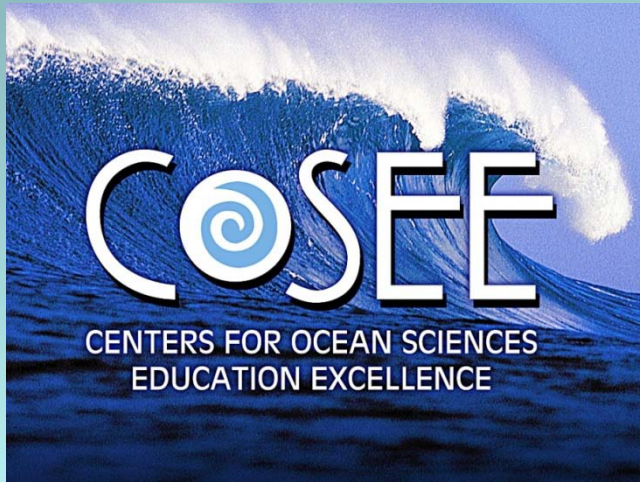


# Ways of Knowing about Ocean Climate Change



## Alaska

People, Ocean, and Climate

**2009 Alaska Math/Science Conference  
Juneau, Alaska**

**Marilyn Sigman, COSEE-Alaska**

# COSEE: A National Network





# CENTERS FOR OCEAN SCIENCES EDUCATION EXCELLENCE

## COSEE ALASKA

**Mission:** To help ocean scientists achieve their broader impacts and share place-based knowledge of ocean climate change with the COSEE network.

**What We Do:** Work closely with ocean scientists, educators and coastal community members to enhance ocean and climate change literacy in formal and informal audiences and the public:

- **Weave:** Link scientists, educators and coastal communities in Alaska and nationwide with emphasis on ocean climate change.
- **Bridge:** Communicate western science and traditional knowledge about ocean climate change to Alaska and the nation.
- **Invite:** Increase participation in ocean sciences by underrepresented and under-served audiences.
- **Pathfind:** Provide tools and services to ocean scientists for effective outreach with focus on ocean climate change literacy.
- **Share:** Enhance teacher capabilities for incorporating ocean climate change and place-based knowledge into curricula.

**Why We Were Established:** COSEE Alaska was established as both a regional (Alaska) and thematic center (People, Oceans and Climate Change) to weave together traditional knowledge and western science about ocean climate change in the north.

- **Leadership:** Nora L Deans, director
- **Location:** COSEE Alaska is based in Anchorage, Alaska
- **Website:** <http://www.coseealaska.net>
- **Collaborators/Partners:** Alaska Ocean Observing System, Alaska Sea Grant, University of Alaska Fairbanks, Alaska SeaLife Center, Anchorage School District, North Pacific Research Board
- **Co-Principal Investigators, and Key Project Partners:** Molly McCammon (Alaska Ocean Observing System), Michael Castellini (University of Alaska Fairbanks, School of Fisheries and Ocean Sciences), Ray Barnhardt (University of Alaska Fairbanks, Center for Cross-Cultural Studies), Paula Cullenberg (Alaska Sea Grant), Jessica Ryan (Alaska SeaLife Center), Texas Gail Raymond (Anchorage School District) Nora Deans, Director (Alaska Ocean Observing System, North Pacific Research Board), Andrea Anderson (Soundview Evaluation) Ruth Post, (University of Alaska Fairbanks), Alan Dick (Curriculum Consultant)




***THEME: People, ocean, and climate***

***Weave*** – link scientists, educators, and coastal communities in Alaska and nationwide with emphasis on ocean climate change.

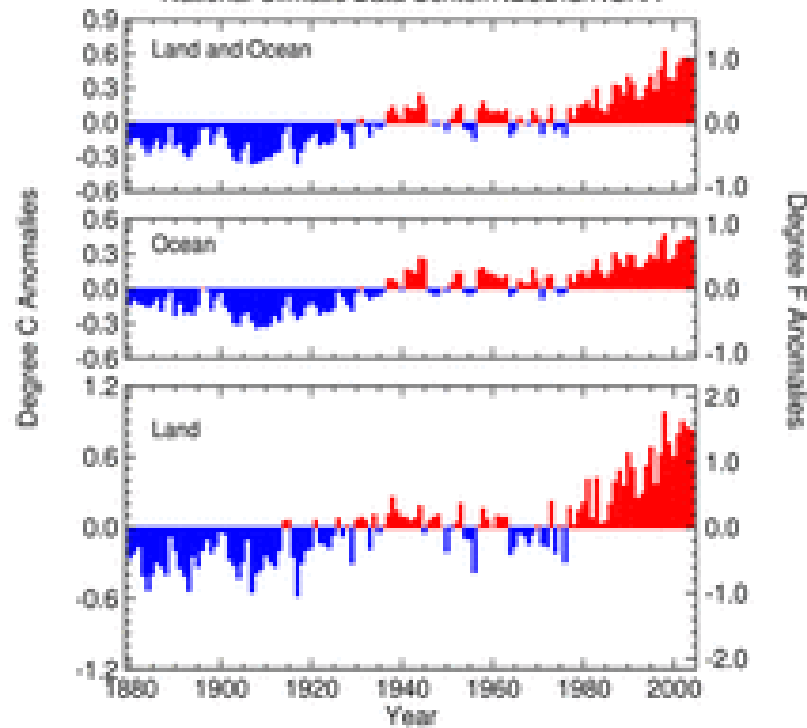
***Bridge*** western science and traditional knowledge about ocean climate Change to Alaska and the nation.

# COSEE-Alaska Partners

- Funding by NSF Ocean Sciences Program
- Partners”
  - UAF/Alaska Sea Grant
  - UAF/School of Fisheries & Ocean Sciences
  - UAF/Center for Cross-cultural Education, Alaska Native Knowledge Network
  - Alaska Ocean Observing System
  - Alaska SeaLife Center
  - Anchorage School District

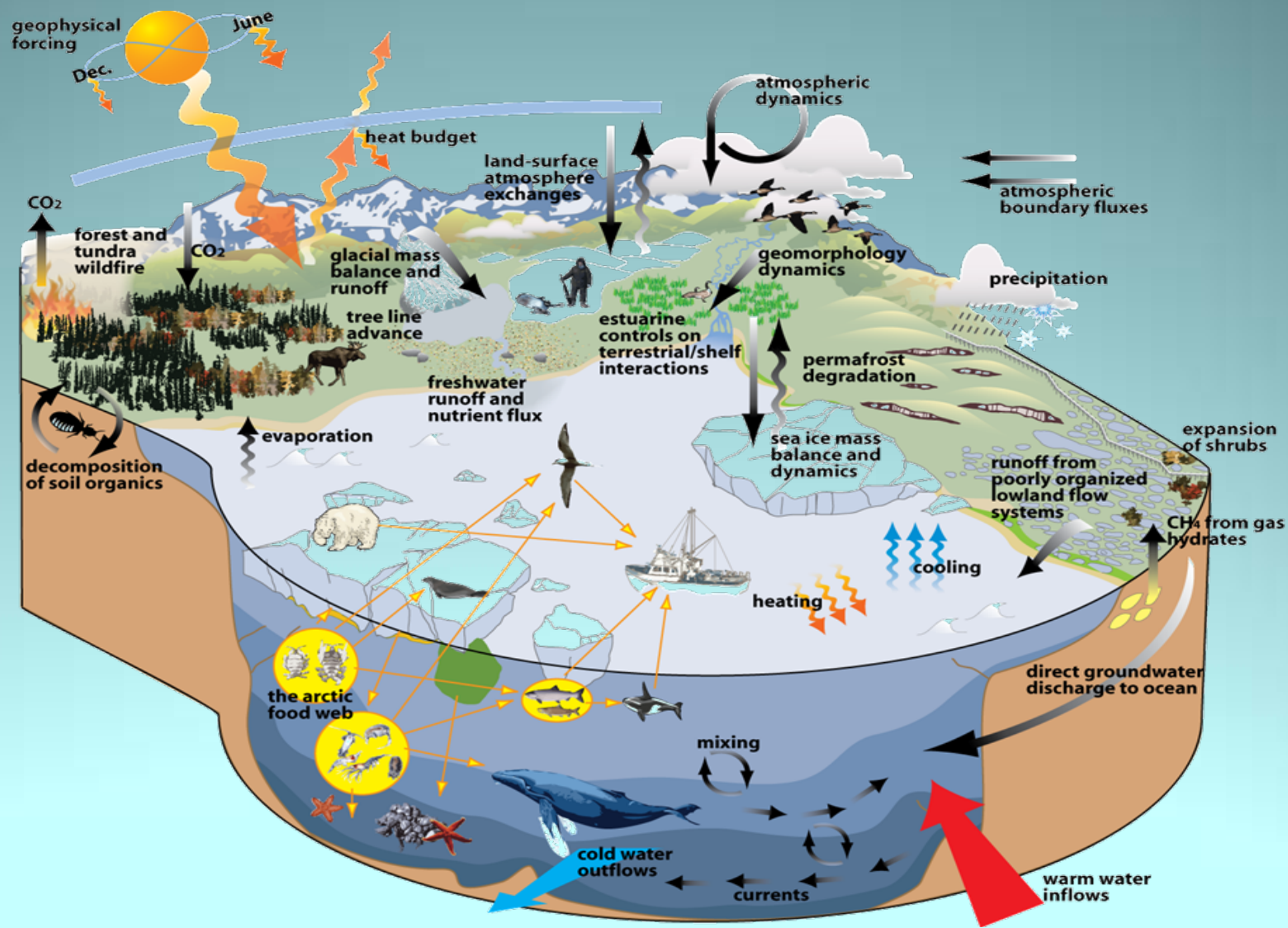
## Jan - Dec Global Surface Mean Temp Anomalies

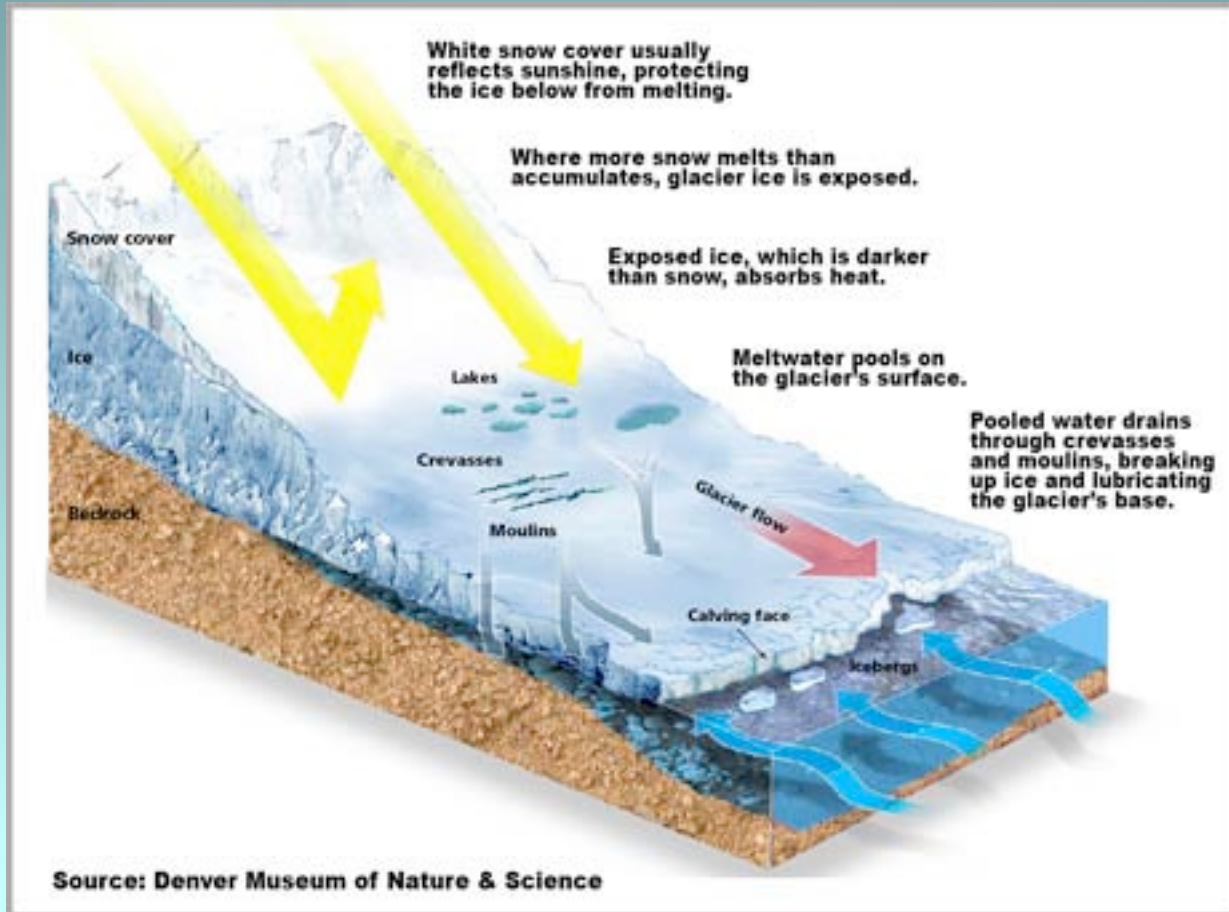
National Climatic Data Center/NESDIS/NOAA



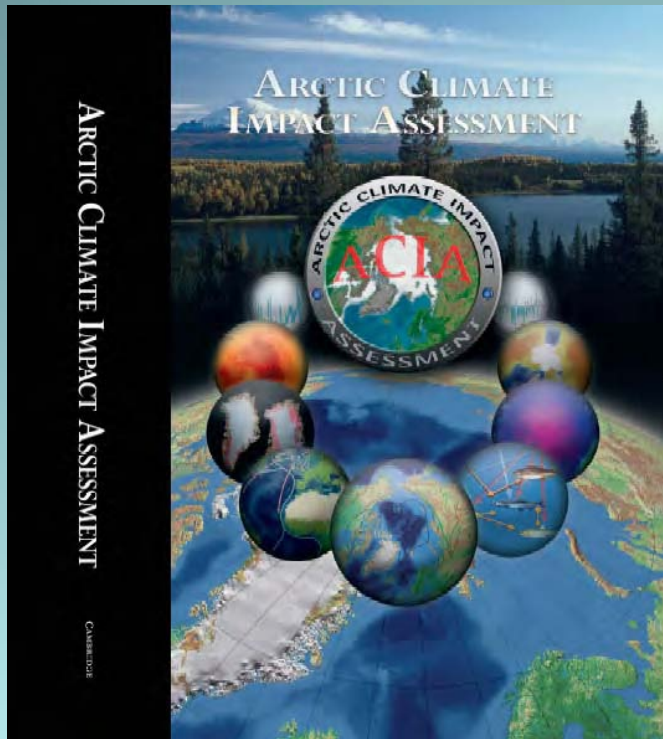












**Arctic Climate Impact Assessment  
2005**

<http://www.acia.uaf.edu/>

**Big Idea #1: The scientific evidence supports a warming climate with the rate of change faster and accelerating in the Arctic.**

**“Warming of the climate system is unequivocal, as is now evident from observations of increases in global average air and ocean temperatures, widespread melting of snow and ice and rising global average sea level . . . Warming (will be) greatest at most high Northern latitudes.”**

**Intergovernmental Panel  
On Climate Change  
4<sup>th</sup> Assessment - 2007  
<http://www.ipcc.ch>**

# Summary for Policy Makers

**“29,000 observational data series, from 75 studies, show significant change in many physical and biological systems, more than 89% are consistent with the direction of change expected as a response to warming.”**

By: Lenny Bernstein, Peter Bosch, Osvaldo Canziani, Zhenlin Chen, Renate Christ, Ogunlade Davidson, William Hare, Saleemul Huq, David Karoly, Vladimir Kattsov, Zbigniew Kundzewicz, Jian Liu, Ulrike Lohmann, Martin Manning, Taroh Matsuno, Bettina Menne, Bert Metz, Monirul Mirza, Neville Nicholls, Leonard Nurse, Rajendra Pachauri, Jean Palutikof, Martin Parry, Dahe Qin, Nijavalli Ravindranath, Andy Reisinger, Jiawen Ren, Keywan Riahi, Cynthia Rosenzweig, Matilde Rusticucci, Stephen Schneider, Youba Sokona, Susan Solomon, Peter Stott, Ronald Stouffer, Taishi Sugiyama, Rob Swart, Dennis Tirpak, Coleen Vogel, Gary Yohe

## Big Idea #2.

### Climate change has impacts on: the ocean surrounding Alaska Alaska's fish, wildlife, and ecosystems Alaska's people and cultures

Arctic Report Card - Mozilla Firefox

File Edit View History Bookmarks Tools Help

http://www.arctic.noaa.gov/reportcard/index.html

Arctic Report Card 2008

Tracking recent environmental changes

Home Atmosphere Sea Ice Ocean Land Greenland Biology

Atmosphere  
 Sea Ice  
 Biology  
 Ocean  
 Greenland  
 Land

Warming (red) and mixed (yellow) signals

There continues to be widespread and, in some cases, dramatic evidence of an overall warming of the Arctic system.

**Atmosphere**  
 5° C temperature increases were recorded in autumn

**Sea Ice**  
 Near-record minimum summer sea ice extent

**Biology**  
 Fisheries and marine mammals impacted by loss of sea ice

**Ocean**  
 Observed increase in temperature of surface and deep ocean layers

**Greenland**  
 Records set in both the duration and extent of summer surface melt

**Land**  
 Permafrost temperatures tend to increase, while snow extent tends to decrease

About the Report Card

Printable Handout :: Full Arctic Report Card (PDF)  
NOAA Arctic Theme Page



# UNEP Climate Change Science Compendium 2009

**September 24, 2009**

**The “It Could Be Worse!” Report**



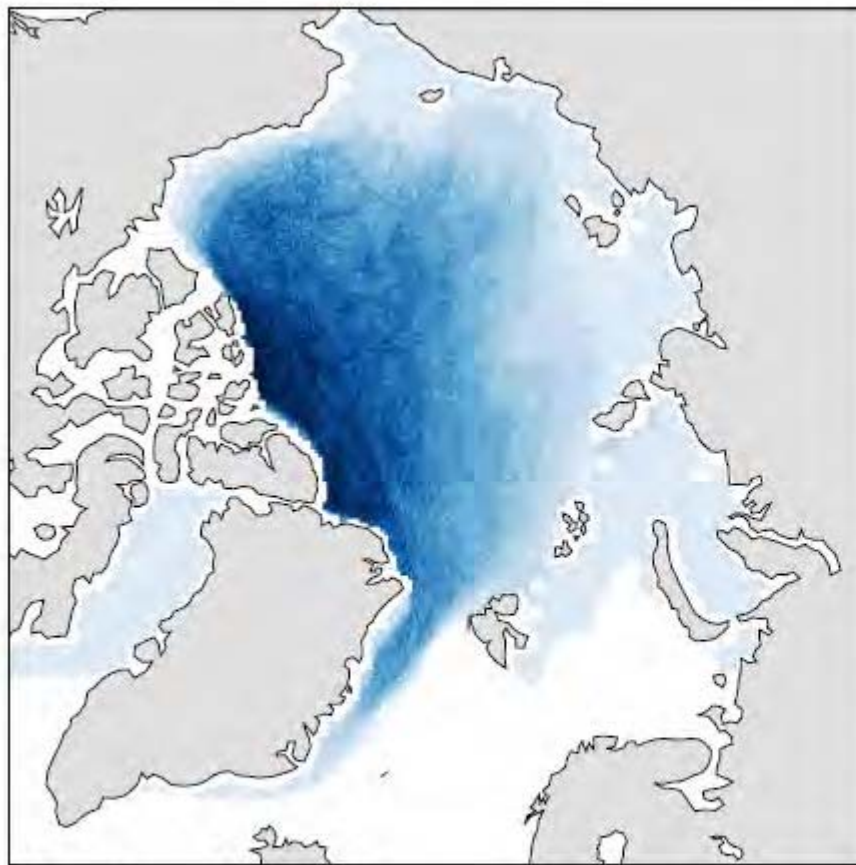
**A warmer atmosphere and a warmer ocean melts sea ice**



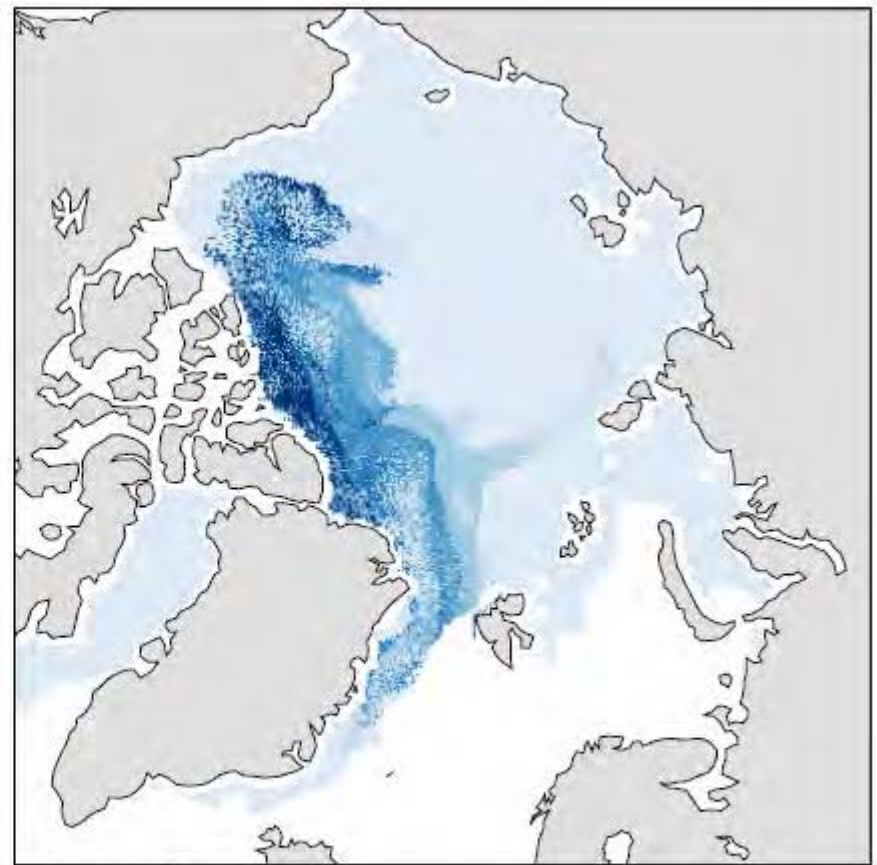
The record-setting 25% reduction in sea ice cover in 2007 was not predicted in the IPCC 2005 report. The 2008 ice cover was 2009 was the third.



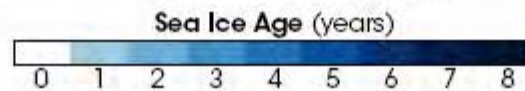
## Warmer temperatures change the extent of sea and its thickness



February Average (1985-2000)



February 2008



**The rate of thinning and rate of loss of “old ice” was not predicted by the 2005 IPCC report.**



In addition to loss of physical sea ice habitat, the 2009 UNEP report projects:

- Extinctions of marine life in sub-polar waters
- Severe species invasions in the Arctic
- Up to 60% turn-over of species in marine ecosystems

## Global warming's threat to polar bears

### Sea ice and polar bears

Sea ice extent in the fall of 2007 dwindled to the lowest level since satellite measurements began in 1979. The sea ice extent at the end of summer melting was 1.7 million square miles, compared to the 1979-2000 median of 2.7 million square miles. The greatest loss has been north of Siberia and Alaska coasts. Over most of their range, polar bears hunt and feed on ice year-round, visiting land for only short periods. The bears' summer habitat – the shelves of summer sea ice that allow them to hunt seals – is disappearing because of global warming.

### Alaska's polar bears

The state's polar bears come from two areas (see map below). The Chukchi Sea bears roam between Alaska and the Russian Far East coasts. The southern Beaufort Sea bears cover a wide swath of the Alaska and Canada coastline and waters.

■ **Size:** Males stand 8-11 feet tall, leave a 10-inch-wide footprint and weigh 500 to 1,000. Females are smaller, usually 400 to 700 pounds.

■ **Life span:** 25 to 30 years.

■ **Natural history:** Polar bears follow sea ice and ringed seals, their primary prey. They also eat bearded seals, whales and carrion. They do not hibernate.

■ **Breeding:** Female bears reach breeding age at 3 to 5 years and typically have two cubs every three to four years, one of the slowest reproductive rates of any mammal.

■ **Denning:** Females den on land or sea ice.



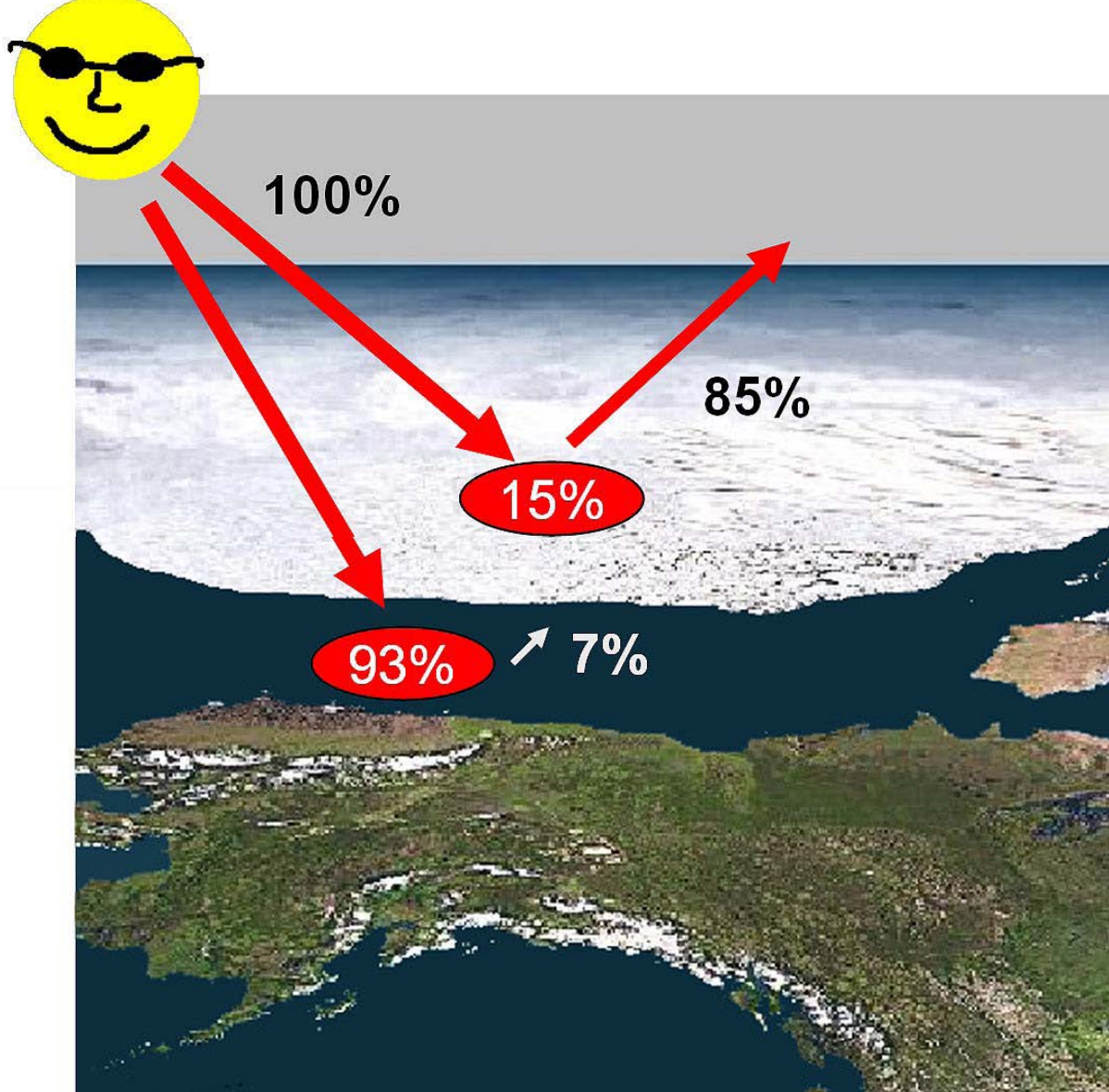
LOCATION	(YEAR)	ESTIMATED POPULATION
1. Chukchi Sea	(1993)	2,000
2. Southern Beaufort Sea	(2006)	1,500
<b>Total</b>		<b>3,500</b>



Sources: National Sea Ice Data Center, USGS, U.S. Fish & Wildlife Service, Arctic Climate Impact Assessment, Ringed seal photo by BRENDAN P. KELLY / Associated Press

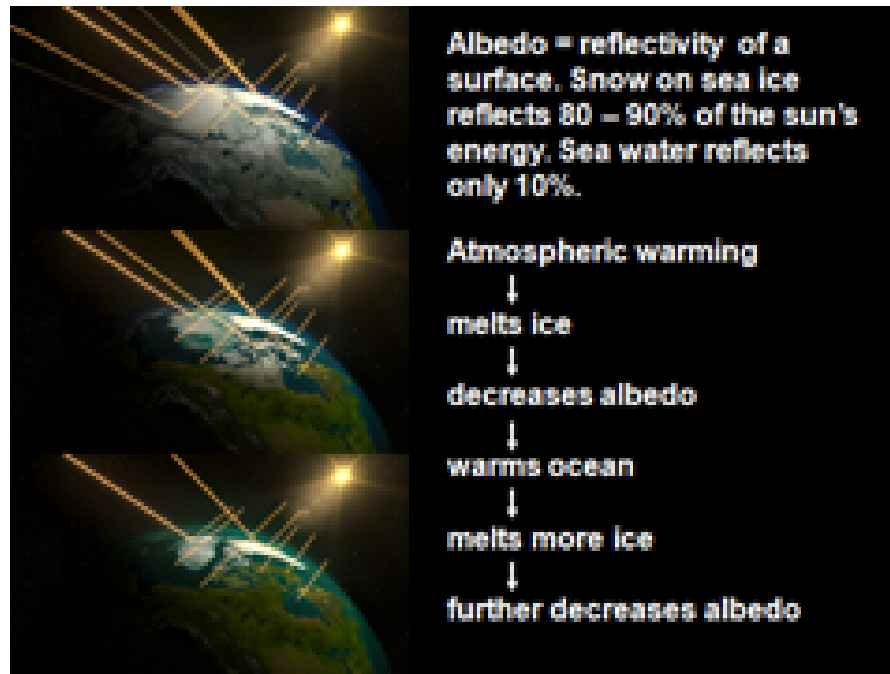
RON ENGSTROM / Anchorage Daily News





**But, that's not all. The process accelerates because of the albedo effect.**

## Albedo Effects have increased Sea Ice Melt Rates beyond IPCC Predictions in 2005



**An Ice-Free Arctic Ocean is Predicted as soon as September, 2030**

# **A Warmer Climate Accelerates the Melting of Glaciers**



**1941**

**Muir Glacier**



**2004**

**The Columbia Glacier Retreated 1.9 miles in 3 years  
Documented by time-lapse photography <http://www.extremeicesurvey.org>**



# **Glacial Melt Changes Ocean Salinity Regimes So Affects Ocean Current Systems**

# Alaska Current Systems are Part of Global Current Systems





### **Other Impacts (Big Idea #2):**

- Increased storminess**
- Change in storm tracks**
- Melting of Landfast Ice Removes  
Erosion Protection from Storm Surges**
- Changes in the Distribution of Wildlife  
will affect Subsistence Users**





**So Why Teach about a Subject  
as Scary as Climate Change?**

- “Real science” is needed now to observe how global-scale changes are happening at the local scale.
- A tremendous amount of scientific understanding is needed to make accurate predictions and help people adapt to climate change
- A tremendous amount of technological change will be needed to slow climate change or adapt to it.
- Society will need scientists and engineers!
- (P.S. “Climate change” is in the Alaska grade 9-11 GLEs)



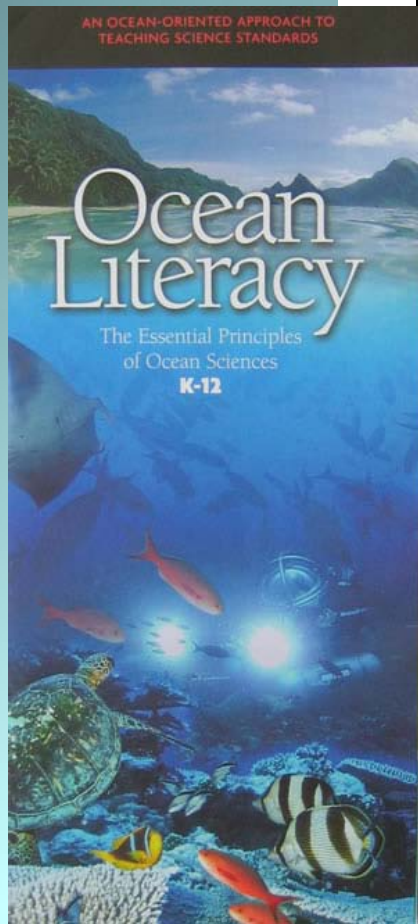
# Why Teach About Alaska's Ocean?

- Alaska has:
  - 44,500 linear miles of coastline
  - 2/3 of the nation's coastline
  - 50% of the nation's offshore waters
  - 40% of the nation's surface waters
  - > 50% of the wetlands
  - > 50% of the total fish harvest
- The Yukon-Kuskokwim River Delta is the size of Oregon
- (P.S. The word “ocean” or “watershed” does not appear in the Alaska GLEs)

# COSEE is about Connecting YOU with Scientists so you can Teach about the Ocean and Climate Change

- Resources for Teaching about Alaska Ocean Climate Change
- “Marriage Broker” Services:
  - Teacher-Scientist Partnerships and Collaborations
  - Teacher-Scientist-Community Partnerships
- Organizing SEANET: A Network of Alaska Ocean Scientists and Educators
  - A virtual community (website + listserve + an interactive Ning community)
  - Opportunities for mutual professional development
  - Sharing best practices for science education and scientist outreach
  - Sharing of educational resources
  - Sharing of scientific knowledge and traditional and local knowledge about ocean climate change

# Curriculum Resources



## ***Ocean Literacy Essential Principles and Fundamental Concepts, 2005***

1. The Earth has one big ocean with many features.
2. The ocean and life in the ocean shape the features of the Earth.
3. The ocean is a major influence on weather and climate.
4. The ocean makes Earth habitable.
5. The ocean supports a great diversity of life and ecosystems. The ocean and humans are inextricably interconnected.
6. The ocean is largely unexplored.



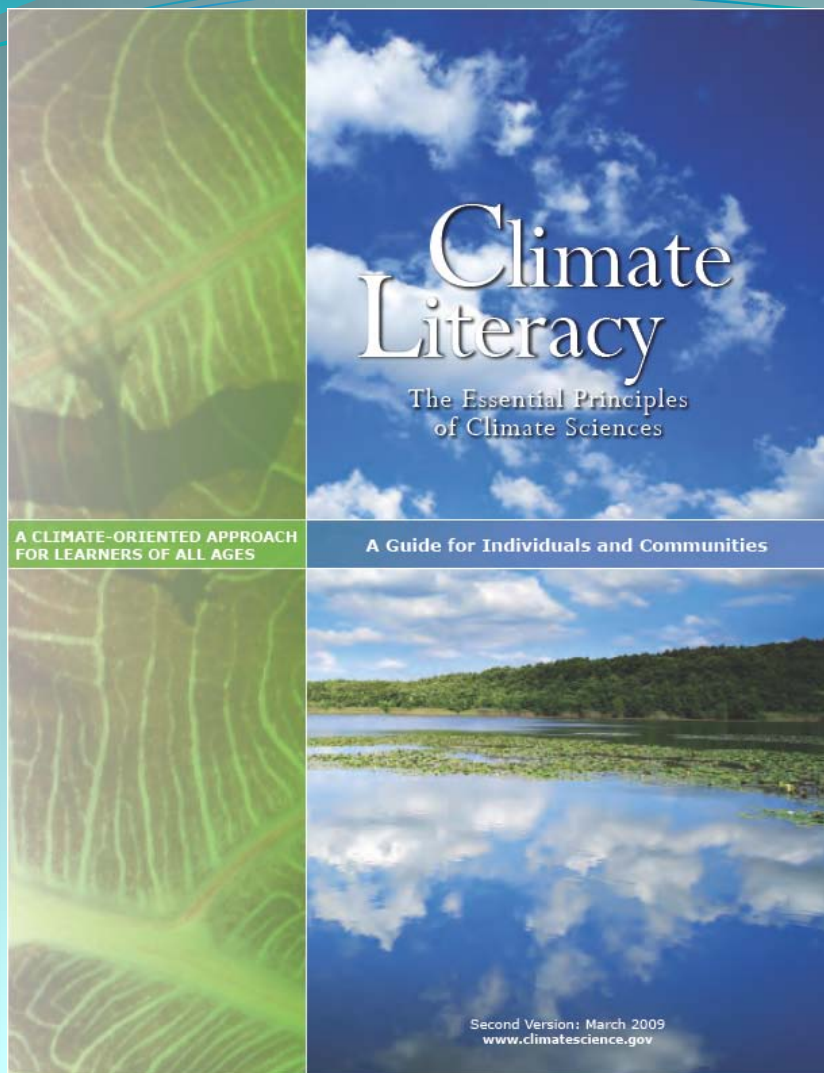
**EXPLORE**

Used to Develop Alaska Seas and Rivers Units

Alaska Seas and Rivers K-8 Framework

Suggested Grade Level	Title	Essential Question(s)	Enduring Understandings
Developing Awareness K-2			
K	Discovering our Blue Planet	What are the characteristics of the living and non-living things you discover in the water?	<ul style="list-style-type: none"><li>Living and non-living things in Alaskan waters come in a great assortment of colors, shapes and sizes.</li><li>Living things move, grow, and change.</li></ul>
1	Plants and Animals of Seas and Rivers	What kinds of plants and animals live in or near the water?	<ul style="list-style-type: none"><li>Plants and animals can be sorted into groups based on different characteristics.</li><li>People use the plants and animals of the seas and rivers in different ways.</li></ul>
2	At Home in the Water	Who Lives Where and Why?	<ul style="list-style-type: none"><li>Living things have certain characteristics that help them survive.</li><li>Living things need food, water air and shelter to survive.</li><li>Science is a way to help us answer questions about the world around us.</li></ul>
Making Connections 3 - 5			
3	Rivers to the Sea and Back Again	How are we connected to wetlands, rivers and the sea? What is the salmon's life journey through the wetlands, rivers and the sea? Where does our local water come from and where does it go?	<ul style="list-style-type: none"><li>Watersheds, rivers wetlands and the one big ocean of the world are an interconnected system.</li><li>Salmon depend on the rivers and the ocean during parts of their life cycle.</li><li>Science is a way to help us study the many connections in our world.</li></ul>
4	An Aquatic Eco-Mystery: The Case of the Missing Otters	In what ways are organisms in aquatic environments connected to each other?	<ul style="list-style-type: none"><li>Organisms in aquatic habitats interact with and depend on one another in various ways.</li><li>An ecosystem is a community of living things with its physical environment, functioning as a unit.</li><li>Science is a way to help us study the many connections in our world.</li></ul>
5	The Oceans and Us	How do people interact with the ocean? What can we do to take care of the ocean?	<ul style="list-style-type: none"><li>The connections between humans and the ocean are important.</li><li>Everyone is responsible for caring for the ocean.</li><li>Science is a way to help us study the many connections in our world.</li></ul>
Application of Knowledge 6 - 8			
6	Exploring the Ocean	How can technology help us explore the ocean? Why do we want to explore the ocean?	<ul style="list-style-type: none"><li>The ocean is largely unexplored.</li><li>Humans must use ingenious ways to study the ocean.</li><li>Science and technology can be used to detect and solve problems.</li></ul>
7	Ocean in Motion	What are the patterns of physical changes in aquatic environments? How do they affect us? What are the major weather and ocean circulation systems in Alaska?	<ul style="list-style-type: none"><li>Physical changes in the aquatic environment occur on a daily, seasonal, and long-term basis.</li><li>Weather systems and ocean systems have major influences on one another and the dynamics of matter and energy.</li><li>Science and technology can be used to detect and solve problems.</li></ul>
8	Our Changing World	How do changes in physical environment affect our ecosystems? What impacts will climate change have on our water resources in our community and in Alaska?	<ul style="list-style-type: none"><li>Climate patterns cause physical changes in the environment.</li><li>Physical changes in the environment can change the conditions for life.</li><li>Science and technology can be used to detect and solve problems.</li></ul>



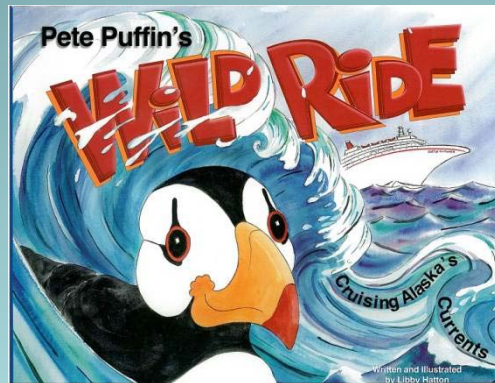


# 2009

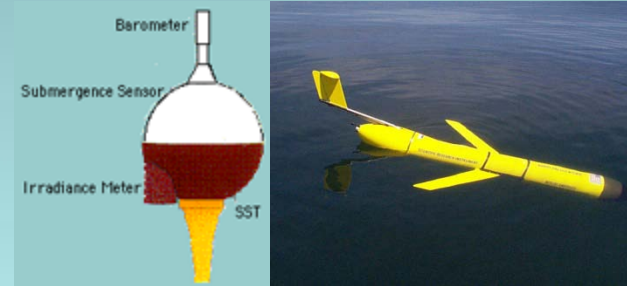
**Coming Soon! An Alaskan  
Curriculum Framework  
for Ocean and Climate Change  
Literacy for grades 9-11**

**“The Big Ideas”**

# Expanding & Finding Resources



**Lesson Plans for grades 4-6**



**Lesson plans using data from  
the Alaska Ocean Observing System**

- + A Portal Website for Other Teacher Resources**
- + Sharing through SEANET**
- + Virtual Field Trips**

# Involving Scientists in K-12 Education

**Mutual Professional Development with Educators**



**Tania Spurkland, Retired Teacher  
and Graduate Student in  
Marine Biology**

# Scientists Providing Information to Teachers and Students about Current Alaska Research

## Case of the Missing Otter

A 3-5 Week Science Unit for Intermediate Level

### Essential Question:

In what ways are organisms in aquatic environments connected to each other?

### Enduring Understandings:

- Organisms in aquatic habitats interact with and depend on one another in various ways.
- An ecosystem is a community of living things with its physical environment, functioning as a unit.
- Science is a way to help us study the many connections in our world.

This unit is designed for 4th grade but could be adapted for use at any of the intermediate grades. Students develop an understanding of how organisms in aquatic environment are connected to each other through four investigations that weave together the story of "The Case of the Missing Sea Otter." Students participate in a sampling simulation, make predictions, and try to solve the mystery of the missing otters. They then apply their knowledge of ecosystems to their local aquatic environment. Finally, students share their collected data with other classrooms around the state.



Sea Otter, photo courtesy of David Menke/US Fish and Wildlife Service



# Scientists and Teachers Partnering on a Sustained Basis



**Teacher-Scientist  
Partnership**



**Teachers Do “Real Science”**



**Collaborative Research  
Students Do “Real Science”**



# Providing Data to Scientists By Participating in Observation Networks

pH

Temperature

**Water Quality**

Dissolved  
Oxygen

Beached Birds

**COASST**

**Organisms**

Phytoplankton

**HAB**

Green-up Brown-down

**Phenology**

**GLOBE**

Seasons & Biomes

Freeze-up Break-up

Rockweed

Precipitation

**Weather**

**GLOBE**

Wind

Air Temperature

Lake Ice

**ALISON**

**Snow and Ice**

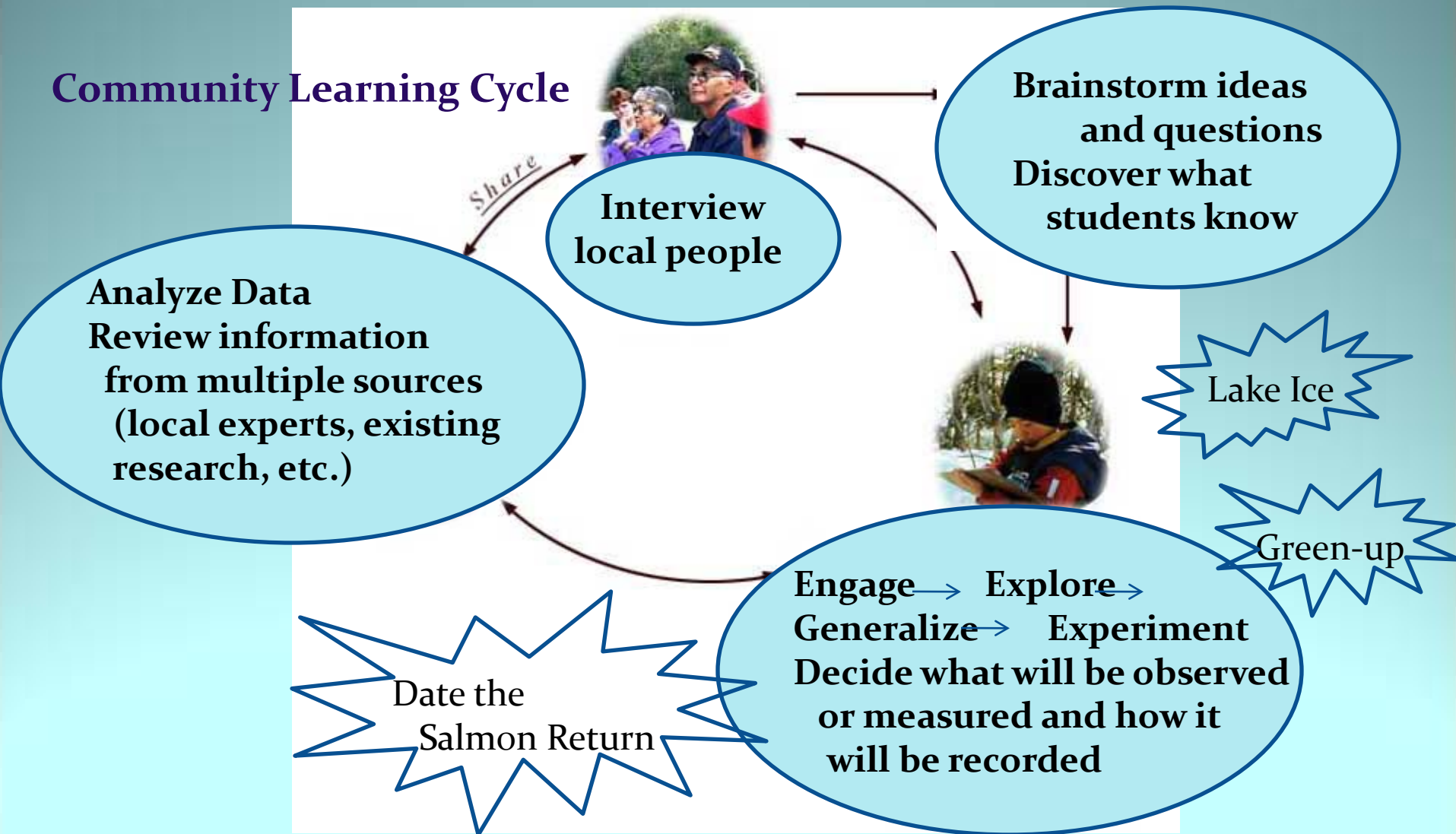
Tundra Snow  
Cover

Permafrost  
**Boreholes**



# The COSEE Project is about Connecting Your Classroom and Your Community

## Community Learning Cycle



# The COSEE Project is about Connecting your Classroom to Large Marine Ecosystems

Scientific Research is being done in an integrated, ecosystem approach



INTERNATIONAL 2007-2008  
**POLAR YEAR**

BSIERP

What Happens When the **Ice Melts?**



**Change the Image.**

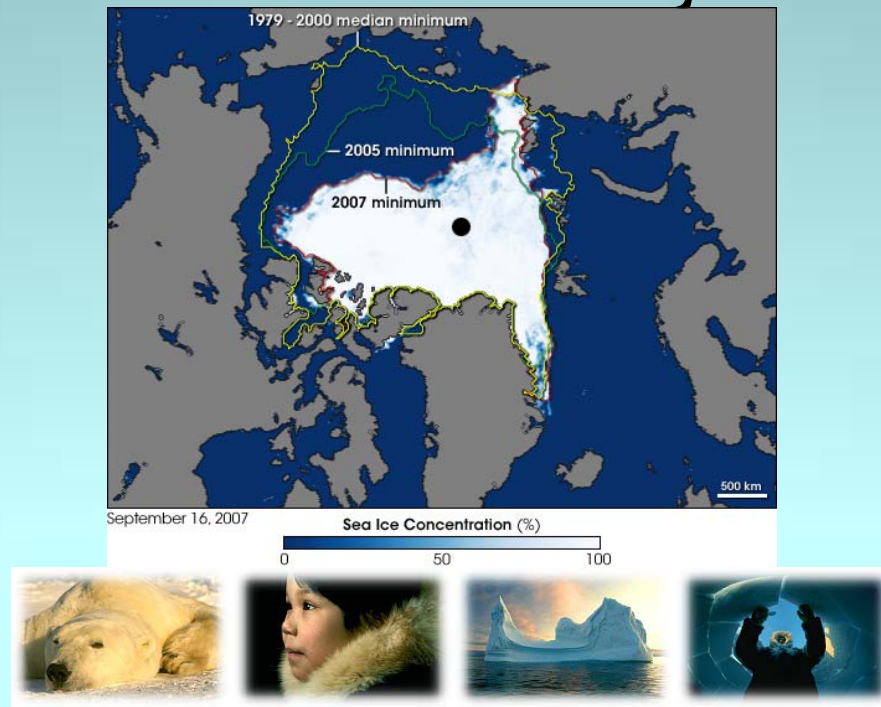
- 200 projects
- Thousands of scientists
- More than 60 nations
- Biological, physical, and social research

**Coming Soon!**

**The Gulf of Alaska  
Integrated Ecosystem Research  
Program**

# The COSEE Project is about Connecting Your Classroom to the Global Community

## Big Idea #3: The Global Climate System influences Alaska's Marine Ecosystems and People



# **Big Idea #4: Alaskan and Arctic Climate Systems influence the Global Climate System**

**Albedo Effects**

**Sea Ice  
Cooling Effects**

**Methane  
Release**

**Changes in Ocean  
Circulation Patterns**

**Melting Glaciers**

# Other COSEE Activities

- Summer professional development workshops, 2010-2012 – Fairbanks, Barrow, Seward
- Oceancaching Project – Anchorage School District pilot
- Virtual field trips – Barrow, Seward
- National Marine Educators Conference in Alaska, 2012
- Ocean science fairs (next session!)



**<http://coseealaska.net>**

**SEANET**

**<http://oceanseanet.ning.com>**