
Canada-United States
Northern Oil & Gas
Research Forum
2010

The Second Canada - United States Northern Oil and Gas Research Forum is an opportunity for American and Canadian regulators, Indigenous people, industry members, scientists, and other stakeholders to discuss current scientific research and its relevance to northern oil and gas management.

The Forum will examine the current status and future directions for the Beaufort and Chukchi Seas, North Slope and Mackenzie Delta, with a focus on technical, engineering and scientific research concerning offshore drilling safety, oil spill prevention and management, ice engineering and transportation issues as well as the environmental effects of oil and gas exploration and development in the North.

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General Programme

Date	Time	Imperial 4/6/8	Imperial 5/7/9
Monday Nov 29	17:00 - 19:00	Delegate package pickup & Registration	
Tuesday Nov 30	7:30	Continental Breakfast	
	8:30	Welcome	
	8:40	Opening remarks by Canadian and US officials	
	9:10	Overview of Canadian Northern Oil and Gas Research Programs	
	9:35	Overview of US Northern Oil and Gas Research Programs	
	10:00	Break	
	10:30	**Management panel: US and Canadian research needs and priorities, and the regulatory processes in North**	
	12:00	Lunch	
	13:30	**Panel: Environmental conditions in exploration areas**	**Panel: Safety on northern offshore platforms & EER issues**
	14:30	Scientific talks	Scientific talks
	15:10	Break	
	15:40	Scientific talks	Scientific talks
	17:00	End of Day 1	
Wednesday Dec 1	7:30	Continental Breakfast	
	8:30	**Industry panel: US and Canadian research priorities from an Industry perspective**	
	10:00	Break	
	10:30	**Panel: Monitoring for cumulative effects in the Arctic**	**Panel: Transportation logistics for exploration and development in the Arctic**
	11:30	Scientific talks	Scientific talks
	12:10	Lunch	
	13:30	Scientific talks	Scientific talks
	14:10	**Panel: Interaction of oil and gas activities with sensitive coastal habitats**	**Panel: Ice engineering for offshore operations**
	15:10	Break	
	15:30	Scientific talks	Scientific talks
	17:00	Poster Session and Reception	
	18:30	End of Day 2	
Thursday Dec 2	7:30	Continental Breakfast	
	8:30	**Panel: Oil spill prevention in the Arctic**	
	9:30	Scientific talks	
	10:10	Break	
	10:40	**Panel: Oil spill management in the Arctic**	
	11:40	Scientific talks	
	12:20	Lunch	
	13:30	Scientific talks	
	14:50	Forum wrap up and closing remarks	
	15:30	Close of Forum	

General Information

Registration

Delegate packages and name badges can be picked up at the registration area. Registration is available on site at the cost of $400 per person. The registration area will open from 17:00 to 19:00 on Monday, November 29 and will remain open during conference hours.

Food and Beverages

Food and beverages will be provided for breakfast, morning and afternoon breaks and lunches during the conference. All food and beverages will be served in Grand Foyers 3 and 4. Consult the floor plan at the end of this programme for location information.

Breakfast	A light continental breakfast will be served from 7:30 to 8:30.
Breaks	Coffee, tea, juices and snacks will be served during morning and afternoon breaks.
Lunch	A lunch buffet will be served during the lunch break.
Reception	A reception with complementary hors d'oeuvres and cash bar will be held during the Poster Session, from 17:00 to 18:30 on Wednesday, December 1.

Speaker Ready Room

The speaker ready room is located in Neilson 3. Consult the floor plan at the end of this programme for location information. The room will be open from 17:00 to 19:00 on Monday, November 29 and will remain open during conference hours.

Questions?

Consult someone at the registration area.

PLENARY SESSIONS

Imperial Ballroom 4/6/8

Tuesday, November 30 – 8:30 to 10:00 ***OPENING PLENARY*** <u>Co-chairs</u> **Mimi Fortier,** Director General, Northern Oil and Gas Branch, Indian and Northern Affairs Canada **John Payne**, Executive Director, North Slope Science Initiative		
8:30	Welcome Opening prayer by **Elder Margaret Waterchief**, Siksika Nation	
8:40	**Patrick Borbey** Sr. Assistant Deputy Minister, Treaties and Aboriginal Government, Indian and Northern Affairs Canada	Opening Remarks from Canada
8:55	**Mark Myers** Coordinator, Alaska Gasline Inducement Act, State of Alaska Department of Natural Resources	Opening Remarks from the United States
9:10	**Geneviève Carr** Science Advisor, Northern Oil and Gas Branch, Indian and Northern Affairs Canada **Marc D'Iorio** Director General, Office of Energy Research and Development, Natural Resources Canada	Overview of Canadian Northern Oil and Gas Research Programs
9:35	**John Goll** Regional Director, Bureau of Ocean Energy Management, Regulation and Enforcement, Alaska Region **Nathan Frey** Policy Analyst, Office of Information and Regulatory Affairs, U.S. Office of Management and Budget, Executive Office of the President	Restructuring of BOEMRE and Related Regulatory and Science Issues. The Office of Information and Regulatory Affairs: Regulatory Review and its Relevance to Northern Oil and Gas Management
10:00	Break	

Tuesday, November 30 – 10:30 to 12:00 ***MANAGEMENT PANEL: U.S. AND CANADIAN RESEARCH NEEDS AND PRIORITIES*** <u>Co-chairs</u> **Mike Peters**, Manager, Northern Canada Operations, Canadian Association of Petroleum Producers **Mark Myers**, Coordinator, Alaska Gasline Inducement Act, State of Alaska Department of Natural Resources	
Robert Steedman Professional Leader, Environment, National Energy Board	The National Energy Board's Arctic Offshore Drilling Review: Research and Risk Assessment in the Context of Safety and Environmental Regulation.
Brenda Pierce Acting Chief Scientist, Geology Program Coordinator, Energy Resources Program, U.S. Geological Survey	USGS Study on Science Needs to Inform Decisions on Outer Continental Shelf Energy Development in the Chukchi and Beaufort Seas
Frank Pokiak Chair, Inuvialuit Game Council	Wildlife and Environmental Research and Management in the Inuvialuit Settlement Region
John Payne Executive Director, North Slope Science Initiative **Bill Streever** Chair, North Slope Science Initiative's Science and Technical Advisory Panel	North Slope Science Initiative: Mission and Organization Research Priorities and Resource Management on Alaska's North Slope: Old Problems and New Opportunities
LUNCH (12:00)	

Wednesday, December 1 – 8:30 to 10:00 ***INDUSTRY PANEL: U.S. AND CANADIAN RESEARCH PRIORITIES*** <u>Co-chairs</u> **Martin Fortier**, Executive Director, ArcticNet **Richard Ranger**, Upstream/Industry Operations, American Petroleum Institute	
Mike Peters Manager, Northern Canada Operations, Canadian Association of Petroleum Producers	Canadian Industry Perspective of Emerging Oil and Gas Research Needs in the North
Susan Childs Alaska, Shell Exploration & Production Company	Offshore Alaska Oil and Gas Research Needs; Environment, Technology, and Resources
Bill Streever Environmental Studies Program Director, BP Alaska Exploration Inc, Alaska	Ecological Research in a Mature Arctic Oilfield: Prudhoe Bay, Alaska
Jim Hawkins Beaufort Mackenzie Operations/Regulatory Manager, Imperial Oil Resources	Research Needs in the Beaufort Sea: Unique Challenges of Exploring in Deepwater Regions
BREAK (10:00)	

Topical Sessions

Imperial 4/6/8

Tuesday, November 30 – 13:30 to 17:00

Environmental Conditions in Exploration Areas

Co-chairs
Leslie Holland-Bartels, Deputy Alaska Regional Director and Director Alaska Science Center, U.S. Geological Survey
Henry Huntington, Science Director, Oceans North/Pew Environment Group

Panel

13:30 - 14:30	**Richard Glenn** Executive Vice President, Arctic Slope Regional Corporation, Lands and Natural Resources	North Slope Oil and Gas History – Traditional and Western Science
	Louis Fortier Scientific Director, ArcticNet	Current Understanding of the Beaufort Sea Environment and its Relation to Oil and Gas Activities
	Dee Williams Chief, Environmental Studies Section, Bureau of Ocean Energy Management, Regulation and Enforcement, Alaska Region	Monitoring Effects Related to Offshore Petroleum Development in Alaska
	Giles Morrell Manager, Oil and Gas Regulatory Affairs, Indian and Northern Affairs Canada	Existing Data to Identify Environmental and Social Sensitivities to Oil and Gas Activities: the Petroleum Environmental Management Tool
	Q&A, discussion	

Science Talks

14:30	**Robert Day**, ABR Inc. "The Chukchi Sea Environmental Studies Program: an overview"
14:50	**Kenneth Dunton**, Marine Science Institute, University of Texas at Austin "An Integrated Chemical and Biological Study of the Benthos of the Chukchi Sea: Preliminary Results from the COMIDA-CAB Program"
15:10	BREAK
15:40	**Mike Curtin**, Imperial Oil Resources Ventures Limited "Collaborative Research to Characterize Biological, Physical and Geotechnical Conditions in Support of Beaufort Sea Drilling Operations"
16:00	**Susanna Blackwell**, Greeneridge Sciences Inc. "Assessing the Effects of Seismic Exploration Activities on Bowhead Whale Call Distribution in the Alaskan Beaufort Sea: 3-year Summary"
16:20	**Sharon Smith**, Natural Resources Canada "Updated Characterization of Permafrost Thermal Conditions in the Mackenzie Delta Region"
16:40	**Philip Marsh**, Environment Canada "Hydrology of the Outer Mackenzie Delta in the Vicinity of Proposed Natural Gas Development"

Imperial 5/7/9

Tuesday, November 30 – 13:30 to 16:00
SAFETY ON NORTHERN OFFSHORE PLATFORMS AND EMERGENCY EVACUATION AND RESPONSE ISSUES

Co-chairs
Anne Barker, Project Engineer, National Research Council Canada
Jim Regg, Petroleum Engineer, Alaska Oil and Gas Conservation Commission

Panel

13:30 - 14:30	**Bharat Dixit** Team Leader, Conservation of Resources, National Energy Board	Regulating and Ensuring Safety When Authorizing Offshore Operations
	LT Darin W. Qualkenbush National Technical Advisor, U.S. Coast Guard	United States Outer Continental Shelf Regulatory Overview
	Jeffrey Walker Regional Supervisor for Field Operations, Bureau of Ocean Energy Management, Regulation and Enforcement, Alaska Region	Safety and Inspections for Oil and Gas Operations on the Alaska OCS
	Q&A, Discussion	

Science Talks

14:30	**Anne Barker**, National Research Council Canada "Seasonal Strategies for Evacuation from Offshore Structures in the Beaufort Sea"
14:50	**Frank G. Bercha**, Bercha Group "Arctic Emergency Evacuation and Rescue: Present and Future"
15:10	BREAK
15:40	**Chris Hill**, Canatec Associates International Ltd. "Ice Forecasting for Offshore Operations"

Imperial 4/6/8

Wednesday, December 1 – 10:30 to 14:10
MONITORING FOR CUMULATIVE EFFECTS IN THE ARCTIC

Co-chairs
Lisa Loseto, Section Head, Ecosystem Impacts, Fisheries and Oceans Canada
Robert Suydam, Wildlife Biologist, North Slope Borough, Department of Wildlife Management

Panel

10:30 - 11:30	**Cynthia Pyc** HSSE/Regulatory Team Lead, North American Arctic Exploration, BP Exploration Company	Cumulative Effects Assessment for the Canadian Beaufort Sea
	Robyn Angliss Deputy Director, National Marine Mammal Laboratory, National Ocean and Atmospheric Administration	Monitoring of Oil Spill Effects
	Dave Yokel Wildlife Biologist, Arctic Field Office, Bureau of Land Management	Monitoring Terrestrial Ecosystems in the National Petroleum Reserve – Alaska for Effects from Oil and Gas Activities
	Marc Lange Manager, Environment and Conservation, Indian and Northern Affairs Canada	Cumulative Impact Monitoring Program in the Northwest Territories
	Q&A, Discussion	

Science Talks

11:30	**Neil J. Mochnacz**, Fisheries and Oceans Canada "Modelling Habitat of Dolly Varden (*Salvelinus malma*) in the Western Canadian Arctic in Support of Ecosystem-Based Management"
11:50	**Doug Mason**, Nunami Stantec "A New Tool for Identifying Sensitive Areas and the Relative Environmental Risk of Hydrocarbon Activities in the Canadian Arctic"
12:10	LUNCH
13:30	**Robert Suydam**, North Slope Borough, Department of Wildlife Management "Traditional Knowledge and Scientific Information about the Sensitivity of Bowhead Whales (*Balaena mysticetus*) to Anthropogenic Sounds"
13:50	**Wojciech Walkusz**, Fisheries and Oceans Canada "Zooplankton of the Coastal Beaufort Sea – Past, Present and Future Studies."

Imperial 5/7/9

Wednesday, December 1 – 10:30 to 14:10

TRANSPORTATION LOGISTICS FOR EXPLORATION AND DEVELOPMENT IN THE ARCTIC

Co-chairs
Ivana Kubat, Project Engineer, National Research Council Canada
Jeffrey Walker, Regional Supervisor for Field Operations, Bureau of Ocean Energy Management, Regulation and Enforcement, Alaska Region

Panel

10:30 - 11:30	**Ross MacDonald** Manager, Special Projects and Arctic Shipping, Transport Canada	Regulating Transportation in Harsh Arctic Environments
	David M. Seris Deputy Waterways Management, U. S. Coast Guard 17th District	Port Access Route Study for the Bering Strait
	Scott Guyer North Slope Science Initiative Bureay of Land Management	Impact of Ice Roads and Ice Pads on Tundra Ecosystems
	Q&A, Discussion	

Science Talks

11:30	**Ivana Kubat**, National Research Council Canada "Canadian Research to Improve Navigation in the Arctic"
11:50	**Michael Lilly**, Geo-Watersheds Scientific "Alaska North Slope Oil and Gas Transportation Support Systems: Taking Alaska Forward Into New Development"
12:10	LUNCH
13:30	**Rod Smith**, Natural Resources Canada "The Application of Seismic Shothole Drillers' Log Records to the Understanding of Permafrost, Ground Ice, Bottomfast Ice, and Granular Aggregate Resources in the Mackenzie - Beaufort Region."
13:50	**Julian Kanigan**, Indian and Northern Affairs Canada "Variability of Active-Layer Freezeback in the Outer Mackenzie Delta, Northwest Territories"

Imperial 4/6/8

Wednesday, December 1 – 14:10 to 17:00

INTERACTION OF OIL AND GAS ACTIVITIES WITH SENSITIVE COASTAL HABITATS

Co-chairs
Linda Graf, Manager, Environment and Stakeholder Engagement, Canadian Arctic, ConocoPhillips
Wayne Svejnoha, Alaska State Office, Bureau of Land Management

Panel

14:10 - 15:10	**Frank Pokiak** Chair, Inuvialuit Game Council	The Significance of Coastal Habitats to the Inuvialuit
	Craig George Senior Wildlife Biologist, North Slope Borough, Department of Wildlife Management	Regional Biology and Activity on the North Slope
	William E. Schnabel Director, Water and Environmental Research Center, University of Alaska Fairbanks	Evaluating Source Waters for Ice Road Planning
	Q&A, Discussion	
15:10	BREAK	

Science Talks

15:30	**Caryn Rea**, ConocoPhillips "Environmental Considerations associated with Oil and Gas Exploration and Development on Alaska's North Slope"
15:50	**Stephen Braund**, Stephen R. Braund & Associates "Oil Development Impacts on Subsistence: Monitoring and Assessing Mitigation"
16:10	**Lois Harwood**, Fisheries and Oceans Canada "Potential for Displacement of Whales and Seals by Seismic and Exploratory Drilling Activity in the Canadian Beaufort Sea - What Have Research and Observations Revealed to Date"
16:30	**Simon Prinsenberg**, Fisheries and Oceans Canada "Available Ice Thickness Datasets Collected in the Canadian Beaufort Sea by Helicopter-Borne Sensors through ArcticNet and Canadian Government Programs"

Imperial 5/7/9

Wednesday, December 1 - 14:10 to 17:00
ICE ENGINEERING FOR OFFSHORE OPERATIONS

Co-chairs
Humphrey Melling, Scientist, Fisheries and Oceans Canada
Kyle Monkelien, Senior Petroleum Engineer, Bureau of Ocean Energy Management, Regulation and Enforcement, Alaska Region

Panel

14:10 - 15:10	**Garry Timco** A/ General Manager, Canadian Hydraulics Centre, National Research Council Canada	Four Approaches for Addressing Ice Forces on Offshore Platforms
	Karen Muggeridge Arctic Engineering Specialist, ConocoPhillips Canada	Design Challenges for Offshore Structures in the Arctic
	Hajo Eicken University of Alaska Fairbanks	Sea-ice Predictions and Integrated Observations for Offshore Operations
	Michael J. Paulin Operations Director Canada, INTECSEA	Ice Related Arctic Pipeline Design Issues and Research Needs
	Q&A, Discussion	
15:10	BREAK	

Science Talks

15:30	**Humphrey Melling**, Fisheries and Oceans Canada "Recent observations of multi-year ice in the Canadian High Arctic"
15:50	**William Perrie**, Bedford Institute of Oceanography, Fisheries and Oceans Canada "The impacts of increased open water on Arctic summer storms"
16:10	**Christian Haas**, University of Alberta "Ice thickness information for safe and environmentally responsible offshore operations"
16:30	**Scott Tiffin**, Canatec Associates International Ltd. "The importance of Ice Islands and Extreme Ice features in relation to offshore structures"

Imperial 4/6/8

Thursday, December 2 – 8:30 to 10:10
OIL SPILL PREVENTION IN THE ARCTIC

Co-chairs
Sharon Smith, Permafrost Research Scientist, Natural Resources Canada
Cathy Foerster, Commissioner, Alaska Oil and Gas Conservation Commission

Panel

8:30 - 9:30	**Steve Blasco** Resource Engineering Geophysicist, Natural Resources Canada	The Importance of Geohazard Assessment in Preventing Oil Spills
	Bill Scott Manager, Chevron Arctic Center, Chevron	Limiting The Flow – A Pragmatic Approach To Oil Spill Containment
	Larry Iwamoto Preparedness Section Manager, Spill Prevention and Response Division, Alaska Department of Environmental Conservation	Spill Prevention and Response in Alaska's Arctic Waters
	Kyle Monkelien Senior Petroleum Engineer, Bureau of Ocean Energy Management, Regulation and Enforcement, Alaska Region	New Regulatory Requirements as a Result of the Presidential Commission's Safety Measures Report
	Q&A, Discussion	

Science Talks

9:30	**Frank G. Bercha**, Bercha Group "Arctic Oil Spill Probabilities"
9:50	**Mark Swanson,** Prince William Sound Regional Citizens' Advisory Council "Oil spill prevention Planning"
10:10	BREAK

Imperial 4/6/8

Thursday, December 2 – 10:40 to 14:50
OIL SPILL MANAGEMENT IN THE ARCTIC

Co-chairs
Sonia Laforest, Emergency Operations Officer, Environment Canada
Capt. Carl Uchytil, Chief of Plans, 17th District (Alaska), US Coast Guard

Panel

	Ken Lee Research Scientist, Bedford Institute of Oceanography, Department of Fisheries and Oceans	Clean Up and Containment of Oil Spills in Ice Infested Waters
	Ron Morris President and General Manager, Alaska Clean Seas	Alaska Clean Seas – Oil Spill Removal Organization with a long history in R&D
	Jeep Rice Habitat Assessment & Marine Chemistry, National Oceanic and Atmospheric Administration	Oil Spill Management; biological considerations
	Q&A, Discussion	

Science Talks

11:40	**Elizabeth Logerwell**, Alaska Fisheries Science Center "Natural resource damage assessment in Arctic waters"
12:00	**Jason Duffe**, Environment Canada "Earth Observation data to support emergency response and wildlife management in case of an oil spill in Canada's northern coastal ecosystems"
12:20	LUNCH
13:30	**Thomas Weingartner**, University of Alaska "Shore-based, high-frequency surface current measuring radars in remote arctic settings"
13:50	**Roger Pilkington**, Canatec Associates International Ltd. "Understanding Ice Movement for Oil Spill Monitoring and Cleanup"
14:10	**Steve Potter**, SL Ross Environmental Research Ltd. "In situ Burning in Arctic and Ice-Covered Waters: Tests of Fire-Resistant Boom in Low Concentrations of Drift Ice"
14:30	**Steve Potter**, SL Ross Environmental Research Ltd. "Beaufort Sea Oil Spills State of Knowledge Review and Identification of Key Issues"

Thursday, December 2 – 14:50 to 15:30
CLOSING REMARKS

14:50	**Closing Remarks and Discussion**
15:30	**Close of Forum**

POSTERS

Grand Foyer 3 & 4

Wednesday, December 1 – 17:00 to 18:30

POSTER SESSION

[1] **G. Pavia and S. Blue**, "The Arctic Regulatory and Stakeholder Experience"

[2] **A.R. Majewski and J.D. Reist**, "Fisheries Research in Support of Fisheries and Oceans Canada's Regulatory Role in Hydrocarbon Development in the Canadian Beaufort Sea"

[3] **C. Nachman and S. Guan**, "The U.S. Marine Mammal Protection Act Incidental Take Authorization Process: Challenges in the Arctic"

[4] **R. Goodwin**, "The Hydrocarbon Impacts Database: Your Gateway to Northern Canadian Oil and Gas Environmental, Socio-Economic and Regulatory Publications"

[5] **M. Lilly et al.**, "The Role of Soil Conditions in Managing Arctic Transportation on the North Slope, Alaska"

[6] **M. Lilly et al.**, "The Role of Snow in Arctic Transportation Networks: From Design to Management"

[7] **M. Lilly et al.**, "The Use of Lakes and Reservoirs in Arctic Transportation Networks and Applications of Adaptive Water Resources Management to Improve Water Availability While Reducing Environmental Risks"

[8] **R. Brumbaugh**, "Who Needs an Ice Road?"

[9] **S. Guyer et al.**, "Land Cover Mapping of Alaska's North Slope Utilizing Landsat TM Imagery"

[10] **L. Jenkins et al.** (presented by R. Shuchman), "Data Assimilation of Robotic and Satellite Data for Characterization of North Slope, Alaska Lakes"

[11] **J. Grunblatt and D. Atwood**, "Using SAR to Characterize Winter Liquid Water Availability in Lakes on the North Slope Coastal Plain of Alaska-A Regional Assessment"

[12] **A. Jones and K. Pierce**, "Geoscience Data for the Peel Plateau and Plain, Northwest Territories and Yukon"

[13] **P. Marsh and S. Endrizzi**, "Hydrology and Northern Pipelines: Hazards and Environmental Protection"

[14] **C. Stevens et al.**, "Controls on Permafrost Distribution Within the Near-Shore Zone of the Mackenzie Delta"

[15] **A. Gall et al.**, "Influence of water masses on the distribution within the near-shore zone of the Mackenzie Delta"

[16] **R. Hopcroft et al.**, "Interannual variability of the planktonic communities in the Northeastern Chukchi Sea"

[17] **A. Blanchard et al.**, "Influence of Environmental Gradients on Macrofaunal Community Structure in the Northeastern Chukchi Sea."

[18] **C. Parris and A. Blanchard**, "Distributions of Epibenthic Macroinvertebrates in the Northeastern Chukchi Sea, 2009"

[19] **M. Sexson**, "Distribution and Migratory Timing of Threatened Spectacled Eiders in the Beaufort and eastern Chukchi seas"

[20] **D. Funk and A. Macrander**, "A Marine Mammal Monitoring and Mitigation Program for Oil and Gas Exploration in Arctic Alaska"

[21] **D. Hannay**, "Passive acoustic monitoring for assessing marine mammal distribution near exploration areas in the northeastern Chukchi Sea"

[22] **R. Greer**, "Effects of Ambient Artificial Light on Arctic Marine Fauna"

[23] **S. Prinsenberg et al.**, "Observing the Snow and Ice Properties in the Arctic Coastal Waters of the Canadian Beaufort Sea with Helicopter-Borne Ground-Penetrating Radar, Laser and Electromagnetic Sensors."

[24] **T. Sylvestre et al.**, "Using Position Beacons to Measure Ice Movement for Beaufort and Chukchi Offshore Petroleum Activities"

[25] **J. Boxwell**, "Gwich'in Renewable Resources Board"

[26] V. Kostylev et al., "Framework for evaluating impacts of mechanical seabed disturbance in relation to oil and gas development activities"

ABSTRACTS – PANEL DISCUSSIONS

Management Panel

NORTH SLOPE SCIENCE INITIATIVE: MISSION AND ORGANIZATION

John F. Payne

North Slope Science Initiative, c/o Bureau of Land Management, Alaska State Office (910) 222 West 7th Avenue, #13, Anchorage, Alaska 99513

The North Slope Science Initiative (NSSI) was formally established by legislation in the Energy Policy Act of 2005, but planning for such an initiative began several years prior when local, state and federal governments with responsibilities for land and ocean management recognized the need to facilitate and improve collection and dissemination of ecosystem information of Alaska's North Slope region, including coastal and offshore regions. The NSSI's ***mission*** is to improve scientific and regulatory understanding of terrestrial, aquatic and marine ecosystems for consideration in the context of resource development activities and climate change. The NSSI's ***vision*** is to identify the data and information that government agencies will need in the future to manage development using the best information and mitigation to conserve the environments of the North Slope. The NSSI adopts a strategic framework to provide resource managers with the data and analyses they need to help evaluate multiple simultaneous goals and objectives related to each agency's mission on the North Slope. The NSSI uses and complements the information produced under other North Slope science programs, both internal and external. The initiative also facilitates information sharing among agencies, non-governmental organizations, industry, academia, international programs and members of the public to increase communication and reduce redundancy among science programs.

USGS STUDY ON SCIENCE NEEDS TO INFORM DECISIONS ON OUTER CONTINENTAL SHELF ENERGY DEVELOPMENT IN THE CHUKCHI AND BEAUFORT SEAS

Brenda Pierce[1] and Leslie Holland-Bartels[2]

[1] U.S. Geological Survey, Energy Resources Program Coordinator
[2] U.S. Geological Survey, Regional Executive, Alaska

The U. S. Geological Survey (USGS) is conducting an initial evaluation of science needs to understand the resilience of Arctic coastal and marine ecosystems to Outer Continental Shelf resource extraction activities. The study will summarize major information is available, significant knowledge gaps, and what priority research is needed to mitigate risks. The evaluation will look at the work done by many organizations that can help inform energy development decisions in the Arctic. The report will address issues such as the effect of noise on marine mammals; cumulative impacts of development, infrastructure, and maintenance activities offshore and onshore on ecosystems, landscapes, seascapes, water quality, seafloor and land stability, and subsistence hunting and fishing; effective and reliable oil spill response in ice-covered regions; changing climate conditions and how they will either mitigate or compound the impacts from energy development in the Arctic environment. The analysis will focus on any particular concerns that may be unique to the Chukchi and Beaufort. The talk presented at this meeting will update the audience as to findings to date and request thoughts and considerations related to our study.

WILDLIFE AND ENVIRONMENTAL RESEARCH AND MANAGEMENT IN THE INUVIALUIT SETTLEMENT REGION

Frank Pokiak

Inuvialuit Game Council, Inuvik, NT, Canada X0E 0T0

The Inuvialuit Final Agreement (IFA), signed in 1984, established a system of co-management that, more than ever before, provided for a heightened level of community participation in resource management along with increased institutional accountability. This process allows the Inuvialuit and different levels of government, researchers and developers to work together in wildlife and environmental research and management.

This presentation will review the Inuvialuit wildlife co-management system and the role that the Inuvialuit play in research in the ISR. This review will look at how input from the local HTCs, co-management boards and the Inuvialuit Game Council informs conservation, research, management, enforcement and the utilization of wildlife resources in the ISR. It will explore how both the Inuvialuit and research has benefited from a co-management approach to wildlife management.

THE NATIONAL ENERGY BOARD'S ARCTIC OFFSHORE DRILLING REVIEW: RESEARCH AND RISK ASSESSMENT IN THE CONTEXT OF SAFETY AND ENVIRONMENTAL REGULATION.

Robert Steedman

National Energy Board, 444 Seventh Avenue SW
Calgary, Alberta T2P 0X8

On 11 May 2010 the National Energy Board (NEB) announced a review of Arctic safety and environmental offshore drilling requirements (the Arctic Review). The Arctic Review will examine the best available information concerning the hazards, risks and mitigation measures associated with offshore drilling activities in the Canadian

Arctic and measures to both prevent and respond to accidents and malfunctions. The review will be conducted in three phases dealing with: Fact-finding and information gathering (Phase 1, now underway); Examination and consideration of facts and Information gathered (Phase 2); and Preparation of a public report (Phase 3). All information submitted during the course of this review will be available on the Board's website (www.neb-one.gc.ca). As of November 2010 approximately 120 participants had registered.
The scope of this review will include considerations in four categories: Drilling safely while protecting the environment, Responding effectively when things go wrong, Learnings, Filing requirements. The presentation will include an update on progress of the Arctic Review, with specific reference to opportunities for researchers to become engaged.

RESEARCH PRIORITIES AND RESOURCE MANAGEMENT ON ALASKA'S NORTH SLOPE: OLD PROBLEMS AND NEW OPPORTUNITIES

Bill Streever

North Slope Science Initiative's Science and Technical Advisory Panel

Senior Executives of federal, state, and regional resource management agencies asked the North Slope Science Initiative's Science and Technical Advisory Panel to develop short issue papers on ecological and environmental topics relevant to management of Alaska's North Slope. Even though these papers were by necessity simplifications, the end result was an unwieldy collection of summaries that did not offer clear advice on the way forward. With that in mind, the Senior Executives asked the Panel to assess relationships between issues and, in part based on the degree to which the issues might impact one another, to suggest priorities for future work. The Panel's suggestions include: Open, transparent, and systematic consideration of the likely range (from "least" to "most") of additional industrial development spanning the next twenty years in a manner that will generate scenarios capable of informing research planning. Development of regional climate scenarios for the next twenty years in a manner that will further inform research planning. A dedicated effort to improve collection of weather and climate data across Alaska's North Slope. A concerted effort to support ongoing communication among researchers, resource managers, and stakeholders, with a "place-based" focus that breaks down institutional barriers and encourages communication across disciplines. The Panel also suggested general research priorities for each of the issues or topics, noting that some of these priorities may change as future development and climate scenarios become clearer. Furthermore, the Panel noted that some issues are sufficiently understood to support management decisions, while others—including aspects of marine mammal science and tundra restoration science—are not.

Environmental Conditions in Exploration Areas

MONITORING EFFECTS RELATED TO OFFSHORE PETROLEUM DEVELOPMENT IN ALASKA

Dee Williams (Dee.Williams@boemre.gov)

Environmental Studies Section, Bureau of Ocean Energy Management, Regulation and Enforcement, Alaska Region

Since 1973, the United States Department of the Interior has funded and managed an Environmental Studies Program (ESP) to conduct baseline and monitoring research for stewardship of the Alaska Outer Continental Shelf Region. The ESP works to establish social, oceanographic, and biological information needed to assess and manage impacts on the human, marine, and coastal environments that may be affected by offshore energy development activities. By leveraging annual project funds (currently about $15M), the ESP pursues mission-oriented science data in a systematic, comprehensive, and rigorous manner. This presentation will highlight some recent projects in the Beaufort and Chukchi Seas to illustrate the scope and scale of research efforts currently underway. Selected topics of scientific concern include changing ice cover, protection of biological hotspots and subsistence hunting, and oil spill fate and effects. As time allows, the presentation will also highlight new directions in forthcoming research and will invite cost-sharing arrangements with other institutions.

Safety on Northern Offshore Platforms and EER Issues

UNITED STATES OUTER CONTINENTAL SHELF REGULATORY OVERVIEW

LT Darin W Qualkenbush (darin.w.qualkenbush@uscg.mil)

U.S. Coast Guard, Outer Continental Shelf National Center of Expertise, Morgan City, LA 70380

Discussion of regulatory scheme for Mobile Offshore Drilling Units, Floating Offshore platforms, offshore supply vessels and specialty vessels operating on US outer continental shelf. prevention on the Outer Continental Shelf in the Alaska Region. The presentation will focus on exploratory drilling operations. New BOEMRE regulations and program initiatives directed at increased safety and inspection activities will be introduced.

SAFETY AND INSPECTIONS FOR OIL AND GAS OPERATIONS ON THE ALASKA OCS

Jeffrey Walker

Bureau of Ocean Energy Management, Regulation and Enforcement

This presentation will provide an overview of the BOEMRE regulatory requirements for managing safety and pollution

Industry Panel

OFFSHORE ALASKA OIL AND GAS RESEARCH NEEDS; ENVIRONMENT, TECHNOLOGY, AND RESOURCES

Susan Childs

Shell Exploration and Production Company, Anchorage AK

As a leading Global oil and gas explorer and operator , Shell has long been at the forefront of scientific research and development technology to operate safely and reliably and to reduce environmental impacts.
Our experience in Alaska offshore geophysical exploration and preparation for exploration drilling and our operations in sub-Arctic areas of the world, have underscored that there are multiple business drivers for Science These include Permit Stipulations; Support of Engineering/Operational Planning; Compliance with Regulatory ; internal Shell sustainable performance requirements; and to mitigate litigation and legal challenges. All of these drivers make it essential to have robust scientific research carried out which is both transparent and independent and involves local communities to the greatest degree possible. The presentation will describe our Science Program for Alaska, including our recently agreed collaborative science agreement with the North Slope Borough and future science needs.
Technology deployment and research is a key feature in Arctic development. We are actively developing technologies in our company and in Joint Industry Projects to advance oil spill prevention and oil spill response capability in ice. Our Technology program is aimed at reducing our operating footprint and impacts, improving the safety of operating in ice and extending our capability to harsher conditions. We also recognize the importance of incorporating traditional knowledge into our technology programs and activities. The presentation will outline our approach to technology development including an overview of our current focus areas and future technology challenges that need to be addressed. The presentation will give real life examples of our successes.

ECOLOGICAL RESEARCH IN A MATURE ARCTIC OILFIELD: PRUDHOE BAY, ALASKA

Bill Streever

BP Alaska Exploration Inc., Anchorage AK

Oil and gas exploration and development in the Arctic often leads to ecological study requirements ranging from inventories to impact assessments, but what about research needs in mature arctic oilfields? Experience in the Prudhoe Bay oilfield, which has produced oil for more than three decades, suggests that research needs change over time but do not disappear. Current study needs include long-term ecological monitoring, tundra rehabilitation monitoring and research, and occasional studies to assess potential impacts of satellite developments and other activities, such as 4-D seismic surveys. Examples of ecological monitoring include studies of fish, birds, foxes, permafrost, and vegetation. Examples of rehabilitation monitoring and research include tracking of more than seventy sites and a study designed to develop methods of seeding native sedges. Examples of impact assessment work include an effort to document very low frequency underwater sounds associated with extended reach drilling under the Beaufort Sea. Importantly, in addition to support of the studies themselves, companies managing mature oilfields also have a role facilitating research access by third parties and a role as active participants in the broader ecological and environmental research community, where decades of experience can inform and improve new efforts in the Arctic.

Transportation Logistics for Exploration and Development in the Arctic

PORT ACCESS ROUTE STUDY FOR THE BERING STRAIT

David Seris

U.S. Coast Guard

The Port Access Route Study is the initial step toward establishing International Maritime Organization (IMO) approved, binding ship traffic routing measures such as Recommended Routes, Traffic Separation Schemes, Areas to be Avoided, etc. The study process involves coordination with Industry, Federal, State, Tribal, Russian Federation and Canadian interests to consider the views of maritime community representatives, environmental groups, native tribes, and other stakeholders. A primary purpose of this coordination is, to the extent practicable, to reconcile the need for safe access routes with other reasonable waterway uses.

Monitoring for Cumulative Effects in the Arctic

CUMULATIVE EFFECTS ASSESSMENT FOR THE CANADIAN BEAUFORT SEA

Cynthia Pyc

North American Arctic Exploration, BP Exploration Company

A discussion of current regulatory requirements for cumulative effects assessment associated with offshore Beaufort Sea exploration, and the Beaufort Regional Environmental Assessment effort.

MONITORING TERRESTRIAL ECOSYSTEMS IN THE NATIONAL PETROLEUM RESERVE – ALASKA FOR EFFECTS FROM OIL AND GAS ACTIVITIES

Dave Yokel

Bureau of Land Management

The 9 million hectare (22 million acre) National Petroleum Reserve – Alaska (NPR-A) on Alaska's North Slope was set aside in 1923 for oil and gas exploration and production. The U.S. federal government conducted two exploration programs during 1944-1953 and 1974-1981, and two oil/gas leasing programs in the early 1980s and from 1999 to the present. The oil industry followed the lease sales with renewed seismic exploration and exploratory drilling, both during winters. Despite all this, the NPR-A remains largely pristine. The NPR-A is managed by the U.S. Bureau of Land Management (BLM), which has a multiple-use mission including both extraction of non-renewable, subsurface resources and conservation of renewable, surface resources. Following the renewal of lease sales in 1999, the BLM established an advisory panel to provide recommendations on research and monitoring projects related to impacts of oil and gas activities on surface resources and the effectiveness of lease stipulations in mitigating those impacts. The panel's four-year life concluded with an attempt to develop a monitoring plan for the NPR-A. It fell short of this goal, but succeeded in producing a strategy to create monitoring plans for ten issues it felt were most important among surface resources in the NPR-A. Those were caribou, moulting geese, fish, subsistence user access, social/cultural systems, cliff-nesting raptors, predator/prey relations, threatened eider species, deflection of migrating bowhead whales, and environmental contaminants.
This presentation focuses on the caribou issue to demonstrate a strategy for taking a comprehensive view of the pathways through which oil and gas activities may impact a resource and how to distinguish the impacts from those of other stressors. Knowledge of these factors aids determination of which variables indicating status of the caribou resource would be most relevant for monitoring to support the BLM's mission.

Ice Engineering for Offshore Operations

SEA-ICE PREDICTIONS AND INTEGRATED OBSERVATIONS FOR OFFSHORE OPERATIONS

Hajo Eicken (hajo.eicken@gi.alaska.edu)

Geophysical Institute & International Arctic Research Center, University of Alaska Fairbanks, Fairbanks, AK 99775-7320, USA,

The principal challenges for operations in seasonally ice-covered waters considered in this presentation are (1) to assess and forecast the distribution of different ice types and potential ice-related threats to activities in open water (e.g., vessel traffic, exploration drilling), (2) predict ice loads to inform design of structures, and (3) project changes in the sea-ice and met-ocean regime over the lifetime of such structures. The Beaufort and Chukchi Seas are of particular interest in this context, because of substantial changes in the ice regime over the past decades, including substantial reductions in the areal fraction of multiyear ice, and because of the interplay between seasonal ice retreat and advection of ice into the area. While a combination of satellite remote sensing, ground-based radar and ice forecast models are able to provide good insight into ice drift and distribution on the relevant time scales, assessments of the distribution and thickness of multiyear ice in the summer months is somewhat more challenging. Here, integration of data obtained from the emerging Arctic Ocean Observing Network may be of value. A combination of ice-ocean model output and local-scale assessments of ice movement and action may help develop realistic scenarios for ice loads that can inform structural design. Anticipating ice and met-ocean conditions on timescales of decades over the lifetime of major structures is a challenge, mostly because of the inherent uncertainties in climate model output for the region. Here, a combination of heuristic models based on present-day circulation patterns and information gleaned from local-scale studies referred to above may provide further insights.

ICE RELATED ARCTIC PIPELINE DESIGN ISSUES AND RESEARCH NEEDS

Michael J. Paulin

INTECSEA

With the oil industry's continued quest for oil and gas in frontier offshore locations, several developments have taken place in regions characterized by seasonal ice cover including the US Beaufort, North Caspian, and Sakhalin Island. In these projects, pipeline transportation systems

have been used, which are a cost-effective, safe and reliable mode of hydrocarbon transport to shore.
Ice plays a major role in the design of pipelines for offshore Arctic areas. One of the key design issues is ice keel gouging that affects engineering considerations with respect to strain based design, target burial depth requirements, cost and safety.
It is generally accepted that offshore pipelines in ice environments will need to be trenched and backfilled for protection. Burial depth requirements will be a function of the design ice gouge depth (to prevent interaction between the ice and pipe) and an acceptable level of subgouge deformation beneath a gouging ice keel (which strains the pipeline).
In this presentation, the author will provide an overview of ice keel related arctic pipeline design issues and research which is required to advance the state-of-the-art.

FOUR APPROACHES FOR ADDRESSING ICE FORCES ON OFFSHORE PLATFORMS

Dr. Garry Timco (garry.timco@nrc.gc.ca)

Cold Regions Technology, Canadian Hydraulics Centre, National Research Council of Canada, Ottawa, Ontario K1A 0R6 CANADA.

Understating and predicting ice forces is still one of the main challenges facing operations in ice-covered waters. Ice itself is a very complex material that behaves differently depending upon how, and for how long it interacts with an offshore platform. Structural shape and size, ice thickness and morphology, ice type, loading rate, pack ice pressures, etc. all play a role in shaping the loads that the ice will exert on an offshore platform. The question is – how can we try to predict the ice behaviour and the subsequent loads that the ice will exert on any specific offshore platform? Basically four different approaches can be used – physical modelling, numerical modelling, field measurements of ice loads, and data mining of previous measured ice load events. This presentation will briefly describe each technique with examples and highlight the advantages and disadvantages of each technique.

Interaction of Oil and Gas Activities with Sensitive Coastal Habitats

THE SIGNIFICANCE OF COASTAL HABITATS TO THE INUVIALUIT

Frank Pokiak

Inuvialuit Game Council, Inuvik NT

To the Inuvialuit, the coastal environment and the wildlife that inhabits and utilizes it are of great importance. This presentation will begin with a look at the important role that the coastal environment plays in the Inuvialuit culture. The Inuvialuit depend on fish, whales, birds, seals and polar bears that live and migrate along the Beaufort Sea. The coast also is a place of cultural significance for the Inuvialuit with many historic sites still found along the coast.
The presentation will also provide an overview of planned and current oil and gas research and monitoring from an Inuvialuit perspective.
The third part of this presentation will look at the roles of communities in the ISR in oil and gas activities and related research. The Inuvialuit co-management system provides the Inuvialuit a system to be equal and meaningful partners in resource management from the individual level up to the international level. Communities have voiced concerns over the effects of oil spills and the effects of mitigation techniques, such as the use of dispersants. There is also a lack of capacity and support for the communities that are expected to be the first responders in the event of an oil spill.

EVALUATING SOURCE WATERS FOR ICE ROAD PLANNING

Bill Schnabel

Water and Environmental Research Center, University of Alaska Fairbanks, Fairbanks AK

Ice roads represent a critical component of oil and gas exploration activities on Alaska's North Slope. Ice road construction requires access to surface water, however, and surface water is a limited resource in many parts of the North Slope. Moreover, unchecked depletion of surface water can damage sensitive arctic ecosystems. In order to optimize the water available for ice road withdrawals as well as protect arctic ecosystems, we need to understand not only where and when the water is available, but also what are the ecological ramifications of using it. This presentation summarizes a series of projects undertaken by WERC and their collaborating partners to monitor and model the impacts to dissolved oxygen of winter water withdrawal; to evaluate lake depth and late-season water availability using Synthetic Aperture Radar; and to communicate results and planning tools via an online Decision Support System.

Oil Spill Prevention in the Arctic

SPILL PREVENTION AND RESPONSE IN ALASKA'S ARCTIC WATERS

Larry Iwamoto

State of Alaska, Department of Environmental Conservation, Spill Prevention and Response Division

The spill prevention and response planning process in Alaska's Arctic waters is an area of continual focus for federal, state, local, tribal, and non-governmental entities. In the wake of the Deepwater Horizon spill, the Outer Continental Shelf lease sales for the Beaufort and Chukchi Seas, and the federal moratorium on offshore drilling, both government and industry contingency plans have received additional scrutiny. In the State of Alaska, the federal and state regulators (e.g., Coast Guard, EPA, and the Alaska Department of Environmental Conservation) previously implemented a joint planning process to satisfy both federal regulatory and state statutory requirements. The resultant products are the Federal/State Unified Plan and ten region-specific subarea contingency plans.
These plans provide the basis for responding to an oil or hazardous substance release by identifying tactics and strategies, environmentally sensitive areas, and available resources. The industry oil discharge prevention and contingency plans also include measures for preventing major oil spills. Although the proposed OCS exploration and production will occur beyond the State of Alaska's jurisdictional boundaries (e.g., three miles offshore), State agencies play an active role in reviewing and commenting on contingency plans and related documents to ensure the State's interests and concerns are properly addressed.
The challenges for launching a major spill response in Alaska's Arctic waters are daunting. There are seasonal considerations and limitations posed by ice conditions. Logistical support to oil spills in remote locations is also a major concern, given the vast Arctic expanse and limited support infrastructure along the Arctic coastline.
Several spill response planning initiatives are underway for the Arctic waters including updates to the subarea plans, development of geographic response strategies, identification of potential places of refuge for disabled vessels, increased coordination between the Canadian Coast Guard and U.S. Coast Guard (.e.g., CANUS North), an Arctic Natural Resource Damage Assessment work group, plus other initiatives.

NEW REGULATORY REQUIREMENTS AS A RESULT OF THE PRESIDENTIAL COMMISSIONED SAFETY MEASURES REPORT

Kyle Monkelien

Bureau of Ocean Energy Management, Regulation and Enforcement

As a result of the Safety Measures Report developed at the request of the President the Bureau of Ocean Energy Management, Regulation and Enforcement, developed a set of regulations to implement certain safety measures recommended by that report. While these new regulations did not specifically address all aspects of the report it did cover what the report had determined to be appropriately addressed through an emergency rule making process. This presentation will provide a summary of these measures and how the BOEMRE plans to implement them in the near term.

LIMITING THE FLOW – A PRAGMATIC APPROACH TO OIL SPILL CONTAINMENT

Bill Scott

Chevron Canada, 500 - Fifth Avenue SW, Calgary, Alberta, Canada T2P 0L7

The presentation will discuss the impacts of the Macondo incident in the US and the Same Season Relief Well (SSRW) debate in Canada on approaches to future arctic oil and gas exploration & development operations. The issue will be examined from a late season blow-out perspective in a pack ice operating environment and will include discussion of the following key issues: People, Procedures and Training; Well Design; Enhanced Blowout Preventer (BOP) Capability; Well Capping Capability; Late Season Oil Spill Containment.

Oil Spill Management in the Arctic

ALASKA CLEAN SEAS – OIL SPILL REMOVAL ORGANIZATION WITH A LONG HISTORY IN R & D

Ron Morris

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Alaska Clean Seas has maintained an active oil spill research and development program since the early 1980's and acts as a facilitator for much of the research and development related to spill response in arctic conditions. The R & D program focuses on specific areas such as oil spill recovery techniques in, on, and under ice and during various broken ice conditions. Other areas of research include viscous oil pumping, methods to detect and track oil under ice, and alternative response options. This presentation will highlight some of the R & D efforts and how we have integrated that work into the tactics available for response.

OIL SPILL MANAGEMENT: BIOLOGICAL CONSIDERATIONS

Jeep Rice

Auke Bay Laboratories, AFSC/NMFS/NOAA/DOC, Ted Stevens Marine Research Institute, 17109 Pt. Lena Loop Road, Juneau, AK 99801

While the physical stopping of a spill and the clean-up are the first priorities in managing a spill event, there are biological considerations. NOAA has multiple interests regarding oil development and spills; ranging from commenting on leases to damage assessment and restoration after a spill event. We never have all the information we desire, but for the Arctic, our information base is considerably less than other areas, such as Exxon Valdez or Deepwater Horizon events. For the Arctic, we often know a "list" of the species involved, certainly the major players, but we generally lack population dynamic information over a time period and we often lack a detailed understanding of the ecosystem, energy dynamics, or for example, the significance of late springs on populations. Predicting the consequences of development, climate change, oil exposure events or treatment alternatives is problematic for most populations; likewise, evaluating different restoration and mitigation strategies is also difficult without adequate information. Jury is out regarding long term effects to fish in the Deepwater Horizon spill, but Exxon Valdez event resulted in long term persistence of oil and long term effects for several years to nearshore fish. The absence of biological and chemical baselines will make it difficult to define the restoration goals following an event.

ABSTRACTS – TOPICAL SESSIONS

Environmental Conditions in Exploration Areas

ASSESSING THE EFFECTS OF SEISMIC EXPLORATION ACTIVITIES ON BOWHEAD WHALE CALL DISTRIBUTION IN THE ALASKAN BEAUFORT SEA: 3-YEAR SUMMARY

Susanna B. Blackwell (susanna@greeneridge.com)[1], C.S. Nations[2], T.L. McDonald[2], A. Thode[3], K.H. Kim[1], C.R. Greene[1], Jr., M. Guerra[3], D. Mathias[3] and A.M. Macrander[4]

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[4] Shell Exploration and Production Company

The bowhead whale (*Balaena mysticetus*) is central to the culture of Alaska natives and an important food source for them. In addition, its threatened status guarantees additional protection by the U.S. government. Therefore, understanding the effects of oil and gas exploration on bowhead whales is a key part of a sound development plan for oil companies in Alaska. In 2007, 2008, and 2009, 35–40 directional autonomous seafloor acoustic recorders (DASARs) were deployed at five sites spanning ~280 km of the autumn migration corridor of bowheads to study the effects of seismic exploration on the locations of calling whales. Continuous recordings were obtained from mid-August to early October annually. Over the three seasons, >713,000 calls were localized by triangulation, and >250,000 airgun pulses were detected and analyzed. The study area was divided into a hexagonal grid (hexagon width ~1.75 km). Received sound pressure levels (SPL) and cumulative sound exposure levels (SEL) of airgun sounds were modeled for each hexagon in the study area during 15-min periods over the season, using information on the timing and location of airgun activities, the size of the airgun array, and other covariates. Logistic regression modeled the occurrence of whale calls as a function of received levels and other covariates. The purpose of the logistic regression was to estimate the threshold of received level at which call distribution changes are detectable. Received SEL of airgun pulses in the range 115–125 dB re 1 $uPa^2 \cdot s$ (over 15 minutes) resulted in a drop in bowhead call detection rates. SEL in this range could result from a single high amplitude pulse or many weaker pulses. Knowledge of such behavioural thresholds will aid in studying cumulative effects of industrial activities on migrating whales. (Work supported by Shell Exploration and Production Company.)

THE CHUKCHI SEA ENVIRONMENTAL STUDIES PROGRAM: AN OVERVIEW

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In 2008, we began a multi-year, inter disciplinary ecological study (CSESP) in the vicinity of two proposed exploration oil and gas prospects in the northeastern Chukchi Sea. This study was designed to collect information on the ecosystem prior to exploration to fill data gaps in this area and to provide baseline environmental data that can be used for permit applications and for post-development comparisons. CSESP focuses on intensive studies conducted within two nearby study-area boxes (Klondike and Burger) that are 30x30 NM (~55x55 km) in size, ~40 NM (~70 km) apart, and located ~60–90 NM (~100–160 km) offshore from the coast of northwestern Alaska. The integrated studies consisted of the following nine components: physical oceanography; nutrients, primary productivity, and zooplankton ecology; benthic ecology; fisheries oceanography (2009 only); seabird ecology; marine-mammal ecology; marine-mammal hydroacoustics; and baseline chemistry (primarily 2008). We sampled the two study areas primarily during three research cruises that matched seasons within this arctic area: late summer, early fall, and late fall. We also deployed oceanographic and hydroacoustic moorings before and after these three cruises, during the open-water period, and deployed some over the winter. We describe the study background and study design to provide an overview for the various presentations on this study.

AN INTEGRATED CHEMICAL AND BIOLOGICAL STUDY OF THE BENTHOS OF THE CHUKCHI SEA: PRELIMINARY RESULTS FROM THE COMIDA-CAB PROGRAM

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The Chukchi Sea Offshore Monitoring in Drilling Area, Chemistry and Benthos (COMIDA-CAB) Project is a comprehensive program funded by the Bureau of Ocean

Energy Management (BOEMRE) that is designed to establish an integrated knowledge of this biologically diverse ecosystem. This component addresses the benthic system with a particular emphasis on sediment chemical characteristics and the benthic biota. Much of our work was focused in Lease Sale 193 in the northeastern Chukchi Sea, which generated 2.6 billion in bids in 2008. Our objectives for the 2009/2010 summer field seasons were (1) to establish baseline data set for benthic infauna and epifauna, organic carbon and sediment grain size, radioisotopes for down core dating, as well as measure trace metals in sediments, biota and suspended particles, and (2) to determine the sources, cycles and fate of carbon, selected trace metals and the role of trace metals on organic carbon dynamics and food web dynamics on the inner shelf of the Chukchi Sea. Sampling efforts in both years generated immense amounts of data and samples for chemical and biological analysis from over 70 stations that will be used for both contemporary and retrospective evaluation of the region. Preliminary results reveal that sediments contained low or background values for metals and aliphatic hydrocarbons and that the northern whelk, *Neptunea heros*, is a potentially valuable indicator for metals and organic contaminants. Our field efforts included the deployment of a submersible video system to survey a wide variety of epibenthic communities. Our observations reveal that the northeastern Chukchi Sea is a productive but highly complex system that is characterized by significant spatial heterogeneity in both benthic infaunal and epifaunal populations. It forms an invaluable database of information of the seabed in the Sale 193 area that will be of significant value for both science and industry.

COLLABORATIVE RESEARCH TO CHARACTERIZE BIOLOGICAL, PHYSICAL AND GEOTECHNICAL CONDITIONS IN SUPPORT OF BEAUFORT SEA DRILLING OPERATIONS

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In July 2010, Imperial Oil Resources Ventures Limited (Imperial), ExxonMobil Canada Ltd. and BP Exploration Operating Company Limited signed a joint operating agreement covering Exploration Licenses 446 and 449 with Imperial as the operator of the joint venture (JV) project. The exploration licenses are in water depths of 90m to 1200m and include shelf, shelf-break and deeper water environments. In support of drilling operations, multi-disciplinary, multi-year, collaborative field programs were designed and implemented with significant Inuvialuit participation to characterize the baseline conditions of the project area. These 2008 to 2010 field programs included multiple vessel based and aerial platforms and drew heavily on academic and government expertise and traditional knowledge (TK) in the north. In the summer and fall of 2009 and 2010, the JV partners collaborated with ArcticNet onboard the CCGS *Amundsen* to collect biological, physical and geological baseline information in the license areas. In 2009, a collaboration with Fisheries and Oceans Canada (DFO) onboard the *Nahidik* conducted similar studies in the shallow water environment of the Canadian Beaufort coastline including the potential shorebase of Tuktoyaktuk Harbour. In 2008-2010, the JV partners collaborated with Cornell University to characterize bowhead and beluga whale distribution in the vicinity of the project. These vessel based studies were complemented by regional aerial surveys of marine mammals in 2008-2010 conducted both in collaboration with DFO and independently by the JV partners, and by a pilot aerial survey program in the winter of 2009 to test the efficacy of fixed wing offshore polar bear surveys. Baseline information was also collected via a subsistence harvesting study in Tuktoyaktuk harbor in 2009 and via a TK study with the six Inuvialuit Settlement Region communities in 2010. Finally, ice drift studies were conducted in 2009 and 2010 to support oil spill modeling efforts and support US Canada trans-boundary spill response planning. The 2008-2010 field programs were extremely successful and have built a strong foundation for future drilling operations. Past and future programs will contribute significantly to ensuring environmentally responsible operation of any future exploration drilling program in the Canadian Beaufort Sea.

HYDROLOGY OF THE OUTER MACKENZIE DELTA IN THE VICINITY OF PROPOSED NATURAL GAS DEVELOPMENT

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The proposed Mackenzie Gas Project (MGP) will carry natural gas southward from two gas fields in the Kendall Is. Bird Sanctuary (KIBS) located in the low-lying (<1 m elevation) outer Mackenzie Delta. Gas extraction induced subsidence at these two anchor fields, in combination with natural subsidence and a changing climate, will likely result in changes to the hydrology of the KIBS and to bird habitat. Recent hydrologic observations, in conjunction with high resolution digital elevation models derived from LiDAR and semi-annual GPS measurements (see Forbes et al. submitted to this meeting) have provided sufficient data to consider various aspects of the hydrology of KIBS, including frequency of flooding due to spring breakup of the channels of the Mackenzie River, summer floods from the Mackenzie River, and storm surges; spatial variability in flooding; and the hydrology of lakes in KIBS. These data provide the basic information needed to consider future increases in flooding due to induced subsidence. However, in order to better quantify future changes, there is an ongoing need to understand factors controlling spatial variability in flooding

and to consider other natural, and anthropogenic, factors that will also impact flood frequency, duration, and timing in the coming decades (see paper by Forbes et al. to this meeting). Another impact of induced subsidence will be to affect the extent and duration of standing water, soil moisture, evaporation, and runoff to key lakes in KIBS. Potential impacts of this will be considered through the use of a high resolution hydrologic model to consider the impact of induced subsidence on runoff to key lakes in KIBS.

UPDATED CHARACTERIZATION OF PERMAFROST THERMAL CONDITIONS IN THE MACKENZIE DELTA REGION

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Permafrost is an important component of the landscape of the Mackenzie Delta region and has an important influence on ecosystems and resource development. Permafrost and its associated ground ice can influence drainage and terrain stability and can present challenges to the design of production and transportation facilities associated with oil and gas development. Updated and reliable information on permafrost thermal state is critical for engineering design, environmental assessment and sound environmental management of resource development projects. With support from the Northern Energy Development Initiative, the Geological Survey of Canada in collaboration with Indian and Northern Affairs Canada undertook a major field program to address gaps in our knowledge of ground thermal conditions in the Mackenzie Delta region. These efforts resulted in the establishment of about 25 new instrumented boreholes up to 20 m deep. New information has been generated on ground thermal conditions for areas where little recent information was available. The new field data along with data collected from existing long-term monitoring sites have led to a more complete characterization of current baseline permafrost conditions in the Mackenzie Delta region. Collaboration with US colleagues has enabled the development of a new map and database presenting a current snapshot of permafrost thermal state for northwestern Canada and Alaska. Key publicly available databases have been generated from the project, disseminating information on permafrost temperatures and active layer conditions for use by industry, regulators, land managers and local communities. The information generated and the enhanced permafrost monitoring network in the region have contributed to improved understanding of the regional environmental framework, provide a baseline to support cumulative impact assessment and are key components of future environmental monitoring and management programs associated with resource development projects.

Safety on Northern Offshore Platforms and EER Issues

SEASONAL STRATEGIES FOR EVACUATION FROM OFFSHORE STRUCTURES IN THE BEAUFORT SEA

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This presentation will discuss results from an integrated research project, carried out over many years, that examined a variety of evacuation strategies for offshore structures in the Beaufort Sea. The objective of the projects was to address the safety of offshore personnel working in Canada's Arctic environment by examining the issues surrounding emergency evacuation from an offshore structure under the diverse range of conditions in the Beaufort Sea. This was accomplished through: quantification of the ability of individuals to cross ice of a varying degree of severity by foot; the development of decision flow-charts for the establishment of on ice evacuation shelters and their associated costs and logistics; an examination of ice management options when ice rubble is present around an offshore structure; and an examination of generic means of evacuation and their adequacy for four "seasons" of evacuation: open water, moving pack ice, quasi-stable rubble and stable rubble/landfast ice. The project results will provide 1) information related to the viability of systems for a range of realistic ice conditions, especially those involving ice rubble, 2) provide input into the development of the evacuation and rescue options and strategies for Beaufort Sea structures and 3) be used by Operators and Regulators to examine the feasibility of proposed evacuation systems for the Beaufort Sea.

ARCTIC EMERGENCY EVACUATION AND RESCUE: PRESENT AND FUTURE

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The paper presents a historical, current, and developing the state of art review of EER for arctic offshore installations. Technologies, engineering and analysis, and regulatory provisions relating to arctic EER operational today and under development are reviewed. Current national and international regulatory performance based regime has necessitated the development of tools for the evaluation and setting of performance based goals such as availability and reliability requirements, mirrored in current Transport Canada and ISO standards. To facilitate setting of reliability

targets in the Canadian standards, as well as to assist in assessing reliability expectations of arctic installation EER, a multifaceted research and development program was initiated in parallel with regulatory developments. Some of the full scale manned and model tests, engineering and computer simulation, and world wide consultations and studies on human performance in life threatening conditions are described. Concurrently, industry and the private sector have addressed the frontier and arctic EER needs through analyses, development of novel systems, and participation in developing performance based standards. Use of conventional EER systems and technologies was found to have limited applicability in ice populated waters, requiring the development of systems and procedures suited to the environmental, operational, and logistical requirements of arctic offshore regions. The paper summarizes available and emerging regulatory, modeling and research, and non-proprietary technological developments in arctic EER and gives recommendations on a number of promising systems and developments, as well as an estimate of the reliability of currently available arctic EER provisions.

ICE FORECASTING FOR OFFSHORE OPERATIONS

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Forewarning of near-term – from 6 to 72 hours in advance - movements of area and regional ice are regularly sought by offshore operators for purposes of: 1. Avoiding damage to assets due to ice collision, 2. Maximizing productive operating time, 3. Positioning vessels for potential evacuation of drilling and production units.
4. Evacuation of on-ice installations.
Forecasting systems include a simple empirical wind model, an empirical model with wind, current, and tidal inputs, and a warning system based on remote environmental changes. A key element of an effective ice forecast system is an historical record of the timing and effect of episodic local events. Such events may cause significant changes in the ice conditions, and the rapid occurrence of hazardous ice at the location of interest. Local environments in which operational ice forecasts have been formulated and which figure in this presentation are: 1. Sakhalin Island marginal ice zone, 2. Beaufort Sea residual seasonal ice, 3. Multi-year pack ice near the North Pole, 4. Landfast ice surrounding an artificial island installation.
Tidal currents are the dominant factor in moving ice along the Sakhalin coast but are absent in the Beaufort Sea and high Polar areas. The empirical model allows input of pre-calculated tidal currents based on antecedent measurements of local current. The Beaufort zone has significant non-tidal currents due to Mackenzie River outflow, winds, and atmospheric pressure differences. The empirical model was effective in this region since non-tidal currents persisted over many hours. An empirical wind model, with no non-tidal current element, was more effective in forecasting ice drift in the North Pole area. In fast ice movement forecasting, water level change is the critical parameter, but is associated with oceanographic phenomena further removed from the area of interest.

Transportation Logistics for Exploration and Development in the Arctic

VARIABILITY OF ACTIVE-LAYER FREEZEBACK IN THE OUTER MACKENZIE DELTA, NORTHWEST TERRITORIES

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In the resource-rich Mackenzie Delta region, winter overland access to remote seismic or drilling locations is often required. The impacts of historic overland travel have persisted for many decades causing regulators to seek ways to minimize future environmental impacts. Vehicle travel in early winter over terrain that is unfrozen or lacking sufficient snow cover can cause surface erosion, active-layer deepening, and surface subsidence in areas of ice-rich permafrost. These disturbances can lead to increased soil moisture and long-term vegetation change. The purpose of this research is to determine the variability of snow, active-layer freezeback, and soil strength among four common terrain types of the outer Mackenzie Delta in the early winter. Results will contribute to the development of appropriate practices to minimize terrain disturbance associated with winter overland travel. Two years of data have been collected in each of the four terrain types to characterize the natural variability of the ground thermal regime, soil moisture content, snow accumulation, soil strength, and vegetation community composition. Site conditions and freezeback dates vary significantly between the terrain units. A calibrated ground thermal model was used to investigate the effects of changing environmental conditions on ground temperatures in each of the terrain units, including the timing of snow arrival and air temperatures. Results suggest that the timing of overland travel in early winter should account for the variability of environmental conditions between the terrain units.

CANADIAN RESEARCH TO IMPROVE NAVIGATION IN THE ARCTIC

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Experienced Captains in Arctic shipping were interviewed as part of the "Scoping Study:
Ice Information Requirements for Marine Transportation of Natural Gas from the High
Arctic" (Timco et al., 2005). The survey overwhelmingly showed that multi-year (MY) ice and pressured ice are the key factors posing hazards to navigation, causing vessel damage, and affecting offshore operations in the Arctic. The Captains indicated that detection of MY ice should be the key research area and that more information on pressured ice regions is needed. Over the past 15 years, the Canadian Hydraulics Centre of the National Research Council of Canada (NRC-CHC) have carried out a number of research projects to address issues dealing with shipping and ice conditions in Canadian Arctic. The overall objective of these projects was to ensure safe and efficient shipping operations in the Arctic. This presentation will discuss results from three projects that focused on (1) Canadian Arctic Regulatory shipping system, (2) multiyear ice as hazards to navigation, and (3) prediction of pressured ice zones. It will discuss the proposed changes to shipping regulations and present new tools which will enhance efficiency and capability of ships to navigate through ice and diminish the risk of environmental pollution due to oil spills. These will have implications on the Arctic activities of the oil and gas industry. With increased demand for oil and gas, a large increase in vessel traffic in Canada's Arctic is expected in the near future. Drilling operations, LNG tankers, marine supply, support vessels and evacuation vessels, would be affected by ice conditions unique to the Canadian Arctic. Results of the research projects presented here will provide mariners with tools to allow safer, cost efficient, and environmentally responsible offshore operations.

ALASKA NORTH SLOPE OIL AND GAS TRANSPORTATION SUPPORT SYSTEMS: TAKING ALASKA FORWARD INTO NEW DEVELOPMENT

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North Slope, Alaska, oil and gas development has depended on Arctic transportation systems for the life of existing fields. Approaches to build, manage and regulate ice and snow roads were developed in flat coastal terrains, which had a high concentration of natural lakes and some man-made reservoirs. This development occurred from the early development of Prudhoe Bay and Kuparuk fields to current field operations. Development of seasonal ice roads is reliant on adequate snow cover and freezing-soil conditions to protect the fragile tundra landscape. Adequate water sources are also needed to build and maintain ice road networks. Current development is expanding into new regions in the foothills of the Books Range. These new areas of development bring in new challenges with rougher terrain, different lake types and lower lake densities, and different snow conditions. There is also an increase in the number of companies doing exploration and relying on ice and snow roads. Our research project is taking an integrated approach to looking at these multidisciplinary aspects of developing, managing, and regulating Arctic Transportation systems. Improving the efficiency of these systems is important to both address the needs of increasing energy demands and maintaining fragile ecosystems in the Arctic. Our project introduced data standards related to snow and hydrologic observation, and developed simple forecast tools for lake ice formation, soil temperatures, and the application of basic watershed modeling. Future development efforts will contribute to the understanding of blowing snow models running in conjunction with weather forecast models, soil-strength studies to evaluate the potential for different guidelines related to traffic loads on ice and snow roads, and adaptive water management for winter water use in lakes and reservoirs. Current applications of these tools will be presented, which are being achieved with cooperative programs with industry and state and federal agencies.

THE APPLICATION OF SEISMIC SHOTHOLE DRILLERS' LOG RECORDS TO THE UNDERSTANDING OF PERMAFROST, GROUND ICE, BOTTOMFAST ICE, AND GRANULAR AGGREGATE RESOURCES IN THE MACKENZIE - BEAUFORT REGION

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This research discusses the recent database compilation of >275,000 seismic shothole drillers' log records from northern Yukon and the Northwest Territories. These previously, largely unused records have provided a wealth of baseline, near-surface (10-60 m) geoscience information that has enabled the publication of several new and original GIS-based geoscience interpretations and models. Characteristics of permafrost and distribution of massive ice and ground ice is often understood in detail at monitoring stations, but may be poorly constrained on regional bases. While the seismic shotholes are generally too shallow to constrain permafrost depths in the Mackenzie – Beaufort region, they do record 100s of instances of sub-surface unfrozen sediments. These records reflect both hazards to development, and highlight aspects of channel migration and

lake drainage that is of key concern to infrastructure planning and design. The shothole database also has 2111 records of massive ice, and 11,666 records of ground ice, providing far greater understanding of their distribution and character than presently exists. Bottomfast ice formation in near-shore marine areas also represents a significant hazard to pipelines and related infrastructure. There are 12,069 shothole records that constrain bottomfast and floating ice extents and provide a temporal record of conditions that largely predates satellite-based observations.
Identification and delineation of granular aggregate resources is one of the key development constraints in the arctic. The shothole records are ideally suited to identifying new potential resources owing to the drillers' propensity for recording gravel and other granular aggregates. Also, in areas characterized by extensive bog and muskeg, the drillers' logs can serendipitously identify surface and subsurface deposits that otherwise have no geomorphic expression.
Application of this research to the Alaskan North Slope and Beaufort coast is considered of high potential to resolve similar issues of terrain hazards and environmental constraints to oil and gas exploration and development.

Monitoring for Cumulative Effects in the Arctic

A NEW TOOL FOR IDENTIFYING SENSITIVE AREAS AND THE RELATIVE ENVIRONMENTAL RISK OF HYDROCARBONS ACTIVITIES IN THE CANADIAN ARCTIC

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The Petroleum and Environmental Management Tool (PEMT) is an Internet-based mapping tool for regions of the Canadian Arctic. Under development by Indian and Northern Affairs Canada, the tool presents expert judgments on relative environmental sensitivities for selected valued ecosystem components based on syntheses of published information. It is intended as a first order decision support tool to help government, oil and gas companies, Aboriginal groups, resource managers and the public visualize the geography of sensitive areas in the Arctic and their potential interaction with oil and gas activities. It provides a basis for more extensive conversations with Aboriginal groups and other expert authorities to correct and refine the depiction of sensitivities.
This presentation will introduce the tool and options to develop the PEMT beyond its current focus on relative environmental sensitivity. The extension under consideration would provide a view of the relative environmental risk associated with oil and gas activities and give some early indication of the potential for cumulative effects. The perception of risk is based on two factors: the scale of the effect of the proposed activity and the sensitivity of the area where it will occur. This approach would not replace the need for proponents of activities to carry out an environmental assessment based on project specific considerations but, if successful, would provide an initial indication of relative environmental risk that could help inform decision making processes in early stages of engagement. Challenges and opportunities will be highlighted in the discussion.

MODELLING HABITAT OF DOLLY VARDEN (SALVELINUS MALMA) IN THE WESTERN CANADIAN ARCTIC IN SUPPORT OF ECOSYSTEM-BASED MANAGEMENT

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Dolly Varden (*Salvelinus malma*) is a char native to western North America that is harvested by northern communities for subsistence purposes. Populations occur in eight river systems found across the Canadian Western Arctic and several of these have experienced significant declines. As a result, local communities, co-management boards, and government agencies agreed to implement conservative harvest quotas, which included fishing closures in some areas. Several stakeholders believe that changes to habitat, specifically low water levels over successive years, are partially responsible for declining stocks. Winter habitat, which is critical for survival of this species in northern environments, is spatially limiting as it is restricted to several small areas in headwater sections of freshwater streams. Spawning and winter habitats typically overlap and both are associated with perennial groundwater sources. We surveyed two spawning and overwintering reaches from Fish Hole Creek, a tributary to the Babbage River, and Little Fish Creek, a tributary to the Big Fish River. Depth, velocity, substrate, and cover were measured at positions in the stream where fish were observed and also at spawning redds. A two-dimensional hydrodynamic fish habitat model (River2D:www.river2d.ca) was developed and used to estimate minimum discharge thresholds for spawning and winter habitats. These discharges can be used as a guideline to help stakeholders manage Dolly Varden stocks more effectively by monitoring water levels in these rivers annually. Developing a metric which can be used to monitor limiting habitat for this culturally important fish, is an integral component of ecosystem-based management.

TRADITIONAL KNOWLEDGE AND SCIENTIFIC INFORMATION ABOUT THE SENSITIVITY OF BOWHEAD WHALES (BALAENA MYSTICETUS) TO ANTHROPOGENIC SOUNDS

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Bowhead whales (*Balaena mysticetus*) are an important component of northern marine ecosystems and are a vital subsistence resource to many communities, especially those adjacent to the Beaufort and Chukchi seas. For millennia, whales have been hunted by Inuit. Hunters learned that bowheads were sensitive to anthropogenic sounds and passed that information to succeeding generations. In some cases, villagers even several kilometres from hunting areas were required to whisper and were restricted from making loud sounds. As oil and gas activities increased in the Beaufort and Chukchi seas, hunters expressed concerns that sounds from seismic airgun arrays, drilling, production, and ship traffic would displace bowheads from feeding and resting areas, migratory routes, and areas where whales were hunted. They reported that whales were deflected away from industrial activities at a distance of 30 to 40 km, while the initial scientific results suggested reactions at much closer distances. As scientific observations increased, it became evident that bowheads were quite sensitive to anthropogenic sounds, but that the sensitivity was dependent on the whales' behavior. During drilling, bowheads avoided waters 15 to 25 km from the rig (LGL and Greeneridge 1987; Hall et al. 1994; Davies 1997). In the central Beaufort Sea, seismic surveys excluded bowheads from a 15-20 km radius around the source vessel with deflection beginning at greater distances (LGL et al 1999). Ship sounds also deflected bowheads from migratory routes, such as near BP's Northstar production island in the Beaufort Sea (Richardson 2008). Therefore, traditional knowledge, local observations and scientific studies all indicate that bowheads are sensitive to anthropogenic sounds. Care must be taken to mitigate impacts to bowhead whales that use industrialized areas. Most of these studies focused on only one industrial operation, thus it is unknown how multiple operations may cumulatively impact bowhead whales.

ZOOPLANKTON OF THE COASTAL BEAUFORT SEA – PAST, PRESENT AND FUTURE STUDIES.

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Zooplankton are the passively swimming organisms that play crucial role in the energy/biomass transport by feeding on phytoplankton (plants) and at the same time being grazed by fish, seals and whales. Zooplankton of the Beaufort Sea was intensively studied during NOGAP program in the 80's, however, later there was not major study performed until 2002. Recent years were marked by onset of such programs as the Nahidik, Cases, ArcticNet or CFL that provided broad spectrum of data from the Beaufort Sea region. Most of the aforementioned studies on zooplankton were devoted to basic ecological studies that cover spatial distribution, some seasonal variability and interaction with other food web levels. As a result of these studies we learned that there is strong spatial variability, both in zooplankton abundance and diversity, from the coast to the shelf which is one of many variables that needs to be considered in spatial habitat management. There is certainly a gap in knowledge on both ecology and ecotoxicology of zooplankton related to oil production. That should be considered important issue in order to understand and protect the ecosystem and mitigate future industry impacts. Possible scenarios of zooplankton response to potential oil disturbance will be presented.

Ice Engineering for Offshore Operations

ICE THICKNESS INFORMATION FOR SAFE AND ENVIRONMENTALLY RESPONSIBLE OFFSHORE OPERATIONS

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Ice thickness, along with ice drift and concentration, is one of the most important environmental parameters affecting the feasibility and safety of offshore operations, and largely controls the design criteria and operating procedures for offshore structures and ships in ice. Systematic observations of ice conditions and thickness should be performed before, during, and after offshore operations to prevent accidents and to assess the potential impacts of activities. Since many years we have demonstrated the feasibility of electromagnetic induction ice thickness measurements to provide data for ice navigation, ice engineering, and ice management projects, and for long-term monitoring. These can be operated from structures or moving platforms including aircraft, and provide high flexibility in their spatial and temporal coverage and resolution. The presentation will review applications and the potential and limitations of the method, and contrast them with other means of ice thickness measurements. It is suggested to create an inter-

institutional ice thickness observation system as part of a larger environmental monitoring program to manage oil and gas in the Arctic. This would efficiently provide independent and freely available information and synthesis to balance competing interests among the various stakeholders, and to provide guidelines for future procedures and regulations.

RECENT OBSERVATIONS OF MULTI-YEAR ICE IN THE CANADIAN HIGH ARCTIC

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The design of offshore structures for oil and gas development in the Arctic is dictated by the maximum loads anticipated from collisions with multi-year ice. From the viewpoint of ice engineering, there are two relevant environmental factors: 1) the extent of multi-year-ice fields; 2) the severity of features embedded within them. The first factor is related to the recurrence of extreme loads; the second is related to their magnitude. A large decrease in the extent of multi-year pack ice in the Arctic since 1990 has encouraged speculation concerning the disappearance of dangerous old ice some time soon. Meanwhile, recent incidental observations have revealed the continued presence of very thick old floes on the North American side of the Arctic. It is not clear at present whether these thick floes are the last stragglers of a lost regime, or normal residents of enduring ice domain that has simply shrunk in area. Only systematic observations of multi-year ice thickness can provide an answer. Upward-looking sonar on sub-sea moorings has a well-established capability to acquire such data at specific sites. However, such installations have been rare in areas dominated by multi-year ice Arctic because of the expense and difficulty of maintaining them. Fortunately since 2003, there have been several logistic opportunities to place moorings with sonar at locations in the Canadian High Arctic where old floes can be measured as they leave the vestigial perennial pack. These include 9.5 site-years in Kennedy Channel viewing ice streaming from the Lincoln Sea, and recently 1 site-year in Penny Strait viewing ice from Prince Gustaf Adolf Sea. Analysis of these observations reveals the present characteristics and occurrence frequency of thick old floes. Dangerous ice clearly remains relatively common in these straits. Quantifying change is, however, a challenge in the absence of comparable data from earlier times.

THE IMPACTS OF INCREASED OPEN WATER ON ARCTIC SUMMER STORMS

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Storm activity in the Arctic is a fundamental consideration in studies of Arctic weather, climate and ocean conditions. Developing storm intensities and tracks are influenced by factors such as the initial intensities, their spatial extent, thermodynamic state of the atmosphere, storm propagation speeds, and the sea surface fluxes. Although several of these factors are also known to modulate the strength of mid-latitude cyclone systems, little is known about their impact on Arctic storms.
Our investigation uses a state-of-the-art mesoscale atmospheric model coupled to an ice-ocean model. Our case studies are intense summer storms from recent years. In midlatitudes, summer marine storms can encounter a thin ocean mixed layer and produce a cold wake by inducing strong currents, depressing sea surface temperatures and upper-ocean temperatures. Similar effects can be produced in the Arctic. Storm-induced ice movement can be large.
In selected storm cases, we show that the impacts of the ocean surface or ice on cyclone strength may be notable, and these effects can also cause changes in the storm tracks, particularly in the decaying stages of the storm life cycle, along the Beaufort Sea coast as they move over the Arctic Ocean and Canadian Archipelago. Shallow water depths and low gradients in bathymetry in the Mackenzie Delta present a variety of challenges in terms of data collection, landfalling storms and model prediction. For instance, our present understanding of processes controlling bottom friction and other forms of energy dissipation are based on parameterizations that are tuned for mid-latitude environments. There have been few calibration studies for the Beaufort Sea and related Arctic seas. In the presentation, we mention the role of these processes based on model experiments in simulations of Arctic storms, in comparison with in situ field data.

THE IMPORTANCE OF ICE ISLANDS AND EXTREME ICE FEATURES IN RELATION TO OFFSHORE STRUCTURES

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Measuring the long and short drift velocity, dimensions, and dynamics of accretion and decay of Ice Islands and Multiyear Hummock Fields (MYHFs) is crucial for offshore petroleum operations in the Beaufort and Chukchi Seas. Little is known about such characteristics of these Extreme Ice Features. Most research on MYHFs ended in the early 1980s and

studies of Ice Islands have concentrated on understanding break-off events from Ice-Shelves from Northern Ellesmere Island. Public data reveal they are relatively few in number (especially Ice Islands) during their drift along the coastal Canadian High Arctic Archipelago, but their known characteristics of thickness, shape, size, hardness and integrity, all pose significant risks to offshore operations in the Beaufort and Chucki Seas.
Canatec is involved with multi-year, industry research projects on these features. Since they are still in operation, their results are not yet public. However, there are some public data available to sketch the main characteristics of the dynamics of these hazardous drifting Extreme Ice Features. Studies of calving give us estimates of mass, area and timing of Ice Island liberation into the Beaufort Gyre; ice shelf characteristics help us identify the resulting Ice Islands in RadarSat-2 imagery. Some public imagery is available to pinpoint some features and estimate their motion and breakup into fields of hazardous fragments as they move southwest towards the lease areas. Our presentation concludes with recommendations for different types of studies and analyses to fill in the gaps in knowledge that will be critical for regulators, designers and operators in these offshore regions.

Interaction of Oil and Gas Activities with Sensitive Coastal Habitats

OIL DEVELOPMENT IMPACTS ON SUBSISTENCE: MONITORING AND ASSESSING MITIGATION

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The purpose of this project is to develop a systematic method to monitor and evaluate the success of specific mitigation measures as related to industrial exploration and development of hydrocarbons in the coastal and offshore environment of Alaska, especially as they relate to potential impacts on subsistence hunting activities near Nuiqsut. The objective is to develop a prototype method based on a review of six North Slope Alaska oil development projects: Alpine (including Alpine Satellites) Endicott, Meltwater, Northstar, Oooguruk, and Tarn. This study, being conducted under contract to the U.S. Department of the Interior, Bureau of Ocean Energy Management, Regulation, and Enforcement, will evaluate the effectiveness of industry's pre-lease mitigation strategies and post-lease operations.
This presentation is based on an inventory of concerns and mitigation proposals and requirements associated with the six projects and a descriptive analysis. The inventory, developed through systematic review of federal, state and municipal environmental and permitting documents, identified 303 relevant documents and yielded 1,620 analytic records. The purpose of the analysis is to guide the development of interviews with industry and government informants. Analysis results identify 1,213 mitigation decisions over the six projects covering such mitigation categories as pipeline elevation and placement, aquatic habitat protection, helicopter and airplane management, community consultation, and research on caribou displacement. The presentation tracks the incidence of concerns, mitigation ideas, and mitigation decisions by type of impact and mitigation.

POTENTIAL FOR DISPLACEMENT OF WHALES AND SEALS BY SEISMIC AND EXPLORATORY DRILLING ACTIVITY IN THE CANADIAN BEAUFORT SEA - WHAT HAVE RESEARCH AND OBSERVATIONS REVEALED TO DATE

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The Beaufort Sea, shared by Canada and the USA, is important to several species of marine mammals including bowhead whales (*Balaena mysticetus)*, beluga whales (*Delphinapterus leucas*) and ringed seals (*Phoca hispida*). Both whale species arrive through offshore leads in ice in the Canadian Beaufort Sea (CBS) in spring, and remain there during the open-water season. Conversely, the ringed seal is resident throughout the year and breeds there in the fast ice. While limited in scope, existing research results obtained while seismic or drilling operations were underway have shown no marked or measurable effects on either the behaviour or distribution of these species by offshore industrial operations in the CBS to date. Differences in behaviour and distribution have been recorded, but were localized and temporary. Current best-practice of shutting down seismic operations if marine mammals enter the prescribed safety zone (SZ) is in place in the CBS. Aerial survey and shipboard observations reveal that bowheads usually avoid the SZ and immediate area of the seismic activity, but are not displaced for extended distances or periods beyond these proximate areas. The primary activity of bowheads in the CBS is feeding, during which time bowheads appear more tolerant of disturbance and are less likely to be displaced than during migration. In contrast,

aerial survey results show beluga whales are widely distributed throughout the offshore during August, yet they are rarely sighted from seismic ships and rarely seen within the SZ. This is interpreted as their tendency to temporarily avoid areas of seismic activity by greater distances, on average, than bowheads. A four-year study of ringed seals prior to (2003-2005) and during the drilling of an offshore test well (2006) in an area of fast ice in the CBS failed to show any significant effects on either the distribution or behaviour of breeding seals in the area potentially affected by the industrial activities. The evaluation of cumulative effects of future offshore development (multiple sources and among jurisdictions) is limited by a dearth of data to assess the biological significance of cumulative exposures. Without a continuing and well designed data base supported by innovation and the latest technology, and with costs incorporated into planning for future offshore developments, it will be difficult to either predict or measure cumulative effects with confidence.

ENVIRONMENTAL CONSIDERATIONS ASSOCIATED WITH OIL AND GAS EXPLORATION AND DEVELOPMENT ON ALASKA'S NORTH SLOPE

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ConocoPhillips Alaska, Inc. (CPAI) is the largest oil and gas operator in Alaska, having operated on the North Slope of Alaska for more than 30 years. Over this period, significant advances in technology have occurred; resulting in the use of ice roads and ice pads to support winter exploratory drilling, and reduced gravel footprints to access key reservoirs as part of development. Mitigation measures have been developed in consultation with stakeholders, based on the acquisition of key environmental data sets and traditional knowledge of local residents. CPAI has supported an environmental studies program since the discovery of Prudhoe Bay in the late 1960s. The environmental studies program continues today, providing scientific data to support the development of National Environmental Policy Act (NEPA) documents that evaluate the potential impacts of exploration or development activities and recommend mitigation measures, if necessary. CPAI encourages collaboration with federal, state, and local regulatory agencies, as well as universities to collect data that will assist land managers and regulatory staff with decision making based on sound science. With expansion of activities to the west into the National Petroleum Reserve-Alaska, the importance of collaboration in research is imperative in order for all stakeholders to have the information necessary for development with minimal impacts. This talk will present an overview of the coastal environmental studies program supported by ConocoPhillips in Alaska.

Oil Spill Prevention in the Arctic

ARCTIC OIL SPILL PROBABILITIES

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Current catastrophic consequences of the Gulf of Mexico blowout have refocused interest on the probabilities of such events in both temperate and northern regions. In order to adequately reduce the likelihood and impact of oil spills, it is important to understand their chances of occurrence, the principal causal factors contributing to the occurrence, and the probable spill characteristics in terms of location, timing, and volume and rate of spill. This paper reviews both early Beaufort Sea studies on oil spill probabilities with emphasis on oil blowouts, and details more recent comprehensive studies carried out specifically for Beaufort and Chukchi sea locations. Due to the limited history of offshore oil operations in arctic regions, which continues to be the case to the present, it is not possible to base oil spill probability estimates solely on historical empirical data—there have been very few oil spills in the arctic. The early studies in the 70's relied on a detailed fault tree analysis dealing with the offshore operations as systems without history. More recent studies, carried out for the Alaska region MMS, use world wide data as a starting point. In these studies, statistically significant non-Arctic empirical data from the US Gulf of Mexico and other world-wide sources, together with their variance, were used as a starting point. Next, both the historical non-Arctic frequency distributions and spill causal distributions were modified to reflect specific effects of the Arctic setting, and the resultant fault tree model was evaluated using Monte Carlo simulation to characterize uncertainties treated as probability distribution inputs to the fault tree. Numerical values for arctic oil spills of different origins are presented in the paper, together with conclusions and recommendations. It is found that the range of values of exploratory drilling blowout probabilities has not significantly changed between those of the early studies and those based on current data. Based on the ranges of values derived, is recommended that in applications of statistical blowout probability values, it is essential to consider specific operational, reservoir, platform type, environmental, water depth, gas or oil, flow path inside or outside casing, and other factors which can significantly affect the values by one or two orders of magnitude.

EARTH OBSERVATION DATA TO SUPPORT EMERGENCY RESPONSE AND WILDLIFE MANAGEMENT IN CASE OF AN OIL SPILL IN CANADA'S NORTHERN COASTAL ECOSYSTEMS

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The eSPACE project (Emergency Spatial Pre-SCAT for Arctic Coastal Ecosystems) is part of a new joint initiative (MORSE) from the Canadian Space Agency. That project is focused on developing a capacity to enhance our state of preparedness for emergencies in case of an oil spill in the North. Baseline coastal information is required for operational prioritization, coordination of on-site spill response activities and wildlife management. Traditional data development for shoreline classification and sensitivity analyses include manual interpretation of oblique videotape imagery collected in a helicopter. Earth Observation data from satellites such as RADARSAT-2 and SPOT-5 can potentially be used to identify and map shoreline characteristics, coastal habitats and resources at risk. This project will develop remote sensing classification procedures to support shoreline segmentation and sensitivity analyses in the Arctic. Mackenzie River Delta and Beaufort Sea are one of the pilot study regions. In the summer of 2010, videotapes were collected along coastline from Ollivier Island to Warren Point on the Tuktoyaktuk Peninsula for shoreline segmentation and classification. In the same time, RADARSAT-2 fine quad p ole data were acquired. Images processing such as classifications are now conduct on radar and optical data using ancillary data to investigate the ability to differentiate shoreline properties. Results will be compared with the traditional approach to verify that the products are as reliable.

NATURAL RESOURCE DAMAGE ASSESSMENT IN ARCTIC WATERS

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As required by the Oil Pollution Act of 1990, Natural Resource Damage Assessment (NRDA) is a process to determine what restoration actions are needed to compensate for harm to natural resources and their human uses that occur as a result of an oil spill. The process requires natural resource trustee agencies (NOAA, DOI, and state agencies) to assess the transport of oil from the release site, the exposure of natural resources to the oil, and its effects on the biota and human uses. Determining the amount of injury and appropriate restoration requires an understanding of the condition of the natural resources and human uses in the absence of the spill (baseline conditions). Loss of Arctic sea ice suggests that over the next 10 – 20 years ship activity will dramatically increase. Predictions of large reserves of oil and gas are increasing pressure for hydrocarbon exploration and production. One likely result will be the accidental release of petroleum into the Arctic marine environment which would require an NRDA to be initiated. However, little NRDA work has been done in this region. On April 22, 2010, the Coastal Response Research Center (CRRC) and NOAA's Office of Response and Restoration completed a workshop on planning for NRDA in the Arctic. Attendees included natural resource trustees, industry representatives, non-governmental organizations, academic scientists, and Arctic community representatives. This presentation will describe the outcomes of the workshop, highlight challenges particular to the Arctic, and provide suggestions for future research in support of NRDA in the Arctic.

IN SITU BURNING IN ARCTIC AND ICE-COVERED WATERS: TESTS OF FIRE-RESISTANT BOOM IN LOW CONCENTRATIONS OF DRIFT ICE

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Field deployment tests of booms and skimmers in broken ice conditions have highlighted the severe limitations of conventional containment and recovery equipment in even trace concentrations of broken ice. Even small amounts of brash ice concentrated by the containment booms severely affected the effective operation of skimming systems designed for use in ice-affected waters. It is possible, however, that the accumulation of brash ice and small floes in the back of a fire-resistant containment boom would not curtail in situ burning of the oil sandwiched between the ice floes. Field tests have shown that high concentrations of oil in brash/slush between floes can be ignited and burned efficiently.
A two-day test program was conducted in the Barents Sea in May 2009 to perform experiments related to in situ burning of oil in open drift ice. The tests were part of a broader program performed over a two-week period that included tests with skimmers, dispersants, and remote sensing systems, and studies of oil-in-ice behaviour. Preliminary tests were performed with the boom in 2008: these tests did not involve oil, but proved the feasibility of several operational aspects of fire-boom use in ice. In the 2009 test program, oil was collected in ice-affected waters and subsequently burned in situ.
The primary objective of the tests was to determine whether fire-resistant booms could be used to collect and contain oil

in low concentrations of drift ice for burning in situ. This was accomplished with two different booms, the Elastec/American Marine (aka 3M) fire boom and the Applied Fabrics Technologies (AFTI) PyroBoom. The booms were tested in to different ice conditions: the former in a field of 3 to 5/10ths ice, and the latter in trace ice conditions. Both booms proved to be suitable to the task, and were able to contain a modest number of ice floes as would be encountered in a "collect-and-burn" operation in light ice concentrations.
In each test, a high percentage of the oil was removed through in situ burning, some 98% in the first test and 89% in the second. The burn in the second test was less effective and took much longer due to the presence of more densely packed brash and frazil ice and due to the presence of waves.

BEAUFORT SEA OIL SPILLS STATE OF KNOWLEDGE REVIEW AND IDENTIFICATION OF KEY ISSUES

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Exploration activities by Imperial Oil Limited, Dome Petroleum Limited, Gulf Canada Resources Limited, and Panarctic Oils Limited in the 1960s through to the 1980s identified significant oil and gas potential in the Canadian Arctic. With the exception of one tanker of oil from an extended flow test from Gulf's Amauligak discovery in the Beaufort Sea and a few years of seasonal tanker shipments of oil from Panarctic's Bent Horn operation on Cameron Island, these discoveries were not developed and oil and gas activity in the Canadian north stagnated. The issuance of new offshore exploration leases in recent years and changing market conditions have resulted in an increased interest and activity in oil and gas in the Canadian Arctic. Increased exploration activity will bring with it an increase in the risks associated with accidental spills from the operations. The proposed presentation will describe the results of a recently-study commissioned by the Environmental Studies Research Funds (ESRF) with the objectives of: Reviewing the current state of knowledge of oil spills in Arctic waters; Identifying the key issues associated with them; Providing a current reference document for use by industry, regulators and the public; and Preparing a geographic database of coastal resources, vulnerabilities and sensitivities that may influence the choice of oil spill containment and recovery methods.
As a culmination to this study, a workshop was held in October 2009 involving representatives of government and oil companies that may be involved in Beaufort Sea exploration and development. At the workshop, members of the study team presented the draft findings of the study. This was followed by a discussion of a number of key issues of concern regarding planning and response to spills in the Beaufort Sea.
The proposed presentation will present the findings of the study, with a description of the current state-of-the-art for each of the main categories of countermeasures and a summary of the key issues addressed in the discussion portion of the workshop.

UNDERSTANDING ICE MOVEMENT FOR OIL SPILL MONITORING AND CLEANUP

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Monitoring and cleanup of oil spilled in the Arctic requires an understanding of the drift patterns of ice at and away from potential spill sites during the winter, and of the open ocean currents after the ice has melted. This information is vital for determination of the movement of contaminated ice, which might result from a spill on the ice (tanker, refuelling, operations) or under the ice surface (subsea blowout or ruptured pipeline). As far as we are aware, no public information has been published on this subject relating to the Beaufort since the 1980s. Significant changes to the ice cover in the arctic have occurred over the past decade, and new information on ice drift and dispersion should be obtained. A spill or blowout in stable landfast ice would be confined during winter and spread very little.
Spills in the moving pack ice present a greater problem, and hazard to personnel during cleanup. In the event of oil coming from the sea floor (well blowout or ruptured subsea pipeline), it would be necessary to track the oil trapped under the ice by periodic placement of buoys on the ice as it drifts over the site. Such measurements would provide some indication of the accumulation of oil under the ice (form ice drift speed) and where the contaminated ice might end up. Knowledge of locations of high oil accumulation would increase the efficiency of cleanup in the spring, which would assist logistics and HSE planning.
A discussion of these and other oil spill issues, as a result of ice drift, will be presented.

SHORE-BASED, HIGH-FREQUENCY SURFACE CURRENT MEASURING RADARS IN REMOTE ARCTIC SETTINGS

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High-frequency shore-based radars (HFR) collect hourly, realtime surface current data over broad areas of open water. Such data provide insights on the time-varying ocean circulation, predict oil spill trajectories, evaluate circulation models, and in the event of a spill, provide responders with realtime data on spill evolution. The radars detect currents from the Doppler shift of the backscattered radar signal. We

will show examples of HFR data collected recently on a 3 km grid extending from the coast to 50 km offshore from the central shelf of the Alaska Beaufort Sea and on a 6 km grid extending 170 km offshore over the Northeast Chukchi Sea continental shelf. In addition to showing results from these systems we will discuss HFR limitations with respect to sea ice, ionospheric interference, ambient weather conditions and siting constraints.

HFR requires 11kwH/day of AC power but the lack of power availability inhibits HFR use along remote coasts. To circumvent this constraint we developed a modular, autonomous remote power module (RPM) for arctic environments. The RPM design facilitates setup and transport to remote sites using small vehicles. The RPM contains sub-systems that generate power for the HFR and satellite communications and monitor power performance. The HFR, communications, and monitoring systems are powered via a battery bank (with a 4-day power reserve) primarily by wind and solar and secondarily by a bio-diesel generator. The RPM is designed as a stand-alone device for long-term deployments. It minimizes permit issues associated with diesel generators and logistics costs associated with refueling and maintenance. Performance data from a prototype RPM setup in Barrow Alaska in September 2010 will be provided. While our system is designed for high-latitudes, it can be easily modified for remote coasts elsewhere.

Abstracts – Poster Session

INFLUENCE OF ENVIRONMENTAL GRADIENTS ON MACROFAUNAL COMMUNITY STRUCTURE IN THE NORTHEASTERN CHUKCHI SEA

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In 2008, a multi-year, interdisciplinary study was initiated in the vicinity of two proposed oil and gas exploration areas in the northeastern Chukchi Sea. This study was sponsored by ConocoPhillips and Shell Exploration and Production Company to collect information on the ecosystem in these areas prior to exploration and provide environmental data useful for permit applications and for post-development comparisons. Sediment-dwelling macrofauna were collected for taxonomic analysis at 52 sites with a van Veen grab in August, 2008 and 2009. Dominant fauna include the crustacean class Ostracoda, the amphipod Paraphoxus spp., the bivalves Astarte spp., Ennucula tenuis, Nuculana pernula, and Macoma calcarea, the peanut worm Golfingia margaritacea, and the large polychaete worms Lumbrineris sp. and Maldane glebifex. The fauna found in 2008 and 2009 were abundant and animals large although abundance, biomass, and the number of taxon found were all significantly higher at Burger compared to Klondike. The faunal communities demonstrated little temporal change as faunal assemblages sampled in 1986 were comparable to those of 2008 and 2009. A gradient in benthic community structure was associated with sediment and physical variables reflecting the geomorphology and hydrography in the study area. The advection of nutrient-rich water from the North Pacific Ocean and eastern Bering Sea contribute to the high abundance and biomass of faunal communities in the study area.

GWICH'IN RENEWABLE RESOURCES BOARD

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The Gwich'in Renewable Resources Board (GRRB) is a co-management board established under the guidance of the Gwich'in Comprehensive Land Claim Agreement (GCLCA) to be the main instrument of wildlife, fish and forest management in the Gwich'in Settlement Area (GSA).
Fish, wildlife and forests are an important part of Gwich'in culture, lifestyle and economy. The GRRB and our co-management partners work with the communities in the GSA to ensure renewable resources are utilized in a sustainable manner. By working together, resources will be available for future generations.

WHO NEEDS AN ICE ROAD?

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The BLM was forced to plug the Drew Point well when it was threatened by coastal erosion from the Beaufort Sea. The associated reserve pit threatened release of petroleum contaminated drilling muds into the ocean. The material had to be excavated and hauled to an appropriate site that was 37 miles to the south over barren tundra. The BLM worked with the contractor to use specialized equipment including Steigers and rubber-track modified Sidedumpers. The move to all tracked equipment enabled the BLM to save about 4 million dollars by creating and maintaining a snow trail rather than an ice road. When revisited over the summer, final impacts to the tundra were very similar in appearance to an ice road. The Drew Point well is located north of Lake Teshekpuk in NPRA.

A MARINE MAMMAL MONITORING AND MITIGATION PROGRAM FOR OIL AND GAS EXPLORATION IN ARCTIC ALASKA

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Anthropogenic sounds introduced into the marine environment from oil and gas exploration activities can impact some marine mammals. Impacts can be greatly reduced if appropriate monitoring and mitigation measures are implemented. Effective monitoring provides information on marine mammal distribution around operations, allows for real-time mitigation in critical situations, provides data that furthers our knowledge of various species, and provides feedback on the efficacy of implemented mitigation measures. Pacific walruses, bowhead whales, beluga whales, and gray whales all use the arctic waters offshore of Alaska and all undergo long distance migrations that traverse important areas of offshore oil and gas exploration. These areas are also used extensively by bearded, ringed and spotted seals, polar bears and by smaller numbers of other marine mammal species. To successfully monitor animal movements and distribution over such large areas and effectively institute mitigation a three-tiered monitoring program using dedicated marine mammal observers (MMOs) onboard most vessels, aerial over-flights, and wide-area arrays of acoustic recorders deployed on the seabed was implemented in both the Beaufort and Chukchi seas.

The integrated use of these three platforms since 2006 to acquire data on marine mammal movements and distribution has enhanced understanding and detection of natural patterns as well as changes that may be associated with oil and gas exploration. This program has minimized impacts to marine mammal populations and subsistence hunts. It provided data on the unprecedented movement of large numbers of walruses to terrestrial haulout sites along the Chukchi Sea coast in 2007. It showed that bowhead whales will feed in areas near ongoing seismic operations by limiting their exposure to injurious sound levels. It also found that bowhead whales decrease calling near seismic operations. Lastly, it has detected early range expansion of humpback and fin whales into arctic waters that may be associated with climate change.

INFLUENCE OF WATER MASSES ON THE DISTRIBUTION AND ABUNDANCE OF SEABIRDS IN THE NORTHEASTERN CHUKCHI SEA

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As part of a multi-year, interdisciplinary study in the vicinity of two proposed oil and gas exploration areas, we examined relationships between oceanography and the distribution and abundance of seabirds in the northeastern Chukchi Sea in 2008 and 2009. The study was sponsored by ConocoPhillips and Shell Exploration and Production Company following the acquisition of leases in February 2008. Procellariids were the most abundant species-group recorded during 2008, primarily because of large flocks of Short-tailed Shearwaters (Puffinus tenuirostris) that moved through both study areas in early fall. In contrast, alcids were the most abundant species-group recorded during 2009 and consisted primarily of Crested Auklets (Aethia cristatella). In both years, total density was highest in early fall, with densities in 2009 being at least 15 times higher than overall densities in 2008. Diving alcids that forage on small zooplankton and nekton generally dominated in Klondike, whereas surface-feeding larids and procellariids that forage on large zooplankton and fish dominated in Burger. We propose that the structure of the seabird community differs substantially between the two study areas and that these differences reflect oceanographic differences between the two areas. The Klondike study area appears to be a pelagically-dominated system affected by oceanic water associated with the Central Channel Current, and the Burger study area appears to be a benthically-dominated system affected by a gyre over Hannah Shoal.

THE HYDROCARBON IMPACTS DATABASE: YOUR GATEWAY TO NORTHERN CANADIAN OIL AND GAS ENVIRONMENTAL, SOCIO-ECONOMIC AND REGULATORY PUBLICATIONS

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The Hydrocarbon Impacts (HI) database describes 7000 publications and research projects about the environmental impacts, socio-economic effects and regulation of hydrocarbon exploration, development and transportation in northern Canada. The database is available for free at www.aina.ucalgary.ca/hi, and includes links to PDF files of 1600 online publications. HI is maintained for the Northern Oil and Gas Branch of Indian and Northern Affairs Canada by the Arctic Science and Technology Information System (ASTIS) at the Arctic Institute of North America, University of Calgary.
HI includes most of the environmental, socio-economic and regulatory publications about northern Canadian hydrocarbon projects and proposals from the 1970s up to the present day Mackenzie Gas Project and Arctic Offshore Drilling Review. It includes all publications from the Northern Oil and Gas Action Program (NOGAP), all northern Environmental Studies Research Funds (ESRF) reports, and many of the publications from the Northern Oil and Gas Science Research Initiative (NOGSRI). HI also includes an electronic library of key reports for the Beaufort Regional Environmental Assessment (BREA) which was prepared by ASTIS

EFFECTS OF AMBIENT ARTIFICIAL LIGHT ON ARCTIC MARINE FAUNA

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Light radiating outward from structures associated with offshore oil/gas development may affect the marine environment. We conducted a literature review to assess the potential effects of artificial lighting on arctic marine and estuarine species, focusing on the Beaufort and Chukchi Seas during normally-dark periods. Responses to light can vary widely by faunal taxon and environmental conditions. These responses also may be dependent on the type of lighting, its spectral characteristics, and its intensity. In general, marine mammals do not appear to be attracted by artificial lighting but may be locally disturbed. Many species of seabirds are attracted to artificial light, especially during cloudy or inclement weather, with impacts ranging from increased energetic costs to mortality from collision. Birds are

disoriented by longer wavelength (i.e., red) light, which may interfere with their magnetic compass, whereas recent studies in the North Sea indicate that shorter wavelength (i.e., green) lighting is less attractive to migrating birds. Light is an important, but not the only, factor affecting fish behavior; there appears to be no single combination of spectrum, intensity, or duration that attracts or repels all species of fish. Changing light levels is the most likely stimulus for the diel vertical migration in many invertebrate taxa, but other environmental conditions such as ice cover and hydrographic factors also may contribute in the Arctic. Mitigation measures may be implemented to reduce adverse effects of lighting associated with offshore development on marine fauna. Potential impacts of lighting associated with offshore platforms or support facilities could include the attraction or repulsion of some fauna, resulting in the localized, short-term abundance or dispersal of some species. The potential for ecologically significant or long-term impacts from ambient artificial lighting on regional populations of arctic marine fauna can only be speculated on at this time.

USING SAR TO CHARACTERIZE WINTER LIQUID WATER AVAILABILITY IN LAKES ON THE NORTH SLOPE COASTAL PLAIN OF ALASKA-A REGIONAL ASSESSMENT

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The North Slope coastal plain represents a unique landscape that is characterized by permafrost and an immense number of freshwater lakes of varying sizes and depths. These lakes are an important resource for a range of uses including habitat for fish and bird species, subsistence for local populations, and freshwater supply for industrial development. The ability of resource managers to effectively balance these uses depends on our understanding of the capacity of these lakes for water storage and their function as habitat.
During winter, lakes on the coastal plain typically freeze to a depth of about 2m, with deeper lakes retaining liquid water. The identification of deep lakes that contain unfrozen water can help define critical fish overwintering habitat, refine habitat modeling for fish populations and piscivorous birds, and aid in the appropriate selection of lakes as water sources for ice road construction.
A wide variety of localized studies have demonstrated the use of synthetic aperture radar (SAR) as an effective tool to identify those water bodies for which the water does not completely freeze to the bottom. However no broad, regional assessment of winter liquid water availability has been conducted. It is the goal of this study to develop a consistent, assessment of winter liquid water availability on the coastal plain of the North Slope using SAR imagery.
This presentation will outline an operational methodology for characterizing winter liquid water availability in lakes using C-band SAR imagery from the ERS-2 satellite as provided by the Alaska Satellite Facility. The poster will describe theory and processing sequence by which the SAR data is pre-processed, segmented, and classified in a GIS environment. Results of this work will be incorporated into a public, web based information portal. This work is currently ongoing and final results are expected in December 2011.

LAND COVER MAPPING OF ALASKA'S NORTH SLOPE UTILIZING LANDSAT TM IMAGERY

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The North Slope Science Initiative (NSSI) has been working with partners to bring Alaska North Slope land cover maps into the digital age. Land cover data needs are not new-since the 1990s, millions of acres across Alaska have been mapped by the BLM, Ducks Unlimited, the U.S. Fish and Wildlife Service and the National Park Service. Mapping and field protocols developed by these agencies have also been adopted for mapping in Canada's Northern provinces. On Alaska's North Slope, over the past forty years approximately 55 different land cover products have been completed by agencies, universities and industry. All of these map products had a common element: no map used a standard protocol that could be used to combine efforts into a single slope-wide land cover map.
The NSSI held meetings with agencies and non-government organizations to begin a partnership in support of standard protocols that would be used to develop a slope-wide land cover map. In 2008 and 2010, NSSI directed field collection projects with support from Ducks Unlimited, the Natural Resource Conservation Service and the Alaska Natural Heritage Program. These field efforts collected data from hundreds of locations representing millions of acres across the North Slope region. Image processors are currently using this data to finalize the classified map, which when completed will serve as a baseline from which to detect change in habitat, food sources, hydrology, and wildlife movements. The map will also be used as a planning tool for ice and gravel road construction and well as other infrastructure in support of oil exploration. The land cover map address NSSI emerging issues such as: vegetation change, lake drying, saltwater intrusion, changing fire regimes, wildlife habitat selection/availability, weather and climate.

INTERANNUAL VARIABILITY OF THE PLANKTONIC COMMUNITIES IN THE NORTHEASTERN CHUKCHI SEA

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We sampled the planktonic communities of two nearby 30x30-NM study areas (Klondike and Burger) at high spatial resolution in the northeastern Chukchi Sea three times each during the ice-free season in 2008 and 2009. We sampled phytoplankton (chlorophyll a), inorganic macronutrients (nitrate, silicate and phosphate), and zooplankton in a 5x5

station grid within each study area. The 2009 season saw warmer temperatures and an earlier retreat in seasonal ice cover over the regions than what was recorded in 2008; consequently, the spring bloom was partly captured in 2008 but not in 2009, when only low concentrations of nutrients and chlorophyll were recorded on all cruises. We assessed the zooplankton community with both a 150-µm mesh net targeting smaller species and a 500-µm mesh net towed to target larger and more mobile species. We recorded 76 taxonomic categories of zooplankton, including 11 meroplanktonic larval categories. The greatest taxonomic diversity was observed in the copepods (23 species), followed by the cnidarians (11 species), with all species typical for the region and largely of subarctic Pacific origin. In 2009, average abundances in the finer-mesh net were double those observed in 2008 due largely to increases in two small-bodied species, although the overall biomass was similar between years. Although the average abundances and biomass of holozooplankton in the coarser-mesh net were similar in both years, the biomass of key large-bodied lipid-rich copepods in 2009 was double that seen in 2008 during the mid-season cruise. Both the abundance and biomass of meroplanktonic forms were substantial in both years, but their importance was less in 2009 than in 2008. A temporal evolution of the community structure was apparent over both areas, and community structure differed substantially between years. It appears that cold oceanographic conditions in 2008 slowed the normal growth and development of the zooplankton community, causing some of the interannual differences in community structure.

DATA ASSIMILATION OF ROBOTIC AND SATELLITE DATA FOR CHARACTERIZATION OF NORTH SLOPE, ALASKA LAKES

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Radar and electro-optical remote sensing satellite data have been combined with in situ measurements on the North Slope of Alaska to obtain critical lake data for both the oil and gas industry and resource managers. Information provided includes baseline characterization of these lakes, change detection, salt water intrusion, and ecological habitat preference. This information can help define critical fish overwintering habitat, refine habitat modeling for fish populations and piscivorous birds, and aid in the appropriate selection of lakes as water sources for ice road construction. This multi-faceted program, pioneered by the North Slope Science Initiative, has been aimed at using cost-effective technologies to investigate the remote lakes of the North Slope. Autonomous water quality and bathymetry mapping robots have been used to provide in situ data. Synthetic aperture radar data and electro-optical satellite data have been used to delineate lake boundaries, determine which lakes retain liquid water during the winter months, and map limited depth contours. Robotic and satellite data assimilated within a geographic information systems (GIS) framework has allowed for interpolation between measurements and extension of estimates to lakes that have not been directly sampled. With approximately 2,974 lakes on the North Slope, and approximately 1,659 of these lakes with an area over one square kilometer, efficient and cost-effective methods are needed to provide critical lake data. Example applications and methodologies will be presented, as well as a summary of efforts underway to develop a regional map of winter liquid freshwater availability.

THE PEEL PETROLEUM PROJECT

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The Peel Petroleum Project (2005-2009) was initiated by the Northwest Territories Geoscience Office and involved partners from the Geological Survey of Canada, Yukon Geological Survey, universities, and industry. A study of hydrocarbon potential and regional geology in the Peel Plateau and Plain (Peel area) of the Northwest Territories and Yukon addressed the need for modern petroleum geoscience data and interpretation in this underexplored, yet prospective, area in proximity to the proposed Mackenzie Gas Project natural gas pipeline route. A total of 74 wells have been drilled in Peel Plateau and Plain. None of these wells have been productive, but indications of petroleum systems in the Peel area include petroleum shows in exploration wells, gas seeps, oil stained outcrops, and bitumen occurrences. Fieldwork was conducted on the Phanerozoic succession in the northern Mackenzie Mountains, Richardson Mountains, and Franklin Mountains that expose stratigraphy contiguous with the subsurface of Peel area.

The final project volume (Pyle and Jones, 2009) includes structural and seismic interpretation, regional stratigraphy, and a review of petroleum systems elements for the area. A Geographic Information System digital atlas (Pierce and Jones, 2009) accompanies the project volume and contains all of the spatial data associated with the research. The interactive atlas includes field and core photographs, interpreted seismic profiles, core and measured section descriptions, geochemical analyses, isopach and structural contours, and other related data associated with a spatial database of wells and field localities. The result is a comprehensive body of geoscience work for Peel area which will be useful in oil and gas exploration and for informed regional land use and business planning endeavours, when coupled with other pertinent data.

This project's research team has received the 2009 INAC NWT Region Excellence in Science and Technology Award and 2010 NWT Premier's Award for Collaboration.

THE ROLE OF SNOW IN ARCTIC TRANSPORTATION NETWORKS: FROM DESIGN TO MANAGEMENT

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Snow plays many critical roles in Arctic transportation. It is both a construction material and an ecological resource providing recharge to lakes, streams and wetlands. Snow provides a natural covering which helps protect the natural landscape. Collected snow also can be used in building up ice roads and pads. Snow properties can be highly variable over time. Wind redistribution of snow is an important factor, contributing to the formation of more dense snow and snow slabs, however, it can also remove valuable snow from oil and gas operation's areas, which can stop winter transportation, or limit the construction of ice road networks. As part of a larger project developing tools to improve Arctic transportation networks, we are looking at several key issues associated with North Slope, Alaska, oil and gas applications. Standards for making snow measurements and the resulting use by management agencies have been developed and published. These standards are now being used by industry to help develop validation programs. Application of real-time reporting stations for snow depth and the scaling issues with managing larger operation areas are being studied to define the benefits and limitations of this data. We are also investigating applications of various techniques to account for snow redistribution in climate forecast models, primarily the Weather Research and Forecasting (WRF) model. Preliminary project results have shown the benefits of measurement standards and the ability to improve the quality of snow measurements taken by diverse users. Automated measurements are providing useful data to help determine when field conditions may need to be verified, such as the occurrence of wind events, which may impact minimum snow-cover conditions. The development of forecast methods which can predict blowing snow have the potential to provide industry and agencies with better tools to help operations and management of Arctic transportation systems.

THE ROLE OF SOIL CONDITIONS IN MANAGING ARCTIC TRANSPORTATION ON THE NORTH SLOPE, ALASKA

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Arctic transportation networks rely on the frozen state of soils to limit damage to surface vegetation and excessive thermal impacts to permafrost. The Alaska Department of Natural Resources currently uses one standard for the North Slope that requires soil temperatures to be -5°C or colder at a 30 cm soil depth for opening tundra-travel management areas. The standard is applied to any type of ice road and their associated loads, and any type of soils in the transportation corridors without taking into account their differences. This broad approach of the standard is primarily due to the lack of information on engineering properties on soils and the distribution of different soils related to North Slope transportation systems. Our project is part of a larger effort to provide tools for optimizing Arctic transportation networks for the benefit of industry and agencies. Project efforts have characterized soils in key areas related to oil and gas development, adapted soil-freezing thermal models to help generate predictive forecast tools to help industry and agencies better plan for tundra management openings. We are also developing strength of freezing and frozen soil relationships with other soil properties to help evaluate the potential for standards based on ice road usage and planned loads. Prediction (forecast) of soil temperature depends on prediction of the weekly air temperature and snow conditions. Our preliminary evaluations show that soil temperature is less sensitive to daily variability in air temperature. The combined outcome of our studies will help to better define the relationship of soil types and soil properties needed for different transportation applications, and when these conditions are met each season. These combined efforts will help provide better tools for both industry and agencies to design, build, maintain, and regulate Arctic transportation networks over various Arctic soil terrains.

THE USE OF LAKES AND RESERVOIRS IN ARCTIC TRANSPORTATION NETWORKS AND APPLICATIONS OF ADAPTIVE WATER RESOURCES MANAGEMENT TO IMPROVE WATER AVAILABILITY WHILE REDUCING ENVIRONMENTAL RISKS

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Lakes and man-made reservoirs have had a long history of use on the North Slope, Alaska. Management methods and regulatory approaches have primarily taken place in the central coastal plain, which has a high density of natural lakes. These lakes are characteristically shallow thaw lakes, where winter ice formation and protection of overwintering fish habitat are two of the primary factors impacting management and regulatory approaches for industry water use. The general abundance of water led to the development of fairly simple water management approaches. Recent increases in the number of water users, due to exploration by a greater number of companies, exploration in areas

outside the central coastal plain, and competing uses for water over the annual water year are increasing the limitations industry has to manage each year they rebuild seasonal ice-road networks. Meanwhile, management agencies are facing new questions associated with climate change and development in areas with poor background data. Through an active program with agencies and industry, we have developed tools and approaches to better manage water resources in Arctic regions. The application of these tools will allow adaptive management to changing conditions, incorporation of new water-resource information, and an increase in the number of water users and competing uses for water over the hydrologic year. These tools include ice-growth calculation schemes designed for industry water use needs, and the application of watershed delineation tools to estimate potential recharge estimates. Continued project efforts are looking at validation methods to continue to the development of these tools and their application to industry and agency users. The incorporation of these tools and evaluation of hydrologic systems in both Canada and the US will help meet the growing needs for water in Arctic transportation systems

FISHERIES RESEARCH IN SUPPORT OF FISHERIES AND OCEANS CANADA'S REGULATORY ROLE IN HYDROCARBON DEVELOPMENT IN THE CANADIAN BEAUFORT SEA

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The proposed Mackenzie Valley Pipeline Project has sparked renewed intensive oil and gas exploration in the Beaufort Sea. Governmental regulators and resource managers are tasked with assessing the impacts of multiple stressors, including anthropogenic activities, on the region's natural environment, including fish and fish habitat. While proponents are tasked with collecting data in support of Comprehensive Studies under the Canadian Environmental Assessment Act (CEAA), the federal government is mandated to provide unbiased, credible science on behalf of Canadians in order to fulfill its regulatory role. The scope of government science is to conduct regional ecosystem research, and baseline data collection, so Environmental Assessments (EA's) can be cast in the context of the broader ecosystem and the cumulative impacts of multiple stressors. Despite considerable research focus on the biological and physical makeup of the Beaufort Sea during the last period of extensive oil and gas exploration in the late 1970s and early 1980s, the complex dynamics of the Beaufort Sea and its biota are still poorly understood.
Fisheries and Oceans Canada's (DFO's) Northern Coastal Marine Studies program (NCMS), 2003 – 2009, was a multidisciplinary study aimed at characterizing the physical and biological nature of the Canadian Beaufort Shelf. Marine fish surveys were conducted from the Canadian Coast Guard Ship (CCGS) *Nahidik* to study the composition and spatial distribution of fish relative to physical and chemical habitat parameters, and to contribute to the general biological and ecological information on offshore fish populations. In 2010, DFO initiated a pilot monitoring study (ACES, Arctic Coastal Ecosystem Studies) in the newly established Tarium Niryutait Marine Protected Area (TNMPA) to update baseline information and assess the feasibility of proposed indicators of ecosystem change. Herein, we provide an overview of these studies as they relate to DFO's role in conducting science to support its regul atory mandate.

HYDROLOGY AND NORTHERN PIPELINES: HAZARDS AND ENVIRONMENTAL PROTECTION

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Development of pipelines in northern Canada will require detailed hydrologic information (may include streamflow, snow cover, soil moisture, lateral surface or subsurface flow, and soil freezing/thawing for example) to ensure appropriate pipeline design and to minimize environmental impacts. Unfortunately, appropriate data is extremely sparse in these frontier areas. Streamflow observations for example are only available for a small percentage of streams that will be crossed by pipelines or used for water supply during construction, and for those streams with observations, the record is often too short for statistically robust estimates of flows. In addition, information on snow cover, soil moisture, frozen soil conditions, or active layer thickness for example are generally not observed on a routine basis. Given this lack of appropriate hydrologic data, observations must be supplemented by model estimates. To help address this issue, Environment Canada has been involved in the testing and development of hydrologic models for use in cold regions through the Mackenzie GEWEX Study (MAGS); Improved Processes, Parameterization, and Prediction (IP3); and the International Polar Year (IPY). These models consider the fully coupled surface/subsurface water and energy budget at spatial resolutions from metres to kilometers over drainage basins ranging in size from a hundreds to thousands of km^2. This paper will demonstrate the capability of these models at a small number of sites in northern Canada where pipelines may be constructed in the coming years. We will also discuss the need to test these models in a larger range of vegetation, permafrost, and geological conditions in northern Canada to be useful for future pipeline design and construction. Additionally, since climate change is resulting in data sets that are no longer stationary, we will consider whether these hydrologic models, driven by appropriate regional climate or weather models, can consider the effect of a changing climate on the hydrologic regime.

THE U.S. MARINE MAMMAL PROTECTION ACT INCIDENTAL TAKE AUTHORIZATION PROCESS: CHALLENGES IN THE ARCTIC

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The U.S. National Marine Fisheries Service, Office of Protected Resources (NMFS) is responsible for implementing Sections 101(a)(5)(A) and (D) of the U.S. Marine Mammal Protection Act (MMPA), which allow for the incidental "take" of marine mammals during activities other than commercial fishing, including oil and gas exploration and development activities in the Arctic. In order to issue an incidental take authorization (ITA), NMFS must find that the activity will have a negligible impact on the species or stock(s) and that there will not be an unmitigable adverse impact on the availability of the species or stock(s) for subsistence uses. Additionally, in each ITA, NMFS must set forth the permissible methods of taking and mitigation and monitoring measures to minimize potential impacts on marine mammals. To address these issues, NMFS conducts a thorough review of the proposed action and the potential effects to marine mammals and their habitat and to subsistence activities in the project area, including the applicant's proposed measures to reduce impacts to the species and subsistence hunting. This presentation provides an overview of the following: (1) A summary of NMFS' MMPA ITA process, including the interaction with the U.S. Endangered Species Act and U.S. National Environmental Policy Act; (2) A detailed discussion of the information required from applicants; (3) A discussion of general mitigation and monitoring requirements and some common examples; (4) A discussion of potential conflicts with subsistence users and ways to mitigate such conflicts; and (5) Areas where additional scientific studies could help inform NMFS' analyses on negligible impact, impacts to subsistence uses, and cumulative effects.

DISTRIBUTIONS OF EPIBENTHIC MACROINVERTEBRATES IN THE NORTHEASTERN CHUKCHI SEA, 2009

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In 2008, a multi-year, interdisciplinary study was initiated in the vicinity of two proposed oil and gas exploration areas in the northeastern Chukchi Sea. This study was sponsored by ConocoPhillips and Shell Exploration and Production Company to collect information on the ecosystem in these areas prior to exploration and provide environmental data useful for permit applications and for post-development comparisons. Sampling for epibenthic macroinvertebrates was included in the science program in August and October, 2009 and September, 2010. Macroinvertebrates were sampled at 26 sites with a 3 m plumb-staff beam trawl with 4 mm codend liner. Overall abundance was high in both areas although the Burger study area had significantly higher abundances of epibenthic invertebrates compared to Klondike. Biomass was comparable between the two areas. The most dominant taxa included barnacles (Balanus spp.), snow crab (Chionocetes opilio), brittle stars (Ophiura sarsi), hermit crabs and shrimp belonging to the family Pandalidae. Biomass was also dominated by the sea stars Leptasterias spp. Differences in the macroinvertebrate communities resulting from environmental gradients were reflected in the higher biomass of shrimps and sea cucumbers at Klondike and amphipods and basket stars at Burger. Preliminary results from the 2010 program are also presented.

OBSERVING THE SNOW AND ICE PROPERTIES IN THE ARCTIC COASTAL WATERS OF THE CANADIAN BEAUFORT SEA WITH HELICOPTER-BORNE GROUND-PPENETRATING RADAR, LASER AND ELECTROMAGNETIC SENSORS

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A unique data set that was collected with helicopter-borne sensors during April 2010 over the Mackenzie Delta land-fast and mobile ice cover areas. For the first time a Ground-Penetrating-Radar provided in real-time snow depths and ice thicknesses of low saline ice and complemented the Electromagnetic-Laser and Video-Laser data sets to explain the ice and snow properties found in the Mackenzie Delta. In the shallow inshore delta areas where river runoff dilutes the oceanic water such as the Mackenzie Delta, the GPR and EM together can determine the floating, grounded ice conditions from the ice frozen to the bottom where the EM on its own only indicates areas where the ice is attached to the frozen mud layer. In these low saline areas the GPR can measure both the snow depth and ice thickness. The laser brightness when height corrected appears to be an additional observation tool to pin point small young leads and darker ice features (gravel bars). The snow and ice data represents a large spatial distribution to derive ice and snow statistics and to validate ice signatures seen in ASAR imagery in support of Oil & Gas offshore structure designs and navigation. All data and reports are available at: http://www.mar.dfo-mpo.gc.ca/science/ocean/seaice/public.html

THE ARCTIC REGULATORY AND STAKEHOLDER EXPERIENCE

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and economic benefits to its more than 2,200 Iñupiat shareholders and incorporates the traditions and values of our ancestors into our business practices.
UMIAQ technical professionals have decades of experience with strategic planning, permitting, response operations, oilfield services, architecture, engineering and surveying. Our understanding of the Arctic's operating and logistical challenges, federal, state, and local permitting processes integrated with active local, regional, and regulatory stakeholder engagement has played a key role in advancing onshore and offshore energy projects.
Alaska hosts a stringent regulatory environment with litigious stakeholders. Understanding the Social, Political, Operational, Regulatory, and Technical (SPORT) drivers that shape onshore and offshore oil and gas projects is imperative to working in the Alaska. Increased regulatory and stakeholder scrutiny is anticipated in the wake of the Macondo Blowout, resulting in additional delays and regulatory burdens here in Alaska as well as in other domestic and international settings.
Energy project approvals are negotiated with regulatory decision makers. Laws, regulations, policies, and people dictate successful project approval acquisitions. A regulatory road map that includes front-loading pre-application processes and active approval facilitation surfaces project constraints early, and allows active management of baseline data requirements, project approval criteria, mitigation, and compliance strategies. Refined regulatory approaches and methods have proved successful in securing usable regulatory approvals while minimizing the risk of delays introduced by successful appeals and litigation challenges. Executing a robust regulatory plan that integrates and balances SPORT drivers with proactive stakeholder outreach plays a key role in advancing energy projects in Alaska.

DISTRIBUTION AND MIGRATORY TIMING OF THREATENED SPECTACLED EIDERS IN THE BEAUFORT AND EASTERN CHUKCHI SEAS

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The Beaufort and eastern Chukchi seas are important areas for birds that breed in Arctic Siberia, Alaska, and Canada. Spectacled Eiders, large sea ducks listed as 'Threatened' under the U .S. Endangered Species Act, stage and molt in the Beaufort and eastern Chukchi seas annually. To learn more about the distribution and migratory timing of Spectacled Eiders, we implanted satellite transmitters in juvenile (2010, n = 13) and adult (2009, n = 21; 2010, n = 16) eiders at nesting areas in northern Alaska. Early results from our ongoing study showed that eiders occupied areas in the eastern Chukchi Sea between the months of May and October, and the Beaufort Sea between June and September. In both seas, the density of eiders was greatest (50% fixed kernel) within 30 km of the coast of Alaska. Eiders were located near (within 25 km) or within active oil and gas leases in both seas (Chukchi, n = 3; Beaufort, n = 36). With abundant natural resources in the arctic, it is critical that we consider the spatiotemporal distribution of Spectacled Eiders and plan industrial activities to allow for the continued recovery of the species.

CONTROLS ON PERMAFROST DISTRIBUTION WITHIN THE NEAR-SHORE ZONE OF THE MACKENZIE DELTA

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Permafrost presents a significant challenge to proposed oil and gas development in the Mackenzie Delta, due to its influence on the stability of linear infrastructure and foundation conditions. Environmentally safe and economically sustainable development in this region requires an understanding of the spatial variability of ground temperatures and the response of permafrost to natural and human-induced changes of the environment. Recent research conducted by the University of Calgary and the Geological Survey of Canada has investigated permafrost beneath shallow-water environments seaward of the modern delta front. This work has incorporated the use of field-based temperature, drill and geophysical measurements with numerical thermal modeling and satellite remote sensing.
The findings of this study indicate that ground temperatures are mainly controlled by the presence of liquid water or ice at the sediment bed. Where ice freezes to the sediment bed surface (i.e. becomes bottom-fast) conductive transfer between cold air temperatures and relatively warmer underlying sediments leads to heat loss throughout the winter. Interannual variability in ground temperatures results from changes in on-ice snow thickness, which modifies the duration of bottom-fast ice (BFI) and subsequent heat loss from the ground. Thermal modeling indicates that the critical ice contact time for sustaining permafrost beneath near-shore zones of BFI is 142 days. The integration of this finding with a time-series of synthetic aperture radar images, which defines the timing of BFI across the near-shore zone, produced the first map of shallow-water permafrost for the outer Mackenzie Delta. Permafrost was mapped beneath 393.8 km^2 of BFI. These locations typically represent areas where sediment supply exceeds present-day sea level rise. As hydrocarbon exploration and development proceeds in the Mackenzie Delta, the recent advancements in monitoring permafrost beneath shallow water and ice will become critical to the planning and the regulation of development in this dynamic and climatically sensitive environment.

USING POSITION BEACONS TO MEASURE ICE MOVEMENT FOR BEAUFORT AND CHUKCHI OFFSHORE PETROLEUM ACTIVITIES

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Measuring the movement of different types of sea ice in the Arctic is critical for offshore petroleum operations, marine transport and public regulation to mitigate global warming. Beacons using GPS and satellite transceivers are useful to study: drift and disintegration of ice islands and multiyear hummock fields over several years; microdisplacement of shore fast ice; incursions of different ice types into potential shipping lanes; movement of pack ice over wellsites and into seismic exploration areas; drift of oil spill plumes under ice; and ice loads on structures. There are a variety of instruments available on the market for using different locational and transceiving technologies which function in different regimes of ice and water. Extreme temperatures, remote locations, dynamic ice and marine environments, snow cover, polar bears and arctic foxes all impose significant design constraints and limit the functionality on these instruments, often in ways that the manufacturers are unaware or simply cannot cope with yet. Delivery by air or surface is expensive and sometimes involves hazardous operations. Beacons are often best used in some combination with satellite imaging; lessons from recent projects are suggested in how to optimize this complementary use in terms of minimum cost, operational reliability and completeness of data acquisition. New beacons are coming on the market with radically improved accuracies, functionality and lower cost. New developments in power supplies, software and miniaturization of sensors also offer the possibility of developing more complex instruments with additional sensors which can be air dropped or delivered by drones. The trend to more complete, robotic systems is driven not only by technological opportunities and lowering costs, but by increased concerns of operators about safety to personnel.

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Thank you to members of the Executive Committee and the Organizing Committee who contributed their time and effort towards making this Forum possible.

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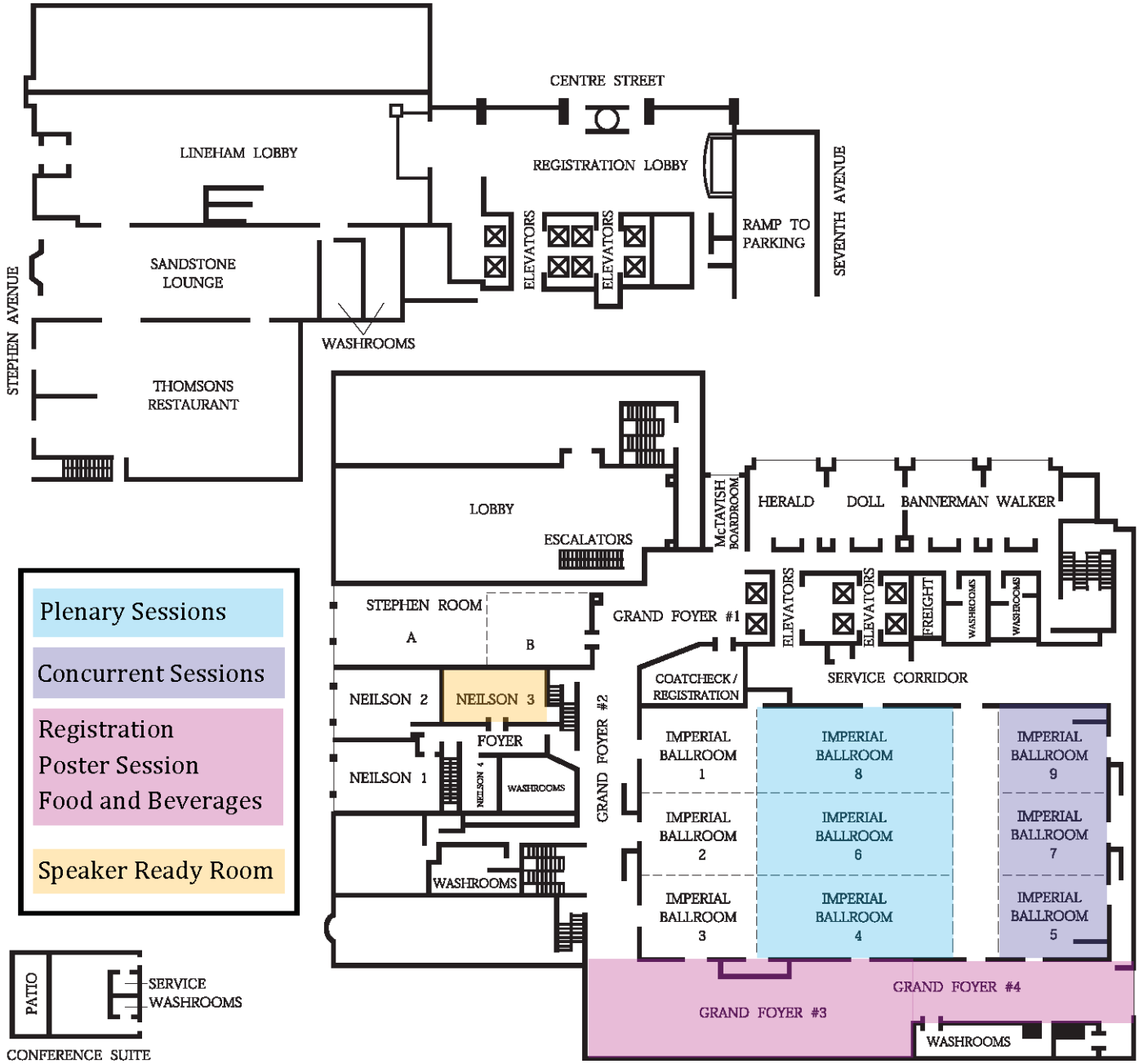

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