Centre for Offshore Oil and Gas Environmental Research
Centre de recherche environnementale sur le pétrole et le gaz extracôtiers

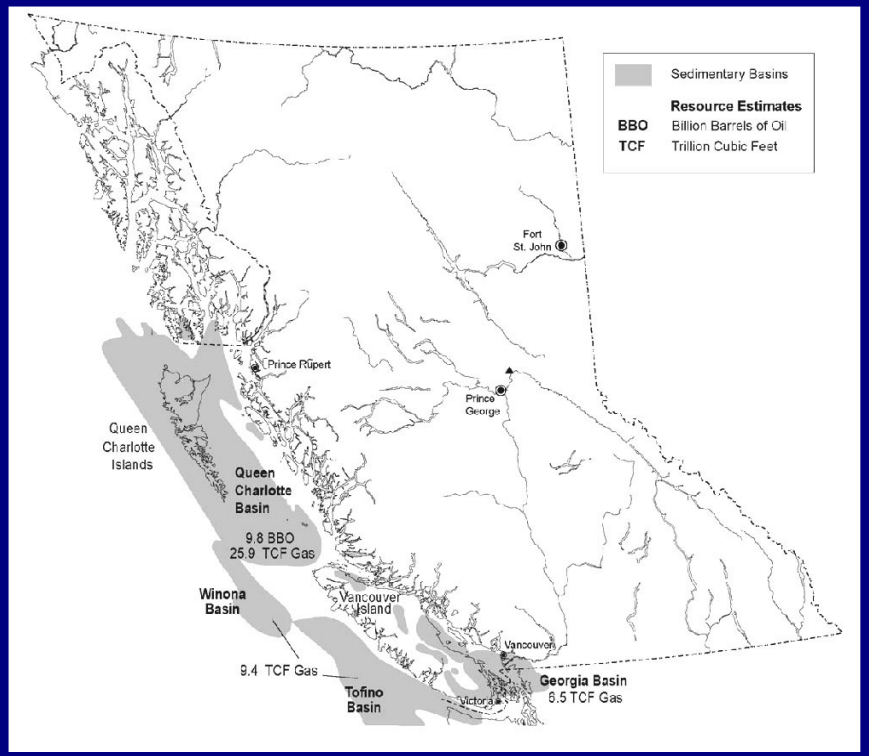
Fisheries and Oceans | Pêches et Océans

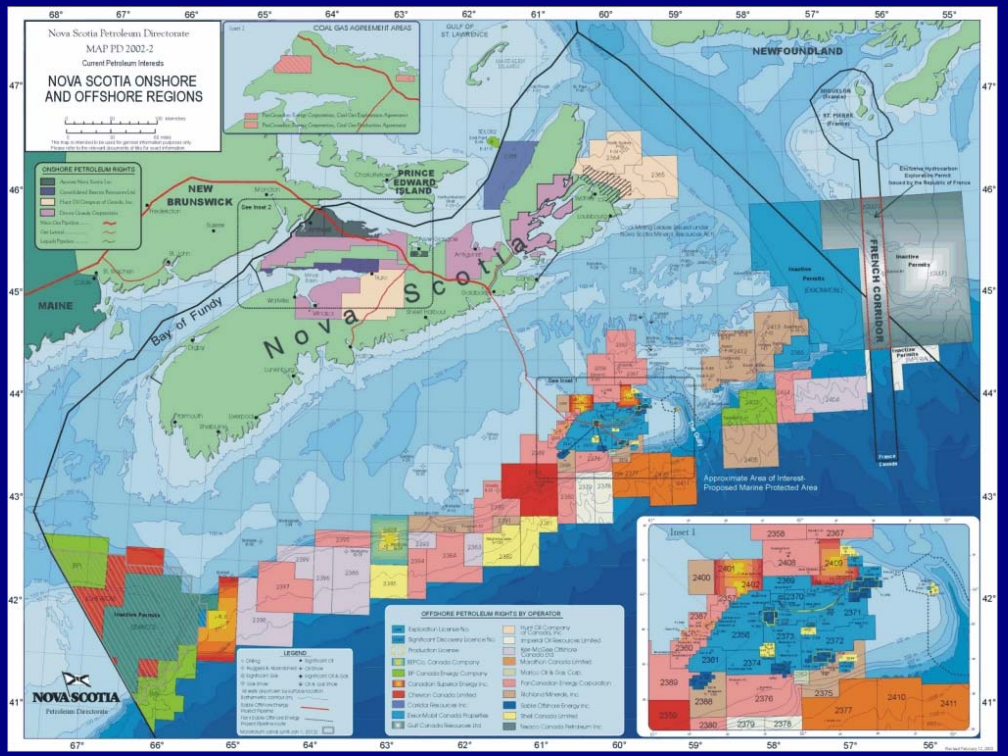
# DFO Science: Addressing Environmental Issues Related to Offshore Oil and Gas Activities

Kenneth Lee

# Background

- ***Canadian offshore oil and gas activities are expanding; many issues are emerging that require scientific knowledge to resolve.***



# COOGER Objectives

- Primary role is research for delivery of scientific information
- Identification of R&D needs
- National co-ordination of existing regional expertise and infrastructure
- Procurement of research funds
- Provision of scientific support to internal clients and external research partners to ensure environmental protection
- Promote national/international research collaborations with other government agencies, industry and academia

# Research Goals

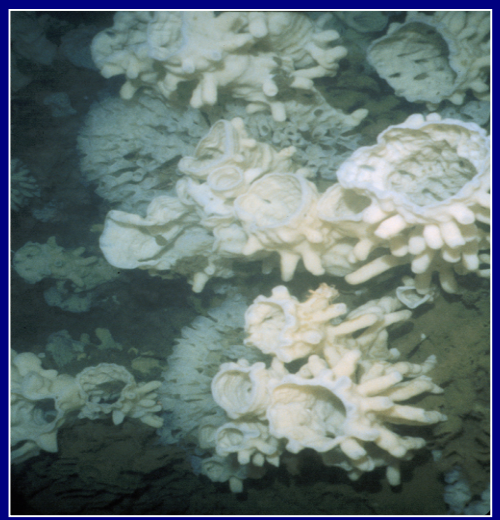
***Assessment of environmental impacts and risks associated with offshore oil and gas exploration, production and transport operations.***

**Primary program focus:**

- **Identification of sensitive habitats**
- **Drilling wastes**
- **Produced water**
- **Assessment of oil spill impacts and remediation**
- **Baseline Information**
- **Environmental factors**
- **Seismic impacts**

# Identification of Sensitive Habitats

***Industry would like to have regulators and resource managers identify acceptable sites for offshore oil and gas activities.***



**Projects include:**

- **Deep Water Benthic Community**
- **Atlas of Fish Eggs and Larvae for the Scotian Shelf and Adjacent Areas**
- **Mapping spawning and nursery areas on the Grand Banks**

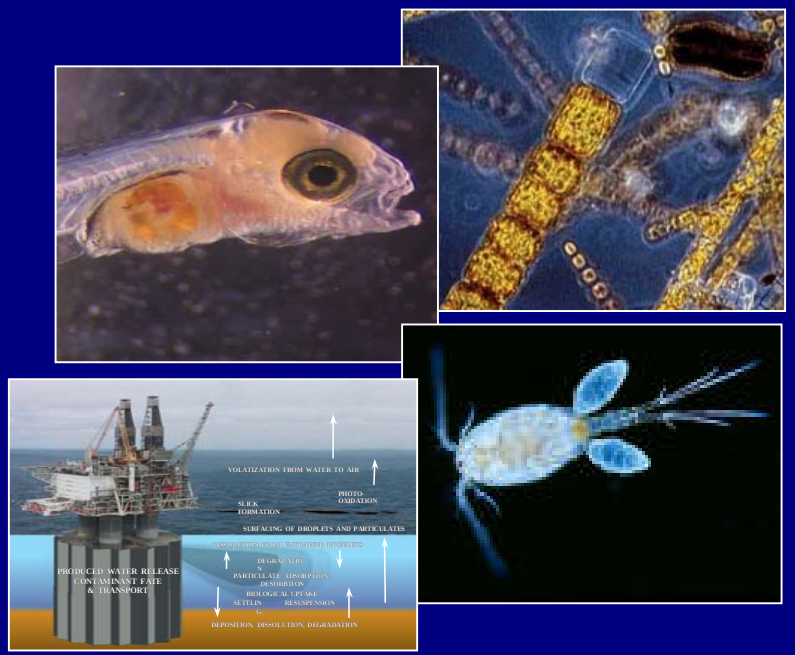
# Drilling Wastes

- **10 years of DFO research on waste discharges has EEM protocols for assessment of risk including predictive models**
  - **International Workshop -** *Offshore Oil and Gas Environmental Effects Monitoring Workshop: Approaches and Technologies, Dartmouth, NS, May 26-29, 2003.*

- **Ongoing programs:**
  - **Mesocosm and Laboratory Study of Effects of Drill Cuttings**
  - **Field Verification of Benthic Boundary Layer Modelling Effects**

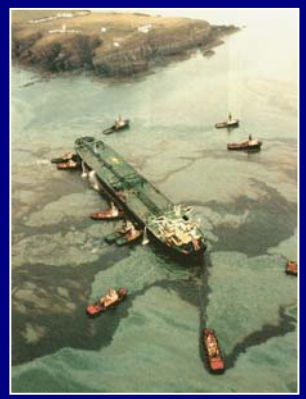
# Produced Water

- Largest volume waste stream from oil and gas production activities
- Research is needed to identify:
  - impact of produced water discharges on the environment, if any
  - acceptable disposal limits
- Projects include:
  - Ecological Risk of Produced Water Discharges
  - Risks of Offshore Development on Crab and Shrimp



# Oil Spill Impacts and Remediation

- **Concern over ecological damage from oil spills**
- **Research on oil spill countermeasures and methodologies to quantify habitat recovery (*How clean is clean?*)**
- **Projects (ongoing):**
  - **Fate and Effects of Chemically Dispersed Oil**
  - **Toxicity Identification and Evaluation (TIE) of Toxic Components in Residual Oil**
  - **Degradation of Hydrocarbon Residues using Chemical and Biological Oxidation**

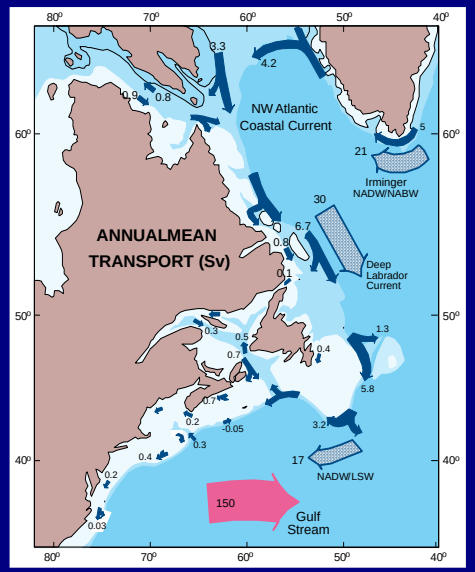



# Baseline Information

- Physical, chemical and biological baseline data are needed for *"state of the ocean"* reports for future comparison and development of predictive models
- DFO should develop baseline monitoring protocols for industry EEM programs. (e.g., Assessment of Baseline Hydrocarbon Data on the West Coast of Canada

# Environmental Factors

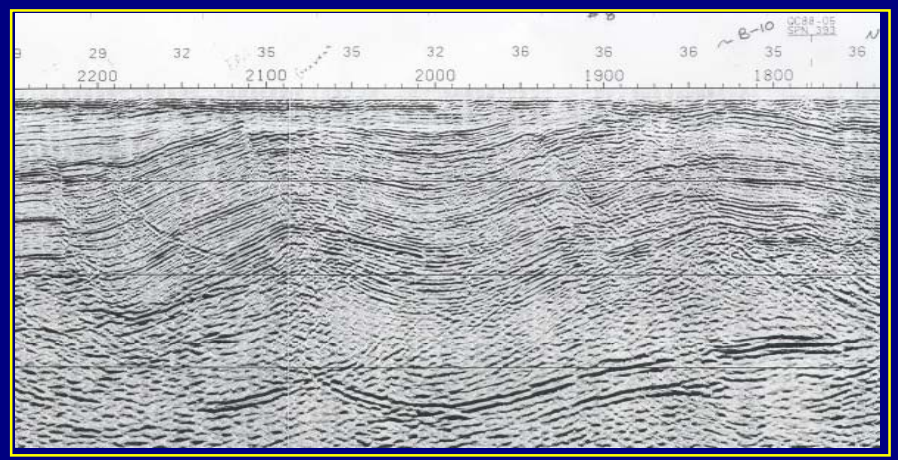
- Research on the potential impact of the environment on offshore oil and gas industry activities
  - Wind, wave and ice projects by physical oceanographers



# Marine Noise: Environmental Issue

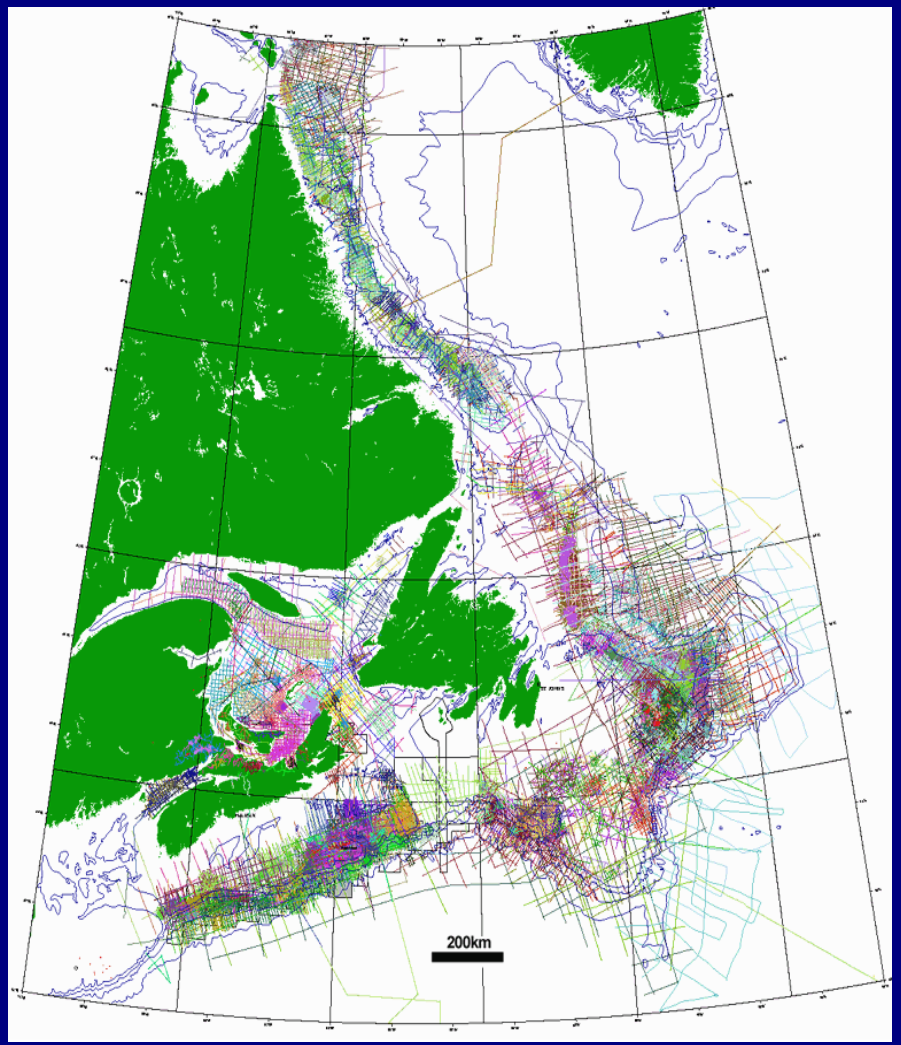
- *Maintenance of environmental quality for living marine resources as related to the production of noise in the marine environment.*

- **Four principal sources of marine noise:**
  - **Resource exploitation**
  - **Military applications**
  - **Transportation**
  - **Seismic operations**



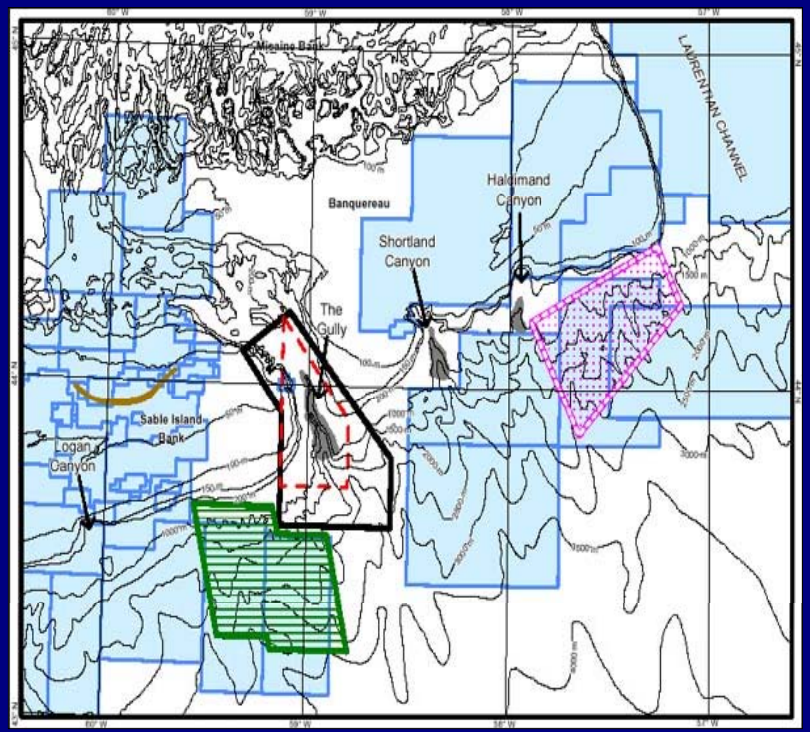
# Seismic Impacts

- Seismic surveys are an essential component associated with oil and gas exploration
- Many surveys have been conducted the past 30 years
- National concern due to uncertainty over potential of impacts on marine life and other ocean uses



# Seismic Impacts – The Gully

**Marine mammals especially the Northern Bottlenose Whale (a species-at-risk) inhabit the Gully Marine Protected Area (MPA), and adjacent canyons of the outer Scotian Shelf and Slope**




# Industry - Mitigation and Monitoring

- No seismic acquisition within the proposed Gully MPA
- Orientation of seismic lines – NNW-SSE direction, reducing sound propagation towards the Gully
- Ramp-up over a 30 minute period
- Airgun arrays shut down during turns at the end of sail lines
- Implementation of safety radius/shut downs for key marine mammals (e.g., baleen whales, NBWs and other endangered whales identified by COSEWIC) based on noise modeling
- Acoustic measurements taken early in the program to verify model results and safety radius
- Dedicated marine mammal observers (MMOs) and fisheries officers (FOs)

# COOGER Seismic Project

Prediction of Sound

Acoustic Monitoring

**Seismic Sound Source**

Whale Distribution and Behaviour

# Project Design

**Two research missions:**

- **Density and distribution of marine mammals in these areas**
- **Anthropogenic sound characteristics**
- **Oceanographic and acoustic characteristics of the Gully and adjacent area**

**27 April – 2 May 2003**

**baseline data collection prior to seismic operations**

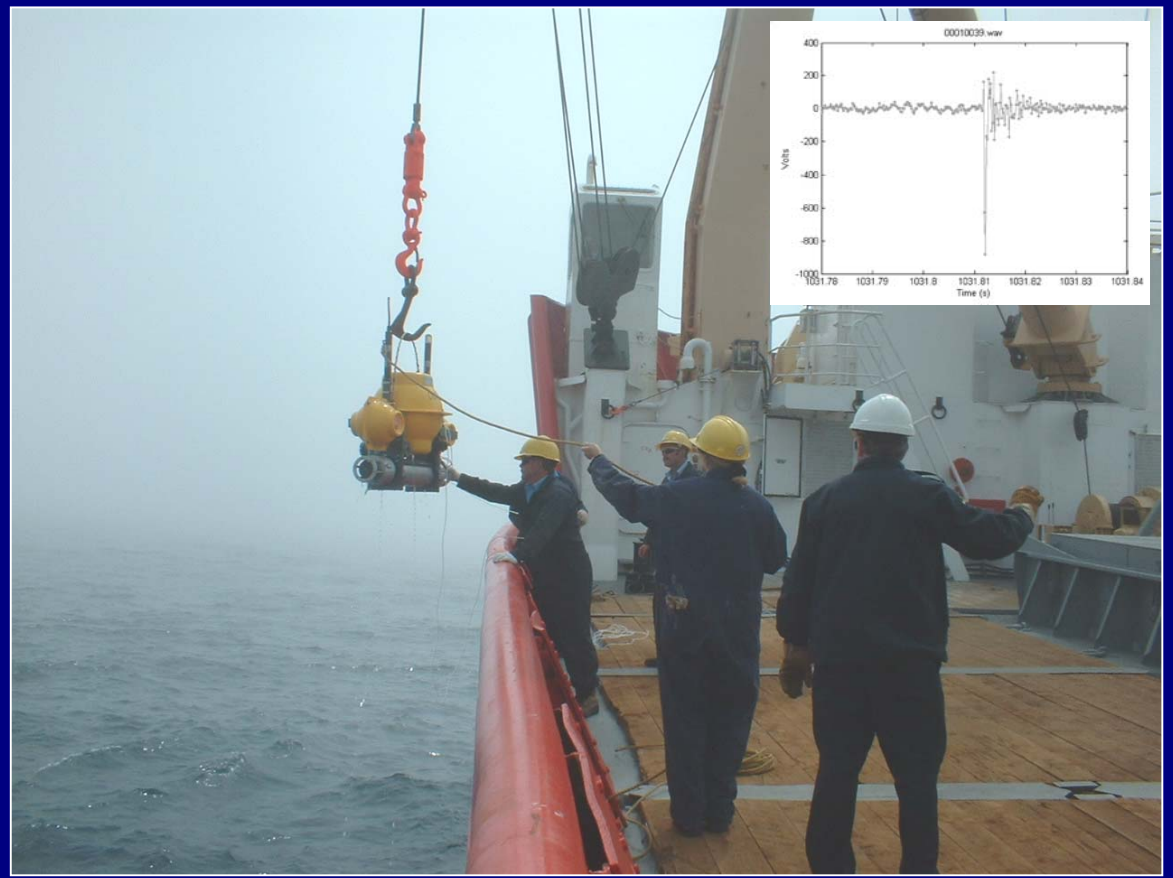
**4 – 16 July 2003**
**data collected after seismic operations had commenced**

# Seismic Impacts

- Deployment of autonomous Ocean Bottom Seismometers (OBS), water-column hydrophones, and marine mammal observers:
  - Determine distribution and density of marine mammals in the study region
  - Quantify acoustic pulse signals of seismic origin within the Gully Whale Sanctuary
  - Determine if seismic sound exposure results in alterations in whale vocal behaviour and marine mammal distribution
  - Validate current sound propagation models by direct measurement in the acoustic far field where sound levels are influenced by water column structure and bottom sediment absorption characteristics

# Acoustic Recordings

- Six Ocean Bottom Seismometers (OBSs) were deployed in the Gully area

# Acoustic Recordings

- Systematic grid of fixed stations (Hydrophone at 90 m - sound channel)
- Half-hour recordings
  - 10-24,000 Hz bandwidth
- CTD profiles to bottom or 550 m

# Visual Surveys - Methods

**3 observers:**

- **Primary search by naked eye**
  - **Marine binoculars with reticles**
- **“Big Eye” binoculars**
  - **Species identification**
  - **Estimation of group size**

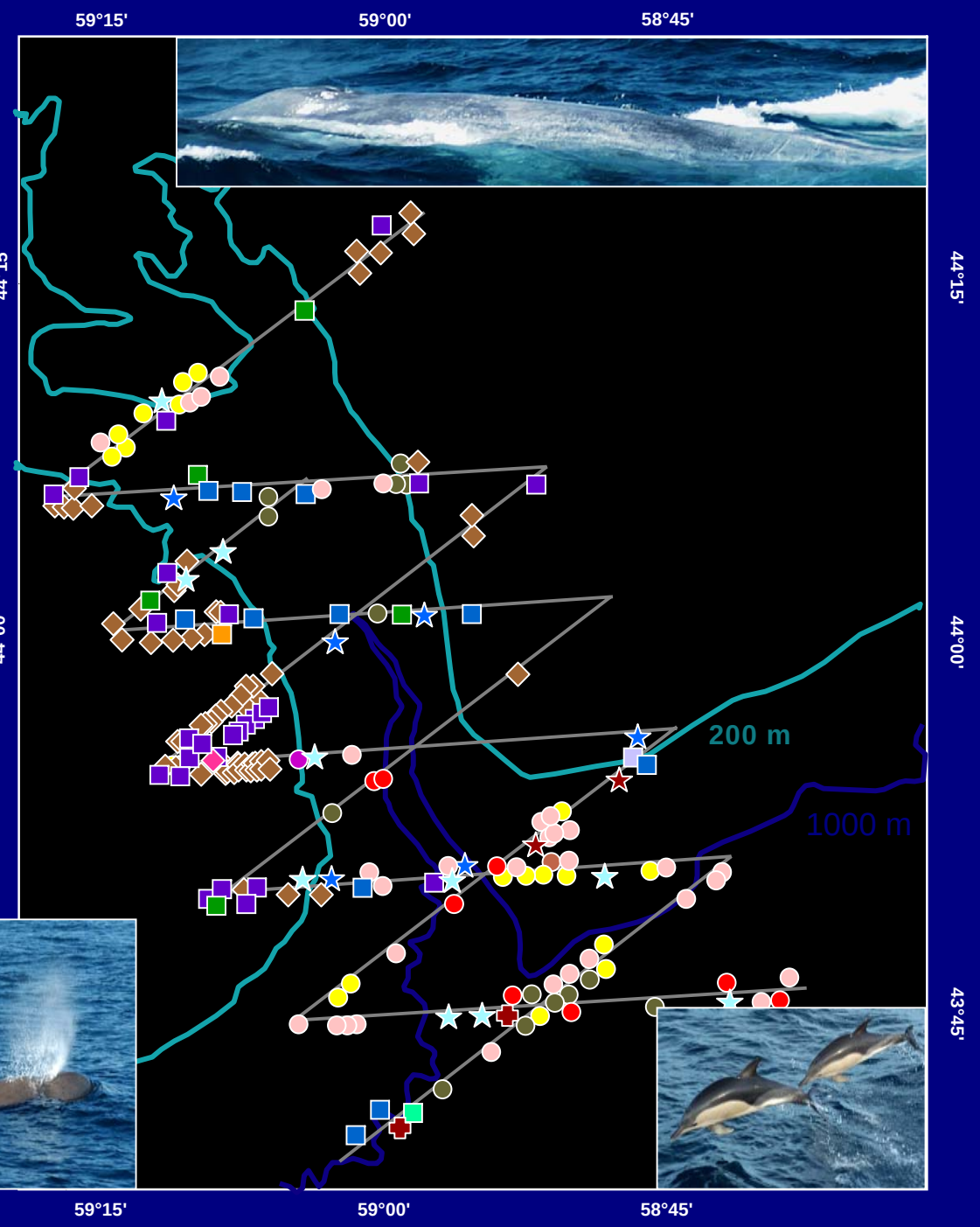
- **Conditions**
  - **Beaufort, wave, swell height**
  - **Visibility**

# Visual Survey - Seismic

400 km of transect line
(July 8, 10 and 11, 2003)

207 sightings - 13 species
563 individuals:

- 35 Northern Bottlenose Whales
- 7 Humpback Whales
- 2 Sperm Whales
- 1 Blue and 1 Fin Whale

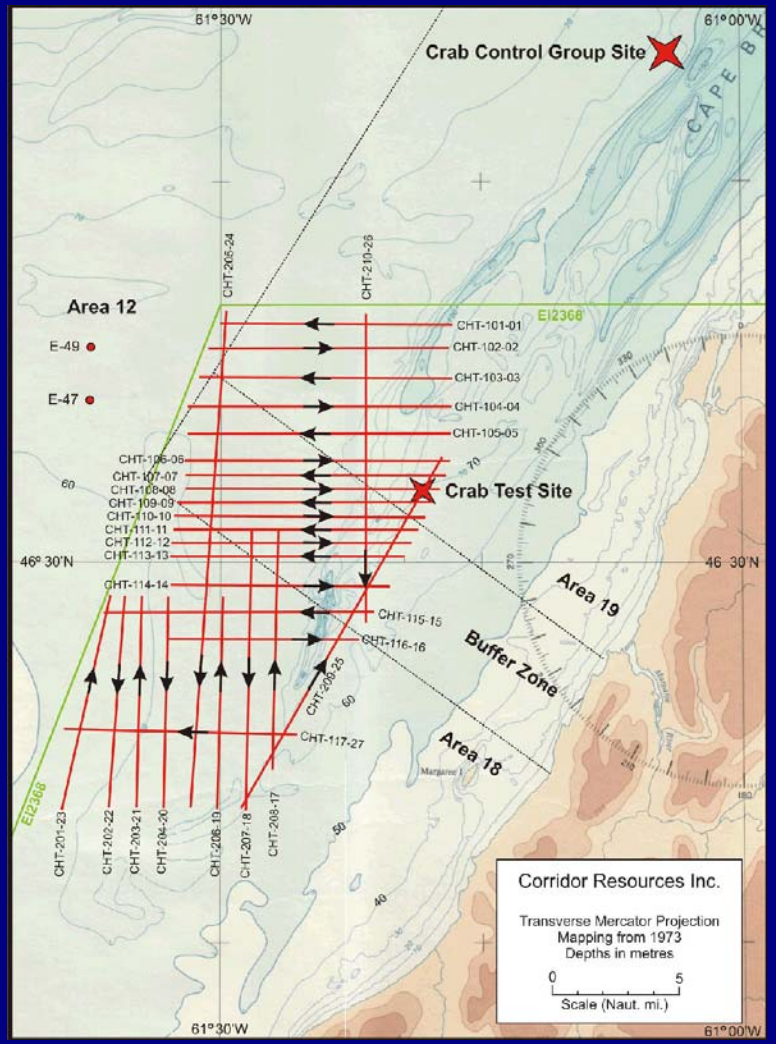


# Summary

- **Many marine mammals were sighted in the Gully and nearby canyons**
- **Species composition changed with season, *migration***
- **Systematic survey provided distribution of marine mammals within the Gully**
- **Estimated numbers of NBW in the Gully in July, not corrected for animals underwater, are higher than published estimates from photo-ID studies**

# Seismic Impacts:
# Western Cape Breton - Snow Crabs

**Location of M.V. Admiral survey lines and test and reference “control” sites**



# Seismic Impacts

- **“Impacts of a Seismic Survey on Snow Crab Caged off Western Cape Breton Island, Nova Scotia”**
- **Conducted by DFO in association with Corridor Resource’s Environmental Effects Monitoring (EEM) program and Area 19 Fishermen’s Association**

# Seismic Impact Assessment

- Caging of female snow crab at control (725) and exposure sites (700) for acute and chronic biological effects studies
- Acoustic monitoring at the cage and reference “control” sites
- Holding of ensonified and reference snow crab in aquaria for biological measurements

# Acoustic Monitoring - Cage Sites

- Ocean Bottom Seismometers (OBSs) were deployed prior to seismic operations (Two at test site with traps and one at control site)
- OBS were recovered after seismic shooting
- Data processed to determine the sound exposure levels experienced by the snow crab during the science program

# Biological Effects

- 225 female snow crabs recovered from the control and exposure sites following seismic testing
  - No immediate signs of mortality
  - Examined for evidence of potential impacts on organs and embryos

- 975 remaining crabs (475 test, 500 control) will be recovered in April 2004
  - Long-term observations will include comparison of larval hatching success

# Biological Effects - Laboratory Studies

- 45 female snow crab from each the test and control sites were recovered for lab studies (DFO-Newfoundland)
- In addition to basic animal husbandry, an enzymological study to investigate liver damage will be conducted

- Behavioural studies include response times and feeding
- Similar analysis will be conducted on crabs to be retrieved in April 2004

# Effects on Seismic Energy on Fish

**Pathological and Physiological Effects:**

- **Stunning of lobster**
- **Blackening of codfish**
- **Alteration of posture in cunners**

***Critical need for selected studies on distance-effect relationships for sub-lethal effects and potential delayed mortality/morbidity***



# Science for Review: Seismic Proposals

- Preparation of interim guidelines to support review of seismic proposals
- Production of DFO advisory documents:
  - Adult and juvenile fish
  - Fish eggs, larvae and zooplankton
  - Marine mammal physiology
  - Marine mammal behavior
  - Invertebrates including benthic and reef-producing animals
- The deliverables will provide:
  - Threshold limits for DFO review of EAs and policy development
  - Identification of knowledge gaps

# DFO Seismic Research Deliverables

- Technology transfer for use by industry in their environmental effects monitoring programs for seismic operations
- Scientific knowledge and data for use in the preparation of future Environmental Assessment (EA) reports to support regulatory approvals
- Data will aid in the development of scientifically-defensible precautionary thresholds for sound exposure for the establishment of acoustic Marine Environmental Quality (MEQ) targets (i.e., acceptable noise levels or thresholds and safe operating distances) in the ocean environment