



The Gully - A Scientific Review of its Environment and Ecosystems

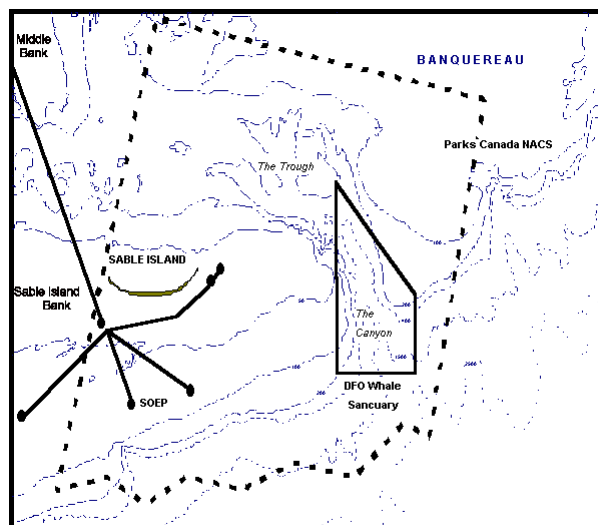
Background

The Gully is an area approximately 40 kilometers east of Sable Island, on the eastern Scotian Shelf. A deep canyon feature with depths over 2000m, the Gully separates Banquereau Bank and Sable Bank. The uniqueness of this large canyon feature on the Scotian Shelf, and the suspected biological significance of the area has attracted the interest of a number of government agencies, researchers, and conservationists:

1) In 1992, Canadian Heritage (Parks Canada) identified a large area (see Figure), encompassing both the Gully and the Sable Island regions, as one of three National Areas of Canadian Significance (NACS) in a study to identify a National Marine Park on the Scotian Shelf (Lane and Associates, 1992). The biological, physical, and historical significance of the overall region resulted in a high ranking for the area as a potential protected area. However, the potential user conflicts with existing and proposed oil and gas activities, shipping, fisheries, and its inability to provide significant visitor opportunities, were identified as limitations with the site.

2) In 1994, DFO designated a Whale Sanctuary in the Gully area in an effort to reduce ship collisions and noise disturbance with whales in the area (see Figure).

3) In 1994, a workshop was organized by Environment Canada (Canadian Wildlife Service) to address conservation issues pertaining to the Gully in 1994 (CWS, 1994). The main conclusions of that workshop were that the Gully is biologically significant; that current conservation strategies are inadequate to protect the significant biological resources; and, that there is a need for an overall conservation strategy for the area.



THE GULLY

4) In 1997, the Sable Offshore Energy Project (SOEP) Joint Review Panel Report identified a number of concerns regarding the potential impacts of the project and future developments on the Gully area (SOEP Joint Review Panel, 1997). SOEP is located to the west of the Gully. The Gully was identified as a 'unique ecological site' and 'valued ecosystem component' in the SOEP Environmental Impact Statement (SOEP, 1996). The Panel recommended that prior to regulatory approval, SOEP submit its Code of Practice outlining protection measures in the Gully as part of their final Environmental Protection Plan.

As well, the Panel recommended that SOEP begin or contribute to research activities in the Gully that will provide the baseline data for Environmental Effects Monitoring programs. In turn, these data will assist in determining the impact of the project and further resource developments on the Gully.

5) In 1997, the World Wildlife Fund (WWF) identified the Gully as a potential site for a protected area as part of their Endangered Spaces Campaign (WWF, 1997). A WWF report details the biophysical characteristics and some of the related management issues for the area (Shackell et. al., 1996).

Summary

- The Gully is unique among canyons of the eastern Canadian margin because of its great depth, steep slopes and extension far onto the continental shelf (i.e. connecting the continental slope to the inner shelf).
- Patterns of circulation in the Gully suggest that it may play an important role in two ways: (1) in the localized retention of materials, and (2) in the larger scale, transport of materials onto and off of the shelf.
- Plankton dynamics in the Gully exhibit features which are characteristic of both shelf basin and shelf break habitats.
- Given the abundance of silver hake eggs and larvae in the region, it is reasonable to conclude that the Gully was an important spawning area for this species at the time these samples were collected (1978-82).
- The Gully and adjacent area has a relatively high demersal finfish diversity relative to the eastern Scotian Shelf.
- The diversity of benthic species and their abundance is generally significantly greater in submarine canyons than adjacent slope waters.
- Corals are recognized as an important part of the benthic biota of the Gully, providing habitat for a variety of additional species.
- Aside from corals, there are no data that suggest the Gully is of special significance to the populations of any benthic invertebrate species.
- There is not enough evidence to assess whether submarine canyons have any

major effect on seabird distributions at the surface.

- The Gully/Sable Island area is an important habitat for both cetaceans and pinnipeds on the Scotian Shelf. The most significant marine mammal habitat within the area for pinnipeds is Sable Island and surrounding waters. For cetaceans, the deep canyon and northern basin of the Gully (>200m in depth) is the most important habitat.
- An integrated ecosystem description of the Gully is not possible now. However, the same could be said for our understanding of the environment and ecosystems of Scotian Shelf in general.

The Issue

In response to the broad interest expressed in the Gully, DFO Headquarters requested, in May 1997, that Maritimes Region initiate a coordinated review of the Gully as a first step in the development of a Conservation Strategy for the region. The Gully Science Review was

to provide a description of the environment and ecosystem(s) of the Gully and surrounding area in order to characterize unique or special features of the Gully in the context of the Scotian Shelf system.

The review team was drawn from local expertise, including government and NGO (non-governmental organization) members.

The Gully review was based on the following principles:

- It will be coordinated by DFO and will include other Federal departments and experts from outside government (NGOs).

- It will be as comprehensive as possible (within the timeframe allocated) and include an up-to-date bibliography.
- It will incorporate unpublished research data to the extent possible.
- It will identify knowledge gaps.
- Where no information exists, it will draw on information from analogous (but better described) regions.
- It will build upon the 1994 CWS sponsored Workshop and Discussion Paper, "Towards a Conservation Strategy for the Gully near Sable Island, N.S."

This review would be subjected to the Regional Advisory Process (RAP), and would be developed into a DFO Research Document.

The Ocean Sciences Division of the Maritimes Region Science Branch of DFO was mandated to initiate and lead the scientific review. The review team, consisting of some 32 government (DFO, NRCan), university (Dalhousie) and other NGO (WWF, NS Museum, Ecology Action Centre) researchers, was to produce a document summarizing the current state of knowledge of the Gully's geology, hydrography, oceanography, benthos, fisheries, seabirds and mammals. The science review document (Harrison and Fenton, 1998) and draft Habitat Status Report (HSR) were presented at a Regional Advisory Process (RAP) meeting in February, 1998 and evaluated by review team members, stakeholders, other invitees, and a panel of external examiners. Revisions were made to both documents, reflecting recommendations made during the meeting.

The Gully Science Review

The individual reports contained within the Gully Science Review document are organized by discipline. They (1) describe the sources of available scientific information, (2) provide an interpretation of the data with

regard to general as well as unique or special features, and, (3) identify information/data gaps. This HSR is a synopsis of the major findings of that review.

Geosciences & Hydrography

This section describes the Gully's origin, bathymetric morphology, bedrock and surficial geology, sediment transport and mineral potential. The data derived from the Geological Survey of Canada inventory are characterized as limited and patchy, largely based on seismic reflection surveys.

The Gully is characterized as a large shelf-edge canyon on the eastern Scotian Shelf **unique among canyons of the eastern Canadian margin because of its great depth, steep slopes and extension far onto the continental shelf (i.e. connecting the continental slope to the inner shelf)**. The Gully is a steep-walled canyon cut into tertiary bedrock in the deeper sections and blanketed by thick quaternary glaciomarine sediments in the shallower portions. The floor of the deeper sections of the Gully probably consists of sands or gravels scoured by strong currents. Recent studies of four small feeder canyons on eastern Sable Bank suggest that these may be sites of active sediment transport into the Gully. Based on studies in analogous regions, the slope of the Gully and its surficial geology are thought to largely determine the region's benthic community structure and biodiversity.

Physical & Chemical Oceanography

A detailed analysis of data on circulation, current variability and exchange, tides and low-frequency variability of hydrographic and chemical properties in the Gully and surrounded regions is based on the DFO hydrography and nutrient database, direct current measurements and finite element diagnostic and prognostic models. **Patterns**

of circulation in the Gully suggest that it may play an important role in two ways: (1) in the localized retention of materials and (2) in the larger scale transport of materials onto and off of the shelf. An analysis of the physical oceanographic data from the Gully and model simulations have indicated that it may feature a weak, counterclockwise circulation that could contribute to the local retention of particles. However, similar patterns are found elsewhere on the Scotian Shelf, e.g. the clockwise gyre around Browns Bank, the Western Bank gyre, and the retention area over Emerald Bank. Low-frequency current variability in the Gully is comparable to that observed in nearby regions and for the Scotian Shelf as a whole.

Surface tides in the area behave regularly. There is some evidence from water column surveys and from fixed sensors measuring temperature variability that internal tides and internal wave activity at the mouth of the Gully may be enhanced. This could lead to increased vertical mixing in the Gully with implications for greater nutrient supply to surface waters and consequently for enhanced primary productivity. However, a comparison of the long-term mean profiles of seawater density indicates very little difference among those from the Gully and from surrounding areas. Therefore either the internal wave activity seen in the Gully surveys extends into the adjacent areas, or enhanced mixing, driven by internal wave breaking and dissipation, is highly localized within the Gully. Our broad averaging of monthly density profiles may have hidden localized mixing 'hot spots'.

There are enough measurements of nutrient and oxygen concentrations in the Gully to calculate their monthly average concentrations. The general picture of nutrient distributions thus derived is very similar to analogous descriptions for adjacent areas. There are inadequate data for an

investigation of nutrient variability on smaller time or space scales. For example, there is no indication in the available data of localized elevated surface nutrient levels resulting from enhanced mixing as some of the physical oceanographic data suggests. Mixing may be no greater in the Gully than on the adjacent regions of the shelf or it may be occurring on small time and space scales not resolved by the limited data coverage. Alternatively, surface nutrients may be rapidly removed by biological uptake.

Low frequency processes, due primarily to meteorological forcing, contribute to the onshore-offshore exchange of heat and salt through the Gully. Calculations based on current meter data and source water nutrient concentrations indicate that nutrient transport through the Gully could make a significant contribution to the eastern Scotian Shelf during summer. In winter, transport from the Gulf of St. Lawrence dominates.

There are no data on chemical contaminants within the Gully. However, extrapolation of data from adjacent areas suggests that elevated concentrations of any of the common contaminants would not be anticipated in the water, sediments or biota of the Gully.

Biological Oceanography - Plankton

Analysis of phytoplankton, zooplankton and ichthyoplankton data from the Scotian Shelf Ichthyoplankton Program (SSIP) surveys, more recent research on the Scotian Shelf, acoustics backscatter data and satellite ocean colour imagery are described.

The seasonal cycle of phytoplankton in the Gully region follows the pattern seen shelf-wide and observed in north temperate coastal waters in general. Low biomass levels occur during winter (due to light-limitation of growth) and summer (due to nutrient-

limitation of growth) and biomass maxima occur in spring and fall (optimal light-nutrient conditions). Analysis of the available data does not indicate that the Gully has persistently higher phytoplankton abundance than observed on the broader Scotian Shelf. Limited data, however, suggest that high frequency events may cause localized enhancement of phytoplankton abundance in the Gully. This feature is missed with the conventional coarse-scale sampling carried out in the past.

The zooplankton seasonal cycle in the Gully, likewise, is similar to that of the Scotian Shelf in general. Analyzed data do not support the idea that mesozooplankton are especially abundant in the Gully compared with other deep water areas of the Scotian Shelf. Because it is an area of deep water, however, it harbours overwintering populations of *C. finmarchicus* at depths >200 m and krill. Krill spend the daylight hours at depths >200 m and the night-time hours in the near surface layers. For the macroplankton (krill), it is unclear whether concentrations in the Gully are generally higher than those in other basins or along the continental slope of the Scotian Shelf. Equally, from existing data, it cannot be determined whether the Gully is an area of intrusion of the very abundant off-shore population of *C. finmarchicus* onto the Shelf in spring. This is the case further to the south and west in the area of the Halifax section. If it is, then it may provide an important source of copepods for Sable Island and Western banks in spring. **Overall, plankton dynamics in the Gully exhibit features which are characteristic of both shelf basin and shelf break habitats.**

SSIP samples were examined to investigate the importance of the Gully as a spawning area for marine fish. Twelve species of fish eggs and nearly thirty species of larvae were encountered in the Gully. Silver hake eggs

were the most abundant, followed by pollock, American plaice and cod. While larvae of sandlance, windowpane flounder and cod were most abundant. **Given the abundance of silver hake eggs and larvae in the region, it is reasonable to conclude that the Gully was an important spawning area for this species at the time these samples were collected (1978-82).** The shelf-wide significance of the Gully as a spawning site for this and other species in more recent years, however, is not known.

Benthos

The sedimentary interface fauna (benthos) of the Scotian Shelf is poorly known and existing studies have been targeted to specific regions or aspects of the benthic community rather than to broad surveys. There have been no studies conducted on the benthic community structure or distribution for the Gully region. Based on a recent limited video survey in the region and research done in other submarine canyons on the North Atlantic continental margin, however, a general picture of the structure, composition and vertical zonation of benthic communities in the Gully region can be constructed. It is clear from studies in analogous regions that **the diversity of species and their abundance is generally significantly greater in submarine canyons, such as the Gully, than adjacent slope waters.** This can be related directly to the richness and variety of habitats found in regions characterized by steep slopes.

An analysis has been made of the distribution and diversity of deep sea horny and stony corals along the Scotian Shelf and within the Gully. It is based on interviews with fisherman and scientists, as well as the study of museum collections and review of the literature. Half of the 20 species of deep sea corals reported from Nova Scotia waters occur in the area of the Gully and the adjacent

continental slope. This is a typical assemblage of species and no "rare" species were found. **Corals are recognized as an important part of the benthic biota of the Gully, providing habitat for a variety of additional species.**

Fish & Fisheries

A description of finfish and invertebrates on the Scotian Shelf is largely based on DFO trawl survey data from 1970-1993. Analyses compared the distribution and abundance of groundfish, pelagics and invertebrates in the Gully and surrounding eastern Scotian Shelf and slope regions.

The Gully and adjacent waters is an area of relatively high demersal finfish diversity relative to the eastern Scotian Shelf. There is no evidence for any endemic demersal species of fish. However, given the low sampling rate and the potentially low efficiency of the trawl in the steeply sloped Gully, this does not rule out the possibility that such species occur.

The slope waters of the Gully, like the Scotian Slope in general, is an area of faunal boundaries. The upper reaches of the slope (<360 m) represent the lower boundaries of distribution for the shelf dwelling species and the upper limits for those species which are truly slope dwellers. Between 360 m and about 900 m, the slope has its own ichthyofauna. Beyond these depths, the demersal fish assemblages change again to represent that of the lower slope and abyssal rise. It is difficult to draw conclusions about the uniqueness of the fish occurring in the slope waters of the Gully given the relative paucity of data from other areas suitable for comparison.

The area does not appear to be important for shelf dwelling pelagic species although these do occur there as migrants. The pelagic

species occurring over the shelf slope and abyssal plain adjacent to the Gully are numerous (> 200 species). Given the broad geographic distributions of many of these species it is unlikely that any are unique to the Gully.

The Gully, relative to the eastern Scotian Shelf, is an area of high density for redfish, squid, cod, witch flounder, white hake, and longfin hake. The top nine species of demersal fish found in the Gully can be split into those whose dynamics are relatively similar to those demonstrated by the same species elsewhere on the eastern Scotian Shelf (redfish, squid and witch flounder), and those whose dynamics show different patterns in the Gully relative to the eastern shelf (American plaice, haddock, cod, silver hake, white hake and pollock). The underlying causes of the different dynamics in these areas has not been investigated.

Although at present the fisheries on the eastern Scotian Shelf are severely restricted relative to the recent past, the Gully continues to be an actively fished area. Longline effort directed at Atlantic halibut and white hake is the most common. In the past, there has also been significant trawler effort in both the Gully and the adjacent slope waters.

Squid is the only active commercial fishery for invertebrates in the Gully trough (>200 m) but there are several other fisheries in the surrounding area (surf clams, scallops, snow crab, shrimp). In the future, there is potential for expansion of existing fisheries to the Gully (*e.g.* snow crab, shrimp) as well as some new benthic fisheries (*e.g.* stone crab). **Aside from corals, there are no data that suggest the Gully is of special significance to the populations of any benthic invertebrate species, but data on shelfwide distribution of most species are not available.**

Seabirds

A description is given of the species making up the western Atlantic pelagic avifauna. This description is derived principally from the PIROP database of CWS which is comprised of 25 years of observational data from ships and more recent studies.

The high variability of seabird distributional data make it difficult to detect small, local anomalies of distribution. The highest concentrations of pelagic birds are found along the shelf edge and in areas of enhanced turbulence and mixing. High seabird numbers also occur predictably in the area of mixing between Sable Island and the mainland generated by the Sable Island gyre.

The PIROP database unfortunately contains few observations made in Gully area, but the few data that are available do not show any unusual enhancement of seabird numbers in the area. Weatherbee (1997) conducted a series of summertime seabird surveys at the Gully. He noted that some species appeared less abundant when compared with the rest of the Scotian Shelf. On the other hand, greater shearwaters and petrels appeared to be slightly more abundant. However the PIROP data used for comparison were gathered more than a decade earlier. Inter-year variations in the numbers of these southern migrants may well account for the small differences observed. Furthermore, Weatherbee's comparison was with data for the shelf as a whole rather than the adjacent shelf edge, where pelagic seabirds are generally more abundant.

Based on the poor spatial/temporal resolution of available data on pelagic seabird distributions off eastern Canada, **there is not enough evidence to assess whether submarine canyons have any major effect on seabird distributions at the surface.**

Marine Mammals

A detailed account is given of existing information on the two principal orders of marine mammals (and the only two on the Scotian Shelf); whales/dolphins (cetaceans) and seals (pinnipeds). Included are descriptions of the area, data sources, and summaries for each species of habitat preference, temporal use of area, approximate numbers and significance of the Gully to the species identified. Marine mammals were treated differently than the other disciplines in that the adjacent area of Sable Island and the Sable Island Bank is also discussed.

Available evidence strongly suggests that **the Gully/Sable Island area is an important habitat for both cetaceans and pinnipeds on the Scotian Shelf. The most significant marine mammal habitat within the area for pinnipeds is Sable Island and surrounding waters. For cetaceans, the deep canyon and northern basin of the Gully (>200m in depth) is the most important habitat.**

The area is notable for (1) a high diversity of cetaceans (8-13 common species), (2) a high density of cetaceans in the Gully canyon, and (3) a high density of grey seals breeding on Sable Island. Densities of most species of cetacea are considerably higher in the Gully than on other parts of the eastern Scotian Shelf. Large whale density is higher in the Gully than elsewhere along the edge of the Scotian Shelf, including the entrance of the Fundian Channel.

In addition, the Gully/Sable area is of particular significance, within a Canadian context, for grey seals, harbour seals, northern bottlenose whales, sperm whales, striped dolphins, Atlantic white-sided dolphins, and Short-beaked common dolphins.

Overview

The goal of the Gully Science Review was to provide a comprehensive description of the Gully's environment and its ecosystems. Ideally, the available information would be sufficient for developing an integrated ecosystem view of the Gully with an understanding of its components, how they interact, and how they respond to their environmental regulating forces. Despite the substantial amount of information the Science Review team has compiled, there are still key components of the Gully ecosystem for which we have virtually no quantitative information and others about which we have incomplete information. As a consequence, at present, **an integrated ecosystem description of the Gully is not possible. However, the same could be said for our understanding of the environment and ecosystems of the Scotian Shelf in general.**

The Science Review has produced a general description of the regional geology, oceanography, fisheries and higher trophic level fauna (seabirds and mammals) of the Gully. However, there is no comprehensive set of contemporary data for any of these components. As we attempt to construct an integrated ecosystem description of the Gully, the nature and importance of these information gaps becomes apparent.

Since none of the data were collected to address specific aspects of the Gully ecosystem, the spatial scale of the data often made it difficult to use the same "boundaries" for the Gully for different ecosystem components. Thus the marine mammals review considered the pinnipeds on Sable Island as well as the whales in the general area referred to as the Gully. Most of the other reviews focused on the smaller area delineated by the 200 m contour. The importance of establishing a "boundary", no matter how

arbitrary it might be, became apparent as the review proceeded. This fundamental omission in the review process has an effect on the ease of interpreting the information but it does not impact the basic conclusions of the review.

The Research Document (Harrison and Fenton, 1998) and Proceedings (Keizer, editor, 1998) have an extensive list of recommendations for each of the disciplines and these should be considered in their entirety.

For More Information

Contact: Paul D. Keizer, Manager
Marine Environmental Sciences Division
Fisheries and Oceans Canada
Bedford Institute of Oceanography
P.O. Box 1006
Dartmouth, NS Canada B2Y 4A2
Tel: 902-426-6138
Fax: 902-426-6695
E-mail: KeizerP@mar.dfo-mpo.gc.ca

References

- Canadian Wildlife Service. 1994. Notes from the Workshop - Evaluation of the Natural Values of "The Gully" and Sable Island Offshore Areas. Bedford Institute of Oceanography, November 2, 1994.
- Canadian Wildlife Service. 1995. Towards a Conservation Strategy for the Gully near Sable Island: Discussion Paper. June, 1995. Canadian Wildlife Service, Sackville, N.B.
- Department of Fisheries and Oceans. 1996. *Notice to Mariners Annual Edition 1996*. Supply and Services, Ottawa.
- Harrison, G. and Fenton, D. (eds.). 1998. The Gully Science Review. DFO Can.

- Stock Assessment Sec. Res. Doc. 98/83.
- Keizer, P.D. (editor) 1998. Maritimes Regional Advisory Process Habitat Subcommittee Gully Science Review. DFO Can. Stock Assessment. Sec. Proceed. Ser. 98/2.
- Lane, P. and Associates Limited. 1992. *A Study to Identify Marine Natural Areas of Canadian Significance in the Scotian Shelf Marine Region*. Project E-363. Report submitted to Canadian Parks Service, Environment Canada, May 1992. Ottawa.
- Sable Offshore Energy Project. 1996. *Environmental Impact Statement - Volume 3*.
- Shackell, N., Simard, P., and Butler, M. 1996. Potential Protected Area in the Gully Region, Scotian Shelf. Report to World Wildlife Fund of Canada. June, 1996.
- SOEP Joint Review Panel. 1997. *Joint Review Panel Report - Sable Gas Projects*.
- Weatherbee, R. A. 1997. The distribution and abundance of pelagic seabirds in 'the Gully'. BSc. Thesis, Dalhousie University, 59pp.
- World Wildlife Fund, 1997. *Endangered Spaces Program Annual Report 1996-1997*, Toronto.

This report is available from the:

Maritimes Regional Advisory Process
Department of Fisheries and Oceans
P.O. Box 1006, Stn. B203
Dartmouth, Nova Scotia
Canada B2Y 4A2
Phone number: 902-426-7070
e-mail address: MyraV@mar.dfo-mpo.gc.ca

La version française est disponible à l'adresse ci-dessus.



Correct citation for this publication:

DFO 1998. The Gully - A Scientific Review of its Environment and Ecosystems. Maritimes Regional Habitat Status Report 98/1 E.