

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



Baseline conditions or historical information are crucial to documenting environmental change.

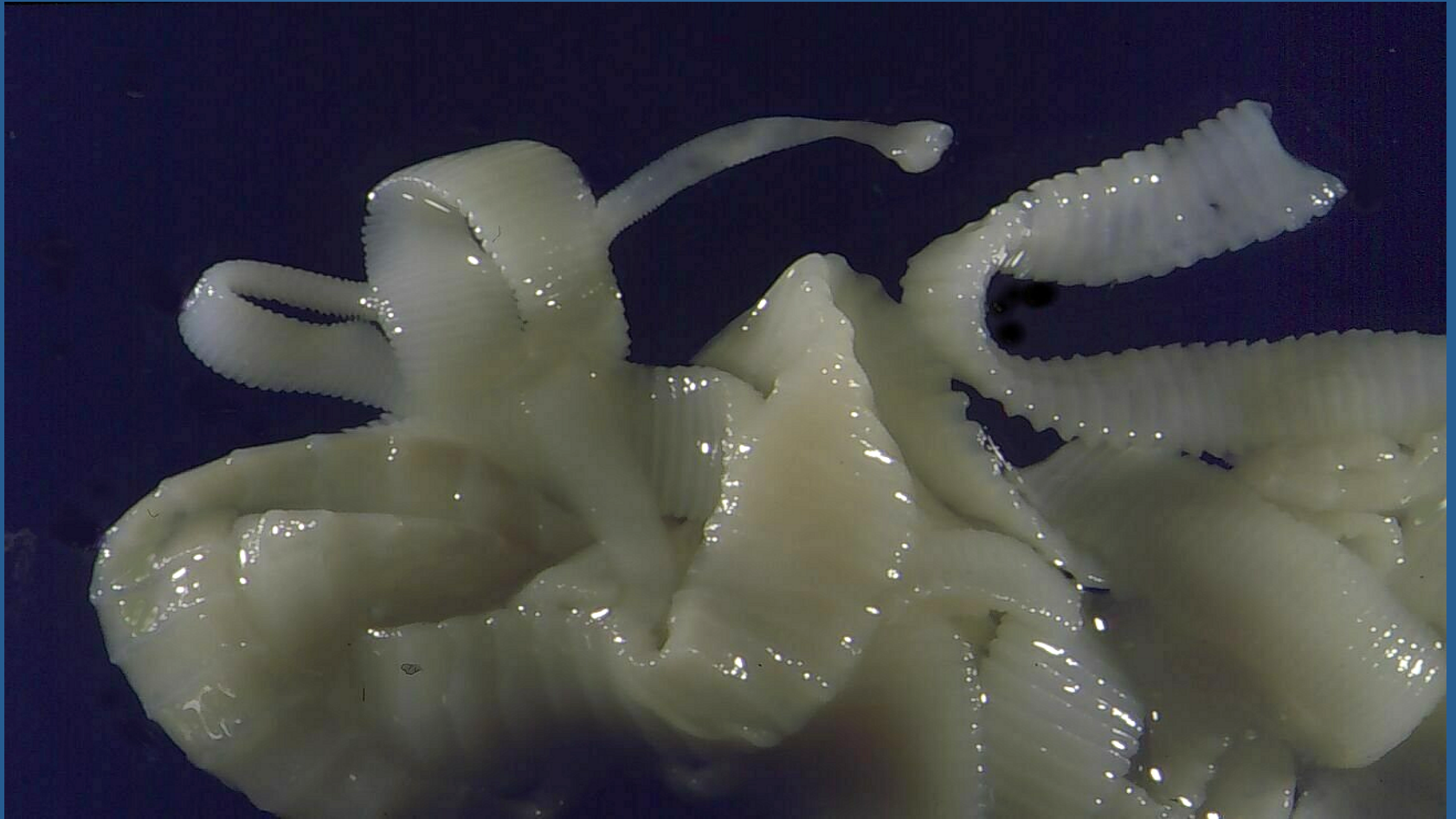
Issues that future generations will be grappling to mitigate.

Building Critical Scientific Infrastructure for Key Societal Issues

Museums have a key role!

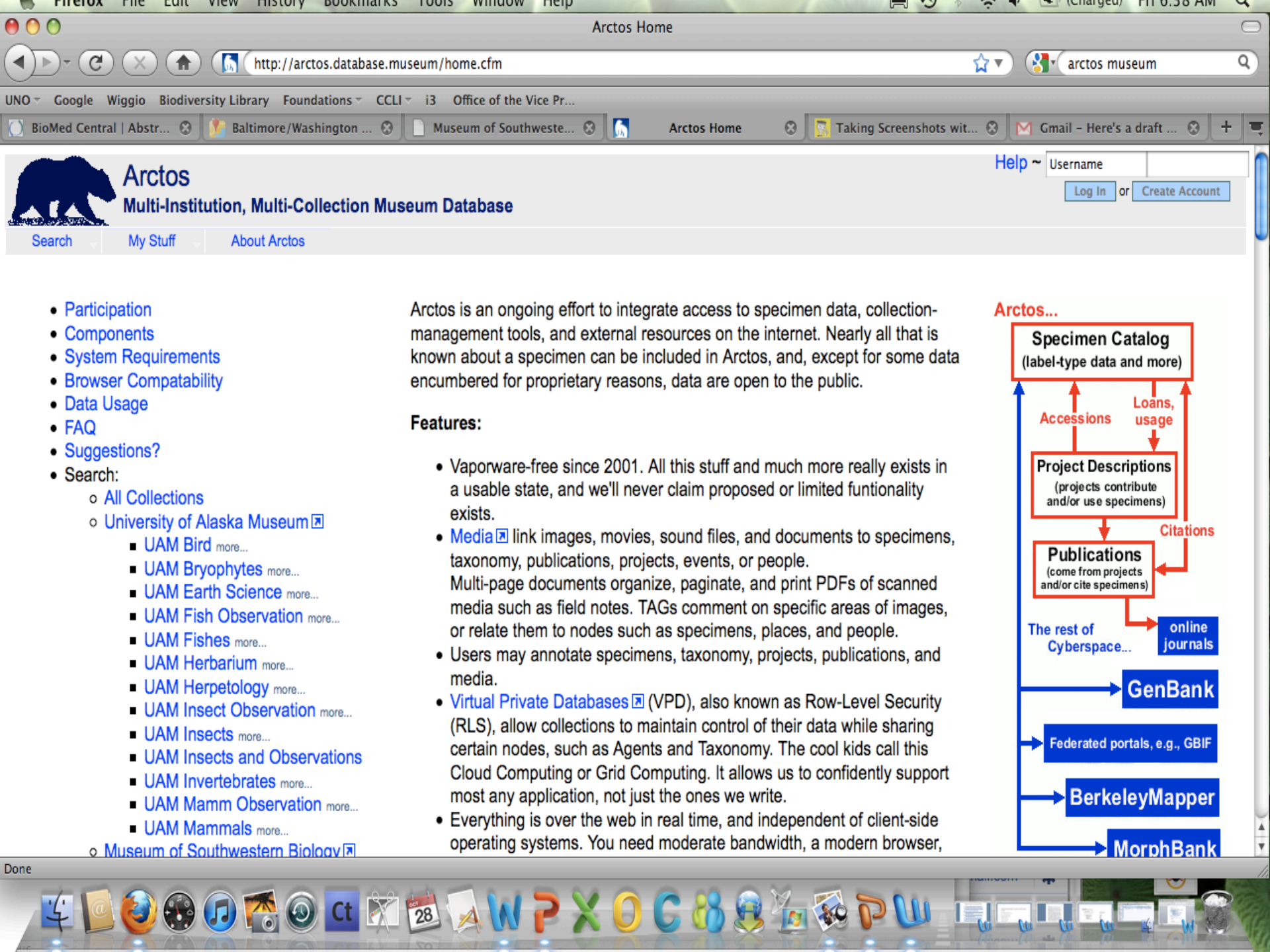
- Integrated and Digitized Archives
 - Lead to Unintended Consequences
- Building Human Capacity
 - Revitalizing Biology Undergrad Education
 - Broadening Participation
 - New Generation of Museum Professionals

Integrated Archives



Integrated Archives

- Diverse Data Connected Through Voucher Specimen
 - Frozen Materials for Molecular Biology
 - Parasites Tied to Hosts
 - Temporally Deep
 - Geographically Broad, Site Intensive
 - Geo-referenced
- Searchable Web-accessible Databases
 - Research, Policy, Education



Arctos

Multi-Institution, Multi-Collection Museum Database

Help ~ Username

or

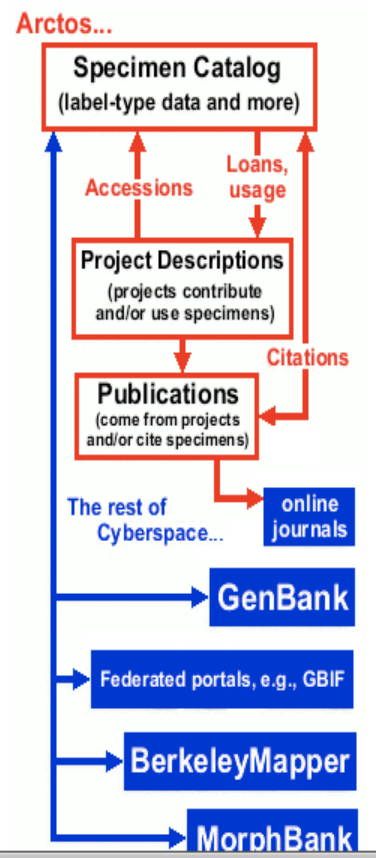
- Search
- My Stuff
- About Arctos

- [Participation](#)
- [Components](#)
- [System Requirements](#)
- [Browser Compatibility](#)
- [Data Usage](#)
- [FAQ](#)
- [Suggestions?](#)
- Search:
 - [All Collections](#)
 - [University of Alaska Museum](#)
 - [UAM Bird](#) more...
 - [UAM Bryophytes](#) more...
 - [UAM Earth Science](#) more...
 - [UAM Fish Observation](#) more...
 - [UAM Fishes](#) more...
 - [UAM Herbarium](#) more...
 - [UAM Herpetology](#) more...
 - [UAM Insect Observation](#) more...
 - [UAM Insects](#) more...
 - [UAM Insects and Observations](#)
 - [UAM Invertebrates](#) more...
 - [UAM Mamm Observation](#) more...
 - [UAM Mammals](#) more...
 - [Museum of Southwestern Biology](#)

Arctos is an ongoing effort to integrate access to specimen data, collection-management tools, and external resources on the internet. Nearly all that is known about a specimen can be included in Arctos, and, except for some data encumbered for proprietary reasons, data are open to the public.

Features:

- Vaporware-free since 2001. All this stuff and much more really exists in a usable state, and we'll never claim proposed or limited functionality exists.
- [Media](#) link images, movies, sound files, and documents to specimens, taxonomy, publications, projects, events, or people. Multi-page documents organize, paginate, and print PDFs of scanned media such as field notes. TAGs comment on specific areas of images, or relate them to nodes such as specimens, places, and people.
- Users may annotate specimens, taxonomy, projects, publications, and media.
- [Virtual Private Databases \(VPD\)](#), also known as Row-Level Security (RLS), allow collections to maintain control of their data while sharing certain nodes, such as Agents and Taxonomy. The cool kids call this Cloud Computing or Grid Computing. It allows us to confidently support most any application, not just the ones we write.
- Everything is over the web in real time, and independent of client-side operating systems. You need moderate bandwidth, a modern browser,



Museum Data Available on Web

NSF's Advancing Digitization of Biological Collections



Critical Scientific Infrastructure for Key Societal Issues

- Integrated & Digitized Archives
- **Building Human Capacity**
 - **Revitalizing Biology for Undergrads**

Stimulate Change in Undergraduate Education

- **Vision and Change—AAAS (2009)**
- **PULSE – (2012) Partnership for Undergraduate Life Sciences Education (NSF, HHMI and NIH)**
40 Leadership Fellows
- **PCAST (Feb 2012) Engage to Excel**

replace standard laboratory courses with discovery-based, relevant research courses

What do collections-based approaches add to undergrad education?

- Integration
 - biotic and abiotic
 - genomic to organismal to ecosystems
- Scale—time and space
- Complexity-multiple views
- Web-based Discovery
- Database exposure
- Scientific Process
 - Experiential vs passive



Challenges



- Few educators (& fewer students) seem to know:
 - about natural history collections
 - or their role in development of key concepts
 - how to access museum information (data)
 - how to incorporate specimen data in teaching

A Few More Challenges



- Collections (and databases) have limitations
 - Specimen availability
 - Regional, smaller university museums***

A Few More Challenges



- Collections (and databases) have limitations

- Specimen availability

- Narrow view of possibilities

- Systematics & natural history,

- “Unintended Uses”

Now extended to other disciplines

- E.g., isotope ecology, developmental biology, molecular genomics, pathogen discovery, geography, art

Other Challenges



- Collections (and databases) have limitations
 - Collections developed for **research**,
 - Databases developed for **collection management**, not education or outreach.

NSF: RCN-UBE

- RCN-Undergraduate Biology Education
 - focuses on improved participation and learning in undergraduate biology curricula.

Goal: create new directions in education coordinating activities across disciplinary, organizational, geographic and international boundaries.



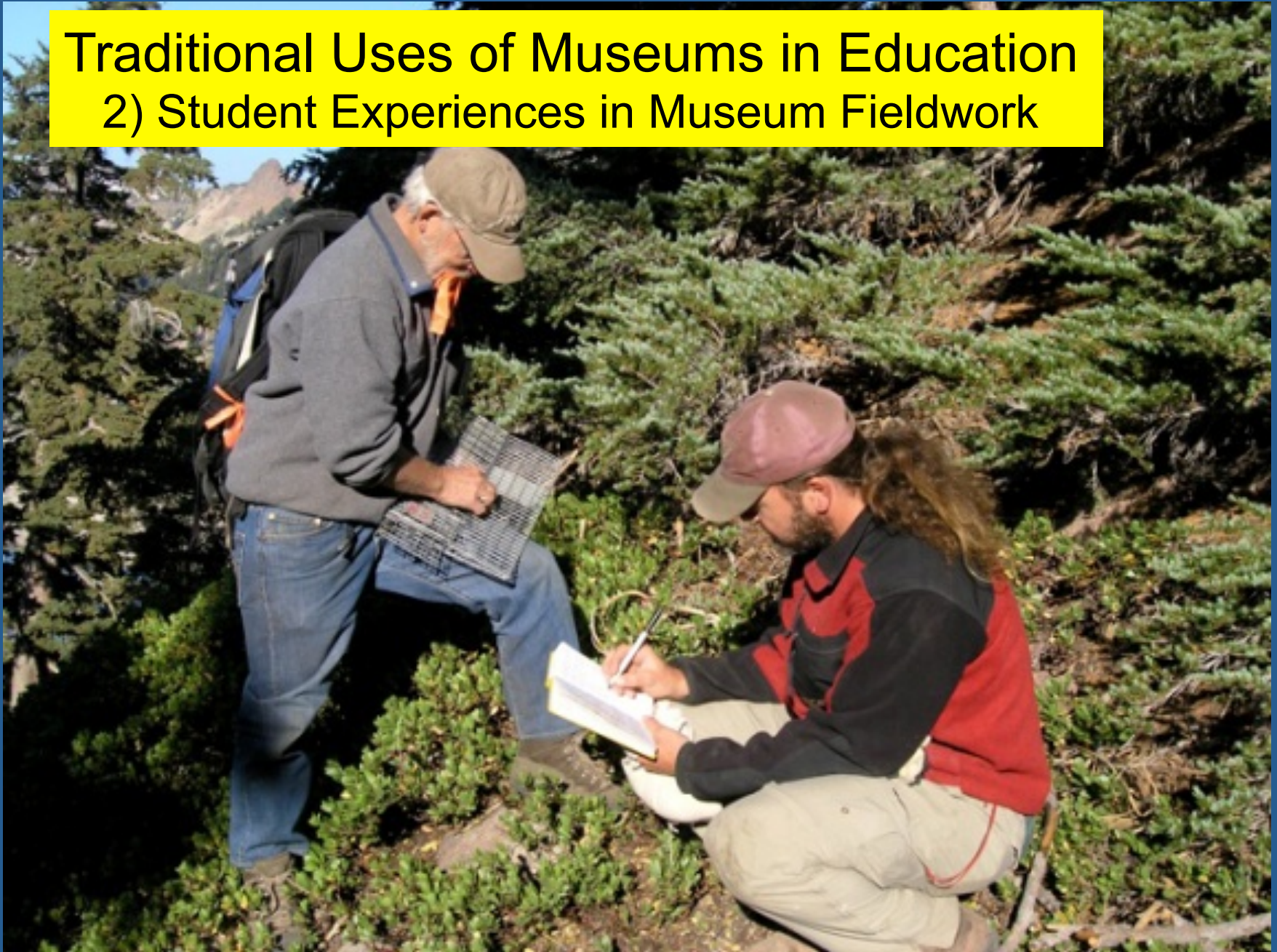
Traditional Uses of Museums in Education

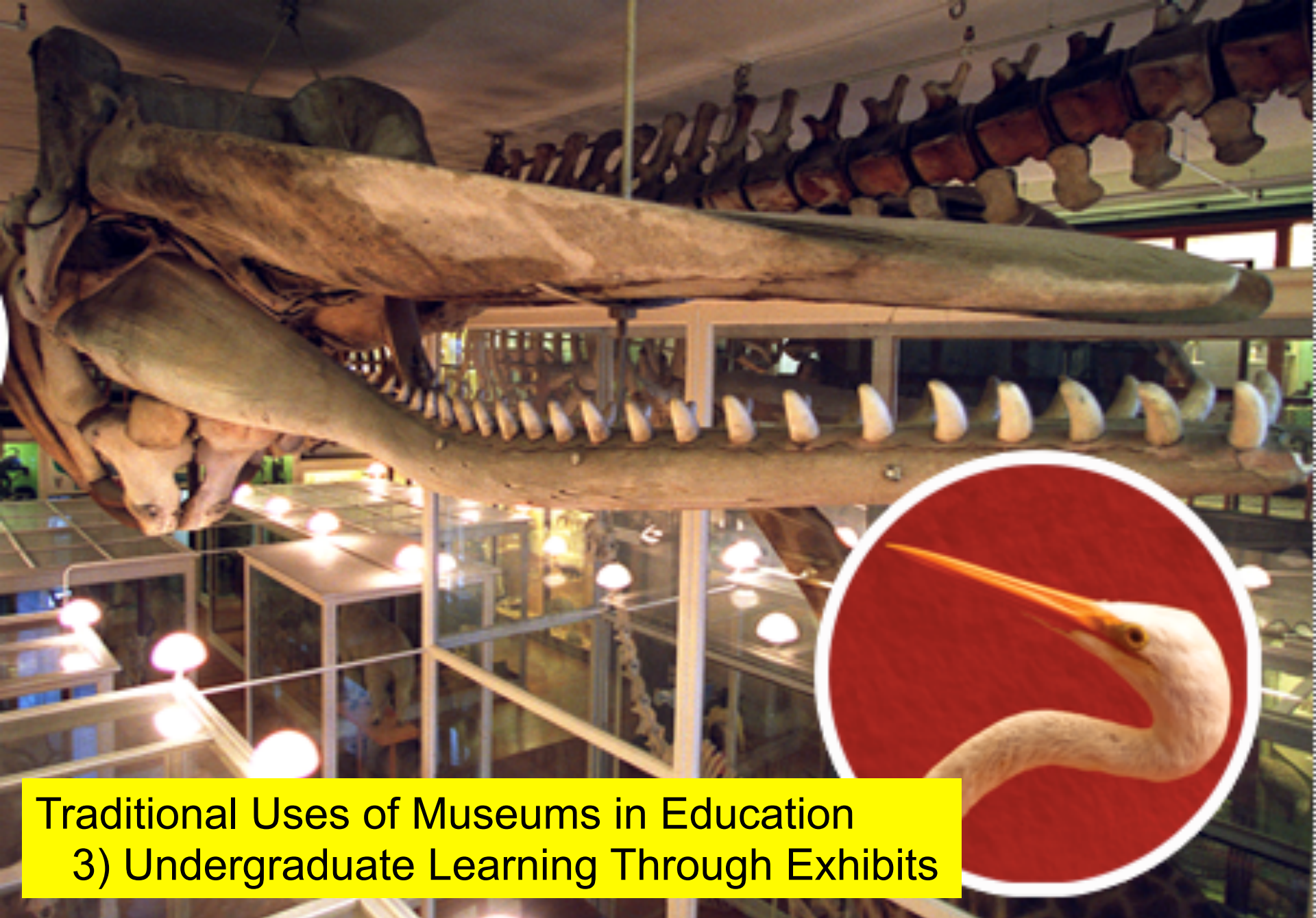
1) Student Experiences in Curation



Traditional Uses of Museums in Education

2) Student Experiences in Museum Fieldwork





Traditional Uses of Museums in Education
3) Undergraduate Learning Through Exhibits

Traditional Uses of Museums in Education

4) Research Experiences Based on Collections



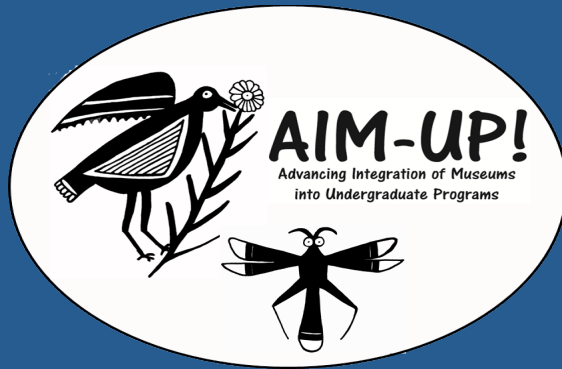


Traditional Uses of Museums in Education
5) Specimens Used in Classrooms

Newer Uses of Museums in Education

Specimens Used in Classrooms

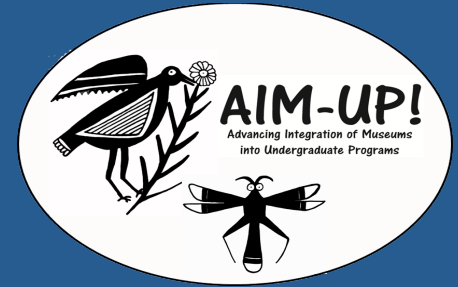




- Crossing Taxonomic Borders
- Educators-Museum Staff
- Biologists-Education Specialists
- Informatics--Databases
- Art and Geography
- Others (GenBank, Agencies)



AIM-UP!--the network



Universities, Community Colleges and Tribal Colleges:

U Alaska, UC Berkeley, Harvard U, U New Mexico
U Michigan, Texas A&M, U Texas, U Colorado, U Arizona, U Kansas, UAS,
UAA, CNM, NM Highlands University, Ohio State U, Occidental College,
Northern Arizona University, U of Florida, Massachusetts College of Liberal
Arts, University of Idaho, Arizona State U, Oglala Lakota

Agencies and Free-standing Museums: USDA National Parasite
Lab, USGS Molecular Ecology Lab, USNM, Denver Museum of Nature &
Science, NY State Museum

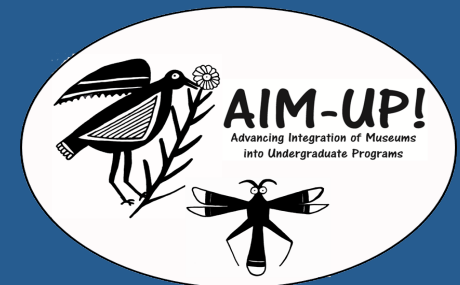
International: U Guelph, U Nacional Montevideo,

Extension to High Schools and Citizens: Highland High (urban)
and Sitka High (rural)



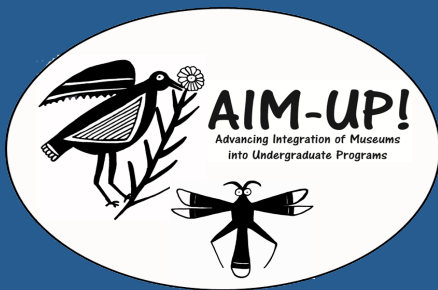
Annual Conceptual Themes:

- 1) Integrative Inventories (MSB-2011)
- 2) Making Sense of Geographic Variation (UAM-2012)
- 3) Evolutionary Dynamics of Genomes (MCZ-2013)
- 4) Biotic Response to Climate Change (MVZ 2014)
- 5) Coevolving Communities and the Human Dimension (MSB-2015)



5 Annual All-Hands Meetings

- Exchange Perspectives on Teaching about *Climate Change and the Museum*
- Explore Educational Modules & Dissemination
- Evaluation



Workshops & Seminars



- 1) Fluid Taxonomy -- on the dynamic practice of classification (Susan Anker)
- 2) Cataloguing Wonder -- collecting through the senses (Brandon Balengée)
- 3) Morphology and Evolution -- investigating change in nature and culture through place and time (Brian Conley)

Art and Natural History Collections



Educational Modules

Island Biogeography: Species Richness Across a Northern Archipelago



Key Concepts and Skills: Evolution & Ecology

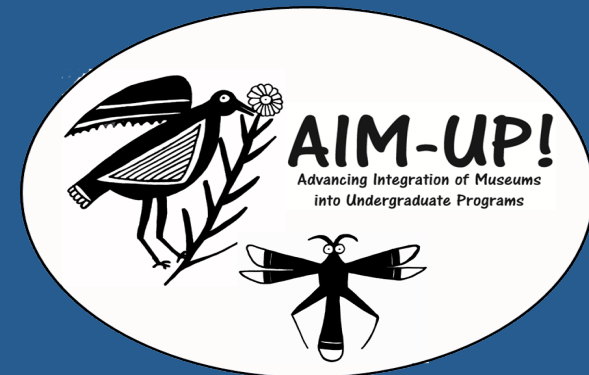
- Body size on islands
- Competitive exclusion/release
- Isolation and Divergence
- Island biogeography

Conservation biology
Scientific process & hypothesis testing
Statistical methods
Management & analyses of large-scale databases

Evolutionary Genomics and the Museum

Potential Topics for Educational Modules

- Tree of Life
- Spatial and Temporal Genetic Variation
- Scientific Process (Replication--without vouchers, difficult to impossible)
- Connecting Big Data (GenBank to GIS Applications)
- Genes and Developmental Biology
- Founder Effects, Island Syndrome



Climate Change Educational Modules

- With warming conditions individuals/populations
 - Move
 - up in elevation—(Grinnell Project)
 - to higher latitudes (musk-ox lungworm parasite)
 - Explore Velocity of Change
 - Species Distributions
 - Niche Envelops
 - Adapt
 - Life history changes
 - Phenology

Products

- **Better Understanding of Existing Programs**
- **Survey of Educators and Students**
- **Stimulate Interdisciplinary Use of Specimens**
- **Publications—**
 - Perspectives, Surveys, Educational Venues, Texts
- **Educational (Dispersion) modules** centered around themes

Grow the Community of Users

*"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 in California and the west, wherever we now work."*

Joseph Grinnell, 1910

"The Uses and Methods of a Research Museum"

Popular Science Monthly

