

Ecological and Genomic Exploration of Environmental Change: Assessing a Century of Climate Change Adaptation

A Western Tri-State Consortium Innovation Working Group Report

Activity Lead: Dr. Gary Roemer

Location: Ladder Ranch, Hillsboro, NM

March 25-28, 2013

Participants

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Dr. Jim Patton, Curator of Mammals (emeritus), Museum of Vertebrate Zoology, University of California, Berkeley, patton@berkeley.edu

Dr. Eric Rickart, Curator of Vertebrates, The Natural History Museum of Utah, University of Utah, Salt Lake City, rickart@umnh.utah.edu

Dr. Gary Roemer, Wildlife Biologist, Dept. Fish, Wildlife and Conservation Ecology, New Mexico State University, Las Cruces, groemer@nmsu.edu

Dr. Michael Thomas, Genomicist/Bioinformaticist, Dept. of Biology – Evolutionary Genomics Group, Idaho State University, Pocatello, mthomas@isu.edu

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Project Statement

Agricultural conversion, urban encroachment, landscape fragmentation and species invasions have eroded global biodiversity. The biodiversity of western North America, like that of the rest of our Earth, is further threatened by global-warming, which has already altered species distributions, changed phenology and caused the extirpation of populations. The loss of biodiversity has the potential to contribute to a decline in ecosystem services. For example, it has been proposed that higher biodiversity lessens the likelihood that zoonosis will cross species boundaries and result in novel human disease. Understanding the patterns and mechanisms involved that have and will alter biodiversity is thus paramount to developing strategies for mitigating current and future losses and the attendant ecological and socioeconomic costs.

Workshop Discussions and Outcomes

Our workshop brought together a diverse group of scientists to assist in developing strategies geared toward climate change adaptation (Appendix I – meeting plan). Our initial discussions focused on the use of an incredible wealth of information regarding the biodiversity of western North America that is housed in natural history collections around the country, such as the collections of the Museum of Vertebrate Zoology at UC-Berkeley and those of the Museum of Southwestern Biology at U. of New Mexico. Using these collections as a base for our discussions, we explored how collections could be integrated with disparate disciplines (e.g., biogeography, ecophysiology, genomics), how much of the information they hold is accessible and how much more would need to be digitized, and how the expertise in cataloguing big data could be used to find solutions to global change.

Day 1, March 25, 2013: After our arrival to the ranch and following lunch, our first afternoon discussion included formal introductions and explanations of current research, followed by a presentation by Dr. Roemer on how this workshop materialized. Later, informal discussions led to the need for funding resurvey efforts and expanding collections to encompass more sampling frames, which would then more accurately reflect a history of faunal change.

Day 2, March 26, 2013: Our second day began shortly after breakfast with the direction of developing a manuscript and white paper. A key approach in the development of our discussions was the application of “story boarding” suggested by our facilitator, Dr. Josh Donlan. During this exercise, participants used “stick-ums” to record their thoughts and ideas, which focused on three themes:

- 1) Biological resurvey efforts: Lessons learned
- 2) The science questions behind biological survey efforts – What are they?

3) What management and/or conservation needs can be addressed by biological resurvey efforts?

As discussions unfolded these topics morphed into how important the specimen is; it is the “anchor” by which all data are referenced. The specimen not only tells us about the past, but it can be used to see the future and the tissues stored will be invaluable for future technological advances in the biological sciences. Natural history collections and the infrastructure and procedures developed for accessioning specimens, archiving and digitizing metadata can and should be used to advance science and address global change in the 21st Century. We kept returning to and expanding upon this theme, and these discussions eventually led to an outline for our first manuscript (see Appendix II).

In addition to the formal discussions, discussions during social periods, especially during and after meals, led to new ideas and applications that were perhaps not an original focus of the workshop but were nonetheless germane. We created a second outline (see Appendix III) whereby novel climate change adaptation strategies were suggested in lieu of recent approaches centered on the implementation and timing of managed relocation.

Day 3, March 27, 2013: After breakfast, we broke out into two working groups and expanded the outlines for each of the two manuscripts. In the afternoon and evening, we discussed funding opportunities, such as NSF’s Advancing Digitization of Biodiversity Collections (ADBC) (http://www.nsf.gov/funding/pgm_summ.jsp?pims_id=503559) and Collections in Support of Biological Research (CSBR) (http://www.nsf.gov/funding/pgm_summ.jsp?pims_id=503651&org=NSF).

In addition to NSF funding for basic research and biological collections enhancement, we discussed resource agency programs in existence that might benefit from natural history collections and procedures, and the approaches we are suggesting. The National Park Service’s Inventory and Monitoring Program and the U.S. Fish and Wildlife’s monitoring program for the National Wildlife Refuge System could be united with public museums and their data assimilated. These discussions raised an important question, and that was why aren’t all of these programs collaborating? Several efforts are underway to understand the effects of global change, to record biotic and abiotic change, and to document ecological alterations at the scale of continents and even the globe, but the general view of the participants was that organizations are not communicating nor sharing data. For example, NSF is funding digitization of data and enhancement of biological collections, research that is mostly carried out by public and private academic institutions. They are also funding NEON, the National Ecological Observatory Network, but NEON is largely overlooking the importance of continuing to conduct biological surveys and to use both historic and contemporary specimens in conjunction with monitoring the Earth to understand ecosystem change. As mentioned, national resource agencies have developed and initiated inventory and monitoring programs but have not, to

our knowledge, secured collaborations with university or state-supported museums where much of the expertise in taxonomy and systematics, and the infrastructure for handling big data exists. NGOs are also not aware of how their funds could be spent to resurvey biodiversity and how such surveys could inform conservation strategies they might have an interest in. Communication and cooperation among these varied organizations and programs could lead toward more informed solutions for climate change adaptation and global change solutions.

Day 4, March 28, 2013: After breakfast, participants departed with most being transported to El Paso International Airport.

Please see the last pages for photos of the workshop.

Appendix I

MEETING PLAN

TITLE: **Ecological and Genomic Exploration of Environmental Change (EcoGenEx): Assessing a Century of Climate Change Adaptation**

PURPOSE: "To design a study that will produce a 'white paper' suitable for submission to NSF as a pre-proposal or as a draft proposal for a resource agency, and to develop a manuscript that will be a 'how to' guide to conduct a resurvey effort. This effort will 1) take advantage of existing natural history collections, 2) contribute to existing collections, 3) extend the model of what natural history collections encompass, 4) advance our knowledge of global change effects (e.g., climate change, urbanization, habitat conversion), 5) offer conservation and management strategies for global change mitigation, and 6) pull together knowledge gaps, methodology and future directions."

PERFORMANCE

OBJECTIVES:

1. Present overview of project, its inception, and its history.
2. Develop our approach: Science to support management and conservation?
3. Discuss knowledge of recent and past resurvey efforts.
4. Discuss survey protocols, essential elements, and how they can be improved.
5. Discuss the potential to incorporate new advances (e.g., genomics, isotopes) into the application of natural history collections as well as storage of metadata and organism tissues beyond just specimens and DNA.
6. Produce a white paper that can be molded into an NSF pre-proposal or a proposal for a resource agency.
7. Produce a manuscript on "How to conduct a biodiversity re-survey to address environmental problems and best inform conservation and management" (sensu Tingley and Beissinger 2010, Pyke and Ehrlich 2010).
8. Identify follow-up actions and groups of individuals who will focus on these. Groups would continue to work after the meeting.

DATE: March 25-28, 2013

LOCATION: Ladder Ranch, New Mexico

ROLES, RESPONSIBILITIES

Facilitator: C. Josh Donlan, Advanced Conservation Strategies

Meeting Leader: Gary Roemer (groemer@nmsu.edu)

Planning Committee: Kris Helgen (SI), Marjorie Matocq (UNR) and Gary Roemer (NMSU)

AGENDA
EcoGenEx Innovation Working Group

Day 1 March 25, 2013

12:00 Arrive at the Ladder Ranch, get situated, have lunch

15:00 Welcome

Opening comments (Gary Roemer, Josh Donlan)
Introductions
General timeline of meeting

15:30 History and Origin of the Proposed Project

EcoGenEx: How did this come about? (Speaker: G. Roemer)
NSF-EPSCoR housekeeping
Draft Agenda
Disseminate: McDonald-Madden *et al.* 2010. Monitoring does not always count. TREE 547-550.

16:30 Break

18:00 Happy Hour – Brief discussion of McDonald-Madden *et al.* 2010

18:30 Dinner and Discussions

Day 2 March 26, 2013

7:30 Breakfast

8:30 Welcome

Purpose, Objectives, Review and Modification of Agenda

9:00 Decision Tree framework: Science, Conservation & Management or Both?

Facilitated Group Discussion: What science questions should we address?

1. Focus on a particular region: the Border – An area of high and recent disturbance or the Intermountain West – An area that has received more intense study.
2. Focus on extreme events – e.g., fire severity, beetle outbreaks, long-term drought.
3. Tease apart impacts owing to climate change vs. those due to other anthropogenic impacts – How does landscape change interact with CC to influence biodiversity?
4. Develop predictive models based on species thermal niches and natural history and test those models with empirical data – Can we predict species declines or reductions in range that require management intervention?
5. Can we predict the occurrence of novel communities and/or species interactions that might cause major perturbations (e.g., urbanization and invasive species)?
6. Examine how anthropogenic disturbances may result in refugia that certain taxa can exploit, perhaps enhancing viability of native species (e.g., deer) or promoting viability of commensal and potentially invasive species (e.g., feral cats).

10:30 Break

10:45 Decision Tree framework: Science, Conservation & Management or Both?

Facilitated Group Discussion: What management questions should we address?

1. Focus on a particular region: the Border – An area of high and recent disturbance or the Intermountain West – An area that has received more intense study.
2. Focus on extreme events – e.g., fire severity, beetle outbreaks, long-term drought.
3. Focus on a biome under duress – e.g., montane forests.

4. Focus on a process – e.g., desertification.
5. Focus on T & E species or protected areas (National Parks or Wildlife Refuges).
6. Develop approaches that identify thresholds to changes in state, and whether or not intervention should be taken to mitigate for the state-change.
7. Determine level of mitigation needed to maintain integrity of a community.
8. Is assisted dispersal something we should consider?
9. Can our desire to understand the factors causing change mesh with existing agency monitoring programs (both NPS and the USFWS are implementing monitoring programs)?

12:00 Lunch

13:00 Decision Tree framework Wrap-up

14:30 Break

15:00 Museum Collections and Historic Surveys – Problems and Pitfalls

Facilitated Group Discussion

1. What collections are best suited for resurvey efforts?
2. The problems with historic records (field notes, memoirs, catch records, etc.).
3. How do we cope with different survey methods historically employed?
4. How do we address the inaccuracy of the historic data collected?
5. How can we identify such collections? Web-based databases?
6. Are current collections amenable to certain analyses given the way in which specimens have been prepared and associated metadata stored and compiled?
7. Where would our collections be housed? Is this even a concern?

Resurvey Studies, Techniques and Methods

1. Occupancy modeling is the ‘cat’s meow’ but will historic data enable us to use it? Some will, but not all. Does this restrict our use to certain survey efforts?
2. Can presence only data be used effectively?
3. Can we improve upon the ideas espoused by Tingley and Beissinger?

17:00 Meeting Adjourns, informal discussions (e.g., resurvey scope, funding sources)

18:30 Dinner

Day 3 March 27, 2012

7:30 Breakfast

8:30 Review previous days topics

10:45 Break

11:00 Landscape Ecology Applications

Facilitated Group Discussion

1. What environmental datasets can be used to inform/design the resurvey effort? Would we use such data as a 'first step' in developing our design?
2. How can such datasets be used in formulating hypotheses regarding landscape or environmental change?
3. What species distribution models (e.g., MAXENT, GARP, Porter's Biophysical models) would be most appropriate for predicting past, current and potential organism distributions?
4. Would a connectivity approach be applicable (Circuitscape)?

12:00 Lunch

13:00 Applications of Stable Isotope Analysis

1. How would stable isotopes be applied?
2. What isotopes would be useful (deuterium, strontium)?
3. What type of destructive sampling would museum curators allow?
4. Which tissues from contemporary specimens would be sampled for future SIA?

14:00 Applications of Genomics to Geographical Ecology

1. How would different tissues from contemporary specimens be sampled to preserve the genome, transcriptome, metabolome?
2. How can we use genomic applications to compare historic and contemporary specimens?
3. What sampling approaches would we need to consider (liquid N₂)?

15:00 Break

15:30 Discussion

17:00 Meeting Adjourns, continued informal discussion of resurvey scope, novel applications and potential funding sources

18:30 Dinner

Day 4 March 28, 2013

7:30 Breakfast

8:30 Discussion/Wrap up

Purpose
Objectives
Agenda

Review from previous day
Wrap up from previous days

Plan to move forward
 Future meetings
 Establish working groups

Summary of meeting (G. Roemer)

NSF housekeeping

Development of white paper/pre-proposal

Concluding comments

Written Evaluation

11:00 Meeting Adjourns

Please have all of your gear packed and ready to go. We will board the van and split!