Beaufort Lagoon Ecosystems LTER

Photo credit: Susan Schonberg

The Beaufort Lagoon Ecosystems (BLE) LTER program focuses on productivity, trophic relationships, and biogeochemical cycling in the network of highly dynamic lagoons spanning Alaska's northernmost coastline. Extreme seasonal variations in environmental conditions are the norm for Arctic lagoons. However, warming-induced changes may challenge the resilience of biotic communities that currently thrive there. Lagoons along the coast of Alaska's Beaufort Sea support large populations of migratory waterfowl, fish, and marine mammals that are essential to the culture of Iñupiat communities in the region.

Research at BLE LTER investigates how temporal variations in terrestrial inputs and ocean exchange over seasonal, inter-annual, and inter-decadal periods affect these lagoon ecosystems. Focuses include factors affecting key species, the stability and resilience of microbial and metazoan food webs, and the role of lagoons near the land-sea interface as biogeochemical reactors and sources of greenhouse gases.

Note: The following entries include foundational work conducted during 2008-2018 that was essential to establishment of BLE LTER in August 2017.

At Present:

15 investigators

6 institutions represented

9 graduate students

Coastal

Principal Investigator:

Kenneth Dunton

University of Texas, Austin

Est. 2017

Funding Cycle:

LTER I

NSF Program:

Geosciences / Office of Polar Programs / Arctic Observing Network (AON)

Key Findings

Spring melt matters. Over half of the fresh water and water-borne nutrients flowing from land to the Alaska Beaufort Sea each year are delivered during a two-week period in the spring — earlier than most seasonal Arctic research begins. These inputs are dominated by three large rivers that flow into the central Alaska Beaufort Sea. The composition of nutrients in river water also varies markedly across Alaska's North Slope; proportions of inorganic versus organic nutrients in rivers feeding the Beaufort Sea increase with watershed steepness from west to east across the region. [Products 1, 2]

Diverse carbon sources fuel food webs. Most consumers in Beaufort Sea lagoons exhibit omnivorous (generalist) feeding strategies. Food web structure shifts with the seasons as food sources change from ice cover to open water. Multiple food sources provide sustenance to consumers including allochthonous (marine and terrestrial/ riverine organic matter) and autochthonous (microphytobenthic and phytoplankton) organic matter. [3-6]

Coastal erosion is increasing. Consistent with reports from other regions of the Arctic and the Beaufort Sea Coast, coastal erosion rates appear to have increased along the shores of Elson Lagoon near Utqiaġvik (formerly Barrow) over the last half century. Areas with historically low erosion rates are changing faster, but rates do not exceed those of areas with historically high erosion. [7, 8]

Extreme variability in physio-hydrological conditions. Beaufort Sea lagoons experience large seasonal variations in temperature and salinity related to the Arctic freeze-thaw cycle. In the most extreme cases, lagoons swing from completely freshwater conditions during the spring to hypersaline conditions during the winter. Variations in salinity regimes among lagoons are modulated by ocean exchange characteristics and proximity to river mouths. Water transparency is highest during ice break-up, but following ice retreat, wind driven sediment resuspension increases light attenuation. [9,10]

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Synthesis

Organic matter synthesis. The BLE LTER is participating in a network-wide synthesis of organic matter (OM) research on patterns and long term trends in OM pools and fluxes under ambient and experimental conditions. This cross-site effort also includes conceptual model development to support ongoing and future work on organic matter dynamics at LTER sites.

Ocean biogeochemistry model. This collaboration between BLE LTER and Northern Gulf of Alaska LTER scientists is focused on the development and application of a river inputs model for the area extending from the Alaskan Yukon to the Mackenzie River in Canada.

Photo credit: Ken Dunton

Partnerships

Arctic Refuge, U.S. Fish & Wildlife Service | Sandia National Laboratories | Belmont Forum | Arctic Domain Awareness Center | U.S.-International Tundra Experiment | NOAA-CREST center | Barrow Area Information Database | NEON | Polar Geospatial Data Center | USGS Alaska Science Center

Data Accessibility

To ensure data accessibility, BLE LTER archives at the Environmental Data Initiative (EDI) and maintains replicate metadata with the Arctic Data Center. Beaufort LTER's online data catalog uses EDI's PASTA API to share archived datasets in real time. To support high quality metadata, BLE LTER maintains an internal data catalog using an EML-oriented design (created in partnership with other LTER sites), along with R scripts for generating EML from the database.

Broader Impacts

K-12 community and classroom engagement. Since 2011, the Kaktovik Oceanography Program has connected K-12 summer science activities to formal lessons in the local public school. In addition, over 40 Iñupiat students annually are led in classroom and field activities by visiting scientists from diverse disciplines. Leveraged fund raising efforts have tripled LTER schoolyard funding.

Traditional knowledge (TK) panel. Iñupiat hunters and fishers meet regularly with BLE LTER scientists to share local and traditional knowledge. Supported by Bureau of Ocean and Energy Management (BOEM) funding, this program helps inform both current and future scientific research aimed at benefiting the local community.

Outreach through art. Collaborations with artists, writers, and musicians have resulted in public interpretive dance performances and a partnership with the Virginia Coastal Reserve LTER to produce a Coastal Futures Festival (Fall 2019).

Citizen science. Young community members collect samples and data seasonally to capture the critical transition from an ice dominated lagoon system to an open-water one. The goal is to support their role in the community as stakeholders and potential future scientists.

Photo credit: Ken Dunton

Top Products

1. McClelland, JW et al. 2014. River export of nutrients and organic matter from the North Slope of Alaska to the Beaufort Sea. **Water Resources Research.** doi: 10.1002/2013WR014722
2. Connolly, CT et al. 2018. Watershed slope as a predictor of fluvial dissolved organic matter and nitrate concentrations across geographical space and catchment size in the Arctic. **Environmental Research Letters.** doi: 10.1088/1748-9326/aae35d
3. Dunton, KH et al. 2012. Food Web Structure of the Alaskan Nearshore Shelf and Estuarine Lagoons of the Beaufort Sea. **Estuaries and Coasts.** doi: 10.1007/s12237-012-9475-1
4. Connelly, TL et al. 2015. Seasonal changes in quantity and composition of suspended particulate organic matter in lagoons of the Alaskan Beaufort Sea. **Marine Ecology Progress Series.** doi: 10.3354/meps11207
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7. Tweedie CE et al. 2012. Spatial and temporal dynamics of erosion along the Elson Lagoon Coastline near Barrow, Alaska (2002-2011). In Proceedings of the Tenth International Conference on Permafrost, Volume 1: International Contributions, Hinkel KM (ed). **The Northern Publisher: Salekhard, Russia**; 425–430
8. Jones, BM et al. 2018. A decade of remotely sensed observations highlight complex processes linked to coastal permafrost bluff erosion in the Arctic. **Environmental Research Letters.** doi: 10.1088/1748-9326/aae471
9. Harris, CM et al. 2017. Hydrology and geomorphology modulate salinity and temperature regimes in eastern Alaskan Beaufort Sea lagoons. **Estuaries and Coasts.** doi: 10.1007/s12237-016-0123-z
10. Bonsell, CE and KH Dunton. 2018. Long-term patterns of benthic irradiance and kelp production in the central Beaufort Sea reveal implications of warming for Arctic inner shelves. **Progress in Oceanography.** doi: 10.1016/j.pocean.2018.02.016