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Community Based Monitoring in Arctic and Cook Inlet Coastal Zones: Extension of the Local Environmental Observer (LEO) Network

U.S. Department of the Interior
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Anchorage, Alaska

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Community Based Monitoring in Arctic and Cook Inlet Coastal Zones: Extension of the Local Environmental Observer (LEO) Network

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List of Abbreviations and Acronyms

ANTHC	Alaska Native Tribal Health Consortium
BOEM	Bureau of Ocean Energy Management
CBM	Community Based Monitoring
CRRC	Chugach Region Resource Commission
IGAP	Indian General Assistance Program
KPB	Kenai Peninsula Borough
LEO	Local Environmental Observer Network
NSB	North Slope Borough
PI	Principal Investigator

1 Background

This project began in October of 2016 with the purpose of connecting local observers, scientists, and other topic experts in a conversation about environmental change through the Local Environmental Observer (LEO) Network. Objectives of this study are to:

1. Expand the LEO Network to the North Slope Borough (NSB) and the Kenai Peninsula Borough (KPB) working through consultation with relevant institutions. The communities of particular interest include: Barrow, Kaktovik, Nuiqsut, Wainwright, Point Lay and Point Hope.
2. Enhance our understanding of environmental change in and on the NSB and KPB.
3. Enhance resources available at the community, regional and federal level to address impacts by expanding the scale of the Community Based Monitoring (CBM) program and enhancing the quality, rigor and consistency of data collection by leveraging scientific expertise outside the communities from the greater region and nation.
4. Further refine a joint monitoring effort to promote healthy and effective adaptation strategies to identified environmental changes through a regionally appropriate outreach and education effort.
5. Perform analysis and interpretation of recorded observations with improved scientific rigor and develop lessons learned.

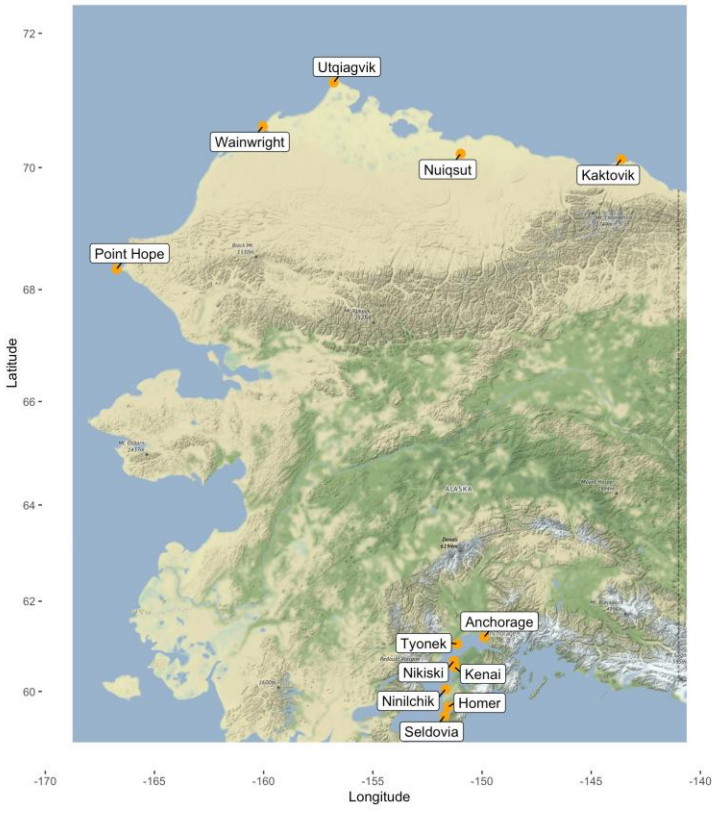


Figure 1: Map of Study Area

The LEO Network is administered by staff of the Alaska Native Tribal Health Consortium (ANTHC). ANTHC is the statewide arm of the tribal health system in Alaska, receiving guidance from the 12 regional health organizations and the 229 tribes that it serves. The LEO Network advances the ANTHC vision statement, that Alaska Native people are the healthiest people in the world, by providing a process for sharing information about environmental events that potentially impact individual and community health.

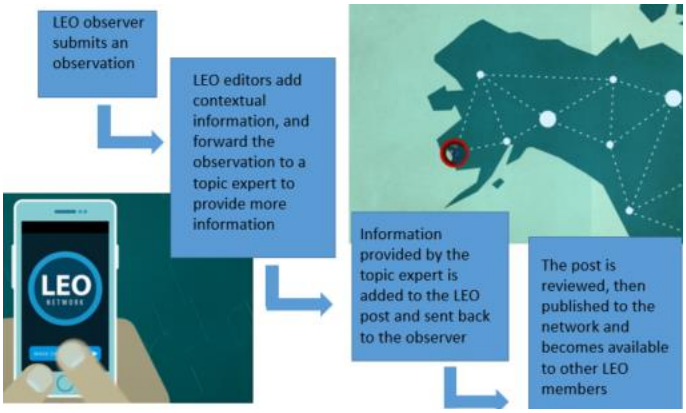


Figure 2: LEO Network Editorial Process

The LEO Network is a web platform for people to document and share changes they see in their local environment. LEO staff connect observers to others who can provide more information about the event and facilitate the creation of a public post collaboratively written by the observer, scientific consultants, regional residents, and topic experts. The goal of this process is to share information about environmental change and build relationships between local communities and staff at universities, state and federal agencies, non-profits and special interest groups. These relationships provide the resources and technical assistance to help communities adapt in healthy and sustainable ways. The collection of anecdotal observations help communities identify and document trends of environmental change in their area and provides interested researchers with information to inform future hypotheses and research questions. While the focus of LEO is local events, it demonstrates a method for information sharing on regional and statewide levels.

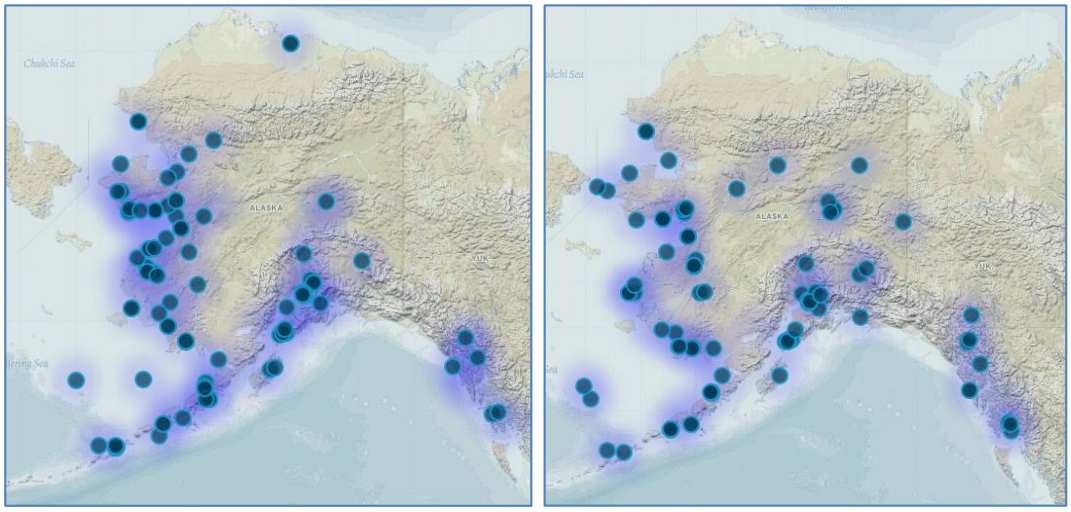
A key objective of this project involved the expanded recruitment of Alaskan residents as local observers of environmental change, reaching out specifically to areas affected by potential development projects, such as the North Slope and Cook Inlet regions. Language is an important tool for observers to access the platform and content, and translating the platform in to Indigenous languages spoken in Alaska was a priority. Beyond recruiting LEO members to share their observations from specific regions, this project also focused on broadly building and supporting relationships between local observers and members of the science community. These included building relationships that can later support organized monitoring as well as peer and group review activities. As membership in the LEO Network grew, staff developed a set of policies and procedures to review and approve observations according to a standardized review process, ensuring that each observation describes a specific event at a given location. These procedures allow staff to collect specific information from observers so that each observation meets the criteria for being posted on the LEO Network map.

Outreach during Years 4 and 5 were limited due to the impacts of the COVID-19 pandemic.

1.1 LEO Network Metrics during the Project Period

During the project period, the LEO Network published 546 observations that document environmental change across Alaska.

Year 1 *Year 2*



Year 3 *Year 4*

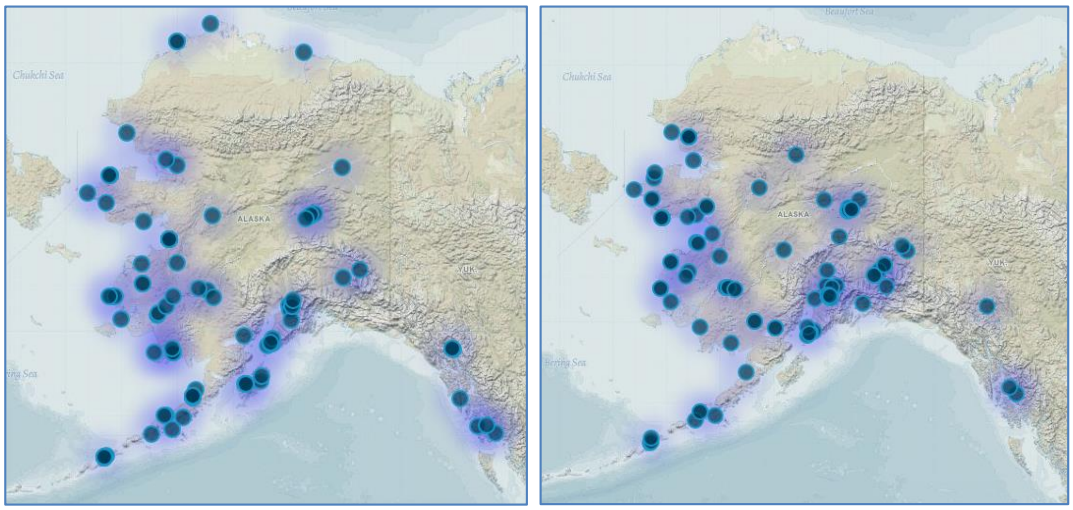


Figure 3: Locations of observations submitted to the LEO Network during the project period

An additional 903 members joined the LEO Network from communities across the state, increasing member numbers from 678 on October 1, 2016 to 1581 by May 15, 2021.

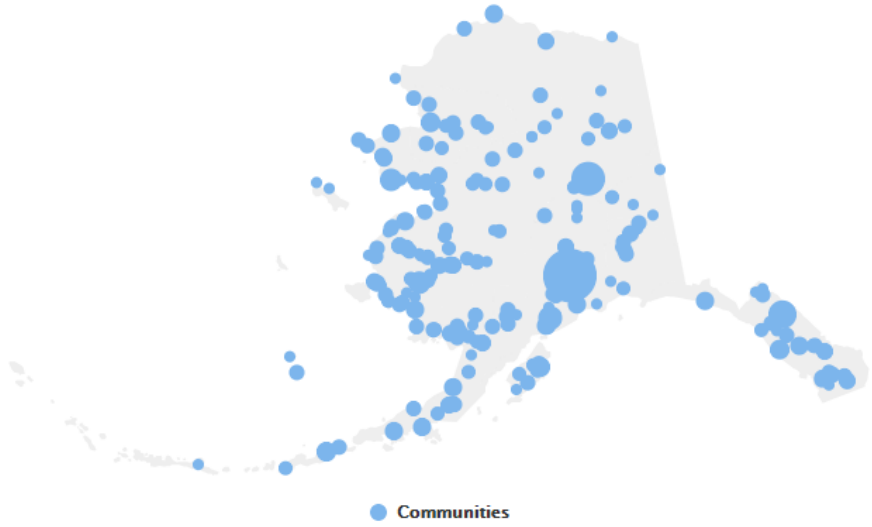


Figure 4: LEO member communities

2 Primary Project Tasks

The cooperative agreement between ANTHC and the Bureau of Ocean Energy Management (BOEM) outlined eight focus areas for the project period:

1. Expansion of LEO in Utqiagvik (formerly known as Barrow), engaging multiple observers.

2. Expansion of LEO network throughout the North Slope, engaging multiple observers in multiple communities along the Beaufort and Chukchi seas.

3. Expansion of LEO throughout communities of practice in Cook Inlet region, including commercial and sports fishermen, guides, and local residents including Indigenous observers.

4. Development for the capability for translation of indigenous languages used in the circumpolar north.

5. Development for organizing monitoring by providing linkages between local observers and scientists.

6. Identification of and recruitment for one or more Super Observer peer groups and a similar group for consultants.

7. QA (Quality Assurance): Development of a planned system of review procedures performed by independent reviewers; identify specific changes made as appropriate (when ten or more observations on the same environmental change or event are made; or on the advice of independent reviewers).

8. QC (Quality Control): Development of a system of routine technical activities used by the Community Based Monitoring (CBM) development personnel in collaboration with BOEM to measure and control the quality of the CBM observational data as they are reviewed, accepted, reported on, and archived.

2.1 Expansion of LEO in Utqiagvik, engaging multiple observers

LEO staff reached out to North Slope residents through an in-person presentation, presentations to staff at prominent community organizations, as well as through targeted mailing to residential addresses. Outreach to North Slope Borough residents was more difficult than anticipated, likely due to the range of monitoring and observing projects established in the area. It is possible that residents experience research participant burden.

During Year 1, LEO Coordinator Erica Lujan traveled to Utqiagvik and gave a community presentation introducing the LEO Network at the Tuzzy Library. That same year, LEO Staff met with the North Slope Borough Department of Health and Social Services Director who encouraged future communication about outreach efforts to North Slope communities. During Year 2, Project PI Mike Brubaker gave two presentations to faculty at Ilisagvik College in Utqiagvik, which included Birgit Meany the Dean of Academic Affairs and Linda Nicholas-Figueroa Assistant Professor Biology and Chemistry. During Year 3, LEO staff mailed informational postcards to Utqiagvik residential addresses. The post cards provided a brief description of the network, ways to get involved, and staff contact information. LEO staff did not track new membership related to the mail-out.

Table 1. LEO members in the North Slope Borough Community of Utqiagvik

North Slope Borough Community	Year 1	Year 2	Year 3	Year 4
Utqiagvik	9	11	12	13

Figure 5: LEO Observation from Utqiagvik

During the project period, one observation was submitted to LEO describing an unusual environmental event in Utqiagvik. On August 19, 2018 Kotzebue resident shared an Utqiagvik residents' observation of a sea lion (*Eumetopias jubatus*) on the Utqiagvik beach, noting that it was unusual to see a sea lion so far north, and out of the water on the beach. LEO staff found that the Alaska Department of Fish and Game describe the northern Bering Sea/southern Chukchi sea as the northernmost part of the stellar sea lion species range, and shared this observation with the North Slope Borough Wildlife Department.

2.2 Expansion of LEO network throughout the North Slope, engaging multiple observers in multiple communities along the Beaufort and Chukchi seas.

LEO staff conducted outreach to other North Slope communities through a combination of in-person and remote presentations, a statewide discussion of northern environmental changes on Alaska Public Radio Network, and an informational mail-out.

One of the most significant changes for coastal communities is the reduction in sea ice extent and ice quality. During Year 2, Erica Lujan traveled to Wainwright in coordination with the University of Alaska Anchorage (UAA) Institute for Circumpolar Health Studies to co-present on injury prevention during winter. UAA staff presented DeLorme InReach satellite devices as a tool to improve search and rescue operations as residents travel on changing ice conditions. Ms. Lujan followed the UAA presentation with a discussion on how LEO can be used to document changes in the landscape and ice, as a useful tool when planning trips out on the ice.

Engaging youth in environmental work is a priority across Alaska. During Year 3, Ms. Lujan presented the LEO Network to North Slope Borough educators. She provided an overview of LEO and shared a set of lesson plans for building observation skills in students as they learn from elders and other adults about environmental change. In a follow up webinar, Ms. Lujan provided additional guidance on how to create and submit an observation to LEO using information on environmental change that students gather through interviews with adults in the community.

Noting that not every person in North Slope communities have access to targeted outreach, LEO staff mailed informational postcards to all residential addresses in Utqiagvik, Wainwright, and Nuiqsut and Kaktovik during Year 3. These postcards provided a brief description of the network and staff contact information. LEO staff did not track new membership related to the mail-out. Additional widespread outreach was conducted by radio. Also during Year 3, Erica Lujan participated in a Talk of Alaska segment along with Brian Brettschneider from the International Arctic Research Center at the University of Alaska Fairbanks. The segment focused on the trends and local observations of changes to sea ice near Alaska. Two LEO members, Robert Tokeinna from Wales and Andrew Kakoona from Shishmaref called in to further discuss their observations of changes to sea ice and the impact it has had on community activities such as hunting and fishing.

Table 2. LEO members in North Slope Borough Communities

North Slope Borough Community	Year 1	Year 2	Year 3	Year 4
Wainwright	2	5	5	5
Nuiqsut	3	5	6	6
Point Hope	1	1	1	1
Kaktovik	1	1	1	1
Total	**7**	**12**	**12**	**13**

During the project period, seven observations of environmental change were submitted from North Slope residents in Wainwright and Nuiqsut. Observers tagged their posts to indicate which aspects of the natural environment were changing, what type of event they observed, and what impacts those events have on communities.

Observations from North Slope Borough communities describe changes in ice and snow that are affecting the permafrost under homes and other infrastructure, as well as traditional ice cellars used for food storage. An additional observation expresses concern about the impact of human industrial activity on tundra ecosystem. Changes to fish include an instance of bacterial infection in whitefish, and the inability of residents to effectively dry harvested fish during periods with heavy wildfire smoke in the air. Changes to the health of fish, and the ability to preserve and store subsistence resources impact the maintenance of cultural traditions and food security. Additional observations include changes to fox populations and dragonfly species range.

The figures below show the number of LEO observations submitted from North Slope Borough communities that were tagged with each change to the natural environment, the type of environmental event, and the impact that event had on the communities.

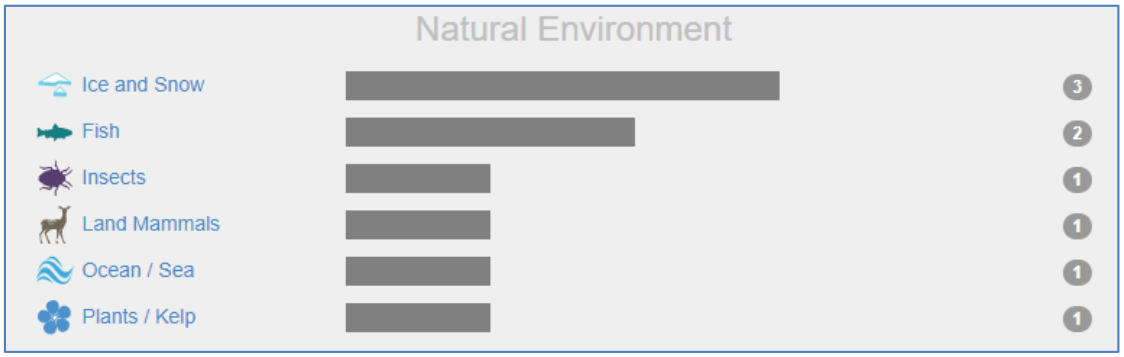


Figure 6: Changes to the Natural Environment in Wainwright and Nuiqsut

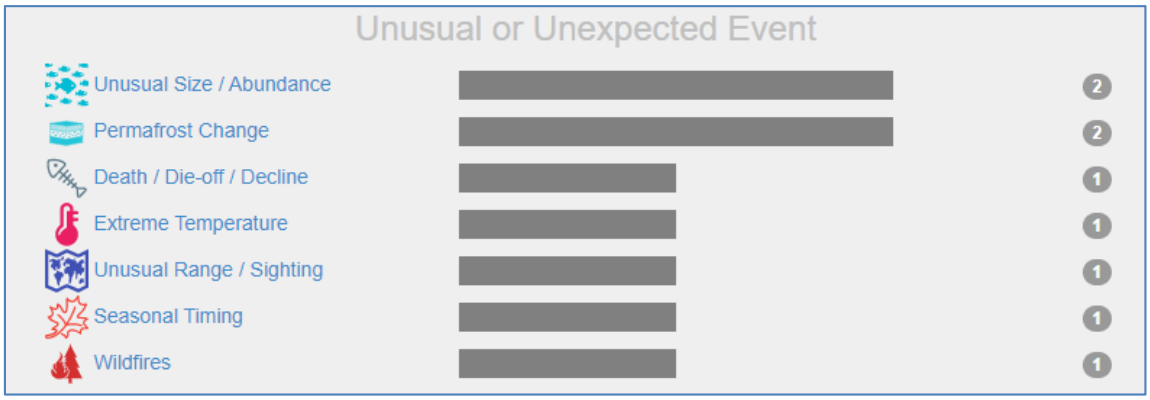


Figure 7: Types of Unusual Environmental Events in Wainwright and Nuiqsut

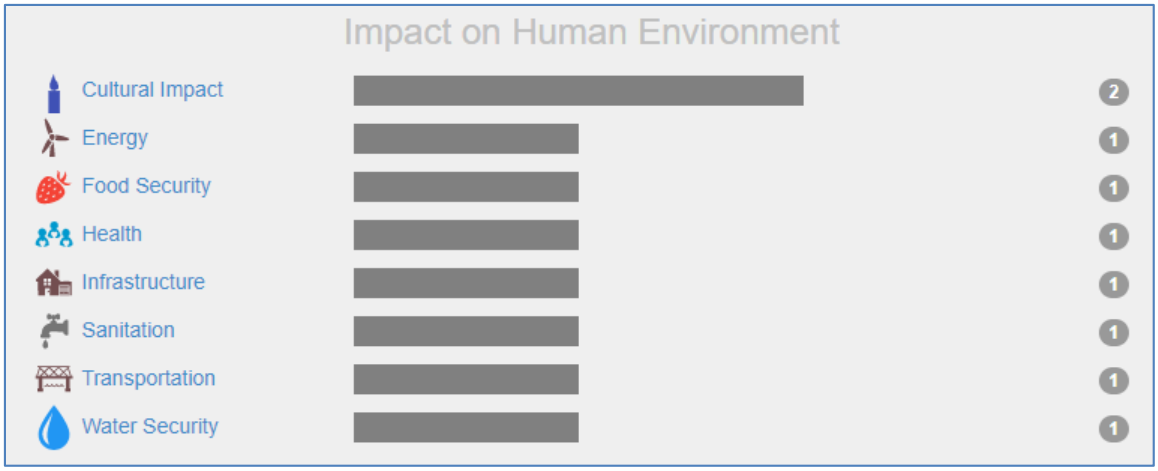


Figure 8: Impact of Environmental Change on the Human Environment in Wainwright and Nuiqsut

2.3 Expansion of LEO throughout communities of practice in Cook Inlet region, including commercial and sports fishermen, guides, and local residents including Indigenous observers

Outreach to Cook Inlet communities was done through presentations to regional service organizations and educators as well as through scientific conferences.

During Year 1, LEO staff participated in the Chugach Region Resource Commission (CRRC) Subsistence workshop in Anchorage, and presented the LEO Network to CRRC board members as a tool to collect additional observations of environmental change from tribal members in the communities CRRC serves.

The science community has a strong presence on the lower Kenai Peninsula. To engage those who work in the area, and who may already work with regional communities, Erica Lujan participated in the Kachemak Bay Science Conference in Homer during Year 2. She presented the LEO Network and participated in a panel discussion on the ways in which scientific findings shared with the public and integrated in to local community work and policy. Later that year, Ms. Lujan returned to Homer to host a LEO workshop for naturalist staff at the Center for Alaska Coastal Studies.

During Year 3, Ms. Lujan presented remotely to three classrooms of students and teachers in Tyonek, Chenega, and Tatilek and shared a set of lesson plans that focus on building observational skills in students. She talked about the process of building observational skills, why those skills are important for environmental stewardship, and discussed how LEO can help students and faculty learn about the environmental changes in their area.

Recognizing that many residents in the Cook Inlet area may not overlap with tribal outreach or with outreach to the science community, LEO staff mailed out informational post cards to residential addresses in Tyonek, Ninilchik, Nikiski, and Seldovia during Year 3. These postcards provided a brief description of the network and staff contact information. LEO staff did not track new membership related to the mail-out.

During Year 4, LEO staff were invited to present at a Susitna River Coalition community event in Talkeetna that focused on maintaining the health of the watershed that flows in to Cook Inlet. Attendees shared the changes they have observed in the Susitna watershed, which flows in to Cook Inlet, including unusual erosion, flooding, and animal activity.

Table 3: LEO Members in Cook Inlet Communities

Cook Inlet Community	Year 1	Year 2	Year 3	Year 4
Kenai	2	2	3	3
Nikiski	0	0	0	0
Homer	11	27	39	41
Seldovia	4	4	5	5
Ninilchik	1	1	1	1
Tyonek	4	6	6	6
Total	**22**	**40**	**54**	**56**

During the project period, observers in the Cook Inlet area submitted 36 observations of environmental change. Observers tagged their posts to indicate which aspects of the natural environment were changing, what type of event they observed, and what impacts those events have on communities.

The majority of observations submitted from the Cook Inlet region describe changes to the ocean and sea, documenting instances of illness that include sick sea mammals and dogs, unusual species sightings that include uncommon catches of green sturgeon (*Acipenser medirostris*), giant wrymouth (*Cryptacanthodes giganteus*), and squid, as well as changes in the abundance of sea stars near Homer and Seldovia, and northern sea nettle jellyfish (*Chrysaora melanster*). Changes to insects and plants were interrelated, describing unusual sightings or changes in insect abundance, as well as insect infestations, which threaten berry bushes important to community food security. Changes in the amount of available surface water resulted in water conservation measures in Seldovia, and causing water levels in Jackalof Creek to drop low enough to prevent a second run of salmon from making it up to spawning grounds, also threatening a culturally important community food source. Additional observations include unusual sightings, or unusual arrival times of several bird species, and coastal erosion near Tyonek.

The figures below show the number of LEO observations submitted from Kenai Peninsula Borough communities that were tagged with each change to the natural environment, the type of environmental event, and the impact that event had on the communities.

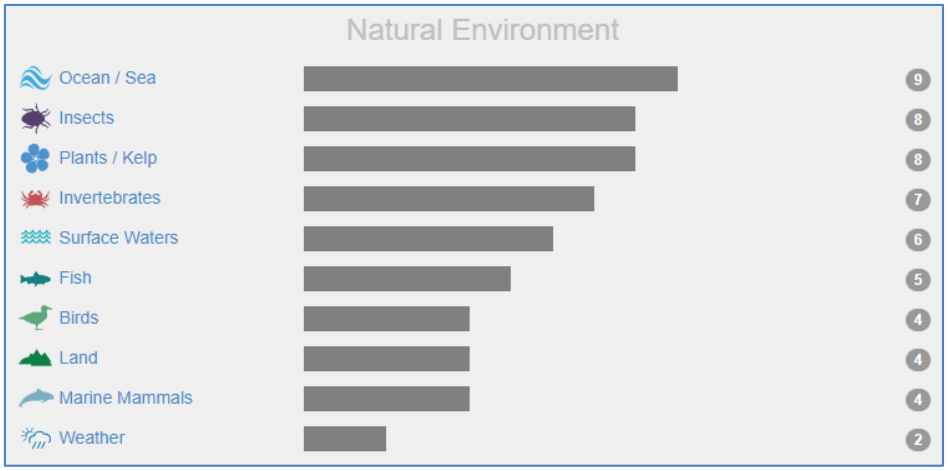


Figure 9: Changes to the Natural Environment in Cook Inlet Communities

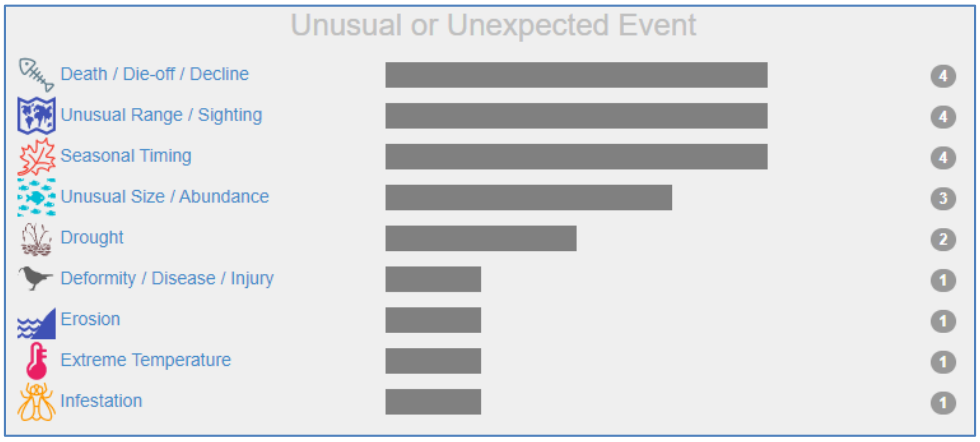


Figure 10: Types of Unusual Environmental Events in Cook Inlet Communities

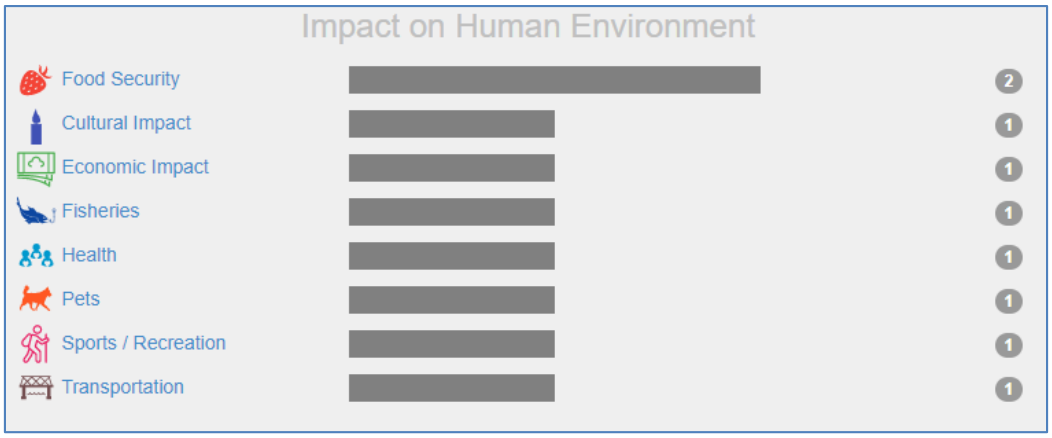


Figure 11: Impacts of Unusual Environmental Events on the Human Environment in Cook Inlet Communities

2.4 Additional Outreach Activities

LEO staff often are asked to give presentations on the LEO Network and discuss relevant observations in community meetings, one-on-one trainings, and conferences. The frequency of these requests demonstrate the unique service niche that the LEO Network fills, and provides opportunities to share information about the Network and encourage those in attendance to become LEO members. A diverse membership promotes information sharing between observers and consultants, and facilitates a broader understanding of the drivers of change from local, Indigenous, and scientific perspectives. The resulting collection of observations demonstrates what issues local residents feel are important to address, and can help funding agencies and researchers shape their services to maximize community benefit. In addition to targeted outreach outlined in the first three project goals, LEO staff worked to build and maintain relationships with observers statewide through monthly webinars, conference presentations, and environmental trainings.

During Years 1 through 4, LEO staff conducted a total of 48 webinars. These webinars are hosted monthly and include a review of recently submitted observations and news articles, as well as topic-specific presentations relevant to the season or observation themes. An archive of previous webinars can be found on the LEO Network website

LEO staff participate in two conferences each year that draw statewide audiences of tribal environmental professionals in Alaska. Each year, Community Environment and Health at ANTHC hosts the Alaska Tribal Conference on Environmental Management. LEO staff hosted several sessions during each of the conferences held during the project period. These presentations included reviews of annual observation themes, updates on the LEO web platform and talking circles for attendees to share about the experiences of environmental change in their area. LEO staff also regularly attend the Alaska Forum on the Environment conference, and presented notable LEO Network observations and platform updates each year during the conference period.

The LEO Network is a tool actively shared with environmental professionals across the state in environmental planning trainings hosted by ANTHC. During project years 2 and 3, LEO staff participated in two environmental trainings, hosting between 18 and 35 attendees from around the state. LEO staff introduced the network during each training, describing the process of submitting an observation, the importance of documenting a local story of change for planning purposes, and the importance of local observations in identifying statewide trends of change. During project year 3, LEO staff supported a multi-day training for FY2020 Indian General Assistance Program (IGAP) applicants. Climate change was a focus in many of the IGAP work plans during the training, and participation in LEO was recommended as a tool to document environmental change in the community. LEO observations are a resource for the development of future climate change adaptation strategies. Environmental Protection Agency (EPA) staff sponsored a similar training in December 2019, and featured the LEO Network during a mentor session. LEO staff provided an overview of the platform, and offered ways to integrate LEO in attendee work-plans.

2.5 Development for the capability for translation of Indigenous languages used in the circumpolar north

Language is an important component of accessibility for users across the state, many of whom speak English as a second language. During Year 1, LEO software architect Mike Brook developed a language translation feature within LEO, which quickly provided the LEO webpage in 17 auto-translated languages. LEO staff also compiled a word-for-word translation document for languages that require manual translation, such as northern Indigenous languages. During Year 2, LEO worked with Yup'ik translators to successfully translate the LEO platform in to Central Yup'ik, the dialect spoken in the Bethel area. Members are now able to submit observations with Yup'ik language prompts.

Figure 12: LEO Network Homepage Icon Translated in to Central Yup'ik

In another effort to improve accessibility, LEO staff added the ability for observers to identify locations of unusual environmental events by Indigenous place names. These place names also appear on the basemap used on the LEO Network homepage.

Figure 13: LEO Network Basemap with Traditional Place Names

During the project period, LEO staff were unable to coordinate translation of LEO in to Inupiaq, due to a significant effort to translate the King James Bible in to Inupiaq. Unfortunately, translators had little time available to work on other projects.

2.6 Development for organizing monitoring by providing linkages between local observers and scientists

LEO members know their local environment best, and are uniquely positioned to report on environmental change in areas that may be otherwise inaccessible to researchers. Connecting LEO members with topic

experts at state, federal, and tribal organizations encourage the inclusion of local observations in to research or monitoring activities, and help shape research that is responsive to community concerns. As our environment continues to change, these collaborative partnerships will be even more valuable in documenting change in ways that leverage resources to address impacts. During the project period, LEO staff actively worked to connect agencies and observers and share information with member groups.

During Year 3, LEO staff used the platform to directly communicate information and alerts from state agencies to LEO members in the affected areas. Following a LEO webinar presentation on tick trends in Alaska, LEO staff used the platform to distribute information to all Alaska members on health risks of ticks and tularemia in Alaska, with guidance from the Alaska Department of Fish and Game. LEO members in coastal communities also received a notice of high levels of paralytic shellfish poisoning in non-commercially harvested shellfish that resulted in a death in Dutch Harbor. The notice was developed from the joint statement released by the State of Alaska Department of Environmental Conservation and Department of Health and Social Services.

Staff also introduced the LEO Network as a resource for identifying environmental change relevant to agency work. In 2013, ANTHC began co-hosting a meeting series with the Centers for Disease Control and Prevention that brought together scientists and research professionals who recognize the interdependence between humans, animals, plants and the environment. This concept is referred to as One Health. Following a two-day workshop, One Health stakeholders from around Alaska recommended LEO as a tool to identify potential instances of prioritized zoonotic diseases. Additionally, LEO was featured in the Anchorage Climate Action Plan as a tool to share information about community emergency response and impacts, to support surveillance for non-native vectors such as ticks, mosquitoes and fleas. The State of Alaska Department of Health and Social Services released an Epidemiology Bulletin on January 8, 2018, titled "Assessment of the Potential Health Impacts of Climate Change in Alaska." The Bulletin included participation in the LEO Network to monitor changes affecting human health, including circumstanced which may increase risk of injury and/or impact food and water security.

Additional outreach to agencies were intended to begin developing relationships for further collaboration. During Year 4, Erica Lujan presented at the National Weather Service Alaska Region Climate Science & Services Workshop. The workshop was attended by the Climate Focal Points from the weather forecast offices in Juneau, Anchorage, and Fairbanks along with staff from the Alaska Pacific River Forecast Center. This presentation inspired discussions on further collaboration between the LEO Network and NWS. LEO staff also gave two presentations in Interagency Arctic Research Policy Committee (IARPC) collaboration meetings during the year. On August 27th, Mike Brubaker presented an overview of the LEO Network in the Arctic Data Collaboration Sub-Team meeting, focused on identifying data needs related to coastal resilience and human health and wellbeing. On November 16th, Erica Lujan presented an overview of the LEO observations that document environmental changes impacting food security in a meeting jointly hosted by the Marine Ecosystems, Health and Well-being, and Coastal Resilience collaboration teams.

2.7 Identification and recruitment for one or more Super Observer peer groups and a similar group for consultants

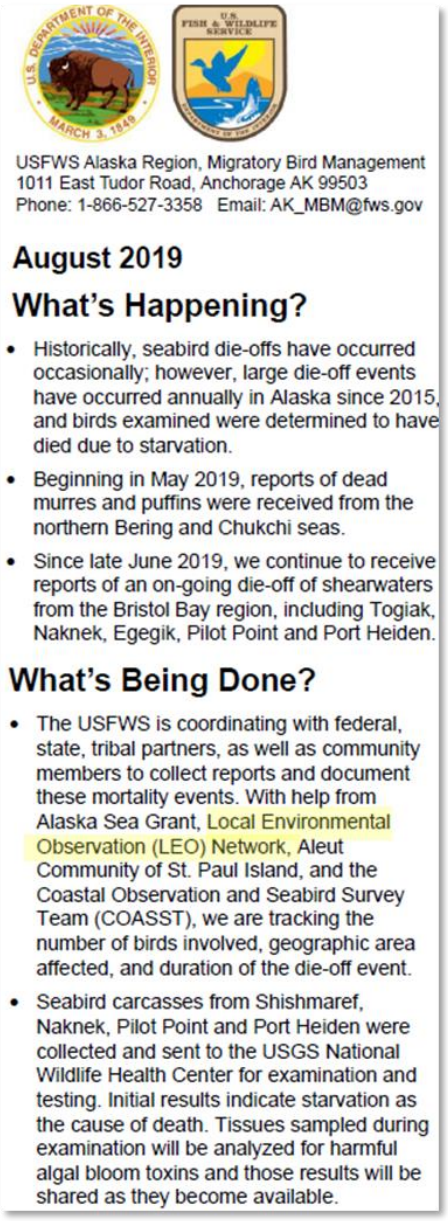
Super observer peer groups and corresponding consultant groups have emerged organically through seasonal collections of observations. Those collections include observations of changes to fish health, changes in weather patterns, changes in the timing of plant blooms, as well as instances of seabird mortalities and ticks.

- Staff from the Alaska Department of Fish and Game Fish Pathology Lab have become well-established consultants on observations of changes to fish health. Dr. Jayde Ferguson has consulted on 20 observations and Dr. Ted Meyers has consulted on 18 observations documenting a range of fish diseases and abnormalities in communities statewide, from Southeast to the North Slope.

- Climate scientist Rick Thoman, with the Alaska Center for Climate Assessment and Policy, has responded to 55 observations about unusual weather events statewide. These observations detail unusual weather events, such as the increase in ice fog along the coast due to lack of sea ice, but also describe events such as increased river erosion as unusually high snowpack melts along river headwaters. In addition to acting as a consultant on individual posts, Mr. Thoman also presents seasonal weather and climate updates in quarterly One Health meetings, preceding descriptions of unusual environmental events described by Mike Brubaker.

- Plants may respond to changes in weather and climate by changing the timing of budding and blooming. Ecologist Dr. Katie Spellman, with the International Arctic Research Center at the University of Alaska Fairbanks, has contributed to 20 observations of early or late budding and blooming plants. These observations have been largely concentrated in Southcentral and Interior regions of the state, but include two additional observations from Kotzebue and Metlakatla.

- Observations of seabird deaths are forwarded to Kathy Kuletz at the US Fish and Wildlife Service (USFWS), and to Hillary Burgess at the Coastal Observation & Seabird Survey Team. Dr. Kuletz has consulted on 22 observations of dead or sick seabirds on the Kenai Peninsula and along the western coast. Ms. Burgess has consulted on 10 observations of dead or dying seabirds largely along the southwestern coast. In 2019, coastal residents submitted 8 observations of sea bird deaths, which helped the USFWS and COASST document a significant die off along the coast.



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August 2019

What's Happening?

- Historically, seabird die-offs have occurred occasionally; however, large die-off events have occurred annually in Alaska since 2015, and birds examined were determined to have died due to starvation.
- Beginning in May 2019, reports of dead murres and puffins were received from the northern Bering and Chukchi seas.
- Since late June 2019, we continue to receive reports of an on-going die-off of shearwaters from the Bristol Bay region, including Togiak, Naknek, Egegik, Pilot Point and Port Heiden.

What's Being Done?

- The USFWS is coordinating with federal, state, tribal partners, as well as community members to collect reports and document these mortality events. With help from Alaska Sea Grant, Local Environmental Observation (LEO) Network, Aleut Community of St. Paul Island, and the Coastal Observation and Seabird Survey Team (COASST), we are tracking the number of birds involved, geographic area affected, and duration of the die-off event.
- Seabird carcasses from Shishmaref, Naknek, Pilot Point and Port Heiden were collected and sent to the USGS National Wildlife Health Center for examination and testing. Initial results indicate starvation as the cause of death. Tissues sampled during examination will be analyzed for harmful algal bloom toxins and those results will be shared as they become available.

Figure 14: USFWS Sea Bird Mortality Notice Crediting the LEO Network

- Invasive and non-native tick species and tick-borne illness are becoming an increasing concern in Alaska. The Alaska Department of Environmental Conservation Office of State Veterinarian, Department of Fish and Game and the University of Alaska Anchorage have co-created the

Submit-A-Tick program. This program accepts ticks recovered by Alaska residents and will identify the species and check for disease. Dr. Micah Hahn, with the University of Alaska Anchorage, helps administer this program and consults on tick-related posts submitted to LEO. During the project period, Dr. Hahn has consulted on four observations of ticks on domestic dogs and wildlife in Southcentral and Southwest regions of the state.

LEO staff also presented to two potential consultant groups. During Year 1, BOEM coordinated a LEO presentation by Mike Brubaker to the Alaska Eskimo Whaling Commission. During Year 4, Erica Lujan presented the LEO Network to Injury Prevention Program managers from the regional Tribal Health Organizations. She highlighted recent observations that describe increased risk of injury and encouraged program managers to review observations from their service area.

2.8 Development of a planned system of review procedures performed by independent reviewers; identify specific changes made as appropriate

LEO Network staff routinely share content with organizations and working groups who are able to shape large-scale research projects to understand and address the impacts of environmental change.

One Health

The One Health quarterly meetings are co-hosted by ANTHC Community Environment and Health and the CDC Arctic Investigations Program. The meetings are attended by a variety of scientific professionals specializing in public health, veterinary science and animal health, landscape ecology, climate scientists, and oceanographers. During each meeting, the Alaska Center for Climate Assessment and Policy provides an overview of recent and forecasted weather and climate models, followed by an update from LEO staff about prominent themes from local observations and news. This presentation series informs meeting attendees of current environmental themes and invites feedback and consultation.

Sea Bird Die Offs

The US Fish and Wildlife Service (USFWS) collects observations of sea bird illnesses and deaths. Along with Alaska Sea Grant, Aleut Community of St. Paul Island, and the Coastal Observation and Seabird Survey Team, LEO staff share observations with USFWS researchers in an effort to track the number of sea birds involved, the geographic area affected, and the duration of the die-off event. USFWS staff have presented their research findings in LEO Webinars, sharing information back to the communities who submitted observations.

Marine Mammal Investigation Team

LEO staff participate in monthly calls with Bering Strait tribes, wildlife veterinarians, marine ecologists, fisheries researchers, oceanographers, and climate scientists to discuss marine mammal stranding. The purpose of the dialogue is to identify trends in marine mammal health that threaten food security in rural communities. Tribes are asked to share any observations of marine mammals who are sick, stranded, or behaving oddly. LEO staff provide updates on observations of marine mammal health submitted to the Network. When possible, the science community investigates each stranding and reports on trends affecting marine mammal health.

In addition to presenting collections of observations to working groups, LEO staff reviews each observation to understand whether it is necessary to reach out to topic experts for review and additional information. During the project period, LEO staff received consults from:

- Alaska Botanic Garden
- Alaska Center for Climate Assessment and Policy
- Alaska Department of Environmental Conservation
    - Office of the State Veterinarian
- Alaska Department of Fish and Game (ADFG)
    - Area Wildlife Biologists
    - Commercial Fisheries
    - Department of Wildlife
    - Division of Sport Fish
    - Fish Pathology Lab
    - Invasive Species Program
    - Statewide Lands and Refuge Program
    - Wildlife Veterinarian
- Alaska Department of Natural Resources
    - Cooperative Agriculture Pest Survey Program
    - Oil and Gas
- Alaska Division of Forestry
- Alaska Division of Geological & Geophysical Surveys Coastal Hazards Program
- Alaska Department of Health and Social Services
- Alaska Harmful Algal Bloom Network
- Alaska Herpetological Society
- Alaska Maritime National Wildlife Refuge
- Alaska Native Tribal Health Consortium
    - Center for Environmentally Threatened Communities
    - Contamination Support Program
    - Department of Environmental Health and Engineering
    - Emergency Preparedness Program
- Alaska Pacific University
    - Marine and Environmental Sciences
- University of Alaska Anchorage
    - Center for Conservation Science
    - Department of Engineering
    - Department of Environmental Health
    - Department of Health Science
- University of Alaska Fairbanks
    - Alaska Center for Climate Assessment and Policy
    - Alaska Fire Science Consortium
- Alaska Sea Life Center
- Alaska Songbird Institute
- Alaska Veterinary Pathology Services
- Aleutian Pribilof Island Association
- Alpine Garden Nursery
- Arctic University of Norway
- Anchorage Municipality
- Auke Bay Laboratory
- Chistochina Elder
- Chuathbaluk Traditional Council
- Coastal Observation & Seabird Survey Team
- Huxley College of the Environment
- Kachemak Bay National Estuarine Research Reserve
- Kasitsna Bay Marine Lab
- Kawerak Environmental Department
- Kodiak Area Health Association
- Marine Mammal Stranding Network
- National Weather Service
    - River Forecast Center
- National Oceanic and Atmospheric Administration (NOAA)
- Native Village of Akhiok
- North Slope Borough
    - Department of Wildlife Management
- Norton Sound Health Corporation
- Nulato Tribal Council
- Ocean Integrity Research
- Puget Sound Mycological Society
- Qawalangin Tribe of Unalaska
- Seldovia Village
- Sitka Tribe of Alaska
- Sky Truth
- St. George Traditional Program
- US Forest Service
    - Forest Health Program
- US Fish and Wildlife Service
    - Seabird Program
    - Raptor Management Program
- US Geological Survey
- University of Washington

- College of Fisheries and Ocean Sciences
- Cooperative Extension Service
- Department of Veterinary Medicine
- Institute of Marine Science
- International Arctic Research Center
- Museum of the North
- Sea Grant Marine Advisory Program
- University of California at Santa Cruz
- School of Aquatic and Fishery Science

- Yukon Kuskokwim Health Corporation

2.9 Development of a system of routine technical activities used by the CBM development personnel in collaboration with BOEM to measure and control the quality of the CBM observational data as they are reviewed, accepted, reported on, and archived

During the project period, LEO staff developed a written manual describing each of the LEO features and how they can be used to create a LEO workflow protocol with multiple team members, search LEO content for specific geographies, understand observations through community data sets, request consults and reviews, as well as engage LEO members through presentations, webinars, and social media. These processes ensure a standard review process according to quality assurance standards. LEO staff have reviewed descriptions and uses of each tool to ensure continuity in usage.

2.10 Other Activities

During the project period, the LEO Network was referenced in three publications:

- During Year 2, LEO staff co-authored a publication with Centers for Disease Control and Prevention, Arctic Investigations program staff, titled, "Environmental observation, social media, and One Health action: a description of the Local Environmental Observer (LEO) Network." This paper describes the LEO processes and its contributions to One Health action. The paper is now available in the One Health journal.
- Also during Year 2, the Alaska Department of Health and Social Services published a Bulletin entitled "Assessment of the Potential Health Impacts of Climate Change in Alaska", referencing the LEO Network as a tool for understanding unusual environmental events affecting health.
- During Year 3, the Scientific American published an article on the importance of Indigenous and local knowledge in environmental conservation. The article references the LEO Network as an example of an international collaboration to collect local observations of change from geographically remote communities.
- Also during Year 3, the Arctic Research Consortium of the US (ARCUS) published an article describing the LEO Network as a resource for the science community to learn about environmental change across Alaska.
- During Year 4, LEO staff at ANTHC partnered with Alaska Pacific University to increase the amount of content in the Network from other Arctic Nations focusing on permafrost thaw and rain-on-snow events. That effort is funded through contributions from two separate National Science Foundation grants awarded to Alaska Pacific University.

- During Year 4, LEO staff co-authored a report for the Arctic Council detailing the activities of the Circumpolar Local Environmental Observer Network (CLEO).
- Also during Year 4, ANTHC also received a small amount of funding from the Environmental Protection Agency, which supported the first LEO Network Event Almanac, detailing observation themes during 2019.

2.11 Deliverables

Year 2:

Presentations at Regional Scientific Meetings

- Local Environmental Observer Network: A Year in Review; Presentation at the Alaska Forum on the Environment
- A Citizen Observer System for Monitoring Environmental Change; Presentation to the Kachemak Bay Science Conference

Oral Presentations

- A Citizen Observer System for Monitoring Environmental Change; Presentation for Wainwright Community Meeting
- A Citizen Observer System for Monitoring Environmental Change; Presentation to the Region 10 Tribal Environmental Leader's Summit

Publications

- Walsh, J.E., Thoman, R.L., Bhatt, U.S., Bieniek, P.A., Brettschneider, B., Brubaker, B., Danielson, S., Lader, R., Fetterer, F., Holderied, K., Iken, K., Mahoney, A., McCammon, M., Patrain, J. 2018: The High Latitude Marine Heat Wave of 2016 and Its Impacts on Alaska. *American Meteorological Society,* **99**(1):S39-S43 DOI:10.1175/BAMS-D-17-0105.I.

Year 3:

Oral Presentations

- Understanding Environmental Change: Using the Local Environmental Observer Network in the Classroom; Presentation to North Slope Borough Educators
- Understanding Environmental Change Using the Local Environmental Observer Network; Presentation to the 7 Generations Environmental Planning Workshop

Publications

- Mosites, E., Lujan, E., Brook, M., Brubaker, M., Roehl, D., Tcheripanoff, M., Hennessy, T. 2018: Environmental observations, social media, and One Health action: A description of the Local Environmental Observer (LEO) Network. *One Health*, **6**: 29-33**.**

Year 4:

Presentations at Regional Scientific Meetings

- Local Environmental Observer Network 2020 LEO Update; Presentation at the Alaska Forum on the Environment
- Local Environmental Observer Network; Presentation to the National Weather Service Climate Focal Points

Oral Presentations

- Local Environmental Observer Network; Presentation to the Susitna Watershed Coalition Members
- Local Environmental Observer Network; Presentation at the ANTHC Injury Prevention Conference
- Local Environmental Observer Network 2020 Update; Presentation to the Alaska Tribal Conference on Environmental Management

Task 8:

- Local Environmental Observer (LEO) Network; Tools and Workflow

3 Platform Updates

Updates to the LEO Network web platform fell in to three categories: 1) updates to LEO content, 2) tools to improve LEO member engagement, and 3) updates to the LEO Network homepage.

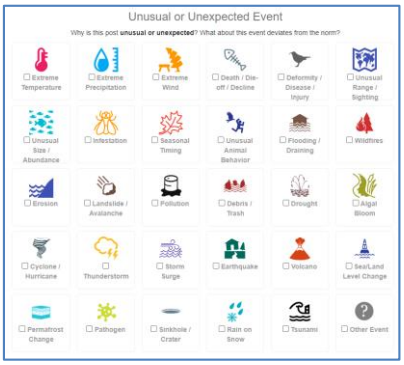
3.1 LEO Content

Over the course of the project, several tools were developed to allow for new types of LEO content and to improve the ways in which that information is organized.

The LEO Network is now able to receive three types of content: observations, news articles, and cross-posts from social media and other monitoring networks. News articles are important pieces of content that provide information on large-scale community events and responses, such as wildfires or landslides, especially in circumstances where residents have been evacuated. All members now have the ability to submit news articles from local news sources, which detail local impacts of the event. In addition to providing LEO members the ability to submit news articles, a search algorithm identifies news articles from local news sources for review by LEO editors. LEO members may translate news articles in to their preferred language.

In addition to submitting news articles, LEO members may also share posts from social media and other monitoring networks. Community residents, as well as agency personnel, in Alaska often post observations of unusual events to social media platforms such as Facebook and Twitter, to both share and collect information. However, social media platforms do not archive posts in a way that is easily searchable for all users. By posting these observations on the LEO Network, they can be saved and

organized in relation to community pages, where they appear on community timelines and contribute to community statistics of environmental change.



All news articles and social media posts can be categorized according to the same criteria used to organize observations, which has also been refined over the project period. Previously, LEO members categorized their observations according to the change they observed in the natural environment. Users were able to search content based on these categories of change. In order to better organize observations and improve the ability to search content, LEO members may now categorize their post based on the type of event they observed, or that is documented in the news article, as well as the impact that event had on the local community.

Figure 15: New observation category options

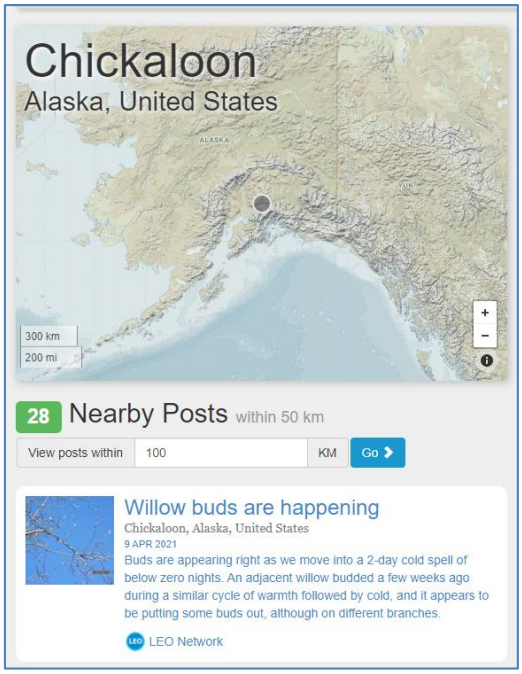
3.2 New Member Engagement

Several features developed over the project period allow LEO members to engage with the platform by messaging individual members, reviewing observations in a particular geography and exploring a range of data tools particular to individual communities.

One of the fundamental purposes of the LEO Network is to connect observers with topic experts who can provide more information about a particular environmental change. LEO members have always had the ability to search the LEO Network for observations of events similar to what they may be experiencing, and now are able to reach out and contact individual observers or consultants using an internal messaging system. This improves member-to-member connectivity without sharing any personal contact information.

Figure 16: LEO member profile

LEO members also have several tools to stay informed of observations submitted from a specific geography. Observations may be sent out to nearby members within 10 KM – 100 KM radius and invite additional observations. This is a helpful tool to understand if a certain events are happening in more than one location. Members may also follow certain event categories, and receive an email alert if an observation meeting one of those categories is published on the website.



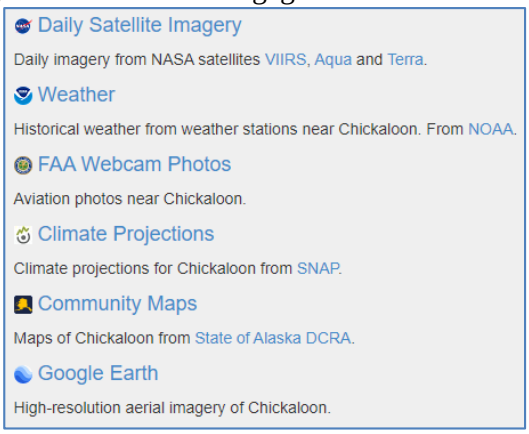
All observations submitted near, or from, a community, appear on a community page within the Network. Users may choose to view posts within any chosen radius of a community. These observations can be viewed on a timeline, on a map, on a slideshow, or as a list. Additionally, it is also possible to explore statistics based on observations and news articles describing events that occurred near the community. This is helpful for community members seeking to understand that range of events occurring in their region.

LEO members can also create collections of observations and news articles on personal maps. These maps can reflect events happening around a certain geography, or reflecting a certain theme. Personal maps can be made public, kept private, or made shareable with a link. The ability to share these event maps can improve collaborations between project partners.

Figure 17: LEO Network community page

To understand events within certain context, LEO staff have added a collection of community-specific data tools to each community page. These data sources provide users with temperature and precipitation data, satellite and FAA images, community maps, and more.

The last tool developed during the project period to strengthen LEO member engagement was a standard webinar invitation form. LEO Network staff held monthly webinars to review observations and news articles submitted during the project period, and host a presentation from a topic expert who can speak in-depth about certain seasonal events or themes reflected in observations. This webinar invitation is sent out to specific categories of member, in this case LEO members in Alaska, with an agenda and a button allowing the user to join the meeting from the invitation.



3.3 Homepage Updates

Several new features have been added to the LEO Network homepage, including mobile-friendly formatting and a resource library.

Figure 18: LEO Network community data tools

Users have a new navigation option available from the LEO homepage. In the menu of options along the top of the homepage, LEO staff have added a Library option to share LEO reports, newsletters, and other publications. The Library currently features the Northern Climate Observer newsletter, the LEO Event Almanacs, as well as other news and research articles featuring the LEO Network.

The LEO webpage has also been revised to become more mobile-friendly. When opened on a mobile browser, the LEO Network homepage displays an abbreviated version of menu options to search posts based on season, geography and timeframe, allows users to browse Network membership, view LEO Library documents, and submit observations or news articles.

4 Summary

Over the project period, LEO Network staff have worked to connect observers and topic experts across the state. With over 900 new members recruited to the Network, there are more opportunities to engage with people across the state to share knowledge about environmental change. LEO staff focused outreach in North Slope Borough and Cook Inlet communities to learn more about change in those regions, but also provided support to members statewide. The wide range of new web features were developed in response to member needs and continue to evolve based on feedback from LEO members, consultants and according to specific project needs.

As a result of this funding, the community of public health professionals, biologists, ecologists, constructions personnel and more, learned what types of environmental changes are occurring across the state, how those changes affect communities, and how those impacts can be collaboratively addressed. LEO Network members have created trust-based relationships necessary to develop and implement adaptation strategies that will promote healthy, sustainable, communities in to the future.

U.S. Department of the Interior (DOI)
DOI protects and manages the Nation's natural resources and cultural heritage; provides scientific and other information about those resources; and honors the Nation's trust responsibilities or special commitments to American Indians, Alaska Natives, and affiliated island communities.

Bureau of Ocean Energy Management (BOEM)
BOEM's mission is to manage development of U.S. Outer Continental Shelf energy and mineral resources in an environmentally and economically responsible way.

BOEM Environmental Studies Program
The mission of the Environmental Studies Program is to provide the information needed to predict, assess, and manage impacts from offshore energy and marine mineral exploration, development, and production activities on human, marine, and coastal environments. The proposal, selection, research, review, collaboration, production, and dissemination of each of BOEM's Environmental Studies follows the DOI Code of Scientific and Scholarly Conduct, in support of a culture of scientific and professional integrity, as set out in the DOI Departmental Manual (305 DM 3).