

The Beringian Coevolution Project: Creating the Baselines and Archives



Significant questions are centered on our ability to assess change

- Climate change
- Habitat conversion
- Pollutants
- Introduction of exotics
- Loss of biotic diversity
- Emerging pathogens & diseases



Sampling is crucial to establish the baselines needed to document changing environments and emerging pathogens

Critical Arctic Infrastructure for Assessing Change

Sampling Design and Availability

- Temporally Deep Sampling
- Geographically Broad, Site Intensive
- Geo-referenced
- Multiple kinds of data tied to central voucher specimen
 - Frozen Materials for Molecular Biology
 - Parasites tied to Hosts

What is Critical Arctic Infrastructure?

– Sampling

- Temporally Deep Sampling
- Geographically Broad, Site Intensive
- Geo-referenced
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– Searchable Web-based Databases

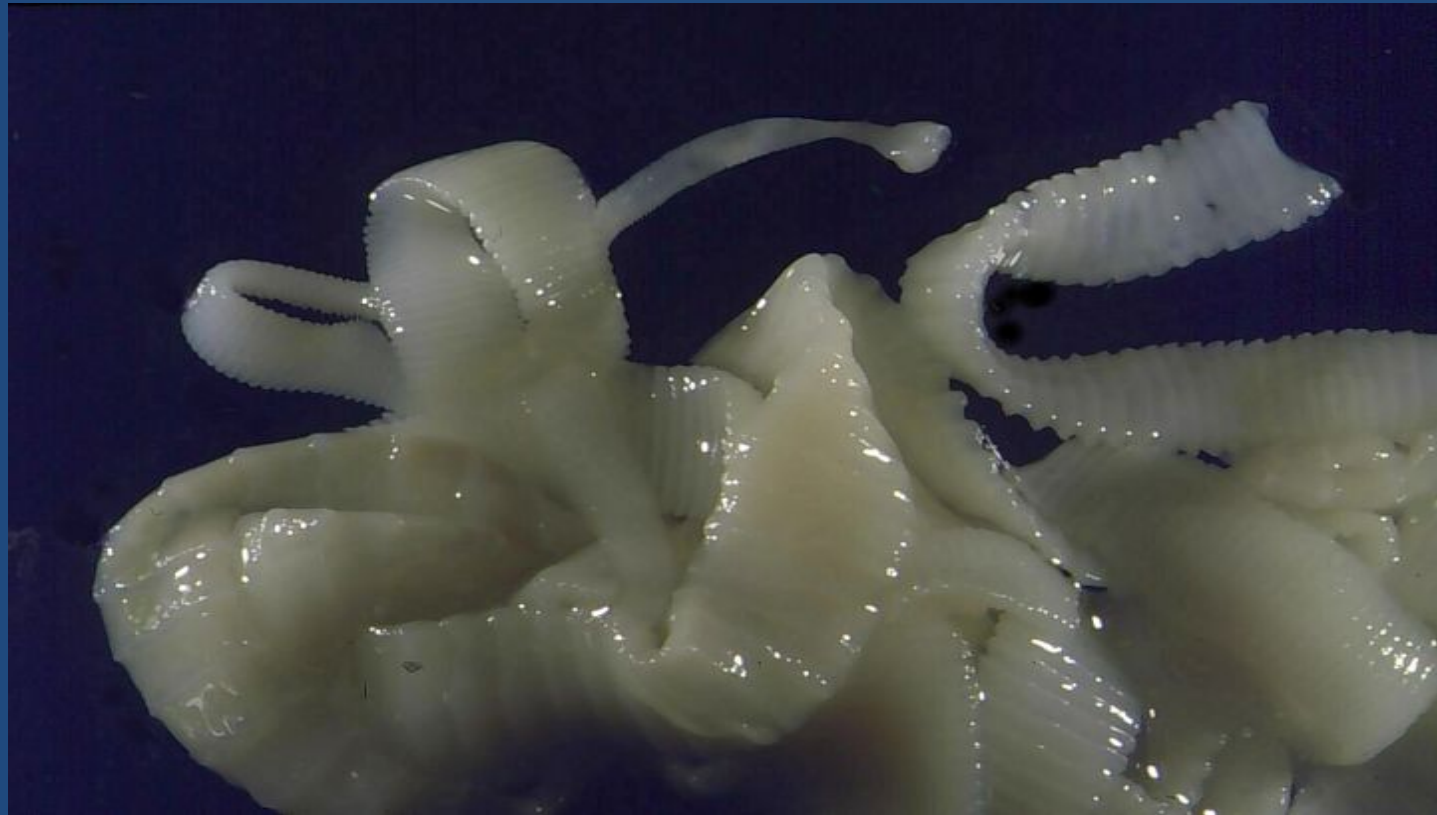
- Research, Policy, Education

* ATTENTION *

IF YOU HAVE A
FEVER ALONG WITH
MUSCLE ACHES AND
PAINS, PLEASE STAY
IN YOUR CAR AND
WE WILL EXAMINE
YOU THERE.

June 199
Clinic on Navajo Reservatio

Natural History Archives: Infrastructure for Training, Research, Surveillance, Management and Communication



What are sources of Big Data for responding to biodiversity crises?

- GBIF
- GenBank
- GIS—GoogleEarth, BerkeleyMapper, etc
- Museum specimens—the nexus

Specimens tie together big data into a powerful tool for assessing emerging pathogens or impacts of environmental change.



Integrating Host-Pathogen Research Through Holistic Specimens



Robert Rausch



Robert Baker

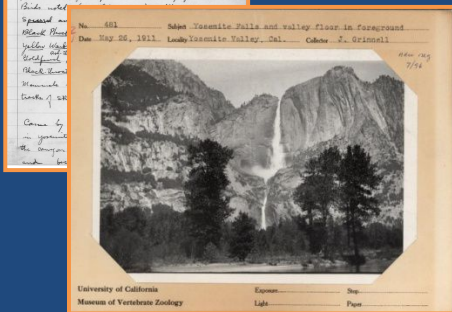
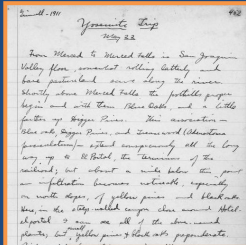


Karl Johnson

Traditional Specimen

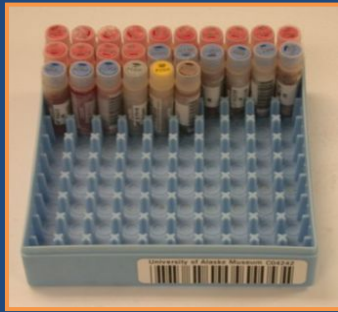


Skin, skeleton or fluid voucher



Field notes,
ecological data

Holistic Specimen



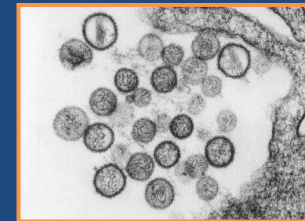
Ultrafrozen tissues



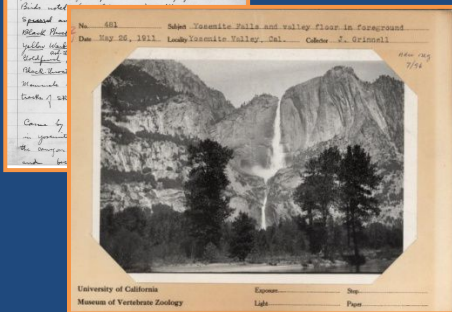
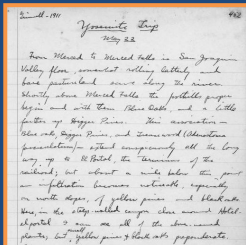
Traditional



Ecto & endoparasites



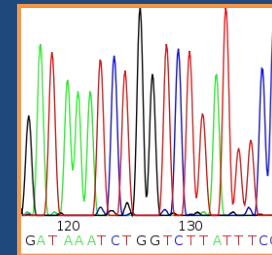
Virus isolates



Field notes,
ecological data



Geo-reference



Genomic data

Natural History

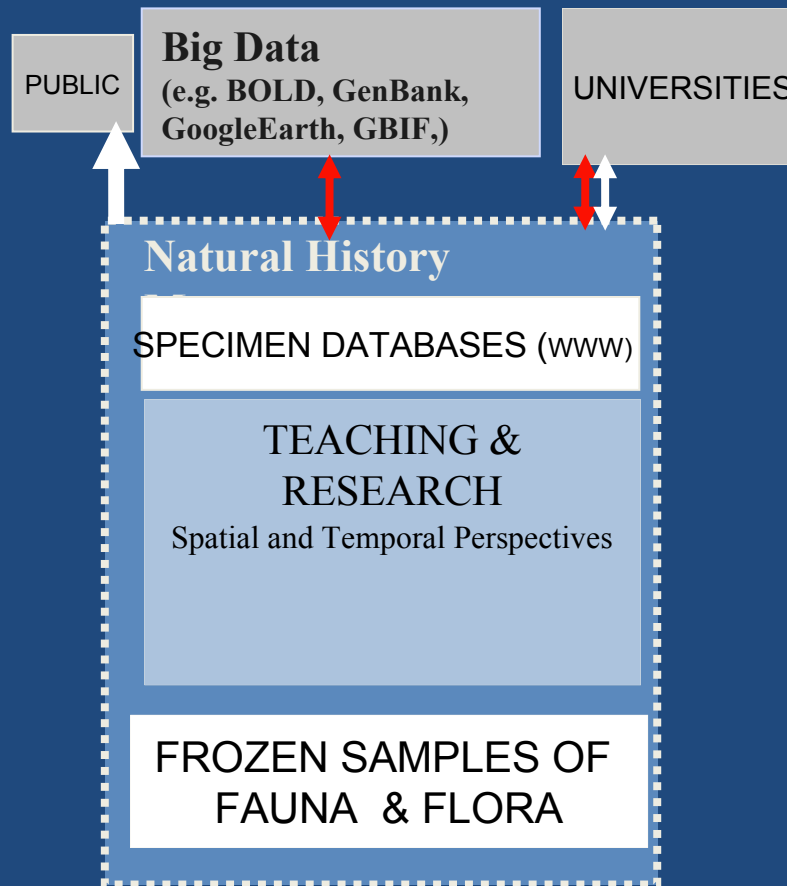
SPECIMEN DATABASES
(WWW)

TEACHING &
RESEARCH

Spatial and Temporal Perspectives

FROZEN SAMPLES OF
FAUNA & FLORA

A Museum Approach to
Pathogen Observatories



specimens & samples

specimen data and project metadata

A Museum Approach to Pathogen Observatories

Policy Initiatives

CAFF
Fauna & Flora

Sample Providers

Long-Term
Environmental
Research Stations

Pathogen
Identification &
Monitoring

Parasitologists

PUBLIC

Other WebTools &
Databases (e.g. BOLD,
GenBank, GoogleEarth,
GBIF, Encyclopedia of
Life)

UNIVERSITIES
Other MUSEUMS
& ARCHIVES



specimens & samples

specimen data and
project metadata

A Museum Approach
to Observatories

Policy Initiatives

SNAP
Fauna & Flora

PUBLIC

Other WebTools & Databases (e.g. BOLD, GenBank, GoogleEarth, GBIF, Encyclopedia of Life)

UNIVERSITIES
Other MUSEUMS & ARCHIVES

Sample Providers

Long-Term Environmental Research Stations

Pathogen Identification & Monitoring
e.g., Hantavirus, Dengue
Agricultura y Ganaderia

Natural History

SPECIMEN DATABASES (www)

TEACHING & RESEARCH

FROZEN SAMPLES OF FAUNA & FLORA

Resource Managers and Local

Management & Research
Fish & Wildlife Protection

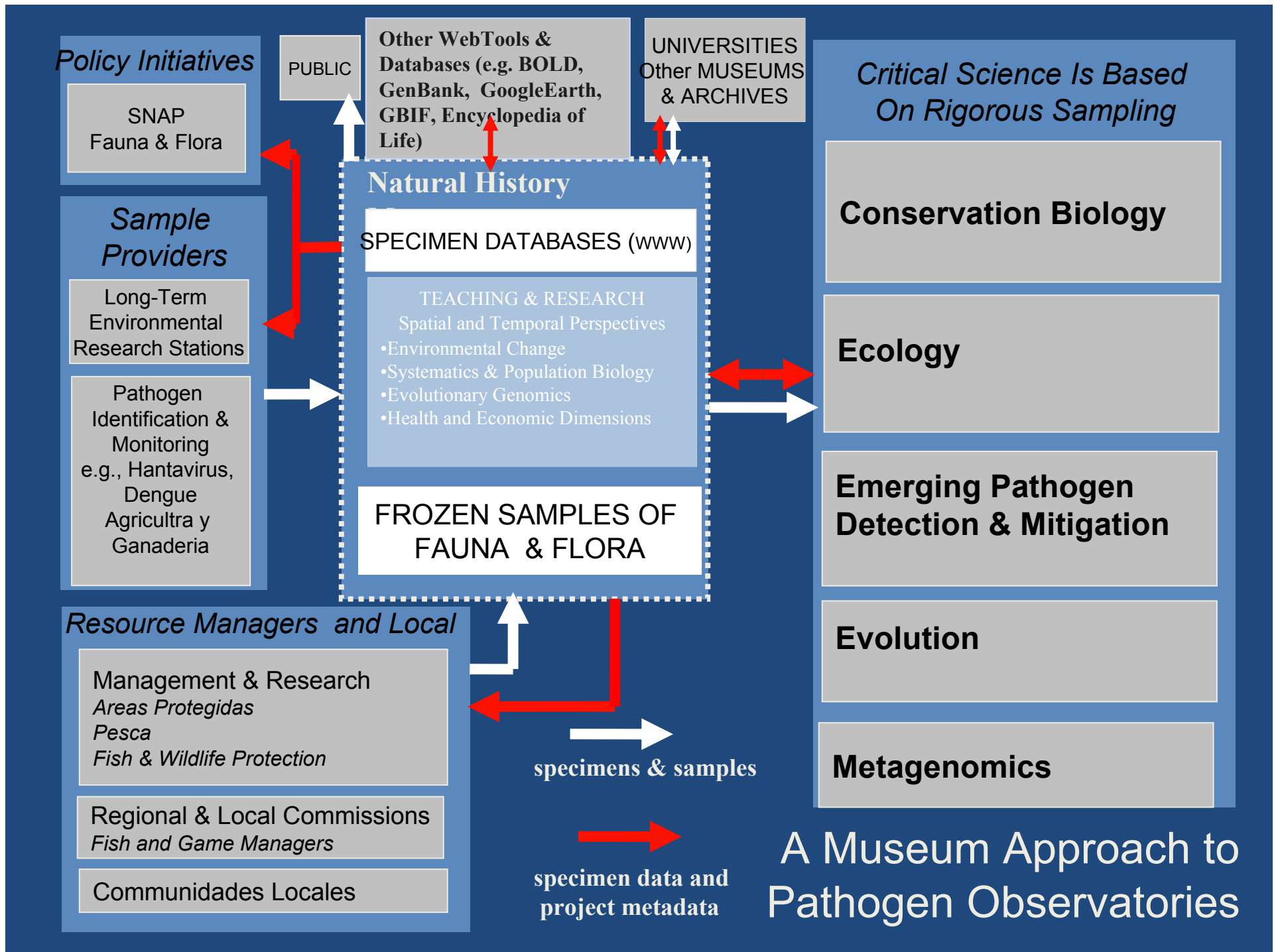
Regional & Local Commissions
Fish and Game Managers

Rural Communities

specimens & samples

specimen data and project metadata

A Museum Approach to Pathogen Observatories



Mammalogy

V Fedorov, L Olson

University of Alaska

H. Henttonen

Vantaa, Finland

S Talbot

USGS-AK Science Center

N Dokuchaev

IBPN, Magadan, Russia

Graduate Students

Chris Conroy

John Demboski

Karen Stone

Amy Runck

Kurt Galbreath

Byron Weckworth

Eric Tomasik

Aren Eddingsaas

Eric Waltari

Natalie Dawson

Andrew Hope

Jason Malaney

Kayce Bell

Bryan McLean

Jocelyn Colella

Donavan Jackson

Dianna Kresja

BCP

Integrated Collections
Host/Parasite

Rural
Communities

Local Trappers &
Hunters

K-12 Students

Natural Resource
Management
Agencies

Parasitology

E Hoberg

USDA

R Eckerlin

N Virginia Comm College

V Haukialmi

Vantaa, Finland

K Galbreath

N Michigan University

S Kutz

University of Calgary

A Markarikov

Russia- Novosibirsk

E Jenkins

Canada

S Telford III

Tufts University

Greg Ebel

Colorado State Univ

Vasyl Tkach, Stephen Greiman

Univ North Dakota

BCP Expeditions

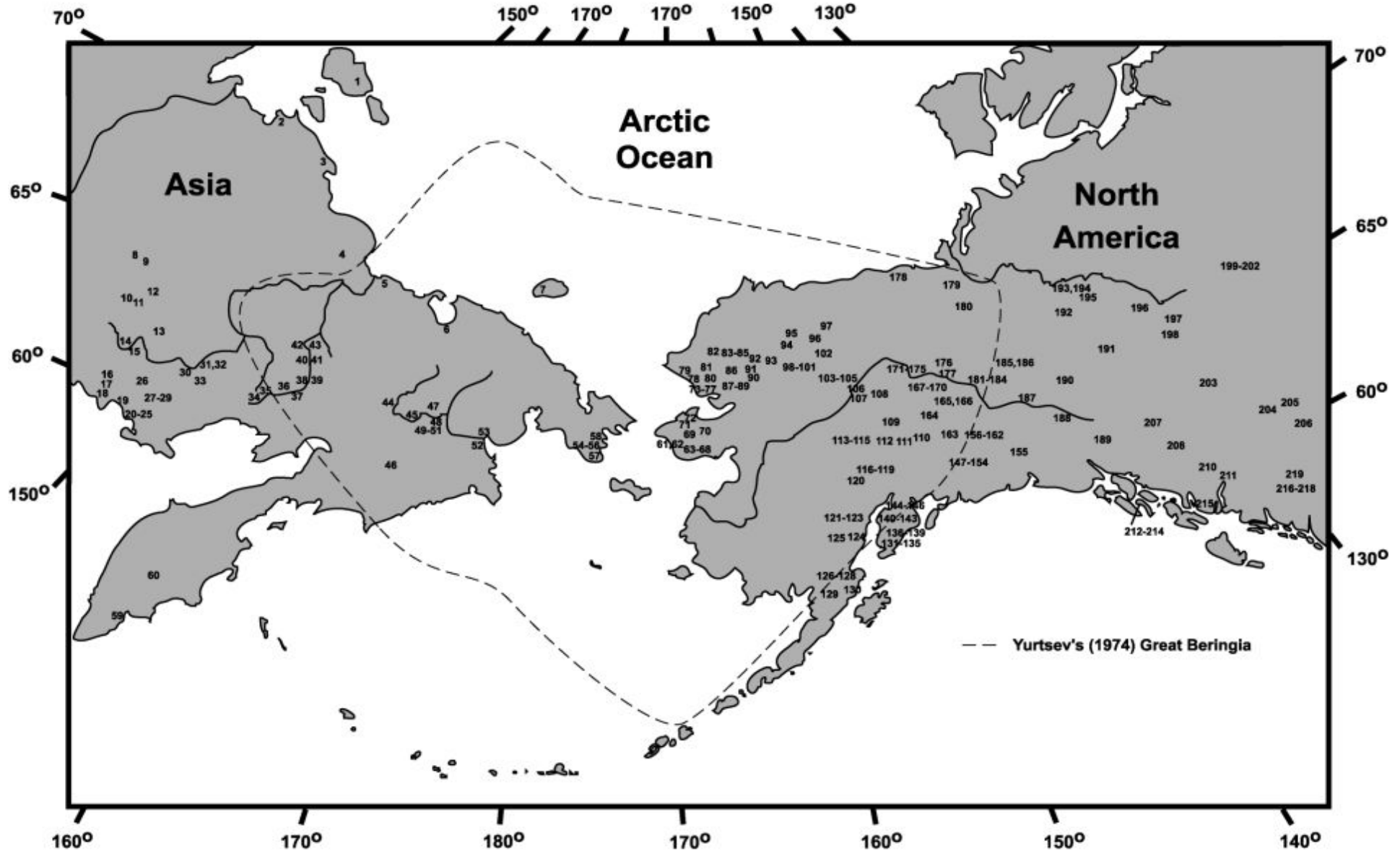


Specimen Based

- Tissues (frozen)
- Ectoparasites
- Endoparasites
- Feces



Beringian Study Sites (1999-2014)



Beringia Coevolution Project



Field---Sampling Regime

- Spatially Extensive (>200 sites across the Arctic)
- Site Intensive
- Hosts
 - mammals (80 spp, >30,000 specimens)
- Parasites- several thousand lots of
 - helminths,
 - arthropods,
 - protozoans,
 - viruses

BCP Integrated Archives

The Collections are

- Temporally Deep
- Geographically Broad, Site Intensive
- Geo-referenced
- Multiple Datasets (tied to central voucher specimen)
 - Frozen Materials for Molecular Biology
 - Parasites tied to Hosts

Available in Searchable Web-based Databases

- Research, Policy, Education



Arctos

Collaborative Collection Management Solution

Username

Log In

or

Create Account

Search

Portals

My Stuff

About/Help

Access to 2,269,629 records

Search

Clear Form

Use Last Values

See results as:

Specimen Records

Type: any

Require Tissues?

Identifiers

Customize Show More Options

Collection: Select options

Catalog Number:

GUID:

Identification and Taxonomy

Show More Options

Identification

Identification (scientific name)

Include previous IDs?

Current ID only

Match Type

starts with

Locality

Show More Options

Any Geographic Element:

Select on Google Map

Date/Collector

Show More Options

Help

Agent Role

Define

Biological Individual

Show More Options

Part Name:

Define Add = for exact match

Usage

Show More Options

Basis of Citation:

Define



Linking Big Data—Space, Time, Genetics

UAM:Mamm:36761

Sorex ugyunak

[<< Return to results](#)

Point Barrow

North America, United States,

Alaska, Barrow Quad

23 Aug 1995

skin; skull; postcranial skeleton; tissue
(frozen); heart (frozen); liver (frozen)

[R
U
first
K
Rec

[Sorex ugyunak](#)

Animalia Chordata Mammalia Soricomorpha Soricidae Soricinae Soricini Sorex
ugyunak Anderson and Rand, 1945

Identified by Gordon H. Jarrell on 2002-11-07

Identifiers

AF: 11764

GenBank: [AF250435](#)

GenBank: [AY014927](#)



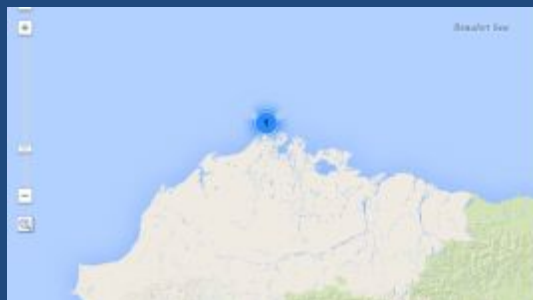
nature
climate change

ARTICLES

PUBLISHED ONLINE: 7 JULY 2013 | DOI: 10.1038/NCLIMATE1976

Future distribution of tundra refugia in northern Alaska

Andrew G. Hope^{1*}, Eric Waltar², David C. Payer³, Joseph A. Cook⁴ and Sandra L. Talbot¹



NCBI Resources How To

Nucleotide Nucleotide Advanced

Display Settings: GenBank Send

Sorex ugyunak NADH dehydrogenase subunit 4 (ND4) gene, partial cds; mitochondrial gene for mitochondrial product

GenBank: [AF250435.1](#)

FASTA Graphics PopSet

LOCUS: [AF250435](#) 582 bp DNA Linear NAM 03-MAR-2003

Beringia Coevolution Project



Field---Sampling Regime

Spatially Extensive

Site Intensive

Hosts- mammals (80 spp, >30,000 specimens)

Parasites- helminths, arthropods, protozoans, viruses

Lab---Species and Genes

Multiple Species

mtDNA

nucDNA



- Three levels of focus for host-pathogens:
 - **Phylogenetics**
 - Diversification, cospeciation, lateral transfer,
 - **Phylogeography**
 - Test explicit hypotheses
 - Identify geographic breaks, refugia,
 - Integrating geospatial data (e.g., vegetation, climate, paleoclimate, geology)
 - Comparative phylogeography
 - **Population genetics:**
 - Demographic signals (refugia, colonizations)
 - Contact zones (hybridization, introgression, parasite loads, parasite transfers)

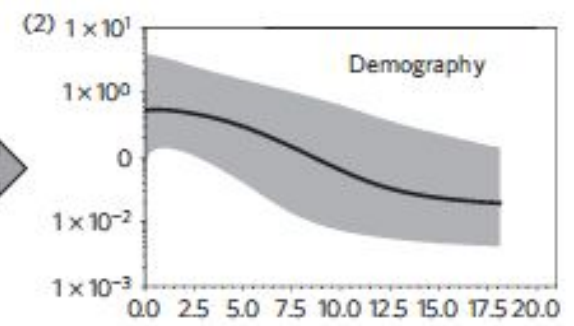
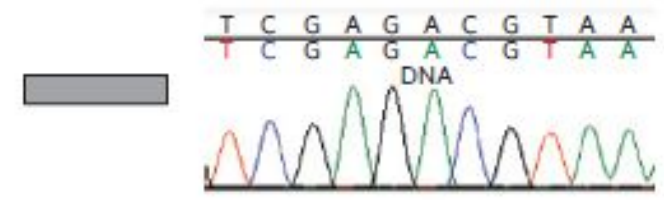
Summary of Beringia Coevolution Project Results

- > 170 papers
- New species described
- New genera discovered
- Implications summarized by Galbreath in Wednesday ABA session “Biodiversity of Beringia: Past, Present and Future”

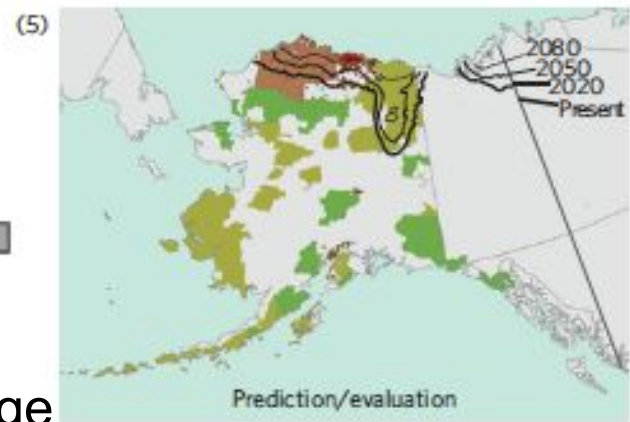
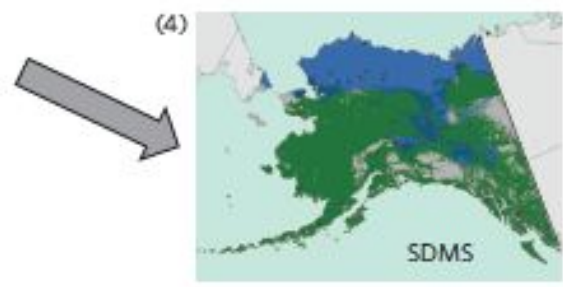
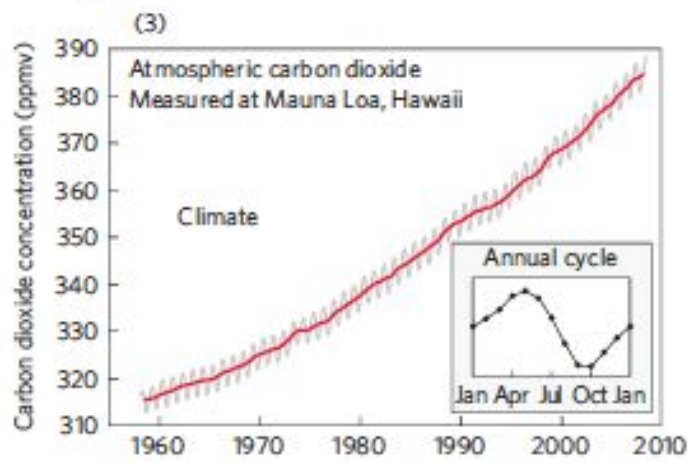


Georeferenced contemporary and fossil specimens

Inventory, monitoring, field collection



Verify (upward arrow)
Refine (downward arrow)



Nature Climate Change

"At this point I wish to emphasize what I believe will ultimately prove to be the greatest value of our museum. This value will not, however, be realized until the lapse of many years, possibly a century, assuming that our material is safely preserved. And this is that the student of the future will have access to the original record of faunal conditions."

Joseph Grinnell, 1910
"The Uses and Methods of a Research Museum"
Popular Science Monthly



Priority Action Items

- **Build Arctic tissue archives**
- **Expand specimen-based biodiversity informatics**
- **Connect Big Data Initiatives**
 - **Museums to GenBank (Genomics) to GIS**
- **Stimulate emerging pathogen monitoring through integrated inventories**
- **Develop educational interfaces for Arctic data**