery. Evidence exists to show clearly that tools are implemented and effective in maintaining the stock at or above appropriate reference levels.			
100	Management tools, appropriate to the species and fishery, have been specified to implement input and/or output controls. These tools are implemented in a responsive, relevant and timely manner. Performance of the tools has been evaluated and evidence exists to show clearly that the management system has a high probability of achieving its objectives.			

SCORING INDICATORS	Comments	Weight	Score

1.1.4		The stock is/are at an appropriate level to maintain long-term productivity.	16.7	100
1.1.4.1		Is there evidence that stock status is consistent with that providing long-term productivity? **[YES - Criteria 1 is complete. NO - Answer Criteria 2]**	100	100
60	The stock is likely to be above limit reference levels or their proxies and trends in the stock are stable or positive.	The stock appears to be above the long term mean levels for the last half century. In fact, the current fishing strategy utilising multibeam mapping data seems to have reduced exploitation on some areas of the bank where bottom type is less favourable for scallop populations. The age and size structure of the population is now dominated by larger, older scallops than in the 1980's. Annual recruitment is of course variable and impossible to predict accurately, but enclosing dense patches of new recruits within seed areas provides a safety margin for the fishery, and a potential source of spawners. The most recent stock evaluations show that the survey abundance levels are above the long term median level, if not on a continuing upward trend. CPUE is also rising.		
80	The stock is likely to be above reference levels, including precautionary levels, consistent with data limitations.			
100	The stock is highly likely to be consistently above precautionary reference levels.			

SCORING INDICATORS	Comments	Weight	Score

1.3 *(MSC Criterion 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.**		**33**	**90**
1.3.1	**Fishing activity maintains the age, genetic structure or sex composition of the stock to a degree that does not impair reproductive capacity.**		**100**	**90**
Weighting Commentary	All Performance Indicators within this sub-criterion are considered of equal significance.			
1.3.1.1	Is the size/sex/genetic structure of the stock monitored to detect significant impairment of reproductive capacity?		**50**	**90**
60	Some monitoring of size/age/sex and/or sub-populations is conducted and evaluated periodically.	Data on size (shell height) is regularly collected from the surveys. (See DFO 2008c). There is information available on the sex and size structure, and the relationship of these biological indicators to reproductive capacity is generally understood. It is unlikely that there are completely separate sub-populations on the Canadian and US sides of the Bank which almost certainly form a metapopulation, hence US regulatory measures on the other side of the boundary will affect the reproductive potential. The US industry/government has acted in a precautionary fashion, and implemented closures and rotating harvest schemes over the last decade that should improve recruitment. Genetic studies have been conducted (e.g., Foltz and Zouros 1984; Beaumont and Zouros 1991; Kenchington et al 2006). It is recommended that research consultations, or the exchange of information with the US counterparts on management measures as they affect the entire population of Georges Bank, be organized from time to time. The current status of the stock appears to ensure that the minimum biomass for successful reproduction is being maintained.			
80	Estimates are available of the size and sex structure, based on adequate sampling and verification for this stock, and the relationship of these to reproductive capacity. Monitoring is continuing to collect such information on a time scale appropriate to the species and fishery. Genetic or sub-population studies have been carried out.			
100	There is comprehensive and reliable information on the sex/age/genetic structure of the stock, and the relationship of these to reproductive capacity. Population structure is well estimated with only insignificant errors.			

SCORING INDICATORS		Comments	Weight	Score
1.3.1.2		Does information indicate any changes in the genetic structure or demography of the stock that would alter reproductive capacity?	**50**	**90**
60	Changes in stock structure have been detected but there is no evidence of negative effect on recruitment of the stock. Or potentially adverse changes in structure are identified and remedial measures are implemented, but their effectiveness may not be demonstrated.	As mentioned, it is unlikely that there are completely separate sub-populations on the Bank, which probably can be considered a metapopulation with several spawning centres. There is no evidence that, as now conducted, the fishery is affecting the genetic structure or demography of the scallop population. In fact the proportion of larger scallops in the stock may have increased towards levels that prevailed in the unexploited population, at least within closed areas. The highly aggregated stocks on Georges Bank suggest that, currently, a high fertilization success is likely (Stokesbury 2000). As expected for sedentary bivalves, there is no conclusive evidence for a predictive stock recruitment relationship. Although such a relationship is suggested by the work of MacGarvey et. al. (1993), the main cause of recruitment variation appears to be environmental change. There is evidence of recent above-average incoming recruitment (Age 2) on both Georges and Browns Banks. There is also evidence of new recruits on German Bank from lined tows. There is no genetic evidence that the stocks of scallops on the offshore banks are sub-stocks. However, based on local distribution factors and differences in population biology – maturation, growth rates etc. separate stocks have been defined as Scallop Fishing Areas. Separate assessments TACs, rolling TACs and meat counts are applied for each Scallop Fishing Area. The age structure of the stocks, using data from surveys and commercial landings, is monitored within each Scallop Fishing Area. While determining ages has been recognised as deficient, a means to improve it appear to be on hand. It has been assumed that fishing has not altered sex and genetic structure. There is no indication of any fishery-related changes in the stock structure that would impair reproductive capacity.		
80	Evidence exists that the fishery has not caused changes in stock structure that would affect recruitment. Or potentially adverse changes in structure are clearly identified and effective remedial measures are implemented.			
100	Data strongly indicate a robust age, sex and genetic structure in the stock, such as would maintain reproductive capacity.			

SCORING INDICATORS	Comments	Weight	Score
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**	**33.3**	**82**
2.1 *(MSC Criterion 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 change.**	**33.3**	**80**
2.1.1	**There is adequate determination of ecosystem factors relevant to the geographical scale and life history strategy of the target species.**	**25**	**86**
Weighting Commentary	The three MSC Criteria are given equal weightings. Sub-criteria under MSC Criterion 2.1 are also weighted equally except 2.1.3, relating to habitat impacts, which is given more weighting than 'ghost fishing' – habitat impact being a higher concern in a demersal mobile gear fishery.		
2.1.1.1	Is the nature and distribution of habitats relevant to the fishing operations known?	**25**	**95**
60 Some information exists on the habitats on the fishing grounds but it is neither detailed nor comprehensive. The general distribution of the benthic habitat that supports the targeted stock is known.	Over 90% of the annual TAC in recent years is taken from Georges, Browns and German Bank. The habitat of these three banks has been mapped cooperatively with high precision (within a few meters) by DFO, NRCan and industry using multibeam technology (e.g. Kostylev et al. 2001). Scallops are most abundant on gravel habitat and this can be mapped with high precision using multibeam backscatter data (Kostylev 2003). These data are used by industry to direct fishing operations to specific areas with the highest concentrations of adult scallops. Some multibeam data are available for the eastern Scotian Shelf but complete coverage of the scallop beds is not available. There is no multibeam data for St. Pierre Bank. Extensive sidescan, photographic, video and grab surveys have been done over the years at specific locations on Georges Bank and the Scotian Shelf but very few if any have been conducted on St. Pierre Bank. Therefore, with the exception of St. Pierre Bank, the nature and distribution of habitat relevant to the fishing operations is quite well known, in part because of the investment made by the fishing industry in multibeam technology. St. Pierre is the least understood of all the banks where fishing takes place.		
80 The nature and distribution of habitat types on the fishing grounds are known in moderate detail. The distribution of the benthic habitat critical to the targeted species is known and monitored.			
100 The nature and distribution of habitat types on the fishing grounds has been mapped in detail. The distribution of benthic habitat critical to the targeted species fishing operations is monitored with high spatial precision.			

SCORING INDICATORS		Comments	Weight	Score
2.1.1.2		Is information available on non-target species which are incidentally caught or otherwise directly affected by the fishery?	**25**	**80**
60	The main non-target species affected have been identified.	Species composition of bycatch (both fish and invertebrates) is known from the observer program but this is limited to Georges Bank. Good information is available on the biology, distribution and population dynamics of the most abundant bycatch species, particularly groundfish (i.e. haddock, cod and yellowtail). The benthic communities on the banks fished for scallops are generally well described, especially on Georges and Browns Bank (e.g. Thouzeau et al. 1991, Kostylev et al. 2001), including information on their distribution and ecology. Some proportion of non-target species could be killed or damaged by the scallop gear. Damaged organisms may fall prey to scavengers or suffer reduced biological fitness. There are no direct measurements of this impact but estimates could be made based on the results of experimental studies conducted elsewhere. The score could have been higher if all bycatch data currently collected were processed, if bycatch data were collected from all the banks that are fished and if some estimates of incidental mortality of non-target species had been provided.		
80	Appropriate information is available on non-target species directly affected by the fishery including some information on their distribution and ecology.			
100	Information is available on all non-target species directly affected by the fishery including their distribution and ecology.			

SCORING INDICATORS		Comments	Weight	Score
2.1.1.3		Is information available on the trophic position, status and relationships of the target species within the food web?	**25**	**95**
60	Key prey, predators and competitors are known.	The sea scallop has been the subject of extensive research. Not only is it an important fishery but it is also being developed for aquaculture. It is also a valuable species for impact assessment studies. Therefore its biology, life history and ecology are very well known and documented in the scientific literature (e.g. Shumway et al. 1987, Barbeau et al. 1994, Tremblay et al. 1994, Stewart and Arnold 1994, Dibacco et al. 1995 and Cranford et al. 2003). The sea scallop was one the principal organisms studied during the four year (1990-1994) Ocean Production Enhancement Network (OPEN) project funded by NSERC involving universities, government and industry partners. While extensive, knowledge of the role of scallops in the food web is not complete hence the score associated with this PI.		
80	Information is available on significant aspects of the position, relationships and importance of target species in the food web at key life stages.			
100	Information is available on the position and importance of the target species and relationships within the food web at key life stages. Specific information is available on major interactions.			

SCORING INDICATORS		Comments	Weight	Score
2.1.1.4		Is there information on the potential for the ecosystem to recover from fishery related impacts?	**25**	**80**
60	Key elements of the functioning of the ecosystem, relevant to the fishery, are identified.	Scallop dredges disturb the seabed ecosystem, both habitat and communities. With the exception of St. Pierre Bank, seabed habitat and communities in the area under assessment are relatively well understood, especially on Georges and Browns Banks (e.g. Thouzeau et al. 1991, Kostylev et al. 2001). While no directed studies of scallop dredge impacts have been conducted in the area under assessment, the expected impacts can be estimated from the results of other studies (e.g. DFO 2006f). Estimates of the recovery time of benthic communities could be made from knowledge of life history traits and growth rates, but these would probably be quite approximate. No direct recovery studies have been done on seabed ecosystems disturbed by scallop dredges in Canadian waters. However, recovery studies have been conducted in US waters on Georges Bank (Collie et al. 2005), just across the Hague Line. This study followed changes in benthic megafauna in Closed Area II which had been fished for many years but was closed in 1995. Significant shifts in species composition and increases in abundance, biomass, production and epifauna cover were documented over a five year period. Their results suggest that recovery from fishery related impacts is possible but that the full recovery time of gravel habitats on Georges Bank is on the order of 10 years. The habitat template model of Kostylev and Hannah (2007) suggests that recovery rates on the other banks fished for scallops could be slower because of less favourable growing conditions. Additional information on ecosystem recovery after disturbance by fishing gear is available from Canadian experiments on the impacts of otter trawls (Gordon et al. 2005, Gordon et al. 2009) and hydraulic clam dredges (Gilkinson et al. 2003). The score could have been higher if there were direct observations of ecosystem recovery from scallop dredge disturbance in Canadian waters.		
80	The main elements of the functioning of the ecosystem and its ability to recover from fishery related impacts are understood.			
100	Detailed information is available on the potential for affected elements of the ecosystem to recover from fishery related impacts.			

SCORING INDICATORS	Comments	Weight	Score

2.1.2	General risk factors are adequately determined.	25	80
Weighting Commentary			
2.1.2.1	Is information available on the nature and extent of the by-catch (capture of non-target species)?	**33.3**	**75**
60	Appropriate qualitative information is available on by-catch species. This enables those species caught in significant numbers to be identified.	By-catch data are collected by the observer program but these data are limited to Georges Bank (60-80% of the TAC). Two observer trips are made each month (about 10% of the fishing trips). The observer program records the larger fish and invertebrates brought on board. Identification of taxa by observers is generally considered to be accurate although some groups are not identified to the species level. Approximately 150 fish and invertebrate taxa have been collected. Occurrence, weight and sometimes length of common fish are recorded. All data are archived in the DFO Virtual Data Centre. Information is available on the distribution and ecology of some bycatch species. The only quantitative information available is for yellowtail flounder, cod and haddock as these data are processed as part of the TRAC agreement with the US (e.g. Gavaris et al. 2007). Data on other bycatch species caught on Georges Bank have not been processed. Information is available on the distribution and ecology of some species. There are no bycatch data for the other banks being fished. The score could have been higher if all bycatch data currently collected were processed and if bycatch data were available from the all the banks that are fished.		
80	Information is available on non-target species directly affected by the fishery including their distribution and/or ecology. Quantitative information is available on significant by-catch. If obtained by sampling, this is considered sufficient to provide adequate information.		
100	Accurate records are kept on the nature and extent of all by-catch species.		

SCORING INDICATORS		Comments	Weight	Score
2.1.2.2		Is information available on the extent of non-retained catch (discards)?	**33.3**	**70**
60	Information is available of the extent of non-retained catch, sufficient to identify the likely significance of this.	Large scallops (100 mm+) are picked out of the catch by hand and processed. Undersized scallops are discarded over the side with the bycatch and rocks. There appear to be no quantitative data on the number of undersized scallops discarded or on their survival. However, observers apparently record an estimate to the total weight of discarded scallops. Tagging experiments in the US indicate that a substantial percentage of discarded scallops can survive if they are handled properly and returned to the water quickly. The level of discarding in the fishery is considered to be low. The industry practice of closing specific areas on Georges and Browns Bank to protect juvenile scallops until they mature should reduce the amount of discards. However, due to the lack of quantitative data, it difficult to estimate the significance of discarding. The score could have been higher if quantitative discard data were available and had been presented.		
80	Adequate information is available to allow estimates of the non-retained catch to be calculated and its significance interpreted.			
100	Accurate and verifiable information is available on the extent of all non-retained catch, and the consequences of these. Or the entire catch is landed.			

SCORING INDICATORS		Comments	Weight	Score
2.1.2.3		Is there information on any unobserved fishing mortality (i.e. sources of mortality other than those above)?	**33.3**	**80**
60	Areas of potential unobserved fishing mortality are identified but no further information is available.	Scallop dredges cause incidental mortality (i.e. scallops that come into contact with the gear but are not caught). This can be quite variable depending upon the type of dredge, how it is deployed and seabed properties (Caddy 1973, Murawski and Sherchuk 1989). It is also influenced by the efficiency of the dredge which is estimated to range from 20-55%. Estimates of incidental mortality are quite variable and available evidence indicates it can be as great as 25%. Incidental mortality is probably reduced by the industry practice of identifying seed beds during annual surveys and not fishing them until the scallops have matured. There is no ghost fishing. Scallops are rarely caught in otter trawls and therefore scallop bycatch by demersal fisheries is not an issue.		
80	Information from existing work has allowed qualitative estimates of unobserved fishing mortality to be made.			
100	Research has been carried out on unobserved fishing mortality allowing quantitative estimates to be made (or it is known that significant unobserved mortality does not occur).			

SCORING INDICATORS		Comments	Weight	Score
2.1.3	**There is adequate knowledge of the effects of gear-use on the receiving ecosystem and extent and type of gear losses.**		**25**	**81**
Weighting Commentary		The significance of lost gear was considered to be low in comparison to the physical impact of the gear on the habitat.		
2.1.3.1		Is there adequate knowledge of the physical impacts on habitat due to use of fishing gear?	**95**	**80**
60	Main impacts of gear use on habitat are identified or can be estimated, including extent and locations of use.	Fishing effort is directed to gravel beds where scallops are most abundant. Scallop dredging does cause considerable disturbance to gravel habitats, which can be readily seen in sidescan sonograms, but no directed studies of the level of immediate impact and recovery have been conducted in Atlantic Canada. Nevertheless, research with other gears and in other regions serves as a good basis for estimating immediate impacts and recovery periods for scallop dredge disturbance of gravel habitats (e.g. Gordon et al. 2006, Collie et al. 2005). The annual disturbance footprint of this fishery has been substantially reduced in recent years. The fleet has been reduced from 68 active vessels in 1986 to 18 in 2007. The location of gravel habitats on Georges, Browns and German Banks has been mapped with high precision with multibeam sonar and only prime scallop habitat is now fished on these banks. This has resulted in a substantial reduction in effort (Pickrill and Todd 2000). Detailed information on the timing and distribution of fishing effort is collected by VMS (hourly) installed on all vessels in the fleet. This score could have been higher if directed studies of scallop dredge impacts on habitat and recovery had been conducted in Canadian waters.		
80	Impacts of gear use on the habitat are identified or can be reliably estimated including reliable information on the extent, timing and location of use.			
100	The physical impacts on the habitat due to use of gear have been studied and quantified, including details of any irreversible changes.			

SCORING INDICATORS		Comments	Weight	Score
2.1.3.2		Is any gear lost during fishing operations and are any effects known (e.g. can 'ghost fishing' occur)?	**5**	**95**
60	Some recording of gear losses takes place and an assessment can be made of ecosystem impacts, including 'ghost fishing'.	Loss of gear is rare and all possible attempts are made to recover it. Any lost gear not retrieved will not continue to fish. Incidents of lost gear are logged and reported.		
80	There is knowledge of the type, quantity and location of gear lost during fishing operations. Estimates made show that losses do not cause unacceptable impacts on the ecosystem.			
100	There is detailed knowledge of the type, quantity and location of gear types lost during fishing operations. The impact of gear loss on target and non-target species can be shown to have negligible effects on habitats, ecosystems or species of concern through for example 'ghost fishing'.			

SCORING INDICATORS		Comments	Weight	Score
2.1.4		**Assessments of impacts associated with the fishery including the significance and risk of each impact show no unacceptable impacts on the ecosystem structure and/or function, on habitats or on the populations of associated species.**	**25**	**79**
Weighting Commentary		All Performance Indicators within this sub-criterion are considered of equal significance with the exception of 2.1.4.5, relating to management strategies to identify and avoid/reduce impacts on the ecosystem which is weighted higher.		
2.1.4.1		Does the removal of target stocks have unacceptable impacts on ecosystem structure and function?	**18.5**	**85**
60	The removal of target stocks could lead to impacts upon ecological systems (applying the precautionary approach where necessary). A programme is in development to identify these and, if appropriate, reduce mortality to acceptable limits.	Scallops are suspension feeders that filter out phytoplankton and detritus from the bottom of the water column. Since, where abundant, scallops tend to dominate benthic biomass, the removal of a portion of the adult scallops might increase the food supply for other suspension feeders in the benthic community. While juvenile scallops fall prey to various invertebrates and demersal fish (Stewart and Arnold 1994), adult scallops do not appear to be important prey items for other key species. Scallops are harvested from only a portion of the available beds each year (less than 25%) and it appears that stocks have a reasonable chance to recover before a given area of seabed is fished again. Overall, it appears that current removals of the target species are not having unacceptable impacts on ecosystem structure or function.		
80	Sufficient information is available on consequences of current levels of removal of target species to suggest no unacceptable impacts of the fishery on ecological systems within major fishing areas.			
100	The ecological consequences of current levels of removal of target stocks have been evaluated and determined to be within acceptable limits.			

SCORING INDICATORS		Comments	Weight	Score
2.1.4.2		Does the removal of non-target stocks have unacceptable impacts on ecosystem structure and function?	**18.5**	**75**
60	The removal of non-target species could lead to impacts upon population status and/or ecological systems (applying the precautionary approach where necessary). A program is in place to identify these and, if appropriate, reduce these to acceptable, defined limits.	Data on the removal of non-target species (i.e. bycatch) by the offshore scallop fishery is collected by the observer program for Georges Bank. However, bycatch data are not collected on the other banks that are fished. Despite the high selectively of scallop dredges, on the order of 6% of the catch (minus rocks) is composed of invertebrate and finfish bycatch. Approximately 150 taxa have been collected to date. Major species of concern on Georges Bank are yellowtail flounder, cod and haddock and these are the only bycatch data processed. Observer data for other common bycatch species such as monkfish and skate have not been routinely processed. Stocks of yellowtail, cod and haddock have been depressed in recent years and the extent to which scalloping may have played a role is unknown. However, haddock is showing signs of recovery. It is judged that sufficient information is not available at this time to conclude that removal of non-target species is not having unacceptable impacts on the populations of other resource species or the ecosystem. The industry has recently taken significant steps to reduce bycatch. Experiments have been conducted with alternate gear configurations to reduce bycatch (McIntyre et al. 2006, Walsh 2008). Time/area closures to scalloping are in place for cod and yellowtail flounder on Georges Bank to reduce bycatch during periods of spawning. Bycatch reserves have been established. The score could be higher if all bycatch information was processed and bycatch data were available for the other banks fished.		
80	Sufficient information is available on consequences of current levels of removal of non-target species to suggest no unacceptable impacts of the fishery on population status and/or ecological systems within major fishing areas.			
100	The consequences of current levels of removal of non-target species on population status and/or ecological systems have been evaluated and determined to be within acceptable limits			

SCORING INDICATORS		Comments	Weight	Score
2.1.4.3		Does the fishery have unacceptable impacts on habitat structure?	**18.5**	**75**
60	There is no evidence that the fishery is having unacceptable impacts, based on a reasonable understanding of the fishery, although the issue has not been directly studied.	The scallop fishery is focused on gravel seabeds which are high energy areas subjected to considerable natural disturbance through currents and waves. Because of their size, weight and mode of operation, scallop dredges do damage habitat structure, both physical and biological. No directed experiments on the extent of habitat damage have been conducted in the area under assessment but estimates can be made from other studies. For example, it can be expected that sediments clasts are displaced, microhabitat features are flattened out and fine sediment resuspended. Gravel seabeds have a high proportion of structure-forming epifauna and these are especially vulnerable to disturbance by scallop gear (DFO 2006f). However, most of the epifauna are relatively small and larger forms such as deepwater corals are not found on scallop beds. It appears that habitat structure can recover if the seabed is left undisturbed for a period on the order of 10 years. Due to the rotational nature of the fishery, it appears that a given area of the seabed may lie fallow for several years before being redredged which will allow some opportunity for recovery before repeated disturbance. The scallop beds on Georges, Browns and German Banks have been mapped in detail using multibeam sonar and these proprietary data are shared among the clients of this assessment. Therefore, vessels can target fishing activity on the highest concentrations of scallops. As a result, the spatial footprint of the fishery has been reduced markedly in recent years on these three banks. However, this is not true on the other banks fished which do not have complete multibeam coverage. Many of the scallop beds exploited today have been fished for many years and it might be that the habitat found today is different, and less sensitive to dredge disturbance, to that existing before the fishery began. While the current healthy state of scallop populations might suggest that disturbance by dredges is not having unacceptable impacts on habitat, this might not be true for other species sharing the same habitat. There is not sufficient information at this time to judge whether the observed impacts on habitat are acceptable or not. This score could have been higher if directed experiments on the impacts of scallop dredges on habitat had been conducted in Canadian waters.		
80	Sufficient information is available on the consequences of the fishery to suggest no unacceptable impacts upon habitats within major fishing areas or on sensitive habitats elsewhere.			
100	Effects on habitat structure are well documented and are within acceptable tested/justified limits.			

SCORING INDICATORS		Comments	Weight	Score
2.1.4.4		Are associated biological diversity, community structure and productivity affected to unacceptable levels?	**18.5**	**75**
60	There is no evidence that the fishery is having unacceptable impacts, although the issue has not been directly studied.	Observations on the Digby scallop grounds indicate that fishing disturbance, both scallop dredging and otter trawling, over a 30 year period has changed the composition of the megabenthic community as sampled by a scallop dredge (Kenchington et al. 2007). There was a relative decline in fragile, sessile and colonial species and an increase in robust, mobile grazers and scavengers. However, no species were extirpated. While the gears and communities are not directly comparable, similar results could be expected for offshore scallop beds. Changes in community structure as a result of fishing disturbance, including scalloping, have also been suggested for Georges Bank (Collie et al. 2005). There also is evidence that fishing disturbance has reduced the benthic productivity of Georges Bank (Hermsen et al. 2003). The overall significance of these demonstrated impacts depends upon the spatial and temporal pattern of the dredging disturbance. Because the annual disturbance footprint appears to be relatively small (at least for the three banks where multibeam data are available) and apparently rotates within a given fishing bank from year to year, the spatial extent of impacts appears to be much less than just a few years ago. Data are available that allow the spatial and temporal pattern of the fishery to be determined in great detail but this has not yet been done. If left undisturbed, it has documented on Georges Bank that the benthic community has the ability to recover in a period of time on the order of 10 years (Collie et al. 2005). However, recovery rates could be lower on the other banks fished because of less favourable growing conditions (Kostylev and Hannah 2007). There is not sufficient information at this time to judge whether the observed impacts of scalloping on biological diversity, community structure and productivity are acceptable or not. This score could have been higher if directed experiments on the impacts of scallop dredges on benthic communities had been conducted in Canadian waters.		
80	Sufficient information is available on the consequences of the fishery on biological diversity, community structure and productivity. This does not indicate any unacceptable impacts.			
100	The effects of the fishery on biological diversity, community structure and productivity have been quantified and are within acceptable tested/justified limits			

SCORING INDICATORS		Comments	Weight	Score
2.1.4.5		Are management strategies in place to address impact identification and avoidance/reduction?	**25.9**	**85**
60	Management strategies include some appropriate consideration of ecosystem impact identification and avoidance/reduction, but may not be tested.	Steps are being taken to minimize the annual footprint of the dredging disturbance. Using multibeam technology, industry is reducing its overall effort and concentrating on gravel habitats with the highest densities of scallops. Industry is also identifying sensitive seed areas which are not fished until scallops have matured. The industry practices an informal rotational harvesting scheme which gives disturbed habitats and communities some opportunity to recover before being dredged again. Rotational fishing of the same scallop beds helps to reduce ecosystem impacts. Steps are being taken to reduce bycatch and these include gear modification, area/time closures and bycatch restrictions. Area/time closures have been established on Georges Bank to protect yellowtail flounder and cod during their spawning season. Bycatch reserves have been established by DFO for yellowtail flounder, cod and haddock on Georges Bank. At least one of the clients, Clearwater Seafoods Limited Partnership, has implemented a bycatch avoidance protocol which is in force on all their vessels.		
80	Management strategies are in place to detect and reduce ecosystem impacts, although these may not have been fully tested, they are considered appropriate to adequately protect key elements of the ecosystem within main fishing areas.			
100	Management strategies are in place to monitor, detect and reduce impacts. These are designed to adequately protect ecosystems, habitats and populations of target and non-target species and keep impacts within determined acceptable levels.			

SCORING INDICATORS		Comments	Weight	Score
2.2 *(MSC Criterion 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.**	**33.3**	**83**
2.2.1		**Fishing is conducted in a manner, which does not have unacceptable impacts on recognised protected, endangered or threatened species.**	**50**	**81**
Weighting Commentary		Within this Criterion, all Sub-criteria and Performance Indicators are weighted equally.		
2.2.1.1		Is there information on the presence and populations of protected, endangered or threatened species?	**33.3**	**90**
60	There is a programme in place to identify protected, threatened and endangered species directly related to the fishery. There is periodic monitoring of the main population trends and status of protected, endangered and threatened species.	The area under assessment has been extensively surveyed so there is an excellent understanding of marine species present, especially fish, reptiles and mammals. Species at risk are assessed under SARA with the assistance of COSEWIC. Several species currently listed by SARA frequent the area where the offshore scallop fishery takes place. Species of *special concern* include the Atlantic wolffish and the fin whale. *Threatened* species include the northern and spotted wolffish and harbour porpoise. *Endangered* species include the leatherback turtle, blue whale, northern right whale and northern bottlenosed whale. Information on these species at risk is obtained by various means, including surveys and research programs by government and university scientists. These include the DFO groundfish surveys. The industry-funded observer program also collects useful information. Several species of skate are currently being considered for listing under SARA. Cusk has been assessed as threatened by COSEWIC and is being considered for listing under SARA.		
80	Protected, threatened and endangered species directly related to the fishery have been identified. Populations are monitored on a regular basis.			
100	There is knowledge of all populations of protected species directly or indirectly related to the fishery including their dynamics. Regular monitoring of protected, endangered and threatened species is undertaken, supported by research programmes to assess threats and promote their conservation. The type and distribution of critical habitats have been identified.			

SCORING INDICATORS		Comments	Weight	Score
2.2.1.2		Are interactions of the fishery with such species adequately determined?	**33.3**	**80**
60	The main interactions directly related to the fishery are known.	The only species at risk identified to date in the observer data base for the scallop fishery are the Atlantic wolffish (species of special concern) and the spotted wolffish (threatened). However, they are caught in very small numbers such that the scallop fishery does not appear to provide a significant cause for concern. Cusk also occur in bycatch but the numbers are also very low. There are no reports of leatherback turtles being collected by scallop dredges. There is no evidence of scallop dredges directly impacting marine mammals. The observer program is limited to Georges Bank so there is no information on the possible presence of species at risk in scallop bycatch on other banks. This score could have been higher if bycatch data was collected and processed from the other banks fished.		
80	Appropriate estimates are made of the effects of interactions directly related to the fishery. There is a requirement to record and report all incidental mortalities.			
100	Reliable quantitative estimates are made of the interactions of all populations directly related to the fishery, and qualitative information is available on indirect impacts. Incidental mortalities are recorded and reported.			

SCORING INDICATORS		Comments	Weight	Score
2.2.1.3		Do interactions pose an unacceptable risk to such species?	**33.3**	**80**
60	Known interactions are within acceptable limits of national and international legislative requirements and are believed to create no biological threats to the species concerned.	Observer data from Georges Bank indicate that two species at risk are caught in scallop dredges: the Atlantic wolfish (special concern) and the spotted wolfish (threatened). The numbers are relatively low and do not appear at this time to cause a threat to these protected species. The captain interviewed said that leatherback turtles are never caught. Data are not available for other banks but the fact that they are dredged less intensively suggests that any adverse impacts could be lower. The score could have been higher if bycatch data was collected and processed from the other banks fished.		
80	Direct and indirect effects are well estimated and do not threaten protected species.			
100	It is known that the direct and indirect effects of fishing on threatened and endangered species are within acceptable limits.			

SCORING INDICATORS	Comments	Weight	Score

2.2.2	**Strategies have been developed within the fisheries management system to address and restrain any significant impacts of the fishery on protected, endangered or threatened species.**		**50**	**85**
2.2.2.1		Are management objectives and accompanying strategies in place in relation to impact identification and avoidance/reduction?	**100**	**85**
60	Management systems are in place to address key areas of impact identification and avoidance/reduction.	SARA procedures are in place to assist in the protection of species at risk. DFO recently conducted a recovery potential assessment for cusk (DFO 2008b).		
80	Management objectives are set to detect and reduce impacts. Accompanying strategies are designed to adequately protect endangered and threatened species within main fishing areas.			
100	Tested management objectives are set to detect and reduce impacts Accompanying strategies are designed to adequately protect endangered and threatened species.			

SCORING INDICATORS	Comments	Weight	Score

2.3 *(MSC Criterion 3)*		**Where exploited populations (of non-target species) 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.**	**33.3**	**83**
2.3.1		**There are management measures in place that allow for the rebuilding of affected populations.**	**100**	**83**
Weighting Commentary		All Performance Indicators within this sub-criterion are considered of equal significance.		
2.3.1.1		Is there sufficient information to allow determination of necessary changes in fishery management to allow recovery of depleted populations?	**33.3**	**80**
60	There is some information on functional relationships, sufficient to allow alterations to be made to fishing to recover and rebuild depleted species.	In this instance, depleted population refer to groundfish such as yellowtail flounder, cod and haddock. Management measures have been taken in other fisheries to promote the recovery of these stocks in the area of focus. These include reductions in effort and closed areas, which have been implemented with mixed success. Haddock shows excellent recovery while stocks of yellowtail flounder and cod remain at low levels throughout the area of assessment. The possible impacts of scallop bycatch on recovery have been explored. Data on yellowtail flounder, cod and haddock bycatch are collected by the observer program and these are subtracted from TACs (Gavaris 2007). Area/time closures in the scallop fishery have been explored to help reduce yellowtail flounder and cod bycatch (DFO 2007), and efforts to reduce bycatch seem to be working. However, the fact that some species are not recovering suggests some gaps in our understanding. It should be noted that recovery of stocks is also strongly influenced by natural factors (i.e. temperature).		
80	There is adequate information, combined with a precautionary approach wherever necessary, to allow alterations to be made to fishing that would be expected to recover and rebuild depleted species to specified levels within appropriate timeframes.			
100	There is a clear understanding of functional relationships between the impacted population and the fishery. Intervention measures based on this understanding have been tested and/or are known to be effective in promoting recovery of depleted species to specified levels within appropriate timeframes.			

SCORING INDICATORS		Comments	Weight	Score
2.3.1.2		Are management measures in place to modify fishery practices in light of the identification of unacceptable impacts?	**33.3**	**90**
60	A mechanism exists for the modification of fishing practices in light of the identification of unacceptable impacts	The three bycatch species of most concern on Georges Bank (cod, yellowtail flounder and haddock) are managed by the Canada/US Transboundary Resource Assessment Committee (TRAC). Bycatch of these species is closely monitored using data collected by the observer program (Gavaris et al. 2007). Bycatch data are now included in annual scallop assessments (e.g. DFO 2008c) which provide advice to fisheries managers and industry. Efforts continue to reduce bycatch. Industry appears to be able to react quickly to meet conservation goals.		
80	Effective management measures are in place to modify fishery practices in light of the identification of unacceptable impacts.			
100	Monitoring programs are in place within the management system to allow the timely modification of fishery practices in light of the identification of unacceptable impacts. Objectives and limits for environmental change are used to guide operational practices. It is demonstrated that these are effective.			

SCORING INDICATORS		Comments	Weight	Score
2.3.1.3		Do management measures allow for recovery of affected populations?	**33.3**	**80**
60	Rebuilding measures based upon appropriate information exist and are being implemented. Measures may not have been tested, but are considered appropriate.	Appropriate rebuilding measures have been implemented. Area time closures to reduce bycatch and aid rebuilding of depleted stocks are in place. The fact that not all species have recovered, despite management intensions, indicates faults in our management approach, lack of understanding of key environmental factors, or failure of industry to compile with regulations. It should, though, be noted that compliance with regulations is reported as being very high, while management has been working to reduce bycatch. It is possible, therefore, that the failure of some species to recover is due to adverse environmental conditions.		
80	Appropriate rebuilding measures based upon appropriate information have been implemented to specified timescales. Measures have been tested and can be shown to be effective in assisting to rebuild the affected populations.			
100	Appropriate rebuilding measures are being implemented to promote recovery as quickly as is possible. Additional measures are being implemented to prevent problems in the future.			

SCORING INDICATORS		Comments	Weight	Score
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**	**33.3**	**87**
3A		**Management System Criteria**	**50**	**88**
Weighting Commentary		Management System criteria (3A) and Operational Criteria (3B) are considered of equal significance. Within 3A, Sub-criteria (3.A.1) and (3.A.8) are considered to be most important and issues of incentives and subsidies (3A.4) least as subsidies are not known to operate within the fishery.		
3A.1 (*MSC Principle 3 Intent and Criterion 3*)		**A management system containing an institutional and operational framework exists with clear lines of responsibility.**	**25.6**	**92**
3A.1.1		Are organisations with management responsibility clearly defined including areas of responsibility and interactions?	**50**	**100**
60	Organisations with management responsibility are known. Responsibilities and interactions may require clarification but are effective in critical areas.	The Canadian constitution grants legislative authority for the management of seacoast and inland fisheries to the Parliament of Canada. There are several pieces of legislation that apply to the fishing industry, the major one being the *Fisheries Act*, R.S. 1985, c. F-14C. That *Act* grants wide discretionary authority to the Minster of Fisheries and Oceans and provides the Governor in Council (for all practical purposes, the government in power) the authority to enact regulations respecting the management of the fishery. The *Atlantic Fishery Regulations*, 1985 and the *Fishery (General) Regulations* are the main regulations 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. 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. A network of scientists, resource managers, monitoring, control and surveillance staff are responsible for the administration of fishery management programs. There is an effective industry advisory committee, the Offshore Scallop Advisory Committee (OSAC), which is composed of the significant stakeholder and other interested parties. This committee reviews DFO assessments and fishery performance data and develops recommendations to the DFO on annual total allowable catches (TAC) and management measures. Annual management plans are drafted and approved by the DFO.		
80	Organisations with management responsibility have been defined including key areas of responsibility and interaction.			
100	Organisations with management responsibility are clearly defined including all areas of responsibility and interaction. Interactions are demonstrably effective.			

SCORING INDICATORS		Comments	Weight	Score
3A.1.2		Is the system consistent with the cultural context, scale and intensity of the fishery?	**16.7**	**100**
60	Inconsistencies may arise in some key areas but a programme is in place to address these.	The system is fully in line with the geographical, structural and cultural features of the fishery This is an offshore fishery conducted by a fleet of 6 freezer vessels and 12 vessels without freezing capability (wetfish vessels), ranging from 90-130 feet overall. The total crew complement of the vessels is around 350, most of which are year-round jobs. The fishery was once composed of some 68 active vessels exerting intense fishing effort on the fishery. Through an EA program, the fishery has rationalized over a 20 year period. Licences and quotas have been established for decades. Through an agreement in 1986, the inshore and offshore fisheries divided into separate mutually exclusive zones. There is no history of aboriginal participation in the offshore scallop fishery although representatives of Aboriginal Organisations and First Nations are members of OSAC. OSAC membership also includes crew union representatives, interested fishing organisations and provincial governments. OSAC meetings are open to the public.		
80	The system is consistent with key elements of the cultural context, scale and intensity of the fishery.			
100	The system is entirely consistent with the cultural context, scale and intensity of the fishery.			

SCORING INDICATORS		Comments	Weight	Score
3A.1.3		Is the management system subject to internal review?	**16.7**	**85**
60	There are mechanisms in place to allow for internal review	IFMPs are internally reviewed by the DFO and the industry through OSAC on a long term basis. The 2000 plan is currently under review and a final draft is expected during 2009. Annual management plans are under constant review by DFO and by OSAC members through the circulation of data from the DMP, dockside grading and meat-count programs. Adjustments are made as required. Surveillance and enforcement plans undergo regular internal review and fisheries are risk-rated for compliance to determine levels of coverage. The Regional Assessment Process (RAP) is by design an internal review of the scientific assessment process and conclusions. Its peer review meetings are a forum for challenging and testing the validity of scientific information and the process is designed to reach consensus on the available data. Hence, the methodology, assumptions and conclusions are put to a rigorous internal review. The score for this indicator would have been higher if a review mechanism at stated intervals was a documented and integral part of the management regime.		
80	The major components of the management system are subject to internal performance review and evaluation at appropriate intervals. Results of on-going evaluation of management performance are made public. Evaluation results demonstrate that the management system shows improvements.			
100	The management system is subject to regular and frequent internal review. This includes evidence that the assessment methodology has been evaluated extensively and that any recommended changes have been made. Monitoring and evaluation are ongoing and improvements quickly tested and implemented.			

SCORING INDICATORS		Comments	Weight	Score
3A.1.4		Is the management system subject to external review?	**16.7**	**80**
60	There are mechanisms in place to allow for external review.	The RAP provides for external parties to attend its deliberations upon application. All Stock Assessment Reports (SAR), Research Documents and proceedings documents are available for external review via the DFO website. The assessment methodology is subject to review with external participation usually on a 5 year basis. Offshore scallops will undergo such a review in 2009. Unless a majority of OSAC committee members say otherwise before a meeting starts, the proceedings of the Advisory Committee are open to the public and to media representatives. Provision has been made in the past for external parties to make presentations and representations. DFO advised that no party has ever been refused the option to attend meetings. The Canadian Auditor General can, and has in the past conducted reviews of the fisheries management regime on an *ad-hoc* basis, (see Auditor General of Canada, 1999. Fisheries and Oceans – Managing Atlantic Shellfish in a Sustainable Manner. Chapter 4 in Report of the Auditor General of Canada April 1999. 35pp) Internal and external reviews of the management regime are occasionally conducted by governments and universities. Two such reviews are Repetto, Robert, Yale University School of Forestry and Environmental Studies, *The Atlantic Sea Scallop Fishery in the U..S. and Canada: A Natural Experiment in Fisheries Management Regimes* and Stevens et al, DFO and Université du Québec à Romouski *The Evolution of Management in Canada's Offshore Scallop Fishery*. The score for this indicator would have been higher if there was a regular review mechanism in place to enable Canadian national fisheries management policy and processes to be reviewed by bodies external to DFO and the industry or outside of Canada		
80	The management system is subject to external review at appropriate intervals. Monitoring and evaluation are responsive to reviews.			
100	The management system is subject to regular and frequent external review. Monitoring and evaluation are ongoing and improvements quickly tested and implemented			

SCORING INDICATORS	Comments	Weight	Score

3 A.2 (*MSC Criteria 1, 2, 4*)	**The management system has a clear legal basis.**	**12.5**	**100**
Weighting Commentary	All Performance Indicators within this sub-criterion are considered of equal significance.		
3A.2.1	Is the fishery consistent with International Conventions and Agreements?	**33.3**	**100**

60	The management system operates under relevant international conventions and agreements, but some management actions may be questionable in relation to the terms of these.	This fishery takes place entirely inside Canada's 200 mile economic zone although a part of St. Pierre Bank is French (see Fig 2 – "Core Area"). following the June 10, 1992 decision of the Court of Arbitration for the Delimitation of Maritime Areas between Canada and The Republic of France, the two countries entered a Process Verbal governing their mutual fishing relations in part of NAFO subdivision 3Ps in which are found both Canadian and French maritime waters and which contains part of St. Pierre Bank. That document set out each country's responsibilities including: • Cooperation with respect to the conservation and management of stocks in 3Ps • Cooperation on research, exchange of information and communication of scientific data particularly on stock assessment • The establishment of an advisory committee composed of both states' regulatory authorities to make recommendations on TACs, conservation and management measures and monitoring, control and surveillance The agreement outlines shares for Iceland scallops (70% France - 30% Canada) in the zone but there are no sharing arrangements for sea scallops. Offshore scallop vessels are not permitted to retain Iceland scallops in the Core area (set out by lat/long in the licence) of SFA 11. Apart from this exception and the obligation to cooperate and to share information, there are no implications for sea scallops management in the Canadian zone. The management regime is 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. The management measures employed in this fishery - limited entry licensing, IFMP, by-catch control of non-target and endangered species, conservative quota management, low exploitation rates, respect of scientific assessments and advice, the implementation of sophisticated monitoring surveillance and enforcement systems – meet or exceed the principles of the FAO Code.
80	The management system appears to be in full compliance with international conventions and agreements.	
100	The management system is demonstrably compliant with all relevant international conventions and agreements.	

SCORING INDICATORS		Comments	Weight	Score
3A.2.2		Is the fishery consistent with national legislation?	**33.3**	**100**
60	The management system operates under relevant national legislation, but some management actions may be questionable in relation to the terms of these.	The management measures for the offshore scallop fishery are entirely compliant with all relevant national and regional fisheries acts and regulations, namely: • Fisheries Act, 1985 • Atlantic Fishery Regulations,1985 • Fishery (General Regulations) • Coastal Fisheries Protection Act, 1985 • Department of Fisheries and Oceans Act, 1985 • Atlantic Fisheries Restructuring Act, 1985 • Fishery (General) Regulations, 1993 • Aboriginal Communal Fishing Licences Regulations, 1993 • Oceans Act, 1996 • Species at Risk Act, 2002 • Fish Inspection Act and Fish Inspection Regulations • Commercial Fisheries Licensing Policy for Eastern Canada		
80	The management system appears to be in full compliance with national legislation.			
100	The management system is demonstrably compliant with all relevant national legislation.			

SCORING INDICATORS		Comments	Weight	Score
3A.2.3		Does the system observe the legal and customary rights of people dependent upon fishing?	**33.3**	**100**
60	The customary and legal rights of the people dependent upon fishing are known and no major conflicts have been identified.	The system observes all legal and customary rights of people dependent upon fishing pursuant to the legislative framework and subsequent agreements. While Aboriginal Organisation and First Nations have first access to fisheries for food, social and ceremonial purposes and while they are members of OSAC, there is no history of their people having participated in the offshore scallop fishery.		
80	The system observes the legal and customary rights of people dependent upon fishing but does not necessarily have a formal codified system.	Initial entry into this fishery by offshore vessels was focused almost exclusively on George's Bank with subsequent development of fisheries on Brown's and German Banks. In 1986, following a series of discussions between DFO and the offshore and inshore fleets, an agreement was reached that split the two fisheries at the 43º40'North Latitude line near Yarmouth. That agreement was upheld by the Federal Court of Canada in 1996. Since that time, both fleets have respected the agreement.		
100	The system observes all legal and customary rights of people dependent upon fishing under a formal codified system.	The fishery has respected the legal and customary rights of all participants throughout the development of its fishery over the past 20 years.		

SCORING INDICATORS	Comments	Weight	Score

3A.3 *(MSC Criteria 2, 5, 7)*	The management system includes strategies to meet objectives including consultative procedures and dispute resolutions.	**9.6**	**78**
Weighting Commentary	All Performance Indicators within this sub-criterion are considered of equal significance.		
3A.3.1	Does the management system contain clear short and long-term objectives?	**16.7**	**75**
60 Short and long-term resource and environment objectives are implicit within the management system.	The long term objectives of the offshore scallop fishery are clearly outlined in the 2000 IFMP: • ensure the conservation and restoration of the resource • to the degree possible, stabilize landings over time • provide increased economic benefits for crews, vessel owners, shore workers and the people of Canada The assessment team was unable to find documented short or medium objectives but several appear to be implicit in management measures and licence conditions contained in annual fishing plans: • limit exploitation rate • protect juvenile stock and maximize value • protect incoming recruitment • reduction of bycatch of vulnerable commercial species • data collection The score for this indicator would have been higher if long-term objectives were more current and short-term objectives were explicit, documented and public.		
80 The management system contains short and long-term resource and environment objectives.			
100 The management system contains clear and explicit short and long-term resource and environment objectives that can be measured by performance indicators.			

SCORING INDICATORS		Comments	Weight	Score
3A.3.2		Do operational procedures exist for meeting objectives?	**16.7**	**80**
60	Operational procedures exist which are applied to the meeting of objectives.	Detailed operational procedures exist to measure performance against objectives: • VMS to track vessel position • At-sea observer when required • Hail-out requirement • 100% dockside monitoring to track EAs/TAC • Offshore Scallop Monitoring Document mandatory • Detailed meat-count protocol • Closure of juvenile scallop areas (“seed boxes”) • Independent observer calculation of bycatch • Circulation of information to all operators (peer pressure) The score for this indicator would have been higher if procedures were more transparent and reporting was public.		
80	Transparent operational procedures are applied to the meeting of objectives. These procedures can be expected to support the objectives.			
100	Operational procedures are transparent and clearly applied. There is a feedback mechanism testing effective application.			

SCORING INDICATORS	Comments	Weight	Score

3A.3.3		Do procedures include for a precautionary approach in the absence of sufficient information?	**16.7**	**75**
60	Measures exist to implement a precautionary approach in the absence of sufficient information. There is some evidence that this is occurring.	The industry does implement a number of precautionary measures. This industry has recommended TAC levels below that allowed by the scientific advice. For the '08 fishery, a TAC of 5,500 tonnes was established for George's Bank "A", 1,000 tonnes lower than the maximum advised by the assessment. Voluntary closures are implemented by industry in two large areas of juvenile scallops reduces the risk of recruitment failure (SAR-2008, p11). In addition to the meat count limit of 33 meats per pound for George's, industry has further placed a tolerance limit on small scallops in an effort to protect future recruitment. Nevertheless, a formalized commitment to the application of the precautionary approach is missing in the IFMP.		
80	Appropriate, formalised measures exist and are implemented to apply a precautionary approach in the development and application of operational procedures in the absence of sufficient information.			
100	All procedures include for evaluation of uncertainty and application of precaution at an appropriate level.			

SCORING INDICATORS		Comments	Weight	Score
3A.3.4		Are there procedures for measuring performance relative to the objectives?	**16.7**	**75**
60	Operational procedures exist which can be used to measure performance relative to the objectives.	Biomass estimates are made annually using data from research cruises and meat count results. Fishery performance data is also available for George's Bank. Survey catch rates for pre-recruits, recruits and commercial sizes are reviewed. Cohort analysis is used to estimate the age structured population abundance and fishing mortality based on the survey index, commercial catch rates and age composition in the catch. (2008 SAR pp 8-9). Monitoring measures such as observer coverage, DMP, log books and VMS assist in measuring performance relative to the long-term objectives and the short-term implied objectives of bycatch, discarding, species-at-risk, seasons, area infractions, etc. The score would have been higher if objectives and specific performance indicators to meet fishery and habitat concerns were clearly outlined.		
80	There are appropriate evaluated procedures used for measuring performance relative to the objectives.			
100	Tested procedures are used for regular measurement of performance relative to the objectives.			

SCORING INDICATORS		Comments	Weight	Score
3A.3.5		Does the system include a consultative process including relevant and affected parties?	**16.7**	**80**
60	The system incorporates a consultative process including key stakeholders within the fishery.	The two major consultative processes in the offshore scallop fishery are the Regional Advisory Process (RAP), which is the process for the scientific review of the stock assessment, and the Offshore Scallop Advisory Committee, which is the DFO/stakeholder advisory committee. The RAP process is founded on the principles of rigour, impartiality, openness and transparency. The process is one of challenge and review of scientific information leading to objective consensus but the process is not intended to be a public information forum. Attendance is by invitation and key stakeholders are always present. Participation can also include individuals with user or traditional knowledge and non-government public interest groups. The process is intended to ensure that requests from knowledgeable participants would not be unreasonably refused. OSAC membership is widely varied and is composed of DFO scientists, fishery managers, and enforcement, a representative from the Canadian Food Inspection Agency (CFIA), the licence holders, some fishermen's associations, crew unions, Aboriginal Organisations & First Nations and provincial governments. Unless a majority of Committee members say otherwise before a meeting starts, the proceedings of the Advisory Committee are open to the public and to media representatives. Presentations and representations have been made in the past by interested parties and have been given consideration by the committee. There are routine operational working group meetings between DFO and the Seafood Producers Association of Nova Scotia (SPANS) as the representative of the licence holders to discuss practical protocols, prices, and day to day operational matters. The score on this indicator would have been higher if OSAC was open to the public as a matter of policy instead of the committee itself having the right to exclude non-members and the press.		
80	The system includes an appropriate consultative process including all main public and private stakeholders and can demonstrate consideration of representations made or a reliable mechanism for such considerations.			
100	The system incorporates an appropriate consultative process including all affected stakeholders. Decisions specifically discuss and/or address stakeholder concerns.			

SCORING INDICATORS		Comments	Weight	Score
3A.3.6		Is there an appropriate mechanism for the resolution of disputes within the system?	**16.7**	**80**
60	Mechanisms are theoretically adequate but have not been consistently applied or tested.	The management system is well defined by the legislation and the IFMP. Most disputes between the regulator and the industry and within the industry are resolved using the representational framework in the OSAC forum. Regional managers in 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. The score would have been higher if there was a clearly defined arbitration process with use of independent arbitrators.		
80	There is an appropriate and effective mechanism for the resolution of disputes within the system.			
100	There is an appropriate, effective and tested mechanism within the system for the documentation and resolution of disputes of varying magnitude.			

SCORING INDICATORS		Comments	Weight	Score
3A.4 *(MSC Criterion 6)*	The management system operates in a manner appropriate to the objectives of the fishery.		**1.7**	**100**
Weighting Commentary		All Performance Indicators within this sub-criterion are considered of equal significance.		
3A.4.1		Does the system include subsidies that contribute to unsustainable fishing?	**50**	**100**
60	Subsidies exist that may contribute indirectly to unsustainable fishing. These are short-term and are in the process of being removed within acceptable timescales.	There are no subsidies of any kind in this fishery.		
80	The system is free from subsidies that contribute to unsustainable fishing or ecosystem degradation.			
100	The system has no subsidies that contribute to unsustainable fishing or ecosystem degradation.			

SCORING INDICATORS		Comments	Weight	Score
3A.4.2		Does the system include economic/social incentives that contribute to sustainable fishing?	**50**	**100**
60	Measures to allocate fishing opportunities and/or entry to the fishery, or other incentives, are generally supportive of achieving fishery objectives related to sustainability.	There are powerful economic and social incentives that contribute to sustainable fishing and ecosystem management in this fishery. It is in the best interests of the participants to ensure that the fishery is managed for the long term. The fishing strategy of enterprise allocations provides strong incentives to preserve the stock for future economic opportunities, fish the resource at maximum yields without harming productivity and to avoid harm to the habitat and other species. The fleet is very conscious of the impact of its fishery on the environment and on other species encountered by its gear. The enhanced attention given to habitat issues has pressed the fleet to exert considerable effort to reduce its bottom impact footprint and reduce bycatch of major vulnerable and threatened species (see 3B.2.1 below for further details)		
80	Allocations of fishing opportunities and/or entry to the fishery, and/or other incentives, promote fishery and ecosystem management goals.			
100	The system has established economic and social incentives that contribute to sustainable fishing and ecosystem management.			

SCORING INDICATORS	Comments	Weight	Score

3A.5 *(MSC Criterion 8)*	A research plan exists in line with the management system to address information needs.		**9.6**	**80**
Weighting Commentary	All Performance Indicators within this sub-criterion are considered of equal significance.			
3A.5.1		Have key research areas requiring further information been identified?	**33.3**	**80**
60	Some major areas requiring further research have been identified.	The joint industry/government management approach to this fishery has resulted in all information requirements being identified for the management of the commercial fishery. Key research activities are constantly under review for this purpose. DFO/industry research programmes support the assessment and advice leading to research documents and DFO Science Advisory Reports. These documents are peer reviewed in the RAP process and made available to OSAC for consideration. Research issues and needs are identified in the process. Uncertainty issues are identified in the SAS and used to further refine the needs. A more explicit focus on the evaluation of ecosystem impacts would be useful.		
80	Key areas requiring further research have been identified.			
100	A comprehensive review of information requirements has been undertaken.			

SCORING INDICATORS	Comments	Weight	Score

3A.5.2		Is research planned/undertaken by the scientific advisers to meet the specific requirements of the management plan?	**33.3**	**80**
60	Research is planned for highest priority information needs and some capacity needs either exist or are programmed.	A DFO scientific survey funded by the industry is conducted on George's Bank. Information is gathered to assess the abundance and composition of the scallop stock. Meat count data is gathered by the DMP and, along with the fishery performance, data are used to produce commercial biomass estimates from which exploitation scenarios are derived. (2008 SAR p6). The observer programme on Georges Bank provides data on the target and non-target species. The research is well funded by the industry and the research program is closely linked to the management objectives outlined above in 3A.3.1 and (in addition to survey cruises) includes extensive fishing data collection by vessels, satellite tracking data, and catch size distribution of all fishing trips per year..		
80	Research is planned and undertaken to provide necessary scientific support to the plan. There are demonstrable resources to allow implementation of the programme.			
100	There is an ongoing, funded, comprehensive and balanced research programme, linking research to the management plan.			

SCORING INDICATORS		Comments	Weight	Score
3A.5.3		Is relevant research carried out by other organizations (e.g. Universities) and is this taken into consideration?	**33.3**	**80**
60	The management system is aware of research carried out by other organisations and elements of this are taken into consideration.	Research on the biology and assessment of offshore scallops in Canada is carried out by DFO in close cooperation with the offshore scallop operators. There is some literature on scallop research from other organizations in parts of the Northeast Atlantic including the Department of Oceanography at Dalhousie University in Halifax, at the University of Massachusetts, the Maine Department of Marine Resources and the National Marine Fisheries Service in the United States which may be taken into account where relevant. Research on groundfish stocks, regime shifts and climate change issues in Canadian waters, and on habitat, especially bottom contact and bycatch issues, is also carried out in DFO, and by some Canadian universities (e.g. Dalhousie, Nova Scotia, and Memorial, Newfoundland), and this is fully taken into account. The four year (1990-1994) Ocean Production Enhancement Network (OPEN) project funded by NSERC involved universities,(e.g. Memorial, Newfoundland and the University of New Brunswick) government and industry partners (including Clearwater). The two species studied were sea scallop and cod.		
80	Appropriate research carried out by other organisations is taken into consideration, although there is not necessarily any proactive co-ordination between organisations.			
100	Relevant research carried out by other organisations is taken into account for management considerations. This research is often co-ordinated with existing research plans of the management system.			

SCORING INDICATORS	Comments	Weight	Score

3A.6 *(MSC Criteria 7, 9, 10)*	The management system includes measures to pursue objectives for the stock.		**9.6**	**94**
Weighting Commentary	All Performance Indicators within this sub-criterion are considered of equal significance.			
3A.6.1	Are the resource and effects of the fishery monitored?		**33.3**	**90**
60	A monitoring programme is in place that addresses some key aspects of resource and effects and which can be extended.	Extensive monitoring of the effects of the fishery on the scallop stock and non-target species is carried out by both DFO and the industry, including research vessel surveys of stock biomass, VMS for real-time vessel position, observer calculation of bycatch, 100% dockside monitoring of landings, port sampling data and meat counts, some at-sea monitoring, aerial surveillance and analysis of logbook data on effort, catch rates and fishing trends. SARs are prepared and published annually and include an analysis of the research cruise data as well as the fishery performance data. Biomass estimates and research recommendations are produced which are taken into consideration by OSAC when developing harvest management measures and plans.			
80	A monitoring programme is in place that addresses all key aspects of resource and effects at appropriate intervals and results are recorded.			
100	The resource and effects of the fishery are closely monitored over appropriate geographical areas and time periods. Full records are kept of monitoring results and these are made available to relevant research and management bodies.			

SCORING INDICATORS		Comments	Weight	Score
3A.6.2		Are results of monitoring evaluated against appropriate reference point(s)?	**33.3**	**80**
60	Reference points or measures with similar intent or outcome exist and some level of evaluation against these is possible.	There are no biological reference points in the traditional manner in this fishery. The scientific advice is based on an interpretation of the survey index and commercial catch data and not on a quantitative assessment model. There are indicators that are evaluated on an annual and in-season basis to track the performance of the stocks. The annual assessment identifies trends in biomass, estimates age-structured population abundance and fishery mortality based on the survey index. The impact of fishery removals in the detailed commercial catch data is also examined. In addition, during the fishing season, the fishery is closely monitored against meat count targets, bycatch limits and catch rates for any warning signs and adjustments are made as required. The result of this monitoring and management regime is that abundance of commercial sized scallops has been above the long-term median since 1999 and is currently the fourth highest level in the survey index since 1981. Recruitment for 2 of the next 3 years is forecast to be above average. The stock has been rebuilt steadily above the long-term average since 2004.		
80	Results of monitoring are regularly interpreted in relation to reference points or measures with similar intent or outcome.			
100	Results of monitoring are quantitatively evaluated against precautionary reference points on a regular and timely basis.			

SCORING INDICATORS		Comments	Weight	Score
3A.6.3		Do procedures exist for reductions in harvest in light of monitoring results and how quickly and effectively can these be implemented?	**33.3**	**100**
60	Practical procedures exist to reduce harvest. Programmes to link these with monitoring results are underway.	Changes in any of the major monitored indicators – meat count, catch rate, incidence of small scallops, age composition of catch, etc – can result in harvest increases or reductions. For example, up until 2007, Brown's Bank South, German Bank and Georges Bank B were managed by a "rolling TAC" mechanism. A rolling TAC starts with a fixed amount. At established times, reviews of the meat count and catch rate (CPUE) take place to determine how the fishery is performing. If the trends are in a positive direction, a roll-over (usually in the amount of the initial TAC, although that can vary in amount and time) is considered. If the trend is negative, no roll-over is considered. Consultation is conducted with the operators and with science staff of DFO and a decision is made in the best interests of the stock. In most fisheries, a formal, legal Variation Order is issued to close a fishery. In this fishery, agreement is quick and effective once all operators agree to the interim measure. The history of consensus on issues is high. Usually, no formal legal notice is required to close a fishery or to adjust other parameters. Once consensus is achieved, the fleet voluntarily agrees to abide by the measure as soon as is practical. Reaction time is usually less than 5 days. The fishing season starts with interim TAC's as the scientific advice is not available upon opening of the fishery. These TACs can be adjusted throughout the year as required through the OSAC forum.		
80	Practical procedures exist to reduce harvest in the light of monitoring results and provide for stock recovery to specified levels. Measures can be implemented speedily			
100	Effective practical procedures exist to reduce harvest in light of monitoring results and provide for stock recovery to specified levels within specified time frames. There are well documented procedures to implement changes and these can be introduced with immediate effect.			

SCORING INDICATORS		Comments	Weight	Score
3A.7*(MSC Criterion 10)*	The management system includes measures to pursue objectives for the affected ecosystem.		**9.6**	**85**
Weighting Commentary		All Performance Indicators within this sub-criterion are considered of equal significance.		
3A.7.1		Are measures in place to address (avoid or minimise) significant environmental impacts?	**50**	**80**
60	Negative environmental effects caused by fishing have been identified. Measures are being applied to reduce any key impacts.	Scallop fishing gear is heavy, intrusive, and causes habitat disruption. The offshore scallop fleet has taken measures to mitigate the environmental impacts of the gear. There has been a significant reduction of bycatch of vulnerable commercial species and a sharp reduction of bottom contact with fishing gear. Five of the six offshore scallop licence holders have formed the Canadian Offshore Scallop Industry Mapping Group (COSMIG) and have partnered with the Canadian Hydrographic Service of Canada (CHS) and the Geological Survey of Canada (GSC) to map the ocean floor using multi-beam technology. The product from this initiative is three-dimensional bathymetric charts, geological charts, and sediment maps of commercial scallop fishing areas. This has resulted in significantly more efficient fishing as the fleet is able to target areas where the bottom type indicates the presence of scallops. Along with significant economic advantages of this venture, come benefits for the environment. There has been a dramatic drop in the total bottom area touched by the scallop dredge. For example, before the multi-beam imagery, 6.37 hours of fishing effort (i.e. the dredge on the bottom) was required for one ton of scallop meat. With the imagery, the tow time was 2.41 hours – a 62% reduction. For a scallop quota of 13,640, tonnes the gear-on-bottom time was reduced from 162 hours to 43 hours, a 73% reduction, and the area of bottom towed was reduced from 1,176 km² to 311km² for a reduction of 74%. This has dramatically reduced the impact of the fishing gear on the seafloor and greatly decreased fuel consumption and the associated greenhouse gasses. (For a more detailed review of this initiative see Bedford Institute of Oceanography, 2001 in Review pp40-41). The fishing fleet has also taken measures to minimize the bycatch of other species with a focus on cod, haddock and yellowtail flounder on Georges Bank through bycatch protocols. Measures include proper release and handling, identification of high bycatch areas, avoidance measures such as adjusting spacing and location of ropebacks in the dredge, reducing tow time and speed, directional changes and finally leaving a high bycatch grid area for a 12 hour period. Bycatch is closely monitored on observed trips and extrapolated over the entire fleet's tow time. The result of such efforts indicates an increase in yellowtail flounder discards from 237 tonnes in 2005 to 525 t in 2006 and a sharp decrease to 110 t in 2008. Cod bycatch increased from 57 in 2005 to 123 in 2007 and down to 28t in 2008. Haddock estimates were highest in 2007 at 61t and declined to 25t in 2008 (DFO). Bycatch figures for other species are recorded but not reported. The score would have been higher on this indicator if all bycatch in all areas by species was compiled and reported.		
80	Measures are being applied to minimise any environmental impacts and there is evidence that the measures are working.			
100	Measures are in place to avoid any significant environmental impacts and are subject to monitoring and periodic review, OR, no significant environmental impacts are known to exist.			

SCORING INDICATORS		Comments	Weight	Score
3A.7.2		Are no take zones, Marine Protected Areas or closed areas for specific periods appropriate and, if so, are these established and enforced?	**50**	**85**
60	The need for no-take zones and/or closed areas / seasons has been reviewed. Plans are in place to implement some or all of these as appropriate..	The industry has implemented voluntary closures in areas of juvenile scallops that have been identified by research cruises. In 2004, a strong pulse of age 2 scallops was detected by the survey cruise on the northern edge of George's Bank. After analysis the industry implemented a voluntary closure of 95 km² around one juvenile aggregation for a two year period. Later two additional closures were established on Georges Bank (2008 SAR). For the 2009 fishing year, three closures are planned for Georges "A" and three for Browns north. These closures cover an area of some 200 square kilometres on each bank. Once opened, the yield in these areas is appreciably higher with fewer scallops and less effort required to catch quotas (catch rate increase of 13%). There are two additional annual closed areas for the protection of cod on Georges (Jan-Mar) and for yellowtail flounder (June) when fishing for scallops is prohibited. The score on this indicator would have been higher if an area was set aside to study impact of habitat disruption and bycatch.		
80	The need for and potential distribution of no-take zones and closed areas / seasons has been reviewed against objective criteria and these are being implemented and enforced if and where appropriate.			
100	No-take zones and closed areas / seasons are established and enforced if and where appropriate and, if implemented, the consequences are being monitored.			

SCORING INDICATORS	Comments	Weight	Score

3 A.8 *(MSC Criterion 11)*	There are control measures in place to ensure the management system is effectively implemented.		**22.8**	**86**
Weighting Commentary	All Performance Indicators within this sub-criterion are considered of equal significance.			
3A.8.1	Are information, instruction and/or training provided to fishers in the aims and methods of the management system?		**33.3**	**90**
60	Mechanisms exist for the dissemination of information, instruction and training of fishers. Implementation of these mechanisms may not be universally implemented.	In order to achieve effective management of the fishery, all licence holders are issued with a fishing licence containing an extensive list of conditions outlining their obligations. These conditions cover such things as: areas authorized to fish by latitude/longitude, a hail-out/hail in requirement, a fully functioning VMS providing data to the DFO operations centre, a requirement to take an observer on board upon request, 100% dockside monitoring of landed weight, mandatory log books containing catch and effort information, completion of a Offshore Scallop Monitoring Document containing tow-by-tow information, dredges must be unshackled in non-authorized areas. Information on fisheries legislation, scientific research, annual SAR's and the Offshore Scallop IFMP is available on the DFO website and from personal contact with Fisheries Officers and scientists. OSAC provides a forum for an exchange of information on the goals and detailed management measures of the fishery between the licence holders, their representative associations and unions and regional managers and scientists on all aspects of the management system. Fishing captains attend OSAC meetings from time to time. Individual company licence holders hold periodic day-long seminars with their vessel officers and crews to ensure all participants of the fishery are up to date on changes and requirements.			
80	Information, instruction and training are provided to fishers in the aims and methods of the management system allowing effective management of the system.			
100	Information, instruction and training are provided to fishers in the aims and methods of the management system allowing effective management of the fishery and operatives demonstrate comprehensive knowledge of this information.			

SCORING INDICATORS		Comments	Weight	Score
3A.8.2		Is surveillance and monitoring in place to ensure that requirements of the management system are complied with?	**33.3**	**90**
60	A surveillance and monitoring system has been implemented; however, its effectiveness and/or compliance has not been fully demonstrated relative to conservation objectives.	Extensive regional fisheries monitoring, surveillance and enforcement systems are in place in all scallop fishing areas, including such things as hail-out/in requirements, VMS for catch and position reporting, at-sea observers, log books, 100% dockside monitoring, fishery surveillance patrols, aerial surveillance, random checks of dockside monitoring, review and analysis of vessel documentation and observer and dockside monitoring data. In addition all vessels are required to complete an Offshore Scallop Monitoring Document containing tow-by-tow information. Further, there are measures that the fleet implements voluntarily such as closed juvenile areas and an industry-funded port sampling program to enforce the meat-count limit. A recent DFO document outlines an extremely high level of compliance with regulations and licence conditions in the offshore scallop fleet. In the past decade, there have been only 4 convictions, two to crew members who neglected to register as commercial fishers, one related to retention of lobsters for food aboard a trip and one related to theft of scallops from a licence holder by a captain and some crew. The latter were fined heavily and dismissed from the company. Catches do not exceed enterprise allocations. The score on this indicator could have been higher if there was an established mechanism for regular and frequent monitoring and verification of compliance with management measures by DFO independent of the industry.		
80	An effective enforcement system has been implemented and there is an appropriate degree of control and compliance.			
100	An effective enforcement system has been implemented and there is a high degree of control and compliance.			

SCORING INDICATORS		Comments	Weight	Score
3A.8.3		Can corrective actions be applied in the event of non-compliance and is there evidence of their effectiveness?	**33.3**	**90**
60	Mechanisms exist or are being developed which can be implemented or applied to deal with non-compliance. Their effectiveness is to be evaluated.	Fisheries officers can issue tickets for less serious offences and institute court proceedings for the more serious infractions. Penalties for non-compliance under the *Fisheries Act* and regulations can be severe amounting to tens of thousands of dollars in fines and forfeiture of entire catches by the court upon conviction. What seems to be even more effective in this fishery is the peer pressure placed on licence holders to comply with established management measures. Trip reports of each company are circulated to the entire fleet and departures from accepted and agreed practices are noted and individual companies are expected to appear before OSAC to explain their actions. This is an immensely effective tool to ensure compliance. The record of compliance in this fishery is very high.		
80	There are set measures that can be applied in the event of non-compliance although these may not be included in a formal or codified system. There effectiveness has been or will be evaluated.			
100	Agreed and tested corrective actions can be applied in the event of non-compliance.			

SCORING INDICATORS		Comments	Weight	Score
3 B		Operational Criteria	**50**	**86**
Weighting Commentary		Within this criterion, greatest weighting is given to issues of compliance (3.B.5).		
3B.1*(MSC Criterion 12)*		There are management measures that include practices to reduce impacts on non-target species and inadvertent impacts upon target species.	**14.5**	**80**
3B.1.1		Do management measures, principally through the use of gear and other fishing practices, include avoidance of impacts on non-target species and inadvertent impacts upon target species? These would include by-catch, discard, slippage and high grading.	**100**	**80**
60	Measures have been, or can be, implemented as appropriate that are intended to reduce the major impacts on non-target species and inadvertent impacts on target species, but their effectiveness is uncertain.	As noted above in 3A.7.1, the fishing fleet has implemented protocols to minimize the bycatch of other species, especially on the depleted cod and yellowtail flounder along with haddock. A wide range of measures are outlined in the protocols which have been effective in reducing the incidental catch of non-target species again with particular success on those three species on Georges Bank. Bycatch figures for other species are recorded by on-board observers but not reported. All bycatch is counted against a quota established for the scallop fishery and is taken into account in the assessment of the non-target species. Amounts are probably overestimated as all incidental catch is deemed not to survive, which is known not to be the case. In addition there are two annual closures on Georges to protect cod (Jan-Mar) and yellowtail flounder (June). The scallop dredge uses a minimum of 3 inch rings to provide for the escapement of small scallops, but little is known about survival. The seabed mapping initiative noted above in 3A.7.1 has more of an impact on the reduction of mortality of non-commercial scallops than any other measure. Due to the precision of the mapping, vessels are able to target beds of mature scallops improving catch rates and avoiding smaller scallops and bycatch. The fleet is experimenting with ring sizes up to 4 inches to improve small scallop escapement and up to 10” mesh in the twinebacks to avoid finfish. The score would have been higher on this indicator if all bycatch by species was reported. Also, while the bycatch controls and observer coverage provide a good picture for George’s Bank, there is a gap with respect to the other fishing areas, albeit for a small percentage of the overall scallop catch.		
80	Measures have been, or can be, implemented as and when appropriate to avoid or reduce any major impacts on non-target species and inadvertent impacts on target species and there is evidence that they are having the desired effect when applied.			
100	Measures have been implemented to reduce the major impacts on non-target species and inadvertent impacts on target species, and their effectiveness is clearly demonstrated.			

SCORING INDICATORS		Comments	Weight	Score
3B.2 *(MSC Criterion 13)*		There are management systems in place that encourage fishing methods that minimise adverse impacts on habitat.	**12.8**	**80**
3B.2.1		Do fishing operations implement appropriate fishing methods designed to minimise adverse impacts on habitat, especially in critical or sensitive zones such as spawning or nursery areas?	**100**	**80**
60	Fishing operations use measures to reduce major impacts on habitat, especially in critical or sensitive zones such as spawning or nursery areas.	The mapping initiative outlined in 3A.7.1 which has identified areas of commercial scallop abundance using multi-beam technology has reduced habitat impact by virtue of a reduction of the time that the gear is on ground. The increase in the efficiency of the gear has resulted in a dramatic drop in the total bottom area touched by the scallop dredge. Reductions of total towing time in the order of 70% have been achieved by being able to target areas of high abundance of commercial sized scallops. Seasonal closed areas are used on Georges to protect cod and yellowtail.		
80	There is evidence that fishing operations are effective in avoiding significant adverse effects on the environment, especially in critical or sensitive zones such as spawning or nursery areas.			
100	There is direct evidence that fishing operations implement appropriate methods to avoid significant adverse impacts on all habitats.			

SCORING INDICATORS		Comments	Weight	Score
3B.3 *(MSC Criterion 14)*	The management system incorporates measures that discourage destructive practices.		**5.7**	**80**
3B.3.1		Does the fishery employ destructive fishing practices (such as poisons or explosives)?	**100**	**100**
60	The fishery does not allow any such destructive fishing practices.	The fishery does not employ any destructive fishing practices such as poisons and explosives.		
80	The fishery does not employ any such destructive fishing practices and enforcement is considered sufficient to prevent their use.			
100	The fishery does not employ any destructive fishing practices. There is a code of conduct for responsible fishing, prohibiting these, that is fully supported by fishers.			

SCORING INDICATORS		Comments	Weight	Score
3B.4 *(MSC Criterion 15)*	The management system incorporates measures that reduce operational waste.		**10.7**	**100**
3B.4.1		Do measures exist to reduce operational waste?	**100**	**100**
60	Measures/facilities are in place to reduce sources of operational waste that are known to have detrimental environmental consequences, but further reductions may be possible.	Scallop shells and viscera are discarded overboard during the on-board shucking operation. No negative impacts of this practice are known or expected. Many experts are of the view that it provides a net effect in providing nutrition and refuge for other species (Naidu, K.S. et al. 1997). Discarded shells also serve as a substrate for attachment. All garbage is bagged and brought ashore for disposal in dockside bins.		
80	Measures/facilities are in place to reduce all sources of operational waste that are known to have detrimental environmental consequences, and there is evidence they are effective.			
100	Measures/facilities are in place to reduce all sources of operational waste that are known to have detrimental environmental consequences, and there is evidence they are effective and these measures are supported by the fishers.			

SCORING INDICATORS		Comments	Weight	Score
3B.5 *(MSC Criterion 16)*		Fishing operations are conducted in compliance with the management system and legal and administrative requirements.	**43.6**	**88**
Weighting Commentary		All Performance Indicators within this sub-criterion are considered of equal significance.		
3B.5.1		Are fishers aware of management system, legal and administrative requirements	**33.3**	**90**
60	Fishers are aware of key management and legal requirements.	Licence holders and fishers are aware of the management and legal requirements of the fishery and are regularly updated on new guidelines. The extensive list of conditions contained in the fishing licence provides the fishers with a complete understanding of the requirements of the fishery, including authorized fishing areas, reporting requirements, a fully functioning vessel monitoring system, 100% dockside monitoring of landed weight, meat-count requirements, etc. Information on fisheries legislation, scientific research, annual SAR's and the Offshore Scallop IFMP is available on the DFO website and from personal contact with regional DFO officers and scientists. OSAC provides a forum for an exchange of information on the goals and detailed management measures of the fishery among the licence holders, their representative associations and Union with regional managers and scientists on all aspects of the management system. Individual company licence holders hold periodic day-long seminars with their vessel officers and crews to ensure all participants of the fishery are up to date on changes and requirements.		
80	Fishers are aware of management and legal requirements upon them and are kept up to date with new developments.			
100	All fishers are aware of management legal requirements through a clearly documented and communicated mechanism such as a code of conduct.			

SCORING INDICATORS		Comments	Weight	Score
3B.5.2		Do fishers comply with management system, legal and administrative requirements?	**33.3**	**90**
60	Fishers appear generally to comply with requirements, but there is incomplete information on the actual extent of compliance.	Compliance in this fishery is considered to be very high. Few reports of non-compliance with management measures have been received since the inception of the enterprise allocation program in 1986 and even fewer over the past decade. The combination of peer pressure and the economic incentives to properly manage the scallop resource for the long-term has been effective in making infractions almost non-existent. In the event of breaches, heavy sanctions are provided in the *Fisheries Act* and regulations to deter non-compliance with licence conditions and fishery regulations, including tickets issues by enforcement officers for low level infractions, the institution of court proceedings for major offences. Forfeiture of entire catches is within the discretion of the court upon conviction. The risk rating conducted by DFO of the potential for illegal behaviour in this fishery is very low.		
80	Fishers appear compliant with relevant management and legal requirements and there are no indications of consistent violations.			
100	Fishers are fully compliant with, and fully supportive of, legal, and administrative requirements, such as through a code of conduct.			

SCORING INDICATORS		Comments	Weight	Score
3B.5.3		What is the record of enforcement of regulations in the fishery: quota control, by-catch limits, MLS, mesh regulations and closed areas?	**33.3**	**90**
60	There is information on breaches of regulations and on corrective action to prevent or curtail.	Quota control in this fishery is very closely monitored. Each licence holder has an enterprise allocation amounting to a fixed percentage of the TAC established for each stock area, converted to metric tonnes. A combination of hail-outs, VMS and dockside monitoring where every pound of scallop meats is weighed provides very tight control. Similarly, bycatch is calculated by extrapolating the tally of at-sea observers across the total tow time for the fleet. An industry-funded port sampling program ensures compliance to the meat-count regulation and closed areas are easily monitored by real-time satellite signals from the on-board VMS. The score for this indicator could have been higher if there was an established mechanism for regular and frequent monitoring of compliance with management measures by DFO independent of the industry.		
80	Evidence of rigorous monitoring of all the enforcement measures and evidence of actions taken in the event of breaches is available.			
100	Strong evidence of rigorous monitoring and control of the enforcement measures through for example satellite monitoring, shipboard observers and nominated landing ports. Strong evidence of firm action taken in the event of breaches			

SCORING INDICATORS	Comments	Weight	Score

3B.6 *(MSC Criterion 17)*	The management system involves fishers in data collection.	**12.8**	**90**
3B.6.1	Do fishers assist in the collection of catch, discard and other relevant data?	**100**	**90**
60	Fishers are involved in the collection of some catch, discard and other information.	The industry provides commercial vessels and covers costs (crew, supplies, fuel, gear, etc) for stock assessment surveys with DFO scientists directing operations. Landing data are derived from commercial dock-side sorting and weighing programs (funded by the industry). The recognition by fishers of the value of scientific information relating to the fishery appears to encourage cooperation. As a condition of licence, fishing captains are required to submit an Offshore Scallop Monitoring Document and fishing log upon landing which includes such information as, detailed information on catch and effort, trip dates, size and amount of gear used, area fished, number of crew, weather conditions, course, area fished by lat/long, number of tows, tow time, depth, bottom type, tow by tow catch and total landings by product form (IQF, fresh, roe-on) of scallops and monkfish. Comments/remarks are recorded per watch. In addition, the vessel provides constant position information via a VMS satellite system. The score on this indicator would have been higher if regular reports of total discards of all bycatch were recorded and compiled.		
80	Fishers are regularly involved in the collection and recording of relevant catch, discard and other information.		
100	Fishers assist significantly in the collection and recording of all appropriate catch, discard and other information.		

APPENDIX B

Peer Review Reports

PEER REVIEWER 1

The Eastern Canada offshore scallop fishery for the sea scallop, *Placopecten magellanicus*, is a very large fishery. Together with the adjacent fishery for the same species in the territorial waters of the USA it forms the largest and most valuable scallop fishery in the world based on natural, wild-caught, populations. The entire fishery covers a large geographical area but is subdivided into a number of fishing areas associated with the offshore 'banks', each of which has its own physical and biological characteristics, stock dynamics, and history of exploitation and management. Overall it is a complex fishery and has been the subject of intensive study. The assessors are therefore to be congratulated on the production of an excellent and very thorough report that has clearly summarised a complex fishery. The descriptions of the stock population dynamics, the fisheries and the management systems are clear and well illustrated and summarise a good, very long, list of literature cited. I believe the information on which the assessments are based is accurate, comprehensive and up-to-date.

This information has been appropriately and rigorously applied in scoring the fishery to the MSC Principles and Criteria, and while one can always argue about the exact scores awarded, particularly in such a complex and data rich fishery, I believe the scores awarded are fair and reasonable, and the explanations that accompany each score are models of clarity. Overall, I believe that some of the scores are, if anything, slightly on the low side of what I might have awarded and are certainly not over-marked compared with other MSC assessments I have seen. I therefore concur with the recommendation that the fishery is certified according to the MSC Principles and Criteria for Sustainable Fisheries.

The conditions to be applied are rigorous, in line with the thoroughness of the assessment. They fall into two groups. Conditions 1 -3 are concerned with improving the knowledge base in crucial areas where the fishery is under-performing, while 4 & 5 formalises aspects of an already effective management system. All five conditions are suitable and achievable, and will enhance the sustainable management of the fishery in future years.

Such is the quality of this assessment that there is very little, if anything, in it with which I would disagree and many of my comments below are very minor or merely seek to expand and support the important issues that have been identified. The report is also presented to a high standard and there are very few errors.

This fishery uses very large, exceptionally heavy, steel dredges pulled by large vessels on offshore grounds where the sea conditions are often very rough so that the gear can lift off and bounce over the seabed. Such gear is acknowledged to cause considerable damage to seabed structure and marine communities. Despite various attempts to design less damaging dredges I believe there is very little scope to further reduce the environmental impact of these dredges and still capture scallops economically on these grounds.

At various points in the assessment (e.g. Scoring Indicator Tables 2.1.3.1, 2.14.3 & 2.1.4.4) it is argued that the development and extensive application of multibeam technology has allowed detailed habitat maps to be produced, which has enabled fishing effort to be more precisely targeted onto high density scallop aggregations. It is argued that this is of conservation benefit as it has reduced the spatial footprint of benthic disturbance and led to an overall reduction in effort in recent years. This is undoubtedly so, and clearly beneficial, but the corollary to this is that the effort, and the disturbance, is directed much more intensely onto the fished areas and this is not really brought out in the report. This is of concern because little is known of the rates of recovery for these grounds and the likely cumulative effects over a long period of time. This is of concern because, over the long term, repeated fishing may not only lead to changes in biodiversity and community structure but also render the grounds less suitable for the settlement and growth of scallops.

MML Comment – The reviewers concern appears to be based on the assumption that the same level

of effort is focused on a smaller area. This is not true for the effort is substantially reduced (see figures in the report). The multibeam data are used to help identify habitats with potentially high scallop abundance. Disturbance of low potential areas is avoided. It is quite possibly the case that disturbance of areas identified using multibeam is not any greater than before, i.e. Once a good spot is found, whether by chance or multibeam, it is fished at the same effort until the catch rates drop to uneconomic levels.

With respect recovery times it is well known and acknowledged within the report that hat chronic disturbance can cause changes in the relative abundance of benthic species. The importance of understanding recovery time is recognized in Condition 3.

Gear selectively is an important topic that appears to have received relatively little study, judging by the age of the references cited in Scoring Table 1.1.2.2 (i.e. Bourne, 1965; Caddy, 1968). Are there no more up-to-date references? There must have been many minor developments in the gear and the way it is rigged and operated since that time so that this should perhaps be revisited. The fact that larger 4-inch rings are mandatory in the US fishery suggests that this should be investigated as there are likely to be conservation benefits from using larger rings. The need for better and more recent estimates of incidental mortalities has also been recognised (Table 1.12.2.); this is important but reliable estimates are not easy to obtain on deep-water grounds such as these.

Gear efficiency is said to average 46% in Table 1.1.2.2 but in Table 2.1.2.3 it is said to be 'of the order of 20%'. This is a big discrepancy that needs some resolution.

MML Comment – This has been clarified in the table and the main text.

The natural mortality estimates for adults (Table 1.1.1.5) are also very old (papers from 1964) and need to be updated, while the juvenile mortality rates in the comparatively new 'seed boxes' are now required, as stated in the table.

MML Comment – There do not appear to be more recent studies on natural mortality

The extent of the recruitment surveys and the speed and adaptability with which 'seed boxes' can be established to protect juvenile aggregations are a strong and relatively new feature in the management of this, or any, scallop fishery. The implications and difficulties of using short term closed areas and spatially directed fishing effort using detailed bottom charts on the traditional stock assessment methods is recognised (Table 1.1.3.6) and this is an area that needs particular attention in future.

MML Comment – Comment noted

Some minor points:

Page 26, Section 6.5. Last sentence does not make sense.

MML Comment – The text has been amended

p.33, Section 7.1.3. Reference to Walsh (1980) not in literature cited. Should this be Walsh (2008)?

MML Comment – The text has been amended

p.63, Table 1.1.1.1. The last sentence is not true. There are more than 2 pectinid species in the area. Suggest you insert 'large' or 'commercial'.

MML Comment – The text has been amended

Table 8 needs to be completed.

MML Comment – This will be completed prior to the final certification report being published.

P 137, Table 3B5.3. What are ‘hail-outs’?

MML Comment - Term equivalent to “hailing out” and “hailing in”, i.e. Reporting in to the authorities when leaving or returning to port.

PEER REVIEWER 2

Overview

The report outlines the current and historical status of the Eastern Canada Offshore Scallop Fishery, including the biology of the target species and relevant ecological considerations. The extent of relevant scientific research, and the participating organisations are also outlined, as well as current harvesting methods, fleet and industry structure. The basis for current management arrangements and the involvement of Government and stakeholder groups in this process is detailed.

The issues of environmental impact and long-term sustainability are also covered in some detail, including relevant research and proposed or implemented measures intended to minimise impacts and ensure long-term viability of the fishery.

The fishery is then assessed against the relevant principles, criteria and guideposts to determine its suitability for certification under the Marine Stewardship Council. A recommendation is made; that the fishery is currently suitable for certification, on the proviso that specific recommendations are implemented. These recommendations are also provided by the review team.

It is acknowledged that this draft report may be amended during subsequent review processes, and it is hoped that the comments provided in this peer review will assist in that process.

General Comments

Overall management of the fishery appears to be varied, conservative, precautionary and responsive. The Department of Fisheries and Oceans (DFO) is a strong and respected research and management organisation and current and proposed management and assessment appears both thorough and appropriate.

The review team have significant and relevant experience and appear very well suited to undertake the compilation of the draft certification report.

The report is well written and presented in a logical and concise format. The content is appropriate, and with sufficient detail to enable considered review of the fishery, its management and the current MSC application.

The assessment by the reviewers, as presented in the scoring tables (Appendix A) is generally fair, justifiably presented and appropriately scored overall. Some specific scores might be considered slightly high, based on the justifications provided in the tables. In these cases attention is drawn to the score in the comments section for Appendix 1 and the comments may be further considered.

However, the extent of disagreement with the presented scores is not considered sufficient to affect the overall scoring for the 3 main principles and therefore I would support the final recommendation that the Eastern Canada Offshore Scallop Fishery be certified according to the Marine Stewardship Council Principles and Criteria for Sustainable Fisheries.

A summary of the main issues which I believe require further consideration, now or in future, are summarised as follows;

- Consideration of potential negative consequences of increased fishing effort directed at high-density scallop areas as identified via acoustic mapping technology.

MML comment - The team consider that the current stock assessment process adequately considers both the spatial distribution of the stock and the fishing effort.

- Formalisation of various management strategies and procedures, for example, gear regulation, dispute resolution processes.

MML comment - The team considers the cooperative management approach that has evolved in this fishery to be commendable and indicative of a high level of commitment and buy-in by the fleet to the conservation and management of the resource. Such active engagement and buy-in of the fleet was noted to contribute to highly effective and adaptive management system that has a high degree of compliance.

- Fleet-wide adoption of environmentally beneficial practices, rather than self adoption, e.g. bycatch restrictions

MML comment - Bycatch allocations are in place that are mandatory and apply across the fleet.

- Where possible, stronger alignment with appropriate US scallop fishery regulations

MML comment - The fisheries are under fundamentally different management regimes which in the Canadian context are primarily output controls such as quotas and regulatory meat counts versus the US system which are input controls such as effort and gear restrictions.

- Consider removal of self-policing management, unless there are strong fishery-specific reasons for retaining

MML comment – The assessment team considered that the stewardship demonstrated within the fishery is a positive element of the management.

- It is a challenge to certify a dredge fishery under MSC criteria due to the acknowledged seabed impacts. If approved, it seems likely that the fishery will receive some increased interest and attention, both internal and external. With this in mind a greater ecological focus to research and management, rather than ecology being a secondary component of improved fishing efficiency would be a desirable investment in the future of the industry.

MML comment - Dredge fisheries are fully within scope of the MSC program. The recent improvements in fishing efficiency will have had direct ecological benefits and as such have been recognised in this assessment. Condition 2 addresses additional work of the ecosystem impacts of the fishery.

- Continued proactive and responsive management should ensure long term sustainability. In this respect the following may be considered; introduction of rotational fisheries, formally recognised and enforced seed box closures, similar closures for important spawning/broodstock areas.

MML Comment - It is agreed that continued proactive and responsive management should ensure long term sustainability. The present shared management and stewardship approach adopted by DFO and the industry appears to underline this. Management has not concluded the need for more formal voluntary seed box closures as the voluntary approach is working and present fishing practices conducted by a relatively small number of fishing companies and vessels allows for a rotational approach to fishing.

Additional comments are contained within the following report.

Specific Report Comments

Page 12 (Section 3.2): Is all of this section based on Stewart and Arnold (1994). Perhaps this should be specifically stated for clarity as this section is not referenced until half way through page 14. In

general the report adopts a scientific format, including referencing, so this should be consistent throughout.

MML Comment – This section is based on Stewart and Arnold (1994). The first sentence has been combined with the second paragraph to indicate this.

This section also contains some slightly odd phrases, e.g. opportunistic feeding. They might be considered quite specialised feeders, adapted to a fairly specific, if varied food type.

MML Comment – The text has been amended

Also, mentions 'species groups with similar environmental requirements include molluscs…' (scallops are molluscs so rephrase for clarity)

MML Comment - The text has been amended

Mention of 'sea snail' – a rather unspecific term, given the context and typical scientific usage throughout.

MML Comment - The text has been amended

Page 15-16: The gear terminology used in text and photo legends need to be the same, as it makes interpretation difficult.

MML Comment – The text has been amended

Page 17 There is mixture of metric and imperial units. While it is acknowledged that some specific items are measured in imperial units, the equivalent in metric should be provided.

MML Comment – We believe this refers to the dimensions of the dredge, i.e. 3-4 m which would be 9-13'. The text has been amended.

Perhaps provide the specifics of the US regulations for dredges, so that comparison with Canadian gear can be easily made.

MML Comment – Where possible the assessment team did not want to compare this fishery with other fisheries as this is not the purpose of the assessment.

It appears that there are no specific measures of Canadian dredge efficiency? (US values are 22-55%, with a mean of 46%)

MML Comment – The assessment team could find no research that provided a measure of efficiency for the Canadian dredge. Walsh 2008 noted that from pers. comm. with the Canadian industry they considered their gear efficiency was toward the lower estimate.

Page 17 No referencing for first two paragraphs on gear impacts.

MML Comment – Reference provided.

Section 3.4.2: There are no specific details provided on what is meant by '*fishing on some of the smaller banks is adjusted by the fleet depending on production in any given year*'. This would be helpful.

MML Comment – This refers to the fleet adjusting its fishing dependent of catch rates. The text has been amended to make this clearer.

Section 4.1 Provide the full titles of the relevant legislation, including dates in the text. This is later provided in Table 1, but should appear in both.

MML Comment – The text has been amended.

Four other Acts are mentioned in Table 1, but they are not mentioned in the text – even in reference to Table 1 would suffice.

MML Comment – The text has been amended

Page 18 Under which Act are IFMP's authorised? These appear to represent an important component of overall management, as they make recommendations to DFO. As such, their authority/remit should be able to be accessed in the literature.

MML Comment – The text has been amended

Provide some detail about OSAC? Frequency of meetings, composition etc.

MML Comment - This is contained in section 6.2 on pg 23

Page 19 (Section 5): It appears that the population is not a single unit, but there are not discrete populations (stocks) for each SFA either (so stocks and SFA do not coincide). The management balance struck seems to be between an all-encompassing strategy for the whole region and separate arrangements for each 'stock'. A regional assessment and management regime is in place, directed at scallop beds? It is a little unclear if a bed is the same unit as an SFA for management purposes. Is it possible to clarify the terminology in a hierarchical table showing, SFA, banks, beds etc and the level of assessment and management or overlap for each?

MML Comment - Page 12 and 18 confirms which Banks are associated with which SFAs. Each Bank is managed separately and stock assessments are conducted for each Bank (Page 20).

Can the extent of collaboration between Canadian and US authorities be clarified? This may be important for later issues.

MML Comment – The Canadian and US authorities collaborate on enforcement.

Page 20 Mention of surveys in May and October, but then later mentions the major survey in August. Can this be clarified?

MML Comment – The text has been amended to confirm that the annual surveys are completed in May for Browns, German, Scotian Shelf and August for Georges.

From the text it appears that Age 2 scallops are prioritised in surveys, though recruitment is at Age 4? Especially since this age group is problematic to sample due to size, why not prioritise or emphasise importance of Age 3s, which would be the pre-recruit cohort.? Is it due to data processing time to input into management arrangements?

MML Comment - The stock surveys are designed primarily to estimate the abundance and distribution of ages commercial and pre-recruits (ages 3+). This has been clarified in the text.

Are there any details relating to the quota setting process using the stock assessment data?

MML Comment - The quota setting process is based on advice provided from analysis of stock assessment data. This is set out on pages 20, 21, 24 and 25.

Page 20-21 Georges Bank – since most rigorous stock assessment occurs here, and it is acknowledged that recent mapping indicates some productive areas will be concentrated on for fishing. Will the assessment and management closely tie in with the increased effort in future. That is, will research and data collection mirror changes in fishing activity- particularly in relation to high density areas.

MML Comment – It should be noted that mapping does not provide stock density information. Stock density and distribution data is collected via the annual stock assessment surveys. The stock assessment includes analysis of the spatial distribution of fishing effort. However, the assessment team recognised the changes in fishing activity and highlight it in their recommendations, i.e. It is recommended that Future Framework Reviews for the offshore fishery should consider the current exploitation strategy into the stock assessment procedure page 45. Also highlighted in narrative for PI 1.1.3.1

Perhaps importantly, what are longer term consequences if more effort is directed at smaller, more productive areas ('*Aggregation of biomass and effort*'). While fishing and economic efficiency is improved, what about the effects on predator attraction (*K. Ramsay, M. J. Kaiser, P. G. Moore, R. N. Hughes (1997) Consumption of Fisheries Discards by Benthic Scavengers: Utilization of Energy Subsidies in Different Marine Habitats. Journal of Animal Ecology, Vol. 66 (6) pp. 884-896*) and subsequent bycatch, and on future recruitment since high density areas are important spawning and fertilisation sources. Targeting these aggregations may have profound long term impacts on recruitment processes if not proactively managed.

MML Comment – The assessment team is not aware of any evidence that shows a correlation between high density areas and recruitment. With respect to bycatch the evidence indicates that bycatch rates have been reduced in recent years.

Page 22 Should short and medium term objectives be specified? This would enable action if they were formally expressed explicitly, rather than implicitly.

MML Comment - A condition has been set on this point, i.e. By the first annual audit explicit short and long-term resource and environment objectives and review of milestones are incorporated into the management system.

Page 22 Why are 'seed boxes' voluntary'? Has this been found to be more effective than prescribed enforcement?

MML Comment – Given the relatively few fishing companies and their strong stewardship ethic management authorities have not seen a need to make these a statutory requirement. Voluntary self-interest measures are generally more effective than regulatory requirements.

Page 23 Consultation and stakeholder representation seems appropriate and comprehensive

As part of the original EA formula are boats restricted to specific SFA's or do they all move on once the SFA TAC is reached?
MML Comment - The EA refers only to the percentage share of the TAC and is not area dependent.

How does the system work in practice?

MML Comment - Each licence holder is assigned an EA in each SFA. Once that EA is reached the licencee must stop fishing in that SFA. Any over-runs are taken off their quota for the following year.

In Table 3, is the client proportion related to the total OSF TAC, with same or different proportions for each stock?

MML Comment - This represents the total client group proportion of the TAC for SFAs 10, 11, 12, 25, 26, 27. The title of the table has been amended to reflect this.

Page 25 Are there no spawning/broodstock closures? Might this be considered in future? (*C.M Dichmont et al. (2000) The first large-scale fishery-independent survey of the saucer scallop, Amusium japonicum balloti in Queensland, Australia. Journal of Shellfish Research Vol.19, no.2).*

MML Comment - Recruitment has been very strong in this fishery. Spawning /broodstock closure are not considered a necessary tool in this fishery. There are voluntary seed box closures, page 22, 25, "...after discussion of survey results by the enterprises, such dense seed areas are enclosed in voluntary 'seed boxes'. The fleet abstains from fishing them until the recruits reach at least Age 4, when they are opened to harvesting..."

Page 26 Are there any details about the risk-rating analysis? How does the rating system and result compare with other similar fisheries?

MML Comment - DFO Conservation and Protection branch does an internal assessment each fiscal year of the potential for illegal behaviour in all fisheries in the region as a means to deploy and target available resources most effectively. The assessment of the potential for illegal behaviourin individual fisheries includes a number of considerations including the type of management controls in place, the scale and geographic scope of the fishery, the record of compliance and the monitoring tools being utilized. General monitoring tools such as over-flights, vessel patrols, and observer coverage are in place across all fisheries as a deterrent to illegal activity and to identify any changes in behaviour. Adjustments to the enforcement approach to an individual fishery can be made on the basis of the annual assessment.

No information was available to make comparisons with other fisheries. This is outside of the remit of the assessment process.

Page 27 (Section 7): Based on text description Figure 4 would appear to indicate that areas south and east of NS may be vulnerable to prolonged dredging (although not, as acknowledged, the Georges Bank area). The use of the mapping tool should be for both preservation as well as exploitative purposes. Are there plans to use the data for such purposes, or, since paid for by the fishers, is it only to be used for actual fishing activity. Do DFO have full access to the data for other related purposes?

MML Comment - The reviewer is confused here. Figure 4 presents the results of the habitat template approach to classifying benthic habitats. This methodology is briefly described in the existing text and full details are in the references provided. It has nothing to do with multibeam mapping. This is presented on pg 30. With respect to the multibeam mapping, the industry has been working closely with both NRCan and the Canadian Hydrographic Service (DFO).

Page 28 The dot points listed are of concern, and suggest a system in crisis. How do they relate to scallops, and how might scallops have contributed to these. While these are clearly large ecological questions, as a major component of the benthos management of scallops seems integral to this system. Significant focus should be applied to understanding this ecosystem as fully as possible.

MML Comment - They reflect a system that has undergone significant environmental changes which may have been exacerbated by human activity. Considerable effort is underway to help us to understand better the ecosystem as indicated, e.g. pg 28 AZMP, pg 27 EBSAs, ESSIM pg 26

Page 30 Canadian dredge efficiency is noted at 20% (Walsh 2008). Earlier, US data for similar gear suggested efficiency of 22-55%, average 46%. Can this be clarified?

MML Comment - The text has been amended.

Does incidental mortality (*'as high as 25%'*) relate to the proportion of target species left on the seabed after dredge has passed, or does it relate to the proportion of non-target species in the net brought on board- i.e. bycatch. Please clarify.

MML - This refers to incidental mortality of scallops and the text has been amended to confirm this.

The multi-beam acoustic mapping programme appears to have significant efficiency benefits, however, additional considerations may arise;

– has it been established whether high scallop densities also coincide with high densities of non-target species? In itself the acoustic apparatus will not provide information on biodiversity. The targeting of the high scallop concentrations may also then have impacts on bycatch rates.

MML Comment –The existing data do not indicate that densities of scallop coincide with densities of significant bycatch species (DFO 2006d, 2007b). Bycatch of demersal fish species has decreased in recent years.

In addition, it is stated that 'Where multibeam data are available, only habitats with the highest densities of large scallops are being disturbed…' The mapping will not in itself identify large scallops and there is no reason to believe that all year classes would not settle and be present in such suitable areas. Is there subsequent dredge sampling to quantify scallop and other biomass in promising areas?

MML Comment – It is correct to say that multibeam data has provided detailed mapping of bathymetry and habitat types but not stock information. Scallop densities and size distribution is determined through annual stock assessment surveys.

Further, what is the potential impact of high level fishing in such areas on subsequent recruitment (i.e. increased mortality of juvenile scallops on the targeted beds), or does settlement really occur in different areas?

MML Comment – The assessment team is not aware of information that shows a correlation between high density areas and recruitment. More information will come from the spatial and temporal mapping of dredging disturbance requested under Condition 3.

Issues of increased bycatch and attraction of predators to heavily fished areas are noted elsewhere.

Is it perhaps a tool which might enable or benefit from the development of a formalised rotational fishery, enabling fixed recovery times between periods of heavy exploitation?

MML Comment - Page 31 talks of, "...self-regulated pattern of rotational fishing without formally-designated closed areas." Furthermore, Condition 3 is intended to provide answers to these points.

Page 31 (Section 7.1.2): Is there a reference for the US tagging experiments?

MML Comment – The statement is based on correspondence with Deborah Hart, Northeast Fisheries Science Center, Woods Hole, MA. The text has been amended.

Paragraph 2 in relation to shucking at sea, there are some potential issues which should be considered;

Dumping of scallop offal at sea, particularly on fishing grounds may attract predators (including turtles) to the area, potentially resulting in increased bycatch (Ramsay et al., 1997).

MML Comment – There are no observer reports indicating that turtles are attracted by the practice of at-sea shucking. While it is possible that predators may be attracted by offal bycatch levels have

decreased in recent years.

The practice of at-sea shucking has also had anecdotal effects in the Western Australian scallop fisheries. Nematode infections were associated with poor muscle appearance, reduced value and the introduction of export restrictions for scallop meat. The practice of returning offal, and hence the infective stages of the parasite, back into the water where they were consumed by attracted predators, is thought to have kept infection levels high in this region. The much lower prevalence of the nematode in equivalent east-coast scallops may reflect restrictions on at-sea shucking in Queensland waters. (Essentially the same species in New Caledonia, where at-sea shucking was also practiced, had high nematode infection levels.) While this specific parasite is not likely to be a problem in the western Atlantic, the practice may warrant review and some degree of management – for example, a recommendation that discarding does not occur on the grounds, if that is currently the case.

- R.J.G. Lester, D. Blair and D. Heald (1980) Nematodes from scallops and turtles from Shark Bay, Western Australia. Australian Journal of Marine and Freshwater Research 31(5) 713 – 717
- J. F. A. Sprent (1977) Ascaridoid nematodes of amphibians and reptiles: *Sulcascaris*. Journal of Helminthology 51:379-387 Cambridge University Press
- Harris, Joll L. and Watson (1999) The Western Australian Scallop Industry. Fisheries Research Report no.114

MML Comment – The assessment team are not aware of any information on high nematode infection in scallops on the eastern seaboard. It is considered that if there were signs of deterioration in the quality of scallop meet it would be quickly picked up by the fishing companies.

Page 33Why are there no gear restrictions in the Canadian scallop fishery, especially if Walsh (2008) concluded that it may be beneficial?

MML Comment - Bycatch rates have been reduced through the current system of mandatory bycatch allocations. The industry continues to develop gear with the intention of reducing seabed impact and bycatch. The managers responsible for ensuring minimal impacts are satisfied that the present adaptive approach to gear development is more beneficial than imposing gear restrictions that could potentially stifle innovation.

Similarly, if there are no gear restrictions, how will gear modifications help the fishery improve its bycatch statistics if they are voluntary?

MML Comment – See comment above.

Page 34Clarify the figures allowable for fish bycatch, 30, 12, 1.03%. Are these proportions of the fish TAC or the Scallop TAC?, presumably the former, although 30% and 12% seems a high proportion of the total catch, especially since none of these species are actually landed (only angler fish are landed). Please clarify this statistic.

MML Comment – These are expressed as a percentage of the total fish TAC and are counted against the TAC.

Bycatch restrictions, as practiced by Clearwater should be applied to the whole fleet if MSC accreditation is granted. It would not be feasible to have accreditation for multiple management systems applied to different operators. This highlights the importance of prescribed regulations under MSC certified fisheries.

MML Comment – A bycatch protocol exists for the whole fleet.

Pages 41-42 (Section 11): Can the process be represented diagrammatically, as a flow chart perhaps?

The explanation is difficult to follow.

MML Comment - An explanation of the scoring methodology has been previously posted on the MSC website for stakeholders to follow, including diagrams. The text has been amended highlighting this and includes the link to the MSC website.

Page 44 (Condition 2): Can the bycatch data be included into the management planning process and reviews. It is not clear at present that this is specifically considered in the development of most management outputs, unless it relates to another commercial species (e.g. cod, haddock). For example, the incomplete analysis for other species suggests that the impacts on general biodiversity is a secondary and acceptable consequence of commercial operations.

MML Comment – This is implicit within the Condition.

Page 45 Recommendations; introduction of gear restrictions (e.g. rings sizes) in light of US industry and Canadian research findings.

MML Comments – This is implicit in the assessment team's recommendation that says, "There is exchange of information with U.S. counterparts on management measures as they affect Georges Bank".

Appendix A Comments

Where no reference to a table is provided the reviewer is in agreement with the scoring and justification provided, and has no specific comment to make.

1.1.1.1 Is *Chlamys islandica* discarded if caught?

MML Comment – It is retained.

Do scores of 87 and 88 represent corrected values for weighted average scores? Page 42 states that scoring increments of 5 are used.

MML Comment - These scores represent weighted scores for the MSC Principle and criteria

1.1.1.2 Comments section makes reference to Age 3 scallops in surveys, although in the text body only Age 2 scallops appear to be important in surveys. Perhaps clarify in text as the use of both makes more sense (see also earlier comment).

MML Comment – The text has been amended confirming it is Age 3 scallops.

1.1.1.3 Was there not some ambiguity about the specific delineation of stocks/beds from the genetic studies conducted (Pg 22)? If so, is it fair to score as 100, which requires the stocks to be 'demonstrably understood and verified'.

MML Comment – This PI refers to the knowledge of the geographical range of the scallop and the team consider that the complete geographic range and biological characteristics of the stock are demonstrably understood and verified. Knowledge of the genetic structure is score under PI 1.3.1.1

1.1.1.7 This table highlights the precautionary importance of closed areas with high spawning densities. As such it would be wise to ensure that this factor is considered when using the acoustic sonar mapping to preferentially target scallop aggregations. It may be a very efficient, but potentially dangerous tool if monitoring and responsive management are not also in place.

MML Comment - The multibeam mapping provides a positive contribution to the overall

understanding of stock dynamics. The removal of scallops and fishing effort are managed through a variety of effective mechanisms outlined in the report including TACs, meat counts, satellite tracking and aggregations of small scallops are protected by voluntary closures.

1.1.2.2 There does appear to be ongoing work into the issue of gear optimisation, but there is no formal gear regulation in Canada, unlike in the US scallop fishery. This may be currently appropriate, but it would be highly desirable for research findings and gear with established improved performance to become formally established in the fishery, i.e. under the MSC certification, introduction of consistent gear types and regulation for overall long-term benefit (e.g. ring sizes), a fleet rather than a discretionary approach, since MSC applies to the fishery, not to the individual.

MML Comment - The team considered that at present no formal gear regulations were necessary owing to the on-going commitment to develop improvements in the gear. It should be noted that if the fishery were to be certified it would be subject to annual audits and the development and adoption of new gear would be subject to review by an audit team.

1.1.3 In relation to improved management practices; '*Caddy (1975) showed that in the absence of local closures and a rigorously enforced meat count regulation fishing effort becomes focussed onto high density patches where young scallops are common*'. While it is acknowledged that meat count is a management feature of the fishery, structured closures appear less so. The sonar mapping identifies suitable ground, with presumed high density - it does not identify the size of the animals which will presumably be both large and small, so how will this new technology improve the targeting of size scallops, versus undersize scallops? It will still target high density areas, just more effectively- so there is still a need to combine this technology with strong input and output control-based management, e.g. closures of undersize areas and ring size regulation.

MML Comment - See earlier comments. Strong output control is in place in terms of TAC and meat count regulations.

1.1.3.3 Support the formalization of decision rules, though agree with the assessment of the overall effectiveness of adaptive management regime and self-policing – especially when the fishery is in good condition. However, if the fishery should deteriorate, or effort changes due to, for example MSC accreditation, then it would be harder to enforce if regulations are not prescribed.

MML Comment - This endorses the narrative for this PI

1.1.3.4 Support the use of observers throughout and especially for both frequently and infrequently exploited areas. A mechanism for observer data to promptly be considered in the management process would be highly desirable. Also agree with the rationale for the scoring on the basis of the introduction of new mapping data and its incorporation into the management process.

MML Comment - This endorses the narrative for this PI

1.1.3.7 Justification does not appear to address the indicator, which is about 'clear and tested decision rules' – are they fully documented, as required for a score of 80?

MML Comment – The decision rules are report in the management plan as indicted in the narrative.

1.1.4 As previously mentioned, reducing exploitation in less favourable grounds does not necessarily ensure long-term productivity. Rather it focuses effort on denser, potentially important broodstock areas. However, seed boxes may provide an important management option for long-term production.

MML Comment – This sub-criterion is about whether the stock is at an appropriate level to maintain long term productivity. The assessment team are of the opinion that the evidence presented in the

report supports their conclusion that the stock status is consistent with that providing long-term productivity.

1.3.1.1 Wording suggests that the US side of the fishery have a more conservative management approach- if so, what could be learned from this? If the US fishery also received MSC status how would different management of the 'same' stock compare or be resolved?

MML Comment - The wording was not intended to suggest a more conservative approach, rather to recognise the US management approach. It should be noted that the assessment scores the fishery against the MSC standard and not against any other fisheries. If the US were assessed it would be done so on its own merits. The US fishery is much larger in scale and is managed within a different framework; hence, different methods of management may be applied with similar intent and outcome.

1.3.1.2 What effect might acoustic mapping-enabled targeting of dense scallop beds have on future reproductive success?

MML Comment - This is a theoretical issue that cannot be answered from research – the fact that scallops live longer and hence are more fecund might be a partial answer.

2.1.1.2 Have invertebrates been adequately included in this consideration?

MML Comment - Yes. The text has been amended to confirm this.

It is clear that this species has been extensively studied and is probably amongst the best understood of commercial scallop species. However, the scoring is specifically related to trophic dynamics and position and relationships within the food web - presumably for the purposes of understanding its ecosystem role, and avoiding long term damage to non-target species and systems. As acknowledged, its role in trophic dynamics is not completely understood, and therefore the purpose of this criterion cannot be adequately addressed from a management perspective. Is 95 therefore an appropriate score?

MML Comment - As stated, the trophic position, status and relationships of the target species in the food web are very well known. It is a filter-feeder feeding on detritus and phytoplankton in the benthic boundary layer. Only some of the more minor details are not known. Therefore the score is considered appropriate.

2.1.4.1 Introduction of gear restrictions may ensure reduced catches of smaller shell, similar to the US situation.

MML Comment - Removals of small scallops are managed through meat count regulation and voluntary industry protocols to further avoid small scallops. Exploitation of small scallops is not considered an issue in this fishery.

2.1.4.3 A rather general statement - gravel substrates are likely to be exposed to current, but not necessarily to wave action - this would be depth dependant. And, current impact is not the same as fishing gear impact, since animals are not adapted to the latter. Therefore it depends on what is considered 'unacceptable'. However, the grounds are not left undisturbed, there is no formal rotational management in place and fallow areas are left for 2 years only, while it may take up to 10 to show recovery – the measures introduced appear to be in place to improve the fishery, rather than allow ecosystem recovery. Agree that there is insufficient information and think a slightly lower score may be appropriate.

MML Comment – This PI scored below 80 and requires a Condition has been set to improve the weakness. The point of discussion is therefore whether the score should be lower. The assessment team are content that score remains the same.

2.1.4.4 Similar to above, it depends on the definition of 'acceptable impact', but clearly not enough information available.

MML Comment – See above

2.1.4.5 Both consistency throughout the fishery and adoption of relevant, proven practices (e.g. from the US fishery), should be seriously considered.

MML Comment – The reviewer seems to infer that the US fishery is better managed than the Canadian. However, we are not aware of any evidence to say that this is the case although, as we indicate in the report, a paper by Repetto 2001 suggests the Canadian fishery compares favorably.

2.2 Ensure that it is not only commercially important species which receive Monitoring and protection. Diversity includes all species and habitat and it is not clear that either the data collected, or the level of analysis or data processing reflects this. A score of 83 is high if considering all, not just commercial biodiversity.

MML Comment - The score refers to the weighted score for this MSC Criterion. The 3 PIs associated with the sub-criterion refer to protected, endangered and threatened species. We believe the reviewers concerns are dealt with within Condition 3.

2.3.1.2 In the absence of formalized gear regulation and formalized, as opposed to self-policing closures, can the widespread implementation of any management measures be ensured?

MML Comment – The assessment team are of the opinion that a significant part of the success of this fishery is the combination of mandatory and voluntary management measures and that this fishery provides a good example of the "duty of care" for resources when there is an ownership component.

2.3.1.3 Reads as though the species is being blamed for not recovering. If environmental factors limit recovery it is likely due to populations being reduced to very low levels. Therefore, any impediment, including any fishery-induced factors, should be considered significant. If populations are not recovering can it be considered that appropriate rebuilding measures are in place?

MML Comment – Management measures (TACs based on scientific advice and rebuilding strategies) are in place to allow for the recovery of depleted groundfish stocks. These are under review by DFO and the industry and are presently considered to be appropriate.

3A1.4 Presumably this means actively seeking external review, rather than not simply preventing it?

MML Comment – This PI says, "Is the management system subject to external review". There is no mention in the scoring guideposts of actively seeking this review. For this fishery the management system is subject to external review and it is not prevented.

3A3.3 Agree with final statement about formalizing. Would be a desirable long-term security measure for MSC certification.

MML Comment – We note the comment.

3A3.6 Appropriate. Can it be reasonably envisaged that MSC status might encourage more interest/activity and disputes in the fishery? If so, might the absence of a formal dispute resolution process be problematic?

MML Comment - At this point there is no reason to believe that this would happen. If a fishery is successfully certified it is subject to annual surveillance audits. If a weakness related to any PI is found during an audit such that it compromises the initial score for a PI it would be re-scored and if

necessary a Condition set.

3A4.2 In relation to a perfect score for the contribution of economic/social incentives to sustainable fishing; such incentives have not resulted in the adoption of standardized gear, only one client group has implemented a bycatch avoidance protocol, and some bycatch data is not yet processed.

MML Comment – As noted above, bycatch avoidance protocols are applied across the fleet and the assessment team does not see the necessity for mandatory standardized gear nor do they consider that the processing of bycatch data is applicable under this PI and so are not minded to reduce the score.

3A 5.1 Appropriate. Recommend expanded research collaboration with US fishery if not already in place. Proactive for any future US MSC application and better overall approach to management. Similar rationale for 5.2 and 5.3.

MML Comment – We note the comment

3A.6.3 Certainly, the management system provides for rapid response in light of new information, although a score of 100 appears to require that the procedures 'provide for stock recovery to specified levels within specified time frames' – is this the case?

MML Comment - This stock has been rebuilt through TAC reductions several times. The rolling TAC on Browns cited in the scoring table is an example.

3A 7.1 Appropriate, although, as indicated previously, the self-policing role and lack of formal gear regulation (in spite of available research data) indicates that more can be done from purely environmental motives, rather than as a secondary consequence of economic benefit or fishing efficiency.

MML Comment - The assessment team are of the opinion that the fleet demonstrates a strong conservation commitment and is proactive in responding to research and conservation issues.

3A7.2 Is voluntary adoption of management measures desirable?

MML Comment – The assessment team are of the view that not only is it desirable it is more effective than a regulatory requirement.

3A8.1 Can details be provided as to how the fishers closely approach 'demonstrating comprehensive knowledge of' the provided management information and training? Are the training seminars compulsory?

MML Comment - The phrase cited ("comprehensive knowledge") is a requirement for a 100 score. The fishery is rated at 90 as it was not possible to demonstrate this level of knowledge. However, fishers were judged to have some knowledge through the seminars, familiarity with the licence conditions and other regulatory requirements. Some crews also participate in industry funded surveys by commercial vessels. We understand that seminars are a company requirement. The score was deemed to exceed the requirements of an 80 score but did not reach 100.

3B 1.1 Why is the fishery' experimenting with 4 inch rings' when the US fishery has already regulated this for essentially a similar fishery? See also earlier comments about application of research on non-commercial bycatch, removal of voluntary practices etc.

MML Comment – See previous comments.

3B4.1 Discarding of scallop offal on, or close to fishing grounds, may attract predators (Ramsay *et al*, 1997) and so lead to increased bycatch by other boats operating in the area. See also comments

about pathogens.

MML Comment – See previous comments.

3B5.3 Apart from observers, who perform a very important role, is there any at-sea inspection by management authorities? Is it too far out to be practical?

MML Comment - DFO have patrol boats that conduct at-sea inspections. The fishery operates within the range of DFO vessels however DFO did explain to us that it “risk rates” fisheries for compliance and that this fishery was considered to be a low risk.

APPENDIX C

Client Draft Action Plan

Seafood Producers of Nova Scotia (SPANS) Offshore Scallop Draft Action Plan

Condition 1
In order to inform management of the incidental and discard mortality of scallops, the client will examine scallop discard and incidental mortality in the offshore scallop fishery based on existing data and literature available. The assessment of mortality may incorporate an estimate or scenarios of different mortality levels into the assessment and science advice. A summary of how this work is being incorporated into the management of the fishery will be provided to an audit team by the fourth annual audit.

Condition 2
In order to better evaluate the impacts of the fishery on the scallop stock, non target species and/or ecological systems, the client will:

- Extend bycatch monitoring to other banks through the observer coverage of one trip per year on each bank outside Georges Bank
- Work with DFO to review methods for collecting undersized scallop data and implement changes if and where warranted
- Report main bycatch species and scallop discards on an annual basis

This work will be completed and provided to an audit team by the second annual audit.

Condition 3
In order to ensure that sufficient information is available on the consequence of the fishery to suggest it is not having unacceptable impacts on habitat and biological diversity, community structure and productivity, the client will:

- Compile existing information on the spatial and temporal distribution on fishing disturbance, as well as existing data on seabed habitats and associated species by the second annual audit.
- Identify any important knowledge gaps and use this existing data and information as the basis of a qualitative analysis on sensitivity of key habitats and gear impacts by the third annual audit.
- Through the IFMP process, apply existing information to evaluate the risk of unacceptable impacts on ecosystem function as a result of the scallop fishery. If unacceptable impacts are identified, management strategies will be developed to mitigate impacts in areas where there is high risk of impairing ecosystem function. This will be completed by the fourth annual audit in conjunction with DFO.

All of the above work will be reported to an audit team as it is completed.

Condition 4
The client will by the first annual audit develop explicit short term and long term objectives. These objectives and procedures for measuring performance relative to the objectives will be incorporated in the update of the IFMP and provided to an audit team.

Condition 5

The client will by the first annual audit describe the application of the precautionary approach in this fishery in the updated IFMP, which will be provided to an audit team.

APPENDIX D

Stakeholder Comments

(*TO BE APPENDED FOLLOWING CONSULTATION OF THE PUBLIC COMMENT REPORT DRAFT*)

APPENDIX E

Summary review of relevant fishing impacts research.

Summary review of relevant fishing impacts research.

Robinson, S.M.C., Bernier S. & MacIntyre A. (2001) The impact of scallop drags on sea urchin populations and benthos in the Bay of Fundy, Canada. *Hydrobiologia*, V. 465, pp. 103-114.
This study was designed to investigate the impacts of using scallop dredges to harvest green sea urchins in inshore waters. Some immediate impacts were observed but short-lived. Due the spatial and temporal limitations of the design, the results are not applicable to offshore commercial fisheries.

Kenchington, E.L., Kenchington T.J., Henry, L.-A., Fuller, S. & Gonzalez, P. (2007) Multi-decadal changes in the megabenthos of the Bay of Fundy: The effects of fishing. Journal of Sea Research, V.58, pp. 220-240.
This study compared the composition of the megabenthos community collected by commercial scallop dredges during two surveys conducted 30 years apart on the Digby scallop beds. During this period, these beds were subjected to chronic fishing disturbance (both scallop dredging and otter trawling). Significant changes were observed. The community became more homogeneous with time and the frequencies of occurrence of dominant taxa changed markedly. Some of those that were most widely-distributed in 1966-67 suffered declines while others species increased in relative abundance, forming a new group of principal taxa. However, nothing in the data sets indicated that any species were lost from the area. Biological traits analysis indicated that mobility, degree of attachment, habitat, feeding mode, body flexibility and regenerative powers could explain some of the change observed in the frequency of occurrence. Over the 30-year period, there was a relative decline in fragile, sessile, permanently-attached and colonial taxa, particularly deposit and filter feeders, and an increase in robust, mobile grazers and scavengers. Taxa with a low ability to regenerate declined while those with an intermediate ability increased. There also appeared to be a corresponding shift towards smaller taxa. The inevitable limitations of the data sets which are confined to a single area and lack adequate controls, because of the use of biological traits analysis, it is concluded that the pronounced changes observed in the frequency of occurrence of dominant taxa over 30 years are due primarily to the chronic physical disturbance applied by frequent scallop dredging and otter trawling. These results are applicable to offshore scallop beds.

Henry, L.-E. & Kenchington, E. (2004). Differences between epilithic and epizoic hydroid assemblages from commercial scallop grounds in the Bay of Fundy, northwest Atlantic. *Marine Ecology Progress Series*, V. 266, pp. 123–134
This study compared the structure of hydroid communities found on cobbles and live adult sea scallops as sampled with a standard scallop dredge in the Digby scallop beds. It was assumed that large scallops have escaped previous contact with scallop dredges and represent pseudo-controls for fishing disturbance, while cobbles may have experienced repeated abrasion, displacement, or burying by scallop dredges and may have even been subjected to processing on board fishing vessels. No attempt was made to sample other components of the benthic community. The mean number of hydroid taxa was lower on cobbles than scallops and the hydroid assemblages on cobbles and scallops were significantly different at all taxonomic levels. This novel experimental approach provides strong circumstantial evidence that chronic scallop dredging can change the taxonomic structure of hydroid assemblages on gravel seabeds. Erect tree-shaped phalanx growth forms with larger and more heavily branched colonies and planula larvae life stages are replaced by taxa with low-lying runner-like growth forms and mixed growth forms which tend to be smaller with less branching and possess medusa life stages. These results are applicable to offshore scallop beds.

Collie, J.S., Hermsen, J.M., Valentine, P.C. & Almeida, F.P. (2005). Effects of fishing on gravel habitats: assessment and recovery of benthic megafauna on Georges Bank. American Fisheries Society Symposium 41: 325-343.
The first part of this US study assessed the effects of chronic fishing disturbance by comparing the megafauna communities at two adjacent sites on gravel lag habitat in Canadian waters, one heavily

fished and one lightly fished as judged by effort data (both otter trawling and scallop dredging). The lightly disturbed site had significantly higher abundance and biomass of benthic megafauna. There also were marked differences in community composition between the two sites with the less disturbed site being characterized by fragile species living in a complex habitat provided by colonial epifauna. It was assumed that these differences were caused by different levels of fishing disturbance but natural spatial differences may also be a contributing factor. The second part of the study monitored the recovery of the benthic community in a previously disturbed area in US waters that was closed to bottom fishing in January 1995 (Closed Area II). Over a six year period, significant shifts in species composition and significant increases in abundance, biomass, production and epifaunal cover were observed. Species-dominance curves reversed following the closure with species abundance progressively decreasing and species biomass progressively increasing as large animals came to dominate the biomass. It was estimated that the recovery time of the gravel habitat community would be at least 10 years. The results of these experiments are directly applicable to the scallop fisheries under assessment.

Hermsen, J.M., Collie, J.S. & Valentine, P.C. (2003). Mobile fishing gear reduces benthic megafaunal production on Georges Bank. *Marine Ecology Progress Series,* V. 260, pp. 97–108.
This study is a parallel to Collie et al. (2005) but calculated the secondary production of megafauna. When comparing the two sites on gravel pavement in Canadian waters, production was higher at the site with lower fishing disturbance. At the site closed to fishing in US waters, production increased markedly between 1994 (just before closure) and 2000. It was concluded that gear disturbance had a measurable effect on benthic megafaunal production in this hard bottom habitat. The results of these experiments are directly applicable to the scallop fisheries under assessment.

Stokesbury, K.D.E. & Harris, B.P. (2006). Impact of limited short-term sea scallop fishery on epibenthic community of Georges Bank closed areas. *Marine Ecology Progress Series,* V. 307, pp. 85-100
A BACI (before/after, control/impact) experiment was conducted at two sites in US waters. It was observed that changes in taxonomic categories and the density of individuals in the area impacted by the fishery were similar to changes in the control area that remained closed to fishing. Further, sediment composition shifted between surveys more than epibenthic faunal composition suggesting this community is adapted to a dynamic environment. It was concluded that this limited short-term fishery altered the epibenthic community less than the natural dynamic environmental conditions.

Lindholm, J., Auster, P. & Valentine, P. (2004). Role of a large marine protected area for conserving landscape attributes of sand habitats on Georges Bank (NW Atlantic). Marine Ecology Progress Series, V. 269, pp. 61–68.
This study compared the relative abundance of microhabitat features (scale at which individual fish associate with seafloor habitat) inside and outside of a large fishery closed area (Closed Area II). Seven common microhabitat types were compared separately. The only significant differences observed were in the relative abundance of shell fragment and sponge microhabitat types, both were more abundant inside the closed area. It is suggested that the lack of differences for other microhabitats may indicate level of fishing activity in the area is matched by the system's ability to recover.

Currie, D.R. & Parry, G.D. (1999). Impacts and efficiency of scallop dredging on different soft substrates. *Canadian Journal of Fisheries and Aquatic Science,* V. 56, pp. 539-550.
This paper describes experiments conducted on shallow soft sediments in Port Phillip Bay in southeastern Australia. Physical and biological changes were measured in large experimental plots dredged with an intensity and duration similar to normal scallop fishing. Dredging flattened all plots. Dredges caught mostly scallops and damage to species was slight except for high mortality rates of spider crabs and ascidians. Changes in benthic community structure caused by dredging were small compared with differences between study sites. They were also small compared to the cumulative changes to the infaunal community structure over 20 years. Results are not directly relevant to offshore scallop beds because of the much different habitat type and limited spatial extent.

Bradshaw, C., Veale, L.O. & Brand, A.R. (2002). The role of scallop-dredge disturbance in long-term changes in Irish Sea benthic communities: a re-analysis of an historical dataset. *Journal of Sea Research*, V.47, pp. 161-184. (And other papers by the same authors)

This study examined changes in benthic communities and the possible impacts of scallop dredging over 60 years. A conservative approach to data analysis ensured differences with time were not due to sampling methodologies or taxonomic identification. The community composition changed at all study sites but to different degrees. The amount of change was related to how long a site had been fished, rather than fishing intensity. Mobile, robust and scavenging taxa increased in abundance while slow-moving or sessile, fragile taxa have decreased. Differences between historical and modern samples were greater than could be accounted for by natural variability of the system and indicated real long-term change. These results are directly relevant to the fishery under assessment.