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Research Proposal: Mediterranean Adaptive Management Modeling
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Abstract: This paper proposes an approach to explore creation of a community learning system focused upon sharing Adaptive Resource Management models, techniques and tools within the Mediterranean biome. MAMM, or Mediterranean Adaptive Management Modeling, is designed to function as an adaptive system which will foster comparisons of models developed across the biome, improve decision schema and produce more effective management strategies through social learning. Instantiations of this Community Learning Systems schema local to San Francisco Bay Area region of the Biome are proposed through modeling structured decision making in the restoration of Islais Creek watershed and teaching and learning in the Central YMCA Gardens and Biome Wall.

Keywords: adaptive, social, mediterranean, biome, community learning, resource management, public participation planning

Available from: http://humanorigins.org/lab/labproject//mamm/index.html

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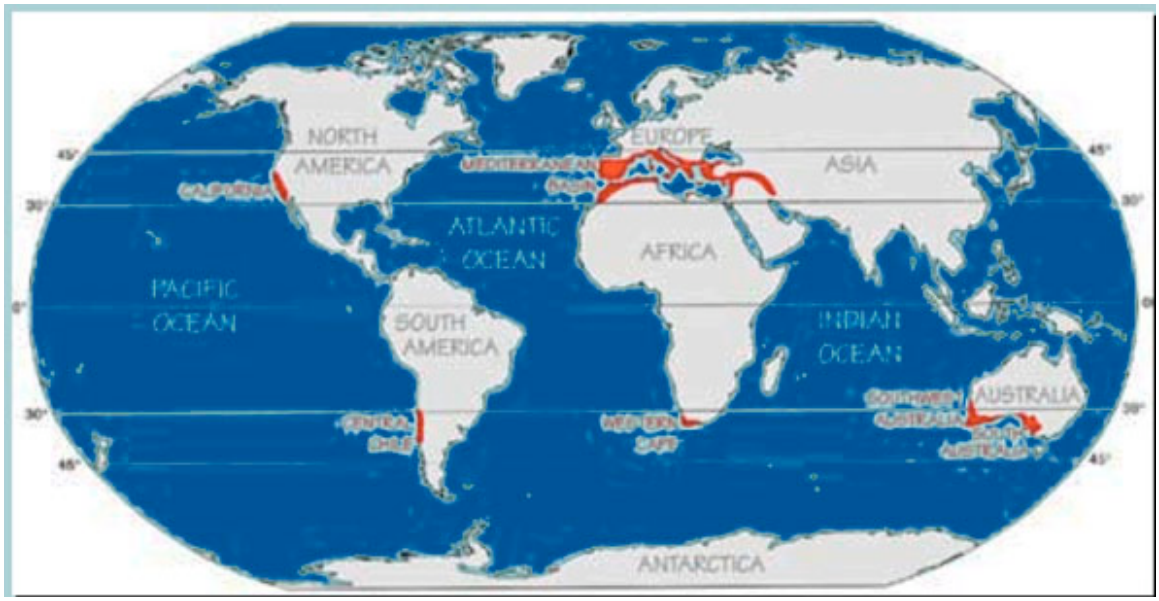
Project Description

This project is proposed to create a Community Learning System [CLS] designed to disseminate and iterate Adaptive Management modeling as a tool for improved decision-making with regard to environmental impacts in the Mediterranean Biome. Through a CLS local approaches could be analyzed by practitioners for their global applicability throughout the seven regions of the Mediterranean biome.

Definition of Spatial Extent



The Mediterranean Biome is comprised of 39 ecoregions dispersed widely over the Earth's surface yet covering less than 2% of its land mass. All the

zones lie slightly polewards between 30° – 40° Lattitude North/South on the western-most edges of continental land masses. Found in otherwise arid regions under the atmospheric high pressure zones generated by ocean currents that travel away from the equator toward the poles, Mediterranean ecoregions are subject to winter rainfall and moderate temperatures. Frequently bounded by deserts, vascular plant and vertebrate animal species are 'corralled' in these areas which influences marked patterns of endemism. Atmospheric interactions with ocean currents also produce upswellings of nutrient rich cold water into littoral zones bringing rich food supplies unusually close to shore supporting complex ecologies. These circumstances form the basis for zones of biodiversity and endemism rivaled worldwide only by tropical rainforests and coral reefs. Because these regions are also very appealing to humans, habitats in these zones are hotly contested. Conservation of biological resources in Mediterranean ecozones has potential to impact worldwide biodiversity disproportionately relative to its landmass. We already see evidence that this trend will steepen with global warming.[1] Taken together these factors press for better understanding of the strategic application of Adaptive Management methods in the Mediterranean biome. This study proposes to facilitate an ongoing survey of a range of methods, support evaluation of them for useful patterns and provide tools to test their robustness in specific settings; such as by modeling the management of an urbanized watershed in southern San Francisco County, California, the currently culverted Islais Creek, the effects of the emergent mosaic of community gardens in the Bay Area or further afield from any region within the Biome.

Islais Mouth in San Francisco Bay, Asberry, Google Earth, 2007

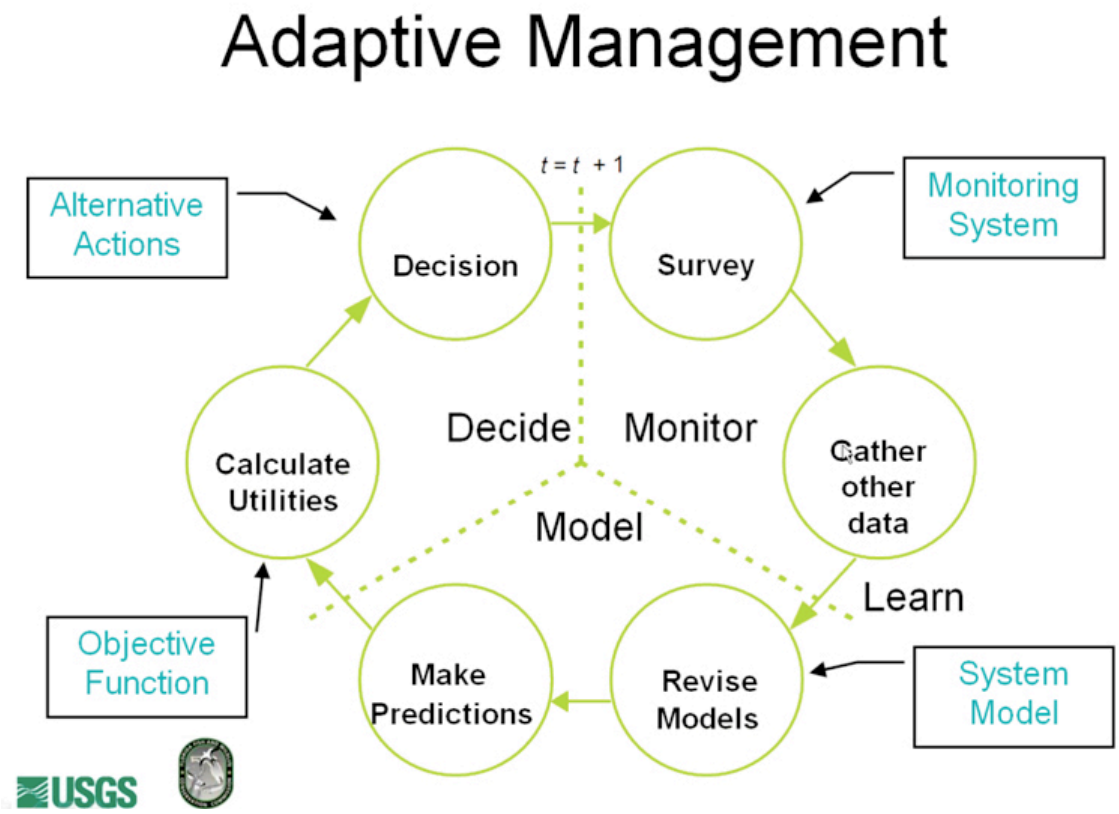
San Francisco Creeks & Watersheds, 1890

http://www.museumca.org/creeks/SFTopoCreeks.html

Islais is the Indian name for islay, Prunus ilicifolia, the California wild cherry tree. Islais Creek formerly drained most of the southern sector of San Francisco, running through Glen Park, the Outer Mission and Bayview Hunters Point to San Francisco Bay. During the late 19th Century, as San Francisco was developed Islais Creek was seen as more valuable as a sewer than a fresh water source and its channel was buried and paved over. The decisions that caused the creek to be fouled and eventually culverted were not made with public participation. MAMM hopes to provide a system that can be used to shine light on local decisions through connecting them with strategies and results from other areas within the biome.

Definition of Conceptual Extent

Adaptive Management, or Adaptive Resource Management, ARM, is a structured process of decision making in complex systems such as ecology or software development[2]. It manages complexity and reduces uncertainty over time through iterations based upon modeling, systemic monitoring and data collection. It arose as an environmental discipline in the 1970's in British Columbia. [Holling, 1978][3] and has been widely applied to fisheries management and waterfowl conservation.



Nichols, M. Adaptive Management Seminar USGS 2010

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More recently in Mediterranean regions where wine is a key agricultural product whose success requires careful attention to complex environmental factors vintners have been driving hyperlocal data monitoring and evolution of analysis [].

Adaptive Management is predicated upon structured decision-making in the context of needs for state dependent monitoring and the evaluation of management strategies over time. Monitoring supplies feedback loops that inform ongoing evaluation of management decisions against objectives while clear structure allows deconstruction of the process and helps define roles of stakeholders and scientists in defining objectives. Modeling organizes these data and methods into patterns whose parameters can be massaged to deliver insight as to sources and results. Models may be predictive or more often derived from competing hypothesis about how decisions affect the states in the system of interest. As datasets have grown richer and computation power has grown, spatial questions can be posed against these data sets and included in models that help mediate discussions by creating common ground, common language, common vision. [Wates, 2000] This project will collect, compare and contrast models that organize parameters relevant to managing environmental risks, tradeoffs in landuse and monitoring specific to resource management in the Mediterranean biome.

Literature Review

Researchers offer a wide range of modeling methods that support structured decision making in environmental systems. From scenarios to geovisualization to spatial statistic analytics there are conceptual tools and toolkits to serve many desired processes. With a wealth of choices, criteria for selection of tools becomes more significant. All dynamic decision analysis methods share a dependency upon clearly defined objectives, roles for

participants and the need to interpret complex data from a structured monitoring system so that it is accessible to human researchers. Models differ in the inputs required and the purposes they serve or emphasize but especially in the ways they manage complexity.

Adrienko et al [2007] in their survey of geovisualization techniques identify key determinants in the structured-decision support landscape. Monitoring capacity has outstripped analytic capacity because of the inability to manage complexity well. This commonly leads to a 'reduced processing strategy', essentially simplifying multivariate datasets to a manageable level. Visualization in general and geospatial visualization in particular addresses this problem by representing relationships within which data is chunked or 'hidden' in the visual hierarchy until required or requested by the process or the human processor. This reduction of cognitive overhead while maintaining integrity of the data is a consistent tension across all techniques. It is particularly relevant to Adaptive Management in the Mediterranean Biome which is characterized by complexities in social, economic and environmental dimensions as well as interrelationships at every scale. Taking their example of emergency response systems and transposing it to the California coastal ecozone of the San Francisco Bay area human responders require rapid, accurate representation of alternative choices and their likely outcomes for fire, earthquake, extreme storms, air traffic, maritime shipping, commuter rail, international disease vectors, insect infestations or disease in agriculture, just to name a few occasions where artificial elimination of complexity can exacerbate a disaster. Accessibility of data and clarity of roles in its organization and interpretation have life and death implications for about five million people and the sensitive environment we inhabit.

The manner in which inclusion of tacit information from human analysts, 'ground truthing', is accommodated is an important distinguishing factor between models. Pure visualization such as in Google Earth facilitates understanding of relationships like contiguity (the house is on the street) but not proximity since it

is a 3D viewer sans quantification tools that can manage such questions as 'what is the density of roads through the forest? Rate of traffic on the roads?' . "The size and complexity of real life problems necessitate the use of computational tools. The challenge is to achieve a real synergy between human and computer in solving spatial problems". [Adrienko, 2007]
Simulations, agent-based metaphors, algorhythms, Self-Organizing Maps are modeling techniques considered here and each resolve a part of the Human Computer Interface (HCI) synergy issue in geospatial reasoning.

Guo et al [2006] divide the HCI problem space into three parts: difficulties in temporal & multivariate mapping, representing large data sets and ordering in support of data mining. In response they have developed a Self-Organizing Map (SOM) to negotiate them. "A visualization technique has to be computationally efficient and scalable with very large data sets to allow human interactions…concerns the usefulness of data views in revealing patterns". [Guo, p 1462] A SOM arranges or projects multidimensional data from a re-orderable matrix into a 2D space using attributes such as color to reveal patterns such as clustering and hierarchy in the data using a tools suite called Vis-Stamp.

Moira Zellner at the Urban Planning Institute at the University of Illinois, Chicago [Zellner, 2008] invites researchers to embrace complexity and manage uncertainty for the sake of integrity not just of the data but of the decision-making process. She describes the phenomena in which uncertainty, for simplicity sake is hidden by use of one dimensional control systems that don't represent social, regulatory, economic factors. Tending to" aggregate actions and natural processes as correlations" while "important information that is the source of complexity such as causality, decision-making, heterogeneity, multiple feedback loops are lost in the translation" [Zellner, p 438] But representing complexity by itself doesn't make patterns more explicit in relationships.

Participatory processes tend to mediate polarity toward consensus around a desired result rather than an analytically derived result. On the other hand, dynamic complexity in a system can be faithfully represented by agent-based models that are location specific since it serves the purpose of testing outcomes relative to actions . This approach serves a collective learning framework which is both inclusive and objective.

Fractal modeling, especially used in concert with remote sensing and ground -truthing have been shown to effectively describe energy use within biological networks, carbon dioxide absorption, absence or presence of particular chemical compounds such as oil slicks on the ocean. "Fractal-dimension analysis may provide a scale-related measure of spatial patterns and can therefore be used to describe and understand pattern in species diversity" [Alados, 2003] Mandelbrot's work in fractal mathematics provides a foundation for ecological modeling by defining measures of roughness, self-similarity and branching complexity. [Mandelbrot, 1983] These measures allow for a non-linear understanding of inter-related behaviors and landscape responses to disturbance over time.

At another pole, Wilson et al propose the Conservation Investment Framework, a holistic approach to risk management in the context of resource allocation with the goal of maximizing biodiversity. They apply this "action and area-specific framework for conservation investment" analysis in seventeen ecoregions across the Mediterranean Biome worldwide. [Wilson, 2007] Their technique combines project management that for each region iterates through a structured decision flow, incorporates assignment of weights (biodiversity benefits) to decisions and probabilities of success. This enables the construction and modification of a species-investment curve which motivates cyclic investment in particular 'eco-actions', conservation actions taken in a specific region.

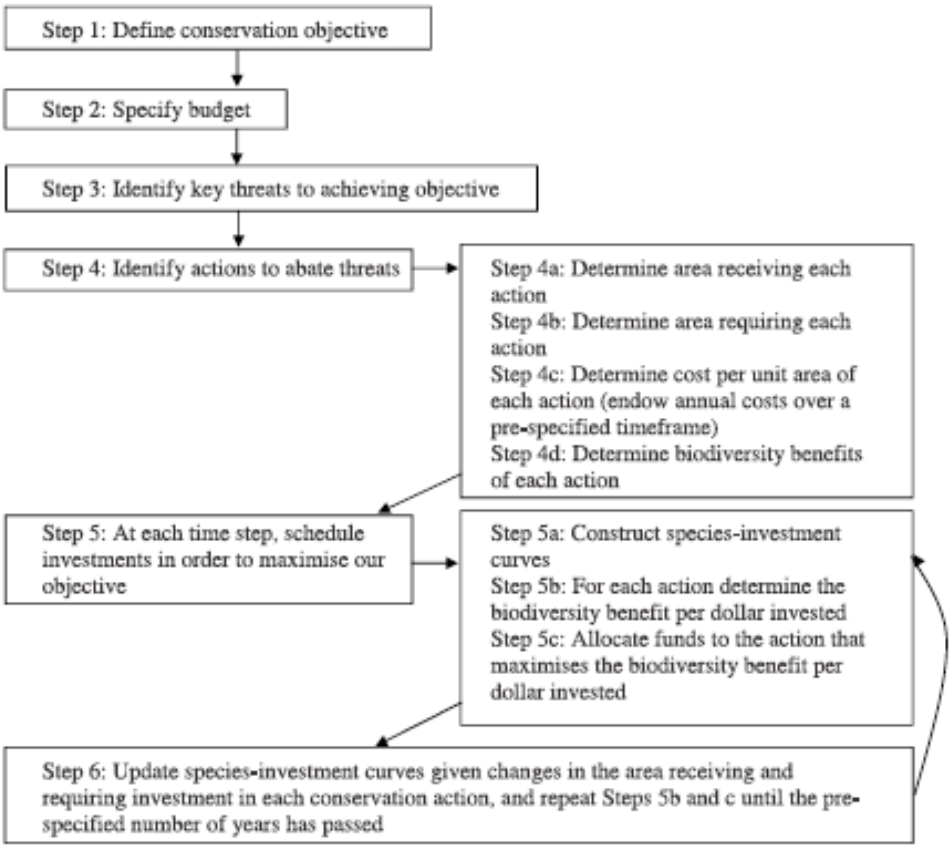
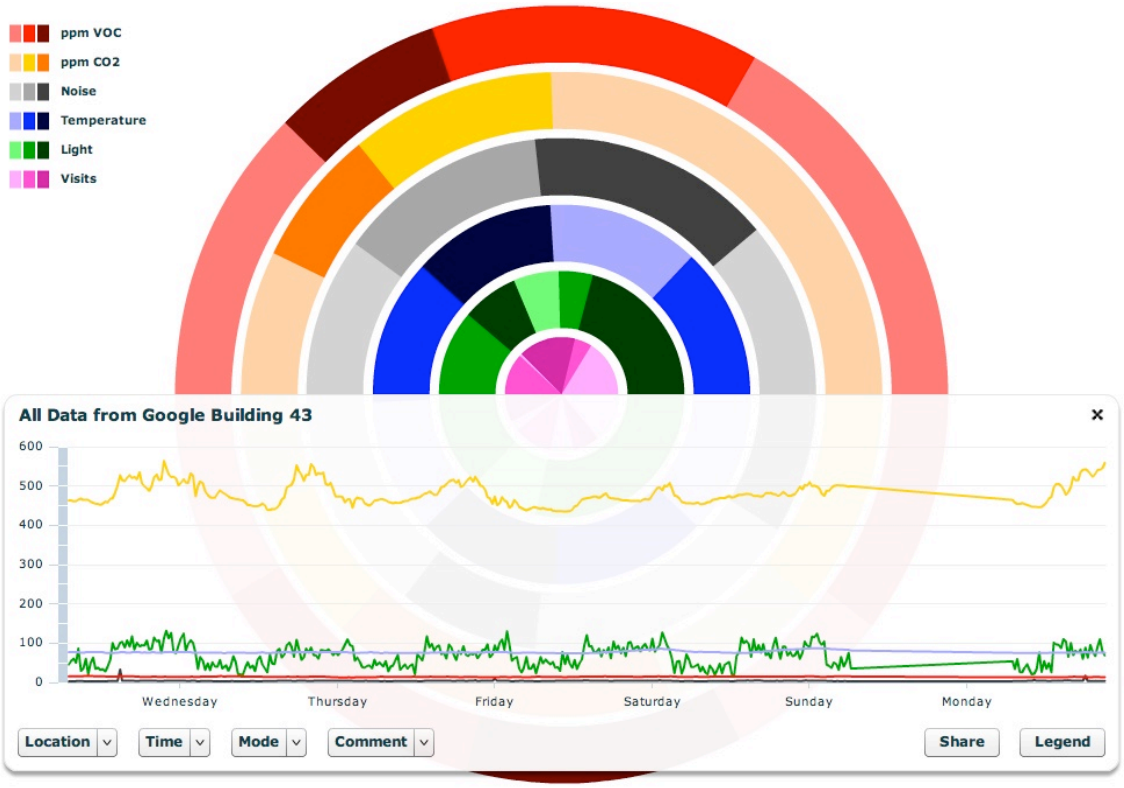


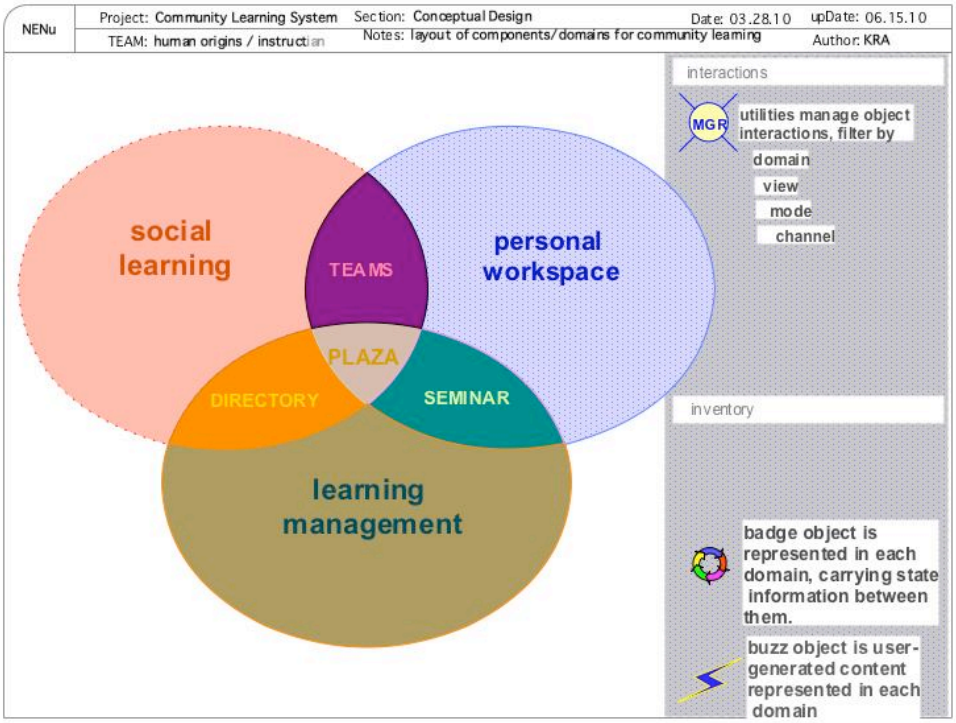
Figure 2. Decision Steps Involved in the Conservation Investment Framework
doi:10.1371/journal.pbio.0050223.g002

The Black Cloud project [Niemeier, et al, 2009] has integrated community dynamics in a distributed hyperlocal monitoring system that provides immediate feedback to affect levels of point sources pollution through behavior.



Methods

The Mediterranean Adaptive Management Modeling system will be comprised of three domains: a personal workspace, integrated social learning tools to facilitate exchanges amongst participants and a learning management system that can manage the repository of models and their iterations. As such it will function as a Community Learning System [CLS] (Asberry & Pollock, 2010).



***CLS Domains**, Asberry & Pollack, 2010*

Visibility of the models will be a core focus of the tools and interactions. To maximize comparison between models the submission process will help normalize and structure the metadata associated with each model. (See Appendix B, Instruments, for a sample input form)

MAMM will encourage the creation of a comparative literature of Mediterranean Biome conservation modeling. It will promote the process by building an accessible, structured repository of models contributed by members of the research community, supported by community-based tools and methods that will iterate with improvements in technology. Use of semantic web techniques, cloudware and Open Source / Open Standards to order models and to make them publicly available in a collaborative work area for community review and testing can insulate the CLS from obsolescence. Work products will include an integrated web-based spatial reasoning environment and a dynamic exchange

platform supportive of Adaptive Management tools and techniques. Such a community can help identify critical factors for the Mediterranean Biome and associate monitoring designs, cost structures and time scales.
Over time from this activity a unified data model or schema and a common criteria structure will emerge which can be transferred across the Biome to maximize scarce resources and hone human efforts to reduce harm and promote systemic health. Locally, the knowledge-building process could be furthered by testing iterations of the unified data model in the Islais Creek restoration context or the mosaic of community gardens and demonstration gardens emerging in the SF Bay Area. By sharing standards, researchers in the Nile Delta, South Africa or Australia may be encouraged to exchange knowledge that will help manage land and water to benefit biodiversity worldwide as earth's climates undergo greenhouse gas induced de-stabilization.

Analysis

Adaptive Resource Management employs 'Double-Loop Learning' (Nichols, et al 2010) as a means to assess and modify management approaches over time. In the first loop objectives are drafted and validated using engaged stakeholders. Then a model is crafted that incorporates possible management decisions toward these objectives and predicts results. Monitoring of the actions in the system must be designed that reveals the actual results of the management decisions. In the second loop optimization methods are applied to the model based on the data returned via the first loop.

Effective comparisons require common language in the physical models or schematics, whether dynamic such as those generated using ARCGIS ModelBuilder or static like Visio. Relative robustness can be assessed using optimization methods provided metrics are standardized or share common indices and meaning. [4]

The Mediterranean biome is characterized by abundant water during winter and drought during maximum growing season. So for Mediterranean resource managers water indices must be pivotal. The modern study of water management has leveraged detailed models from prehistoric and early historic usage to create comparisons that would have been unavailable to their living users. (Scarborough, 2003) Discovery of these commonalities allows answers to questions such as "how many human hours did construction of this irrigation regime require?" and "how many people did it feed?" yielding a basis for comparisons of techniques and efficiencies. As Adaptive Management is distributed and normalized the proposed CLS can methodically track model development over time.

Conclusions

There will be significant challenges in creation and maintenance of an adaptive model repository including sponsorship and the sustained participation of an engaged community. The investment in an online community sufficient to support useful exchanges requires clearly structured, yet modifiable means of interacting within a responsive online system. A Community Learning System can provide the structured access to tools, models, methods and data supportive in knowledge-building throgh local actions over time and communicate them at the scale of the biome and back down to constituting locales.

Appendix A Resources

MAMM Document Library
http://humanorigins.org/lab/labproject/mamm/index.html

Community Learning System
http://humanorigins.org/lab/labproject/cls/index.html

CA BIOS Biogeography Database
http://imaps.dfg.ca.gov/viewers/biospublic/app.asp?zoomtoBookmark=2335

Appendix B Instruments: Sample Metadata Input Form

Available from:
https://spreadsheets.google.com/ccc?key=thmrApHs8lKJoPWbqsTVhfw#gid=0

Glossary

Adaptive Resource Management, ARM, C.S. Holling coined the phrase for learning while doing or iterative management of natural resources based upon careful monitoring of results.
Community Learning System, CLS, employs social interaction through a virtual environment to amplify teaching and learning.
Structured Decision-Making, SDM, an integral element of ARM, SDM facilitates community engagement through use of clear steps in the process which include defined means for stakeholders to contribute criteria, requirements and validate results.

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[Summary: Adaptive Mgt originator, definition]

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NOTES

[1] L. Silla, changes in sea level rise will inundate Heritage Sites worldwide. (Interactive Map)
[2] also known as Agile development or Scrum.
[3] Holling also worked at the Austrian Research Institute, Vienna
[4] BIOS Biogeography database developed by California Department of Fish & Game required an extensive process of data normalization in the California Wildlife Corridors project realized by SFSU GIS Institute in 2008, a step that would have been less necessary if field researchers were able to work together to iterate their standards, methods and metrics.