EBM in Alaska’s Beaufort and Chukchi Seas: Balancing Site-specific against Circumpolar Environmental Constraints
Fig. 1. Large Marine Ecosystems are areas of the ocean characterized by distinct bathymetry, hydrography, productivity, and trophic interactions. They annually produce 95 percent of the world’s fish catch. They are national and regional focal areas of a global effort to reduce the degradation of linked watersheds, marine resources, and coastal environments from pollution, habitat loss, and over-fishing.

Source: Duda and Sherman (2002)
FIGURE 4. Generalized foodweb structure and major seasonal energy dependencies in Alaskan Beaufort Sea coastal ecosystems (from Schell et al., 1982).
Predators and predation: *Macoma* with naticid drill hole, Naticid (*Polinices*, sp), and *Neptunea*; sea star *Crossaster*, and predatory gastropod at Stefansson Sound Boulder Patch.
Optimal Characteristics of Goals & Objectives for Ecosystem-based Management (EBM)

1. NORMATIVE: they imply and reflect specific values and limits;
2. PRINCIPLED: reflect higher values and ethical principles and rules;
3. INTEGRATIVE: reflect the wide range of interests, goals and objectives that exist;
4. COMPLEX: work with, not artificially reduce, complexity;
5. DYNAMIC: accept and recognize the inevitability of change;
6. TRANS_DISCIPLINARY: synthesize a wide range of information and knowledge;
7. APPLICABLE {RELEVANT} are applicable to a wide range of ecosystem types, conditions;
8. PARTICIPATORY: involve stakeholders and the public;
9. UNDERSTANDABLE: are explainable and implementable consistently to groups;
10. ADAPTIVE: are inherently tentative and evolving with changing conditions and knowledge.

1. Conceptualize
- Define initial team
- Define scope, vision, targets
- Identify critical threats
- Complete situation analysis

2. Plan Actions and Monitoring
- Develop goals, strategies, assumptions, and objectives
- Develop monitoring plan
- Develop operational plan

3. Implement Actions and Monitoring
- Develop work plan and timeline
- Develop and refine budget
- Implement plans

4. Analyze, Use, Adapt
- Prepare data for analysis
- Analyze results
- Adapt strategic plan

5. Capture and Share Learning
- Document learning
- Share learning
- Create learning environment

Conservation Measures Partnership
Open Standards

CMP cycle, based on Wikipedia, Adaptive Assessment, Management
FIGURE 1  The management cycle

More sustainable forms of coastal development

1. Issue identification and assessment
2. Programme preparation
3. Formal adoption and funding
4. Implementation
5. Evaluation

Time

Progressively larger cycle loops indicate growth in project scope

Source: Adapted from GESAMP 1996
Two ecologists at The University of British Columbia, C.S Holling (1978) and C.J Walters (1986) further developed the adaptive management approach as they distinguished between passive and adaptive management practice. Kai Lee, notable Princeton physicist, expanded upon the approach in the late 1970s and early 1980s while pursuing a post-doctorate degree at UC Berkeley. The approach was further developed at the International Institute for Applied Systems Analysis (IIASA) in Vienna, Austria, while C.S. Holling was director of the Institute. In 1992, Hilbourne described three learning models for federal land managers, around which adaptive management approaches could be developed, these are reactive, passive and active.

Adaptive management has probably been most frequently applied in Australia and North America, initially applied in fishery management, but received more broad application in the 1990s and 2000s.

(Based on Wikipedia: adaptive assessment and management)
The Navigators’ Paradox

Illustrated by Jules Verne’s Around the World in 80 Days, Phileas Fogg received at the Reformers’ Club having gained a day in his circumnavigation of the globe before the end of the 81st day of his travels

English Version: 1874
OUR PLANET IN THE MIDDLE OF THE UNIVERSE AT NIGHT
Mytilus, Laminaria, Barrow, 1990s
Sea Ice Shown with Bathymetry in Meters

RADARSAT (Scene ID: R1_28935_SWB_180)
21 May 2001, 03:55:51 (GMT)
Georeferenced to UTM Zone 4
RADARSAT ScanSAR® Canadian Space Agency (2000)
1-1a = Jeanette 1881-1890
2-2a = Fram 1892-1896
3-3a = Papanin 1937-1938
Sources:
Papanin (1939); Norton (2008)
1. Fram Strait and East Greenland Sea;
2. Chukchi Sea
3. Barents Sea

Source: Untersteiner, 1990
RADARSAT (Scene ID: R1_28206_SWB_181)
31 March 2001, 03:43:21 (GMT)
Georeferenced to UTM Zone 4 Coast line shown in red
RADARSAT ScanSAR © Canadian Space Agency (2000)
Source:
64 mi = 100\text{ km}

Axis of Barrow Canyon

Approx.
100-km dist. from shore
Biologists’ Discovery of Barrow Canyon, 1949

Waldo Lyon, and the Nautilus (SSN571) Transit the Arctic Ocean, 1958, entering via Barrow Canyon during IGY
Sections of 48-inch-diameter pipe are lowered onto a pipeway along the side of a bridge across the Yukon River. The pipe was later welded and installed in the shoe assemblies, foreground. Alyeska Pipeline Service Company.
The Beaufort Sea
Technology Scenario, 1976-78
The Dinkum Sands Problem

Zones 1-5:

1. Production Drilling within 5 years of 1976;

....

5. ~15-30 years
Box 5 The big picture findings of the International Geosphere Biosphere Programme

- **The earth is a system that life itself helps to control.** Biological processes interact strongly with physical and chemical processes to create the planetary environment, but biology plays a much stronger role than previously thought in keeping Earth's environment within habitable limits.

- **Global change is much more than climate change. It is real, it is happening now and it is accelerating.** Human activities are significantly influencing the functioning of the Earth System in many ways. Anthropogenic changes are clearly identifiable beyond natural variability and are equal to some of the great forces of nature in their extend and impact.

- **The human enterprise drives multiple, interacting effects that cascade through the earth system in complex ways.** Global change cannot be understood in terms of a simple cause-effect paradigm. Cascading effects of human activities interact with each other and with local- and regional-scale changes in multidimensional ways.

- **The Earth's dynamics are characterized by critical thresholds and abrupt changes.** Human activities could inadvertently trigger changes with catastrophic consequences for the Earth system. Indeed, it appears that such a change was narrowly avoided in the case of depletion of the stratospheric ozone layer. The Earth System has operated in different quasi-stable states, with abrupt changes occurring between them over the last half million years. Human activities clearly have the potential to switch the Earth System to alternative modes of operation that may prove irreversible.

- **The Earth is currently operating in a non-analogue state.** In terms of key environmental parameters, the Earth System has recently moved well outside the range of the natural variability exhibited over at least the last half-million years. The nature of changes now occurring simultaneously in the Earth System, and their magnitudes and rates of change, are unprecedented.

Source: IGBP 2001
Box 6 The Chesapeake Bay programme: goal-driven management

The Chesapeake Bay programme was launched in 1974 as a major study that was to produce a plan to restore the largest and most productive estuary in the US. After almost a decade of expensive studies and exhausting negotiations the programme adopted a single goal in 1983. This called for reducing nitrogen loads to the Bay by 40 per cent by the year 2000. As the programme documented progress in reducing nutrient loads it gained public credibility and political support. Additional goals were negotiated by the four state Governors and representatives of the federal government in the region in 1987, 1992 and again in 1999. These quantified and time limited goals have made it possible to evaluate both the processes of management and the outcomes of the programme. The substantial investment made, and achievement or substantial progress on each goal has not led to the full recovery of the bay. It is now known that only limiting population growth and even greater reductions in the nutrients released by agriculture and fossil fuel burning in the 166 000 km² watershed will advance this region toward sustainable forms of development that would provide future generations with the benefits of a restored and productive bay.
1. Beaufort and Chukchi Sea Shelves are located far from Eurocentric globalism;
2. Nevertheless, considerable local ecological expertise has accumulated here;
3. Ecosystem-based management is a construct rooted in northern Alaska experience because NOAA- and BLM-supported environmental assessments of the 1970s involved Buzz Holling and Carl Walters (EBM feels “natural” here);
4. Physical hazards studies illustrate stark distinctions between Alaska’s Beaufort and Chukchi Lease regions, and the need for site-specific expertise;
5. In the Chukchi Sea, we are re-learning some harsh lessons that Soviet Russians learned 70-80 years ago, and re-learning ice science that Iñupiaq whalers have been acting on for hundreds of years;
6. Cold War marine technology capitalized on some early Arctic ecological investigations at Barrow long before U.S. NEPA took effect and Ecological Assessments ignore technology scenarios at their peril;
7. Local agencies and stakeholders that collaborate in Adaptive Assessment and Management can have mixed motivations, hidden agendas, and still make valuable contributions to the process;
8. Local agencies and stakeholders should accept the possibility that ecosystem-based expertise acquired from distant systems can provide insights into local cause-effect relations that have escaped notice here (illustrate with Mars’ polar ice caps and Earth’s tectonic plate dynamics);
9. Conservation Measures Partnerships that fully adopt EBM may still fall short of collaborators’ goals and objectives for reasons external to EBM, as exemplified by Chesapeake Bay and Gulf of Mexico coastal states.