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CONNECTING ARCTIC COMMUNITY-BASED AND CITIZEN SCIENCE OBSERVATIONS WITH EXISTING RECOGNIZED DATABASES

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13	SMHI		**36**	RIHMI-WDC	
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15	NUIM		**38**	WHOI	
16	IFREMER		**39**	SIO	
17	MPG		**40**	UAF	
18	EUROGOOS		**41**	U Laval	
19	EUROCEAN		**42**	ONC	
20	UPM		**43**	NMEFC	
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EXECUTIVE SUMMARY

Community-based and citizen science observations in the Arctic do not only have the potential to inform management decisions at local or provincial and national levels. The observations can also shed light on changes in the environment on a national and even international scale. This will, however, often require that the community-based and citizen science observations are connected with scientist-based datasets. This document contains the description of a model for connecting community-based and citizen science knowledge systems with scientist-based knowledge systems, and of the effort done in INTAROS to make selected Arctic community-based and citizen science data collections connected with the INTAROS data catalogue.

The model for connecting community-based and citizen science knowledge systems with scientist-based knowledge systems is based on collaborative work with multiple partners, led by Dr Maria Tengö, Stockholm Resilience Centre. The model is primarily for use in situations where management decisions about a specific area or specific natural resources require establishment of a knowledge base. The model depicts graphically the notion of 'science and other knowledges' being worked together to build a more comprehensive knowledge base than could be achieved by any one knowledge system alone (Tengö et al. 2014, 2017, and in review). This "Multiple Evidence Base" model positions Indigenous and Local (ILK) and scientific knowledge systems as different manifestations of valid and useful knowledge that generates complementary evidence for sustainable use of land and resources. We demonstrate the use of the model on the case of coastal fisheries management in Disko Bay, Greenland.

The model cannot directly be used for connecting data collections from community-based, citizen science and scientific knowledge systems, but it provides a good background for later applying specific examples of cross-weaving of knowledge. The INTAROS has established a data catalogue (https://catalog-intaros.nersc.no/). The data catalogue comprises brief descriptions of the data collections (meta-data) and links to each dataset. In less than two years, the data catalogue has become an internationally recognized data catalogue for the Arctic environment. As of November 2020, this data catalogue comprises more than 100 data collections. We entered meta-data on a total of 15 Arctic community-based monitoring and citizen science data collections into the data catalogue. Seven of the data collections comprised data from Disko Bay and five from Svalbard. In this report, we describe each of the data collections, the tags and the parameter names used, the links to the datasets, and the potential uses of the data.

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1. Introduction

As well as providing data with which to inform management decisions at local or provincial and national levels, community-based and citizen science observations have the potential to shed light on changes in the environment on a national and even international scale (IASC 2013). This will, however, often require that the community-based and citizen science observations are connected with scientist-based datasets.

This document contains the description of a model for connecting community-based and citizen science knowledge systems with scientist-based knowledge systems (Chapter 2), and of the effort done in INTAROS to make selected Arctic community-based and citizen science data collections connected with the INTAROS data discovery portal (Chapter 3).

2. Model for connecting community- and scientist-based knowledge systems

In this chapter, we describe a model for connecting community-based and citizen science knowledge systems with scientist-based knowledge systems. The model is based on collaborative work with multiple partners, led by Dr Maria Tengö, Stockholm Resilience Centre at Stockholm University. The model is primarily for use in situations where management decisions about a specific area of land or sea territory or about specific natural resources (water, fish etc.) require establishment of a knowledge base.

The text and illustrations in this chapter are extracts from a manuscript under consideration for publication in the journal *BioScience* (Tengö, M., Austin, B, Danielsen, F., Fernández-Llamazares, Á. In review. "Connecting Citizen Science with Indigenous and Local Knowledge Systems").

2.1 From diverse knowledge systems to an enriched picture

Tengö et al. (2014, 2017, and in review) present the Multiple Evidence Base (MEB) as an approach for working with diverse knowledge systems to produce an enriched picture of a given phenomenon identified in collaboration between different stakeholders (see Figure 1 below). It depicts graphically the notion of 'science and other knowledges' being worked together to build a more comprehensive knowledge base than could be achieved by any one knowledge system alone. The MEB positions Indigenous and Local (ILK) and scientific knowledge systems (among others) as different manifestations of valid and useful knowledge that generates complementary evidence for sustainable use of land areas or natural resources.

It has a focus of "letting each knowledge system speak for itself, within its own context, without assigning one dominant knowledge system with the role of external validator" (Tengö et al. 2014, p.584). The MEB model for knowledge weaving emphasizes thoughtful engagement of *actors* – who is representing knowledge; *institutions* – how are different ways of obtaining, storing, safeguarding, and transmitting knowledge secured, and *processes* – how are diverse ways for representing and engaging with knowledge employed? The outcome can be thought

of as knowledge weaving through collaborative pathways, activities and efforts that respects the integrity of each knowledge system (Johnson et al. 2016).

2.2 Description of the model

The MEB model for connecting knowledge systems comprise five different but related steps or tasks (Tengö et al. 2017):

1) Mobilize: Develop knowledge-based products through a process of innovation and/or engaging with past knowledge and experience
2) Translate: Adapt knowledge products or outcomes into forms appropriate to enable mutual comprehension in the face of differences between actors
3) Analyze: Interact among different knowledge systems to develop mutually respectful and useful representations of knowledge
4) Synthesize: Shape broadly accepted common knowledge bases for a particular purpose
5) Apply: Use common knowledge bases to make decisions and/ or take actions and to reinforce and feedback into the knowledge systems

These five tasks aim to guide respectful collaborations between knowledge systems (Tengö et al. 2017, see Figure 1). The first, *to mobilize*, emphasize the need to articulate local knowledge for sharing, using culturally appropriate methods. In many cases, ILK may not be visible directly as knowledge, but rather embedded in various practices or ways of expressing knowledge (e.g. Fernandez-Llamazares and Cabeza 2018).

Secondly, to *translate* concerns the need to spend time to make sure different knowledge contributions make sense to representatives from different knowledge systems – e.g. for scientific knowledge to be understandable for representatives from the local community, and for local knowledge and its different dimensions to be understandable to researchers.

Thirdly, when bringing different knowledge contributions together, representatives from different knowledge systems needs to be involved in analyzing and *negotiating* whether the contributions are overlapping, converging or diverging. An important part is acknowledging that some aspects may be in disagreement, e.g. stemming from incommensurable aspects of different knowledge systems.

The last two tasks concern to *synthesize* and *apply*. To synthesize entails shaping a broadly accepted common knowledge that maintains the integrity of each knowledge system, illustrated in Figure 1 by braided strands, rather than 'integrating' into one. When applying the knowledge, it is critical to recognize benefits and outcomes of the collaboration that can feed into different kinds of interests and needs, e.g. for local communities as well as researchers or regional decision makers. Attention to the five tasks can guide weaving of Community-Based Monitoring and Citizen Science knowledge systems with scientist-based knowledge systems.

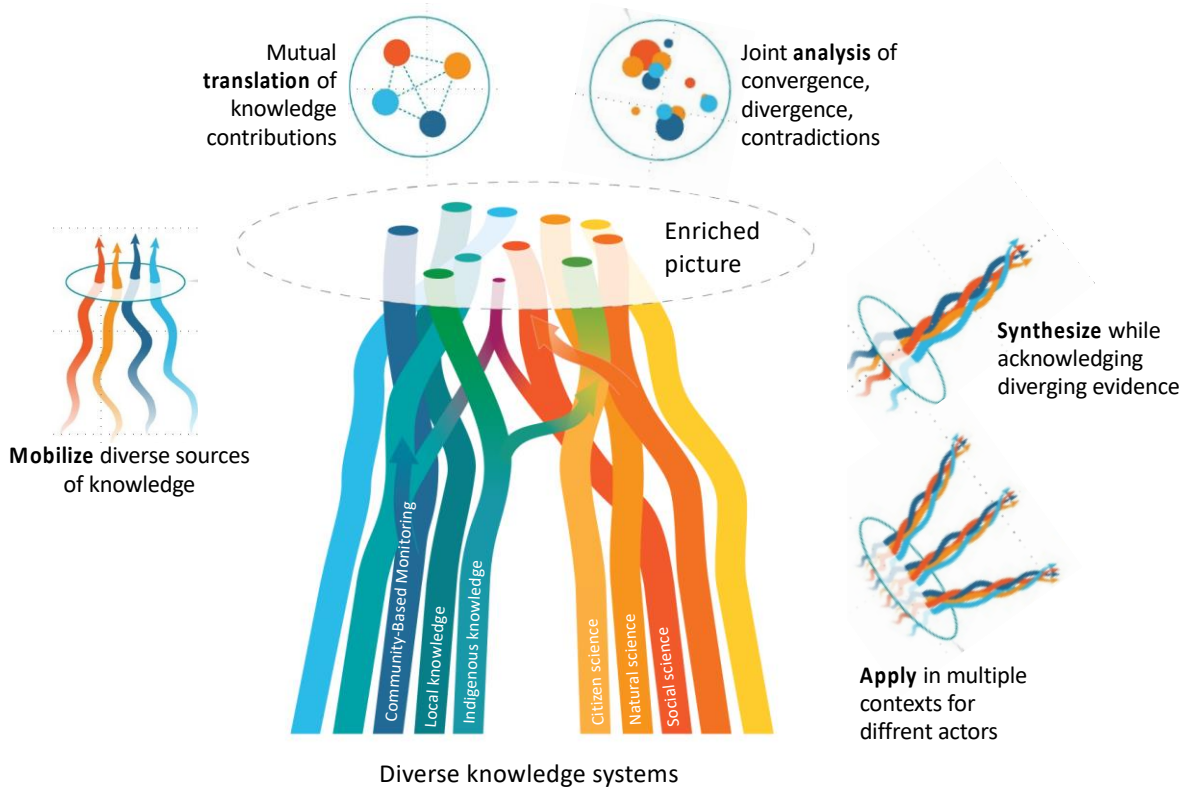

Fig. 1. Illustration of a Multiple Evidence based (MEB) model for the use of knowledge for ecosystem management and conservation (from Tengö et al. in review, adapted from Tengö et al. 2014, 2017). Different knowledge systems are viewed as contributing complementary information and insights into a specific issue – creating an *enriched picture* represented by the circles in the figure. The colored strands represent contributions from different knowledge systems to the topic. Five tasks (to *mobilize*, *translate*, *analyze*, *synthesize*, and *apply* knowledge) provide guidance for knowledge collaborations based on respect, equity among actors and knowledge systems, and usefulness for all involved. This entails engaging with actors as knowledge holders, including with the institutions and practices of generating and transmitting knowledge. They may be different than in scientific knowledge systems but nonetheless guide the generation, validity and transmission of knowledge in their respective context.

Malmer et al. (2020) provides an overview of published experiences with using the MEB model. In practice the MEB model will need to be adjusted to the specific context in which it is to be used. For instance, in the case of coastal fisheries management in Disko Bay, Greenland, the MEB model can ensure that both local user knowledge, research knowledge and manager knowledge contribute to creating an understanding of the resource situation. Adapted to this context, the most important steps are (excerpt from INTAROS D6.6, policy brief on fisheries management in Greenland):

1) That different actors (resource users, researchers and managers) seek to formulate and come together to recognize the problems they see in relation to the sustainability of fisheries. This can be done by ensuring to a greater extent than is the case today that local users' perception of the problems in fisheries management is brought into play.

2) That the different ways of knowing something about sustainability are respected and recognized. In addition, the various groups of actors must themselves within their own groups clarify what their data and observations mean.

3) That transparency is ensured in the preparation of the management advice, where clear reference is made to what knowledge is used and where it comes from. It should be made clear how different actors view solutions differently.

4) That a common understanding of solutions within the sustainability of the fishery is created, and that this is communicated to all actors.

3. Connecting community-based data collections with existing databases

In the preceding chapter, we described a model for connecting community- and scientist-based knowledge systems. In this chapter, we describe how we have connected a number of Arctic community-based and citizen science data collection with existing recognized databases. The connecting of the community-based data collection with the existing databases is not *per se* using the model described, since the model must be used on more specific natural resource management issues, but it provides a good background for later applying specific examples of cross-weaving of knowledge.

In 2018, the INTAROS project established a data discovery catalogue, the INTAROS data catalogue (https://catalog-intaros.nersc.no/). This data catalogue has become an internationally recognized data catalogue for the Arctic environment. The data catalogue does not comprise the data collections themselves but they comprise brief descriptions (the "meta-data") of the data collections and links to the data collections.

We have entered meta-data on 15 community-based monitoring and citizen science data collections in this catalogue. This means that we have made a brief description of each data collection and provided a link or an email address so that readers of the catalogue who are interested in obtaining access to the data will know where to find it. Below we provide information about each of these data collections.

In Work Package 4 of INTAROS, the field activities have focused at two areas, Disko Bay, Greenland, and Svalbard. An overview of the community-based monitoring and citizen science

data collections made available in the INTAROS data catalogue from these and other Arctic areas is provided in Table 1.

	Disko Bay, Greenland	Svalbard	Other parts of the Arctic
PISUNA	+		
Yakutia Community-Based Monitoring Program (CSIPN)			+
Happywhale	+	+	+
eBird	+	+	+
Secchi Disk Study	+	+	+
GLOBE Observer Clouds	+	+	+
Alaska Arctic Observatory & Knowledge Hub			+
Yukon River Inter-Tribal Watershed Council			+
Phenology of Spring Bird Migration			+
Piniarneq	+		+
Pilot Whale Statistics in the Faroe Islands			+
Citizen Seismology Program	+	+	
FMI Snow Depth Measurements Citizen Science Program			+
Sea Ice for Walrus Outlook			+
Spotter Pro			+

Table 1. Community-Based Monitoring and Citizen Science data collections in the INTAROS Data Catalogue.

For each CBM/CS program we provide the following information: program title, name of organizer(s) if different from program, introduction to the program, key-words listed as "tags", attributes listed as "parameter name(s)", and links to data collection or information on how to get access to data collection.

The tags characterize the data collections. With the tags it is possible to separate one data collection from another. The parameter names are the names of the basic attributes that constitute the data in its most disaggregated form. The tags and the parameter names were formulated on the basis of information about each data collection provided by the organizers. In the INTAROS Data Catalogue, the tags and the parameter names are used for quickly searching and finding data collections.

3.1 PISUNA, Greenland

The goal of the PISUNA Program is to optimize the monitoring of living resources through enhanced cooperation between fishermen/hunters, government managers and scientists, and through increased involvement of local community members in the monitoring. The PISUNA database (PISUNA-net) is a database on community-based observations of living resources in Greenland.

Through quarterly (three-monthly) reports of natural resource conditions and explanations of local trends in resources and possible management interventions, local observers assist the local authority and the central government in better understanding natural resource processes and interactions. This information is leading to better-informed government decisions on natural resource management. A wide range of management actions have been proposed of which some have been implemented, while

others were declined or are still awaiting approval. The management actions proposed based on the local natural resource observer program have been locally different in nature. However, they all are directly related to utilization of specific resources or areas and are connected with how the resources and landscapes are being managed. The management proposals include amongst others: regulation of fishing in certain areas, changes in harvesting procedures, regulation of quotas and sustainable harvest, changes in hunting and fishing seasons, proposals on changes in fishing and hunting regulations, changes in access and means of transportation in certain areas, and development of new resource enterprises and ways of utilizing resources. Additionally, the database and interactive website are publicly accessible tools available to community members, educators, outside researchers and policy makers.

Tags: biology, community-based monitoring, environment, human activities, ocean current, resource use, sea ice, socio-economics.

Parameter name(s): living resources, fish, marine mammals, land mammals, birds, ocean current, sea ice.

Possible use: Informing management decisions on living resources and providing an enriched understanding of ecological dynamics and relationships.

Relevant link: https://eloka-arctic.org/pisuna-net/en

3.2 Yakutia Community Based Monitoring Program (CSIPN)

The Centre for Support of Indigenous Peoples of the North (CSIPN) is a non-governmental organisation that works to protect the rights of the indigenous peoples of Siberia and the Russian North and Far East. CSIPN is the leading organization working on indigenous rights in Russia, which provides informational, educational, expert and legal support to a range of representatives of indigenous peoples.

Yakutia CBM is a program under CSIPN. Since 2017, Indigenous peoples' communities in Yakutia, Russia, have been monitoring the environment using community-based monitoring (CBM) approaches. These efforts have helped provide Evenk communities in Zhigansk and Olenek districts with influence over the management of a number of subject areas related to natural resource management at both Republic and District level.

Tags: climate, environmental changes, fisheries, ice cover, pasture quality, pollution, predators, reindeer, snow, visitors, wildlife.

Parameter name(s): wildlife, fisheries, pasture quality, reindeer, predators, climate, environmental changes, snow, ice, pollution, visitors, abundance.

Possible use: Informing management decisions on living resources and providing an enriched understanding of ecological dynamics and relationships.

Relevant link: http://www.intaros.eu/media/1650/process-report-yakutia-cbm-dec-2019-final.pdf

3.3 Happywhale

Happywhale is a global citizen science program using a web-based marine mammal photo ID crowd-sourcing platform. Some data has been contributed under INTAROS WP4. Happywhale engages citizen scientists to identify individual marine mammals, for fun and for science. Happywhale tracks individual whales throughout our world's oceans. Per November 2020 310,673 photos has been submitted and 47,622 Individual marine mammals have been identified, mostly humpback whales. Data can be reached using the Happywhale website browse function.

Tags: biodiversity, biology, citizen science, ecology, marine mammals, polar bear, whales.

Parameter name(s): marine mammals.

Possible use: A better understanding of whale numbers, distribution and population dynamics which may for instance be useful for area-based management measures such as zoning.

Relevant link: https://happywhale.com/browse

3.4 eBird

eBird is among the world's largest biodiversity-related science projects, with more than 100 million bird sightings contributed annually by eBirders around the world and an average participation growth rate of approximately 20% year over year. eBird is managed by the Cornell Lab of Ornithology. Some data has been contributed under INTAROS WP4. eBird provides open data access in several formats to logged-in users, ranging from raw data to processed datasets geared toward more rigorous scientific modeling.

eBird Basic Dataset (EBD) is the core dataset for accessing all raw eBird observations and associated metadata. The EBD is updated monthly (15th of each month), and is available by direct download through eBird to any logged-in user after completion of a data request form. The data request form allows gaining some understanding of how the data will be used. Requests are typically approved within 7 days. Data are provided with documentation in spreadsheet format, which can be read by a variety of programs. Although Excel or similar programs work for basic analyses, for larger datasets (>1 million rows) or more sophisticated analyses, we recommend using programs like R. There are several R packages available for summarizing data, including one that is managed at the Cornell Lab specifically for working with the EBD dataset.

Tags: biodiversity, biology, birds, citizen science, environment.

Parameter name(s): birds.

Possible use: A better understanding of bird population dynamics and the status of bird species including bird conservation management requirements.

Relevant link: https://ebird.org/science/download-ebird-data-products

3.5 Secchi Disk Study

The Secchi Disk study is a global citizen science study of the ocean's phytoplankton. Some data has been contributed under INTAROS WP4.

Privacy and Data Policies for SecchiDisk.org: Individuals or organisations conducting research where data from the SecchiDisk.org project may be useful can apply for access by emailing data@secchidisk.org. The dataset is currently not quality controlled and so comes 'as is'. For sailors, data is freely available via the website map, while for academics / researchers are asked for a donation as the project is run from volunteer time and efforts i.e., there is no under-pinning grant funding salaries etc. Data users are expected to acknowledge the project in any resulting publication using the following: The authors thank the Secchi Disk project www.secchidisk.org for the seafarer Secchi Depth data.

Tags: citizen science, clarity of the seawater, climate change, phytoplankton.

Parameter name(s): Secchi disk depth (clarity of the seawater).

Possible use: A better understanding of water transparency, suspended sediment and phytoplankton, and the effects of eutrophication.

Relevant link: https://www.playingwithdata.com/secchi-disk-project/

3.6 GLOBE Observer: Clouds

GLOBE Observer is an international network of citizen scientists and scientists working together to learn more about our shared environment and changing climate. GLOBE Observer currently accepts observations of Clouds. Some data has been contributed under INTAROS WP4. Clouds observations help NASA scientists understand clouds from below (the ground) and above (from space). Since clouds can change rapidly, frequent observations from citizen scientists can help complete the scientific picture.

Clouds gather data on cloud cover, cloud opacity, cloud types, sky conditions and visibility for ground truthing of NASA remote sensing data.

Tags: citizen science, cloud cover, cloud opacity, cloud types, clouds, sky conditions, visibility.

Parameter name(s): clouds.

Possible use: Ground truthing of remote sensing observations of clouds, thereby contributing to a better understanding of the role of clouds in the temperature and energy balance of the earth.

Relevant link: https://observer.globe.gov/get-data/clouds-data

3.7 Alaska Arctic Observatory & Knowledge Hub (AAOKH)

AAOKH is a program under University of Alaska Fairbanks. The Local Observations database was developed to record, archive, and share indigenous sea ice knowledge and expertise. The information contained in this database was collected through the dedication of Inupiaq and Yupik sea ice experts along the northern and western coasts of Alaska. The goal of this collaboration is to preserve and pass on local and traditional knowledge of sea ice and its use knowledge and documenting local sea ice change and how that change is affecting community and cultural activities.

Yupik and Inupiat hunters and sea ice experts, identified as such by their respective communities, keep daily or near daily notes on local weather and ice conditions as relevant for their activities on landfast ice or among drifting ice. The observers are asked to note a few key weather variables, such as temperature, wind speed and direction, and general ice conditions, particularly with regards to the timing of key events in the annual ice cycle, such as the appearance of the first slush or drifting ice, when the ice becomes safe for travel, timing of ice break-up, etc. Beyond these requests, they are encouraged to report any local details they deem important or interesting having to do with the ice environment, subsistence activities and wildlife seen, sea ice travel, and community events. They are encouraged to use terms in their indigenous languages, specific local place names, forecasting indicators, reference to their personal experience and memories of other community members whenever relevant.

Written observations are sent by mail, email and sometimes via phone conversation to a working group at the University of Alaska Fairbanks where the hard copies are archived and the observation records are entered into the Local Observations online database. Photos taken with a GPS-enabled camera or smart phone are emailed or downloaded directly from the observer's camera to preserve geotagging information for preservation in the online database.

Tags: climate, community-based monitoring, environmental change, sea ice, wildlife.

Parameter name(s): sea ice, wildlife.

Possible use: Providing a better understanding of sea ice and its use and documenting local sea ice change and how that change is affecting community and cultural activities.

Relevant link: https://eloka-arctic.org/sizonet/

3.8 Yukon River Inter-Tribal Watershed Council

Water-quality data has been collected as part of a collaborative monitoring project between the United States Geological Survey (USGS), Yukon River Inter-Tribal Watershed Council (YRITWC), and Yukon River Basin communities known as the Indigenous Observation Network. Since 2006, the USGS National Research Program (NRP) and YRITWC have been partnering to collect water-quality samples from the Yukon River and tributaries with the assistance of trained community members living in the Yukon River Basin.

The YRITWC provides support for this project through sample collection, sample processing and shipment logistics with communities and the USGS. The USGS provides water analysis and data interpretation support. Through this partnership over 300 community members have

been trained in water sample collection, which has resulted in over 1,500 samples collected at more than 50 sites covering the entire 2,300 mile reach of the Yukon River since the program began. The program has allowed the USGS to create and maintain a baseline record (long-term at some sites) of water-quality in the river basin, critical for understanding climate change impacts and informing water resource planning and decision-making.

Tags: surface water, water quality, Yukon River.

Parameter name(s): air temperature, conductivity, dissolved oxygen, pH, water temperature.

Possible use: Providing a better understanding about water quality changes occurring on the Yukon River, so as to inform community water resource planning and regional decision-making.

Relevant link: https://yukon.next.fieldscope.org/

3.9 Phenology of Spring Bird Migration in North Norway

The program Phenology of spring bird migration to North Norway gather data on observations of first arrival dates of spring migrants to Tromsø as reported to R. Barrett or to: www.artsobservasjoner.no. The data are stored at UIT Open Research Data under DataverseNO.

Tags: biodiversity, biology, birds, citizen science, environment, phenology.

Parameter name(s): spring migrants, arrival dates, migratory birds.

Possible use: A better understanding of seasonal natural phenomena (phenology) of birds and the role of climatic changes.

Relevant link: https://dataverse.no/dataset.xhtml?persistentId=doi:10.18710/4MCRQL

3.10 Piniarneq

The program Piniarneq gather hunting harvest statistics based on self-reporting by hunters in Greenland. The data are published annually in Danish and Greenlandic language. Link is provided to the 2020 Danish language version.

Tags: biodiversity, biology, birds, environment, land mammals, marine mammals, natural resources, wildlife.

Parameter name(s): harvest statistics, mammals, birds.

Possible use: Informing management decisions on mammals and birds (e.g. quotas, hunting seasons).

Relevant link: https://www.sullissivik.gl/-/media/Sullissivik/Blanketter-og-pdf/Jagt_fangst_og_fiskeri/Piniarneq-2020-DA.ashx?la=da-DK

3.11 Pilot Whale Statistics in the Faroe Islands

Pilot whale statistics has been gathered in the Faroe Islands dating back to 1584. These are most probably the longest continuous statistics for the use of wildlife anywhere in the world. These statistics are made available in Faroe language by Heimabeiti.

Tags: biodiversity, biology, environment, marine mammals, whales.

Parameter name(s): numbers of pilot whales, size of pilot whales.

Possible use: A better understanding of pilot whale population dynamics and population status, and potentially informing management decisions on pilot whales (e.g. quotas).

Relevant link: https://heimabeiti.fo/hagtol

3.12 Citizen Seismology Program

In Longyearbyen and Qeqertalik municipality, INTAROS has established pilot community based seismic stations for cryo- and tectonic seismological recordings, led by GEUS and UiB. The community-based seismometers collect data from the local seismic activity.

Tags: citizen science, seismology, earthquake, cryosphere, seismic station.

Parameter names(s): cryo-seismological records.

Possible use: Mapping cryo- and tectonic seismic events can help authorities and contractors to be better prepared for landslides and earthquakes.

Relevant links: https://catalog-intaros.nersc.no/organization/uib, https://raspberryshake.net/stationview/. The data are also included in the GEUS' earthquake bulletin (see https://www.geus.dk/natur-og-klima/jordskaelv-og-seismologi/registrerede-jordskaelv-i-groenland/).

3.12 FMI Snow Depth Measurement Citizen Science Program

Since 1919, FMI has organized citizen-based monitoring of the year-to-year changing snow coverage in Finland. Since 2010 number of participants declining rapidly. Program closed by 2018. The dataset comprises snowpack depth measurements in open fields and forested (pine) areas, both around mid-January (since 1947) and mid-March of the year.

Tags: snow coverage, snowpack depth, citizen science, meteorology, weather.

Parameter name(s): snow cover records.

Possible use: A better understanding of snow cover and climatic changes.

Relevant links: Most data and analyses on paper only, stored at the FMIs archives. Further information is available from Achim Drebs, e-mail: achim.drebs@fmi.fi

3.13 Hunters' Self-Monitoring in the Faroe Islands

In the Faroe Islands, hare hunting in the outfield landscapes has a significant cultural value. Since 2012, the University of the Faroe Islands has organized hunters' self-monitoring of shot mountain hare *Lepidus timidus.* The data are available in Faroese in a web-based database.

Tags: outfield landscapes, mountain hare, Faroe Islands, hunters' self-monitoring, citizen science.

Parameter(s): Daily numbers of shot mountain hares and hare hunting trips.

Possible use: A better understanding of hare population dynamics, including management decisions on hare hunting.

Relevant links: http://haran.fo/

3.14 Sea Ice for Walrus Outlook

The Sea Ice for Walrus Outlook (SIWO) is a resource for Alaska Native subsistence hunters, coastal communities, and others interested in sea ice and walrus. The SIWO provides weekly reports from April through June with information on weather and sea ice conditions relevant to walrus in the northern Bering Sea and southern Chukchi Sea regions of Alaska. The Outlooks are produced with information on weather and sea ice conditions provided by the National Weather Service - Alaska Region and Alaska Native sea ice experts. Forecast products of sea ice and weather conditions and local observations of sea ice, weather, and walrus from 2010 to present can be viewed in the data collection.

Tags: community-based monitoring, sea ice, walrus, weather.

Parameter(s): sea ice, wildlife.

Possible use: Providing a better understanding of sea ice and documenting local sea ice change, relevant to safe navigation in the area.

Relevant links: https://www.arcus.org/siwo and https://www.arcus.org/siwo/resources

3.15 Spotter Pro

Spotter Pro is a global citizen science program using an app for recording marine mammals from ships of opportunity.

Tags: biodiversity, biology, citizen science, ecology, marine mammals, whales.

Parameter name(s): marine mammals.

Possible use: A better understanding of whale numbers, distribution and population dynamics which may for instance be useful to prevent ship strikes.

Relevant link: http://rannsoknasetur.hi.is/university_icelands_research_center_husavik

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