The EcoAtlas Toolset

Applied Aquatic Science:

A Business Plan

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Prepared for the California Wetland Monitoring Workgroup

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Contents

Executive Summary....4

Business Plan for the Sustainable Maintenance and Advancement of EcoAtlas....8

- Definitions 8
- Goals and Core Principles 9
- EcoAtlas Background 11
- Detailed Tool Descriptions 20
- EcoAtlas History 24
- Business Model 38
- Funding Model 49
- Roadmap / Next Steps 60

References.... 62

- Figures and Tables 63

Appendix A: Additional Background for the Toolset.... 65

- Milestones (http://sfei.org/ecoatlas) 65

Appendix B: Categories and Descriptions of Related Tools.... 73

- Categories of Tools 73
- Descriptions of Tools 74

Appendix C: Funding Models to Consider 77

- Potential Funding Models 77
- Other Processes to Consider 82

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Executive Summary

The EcoAtlas suite of tools represents a significant investment of time, energy, thought, scientific testing, technical innovation, and capital from a number of state and federal public agencies, grant programs, and NGOs over the course of its 17-year existence. The toolset embodies the scientific and programmatic investments of the California Wetland Monitoring Workgroup (CWMW), its many related state and federal agencies, non-governmental organizations (NGOs), and private consultants, as well as the goals of the growing set of stakeholders who have expanded the circle of interested parties over the years. It is known by many names -- "WRAMP" being most common -- but in its essence it comprises the following tools:

- EcoAtlas map viewer
- Project Tracker
- The California Aquatic Resources Inventory (CARI) map and editor tool
- The California Rapid Assessment Method (CRAM)
- The Riparian Zone Estimator Tool (RipZET)

Now highly capable, the toolset represents more than science and technology alone, but a distillation of both, customized to meet specific goals associated with the landscape-scale tracking and characterization of California's aquatic resources. The US Environmental Protection Agency (US EPA), for instance, has supported the toolset through multiple development grants so that the collected tools might be complementary to a still-nascent, statewide wetland protection program. Meanwhile, the state's Coastal and Delta Conservancies require the use of the tool, and regional water boards -- including SF Bay, Lahontan, and North Coast -- regularly employ the tool for mitigation and restoration project tracking. Essentially, EcoAtlas has proven critical to a variety of programs and represents a successful product of broad-based collaboration. However, it currently stands at a crossroads, and its stakeholders must direct the toolset's future.

The following plan is intended to ensure the continued vitality of the toolset. The plan's success will depend upon the continued collaboration of the public agencies that have supported the toolset thus far, but it must also integrate principles of resilience as it accounts for the tensions that arise as organizations move in different strategic directions.

Challenge

The major challenge we face is how to fund the continued maintenance, development, and innovation for the broad suite of tools constituting EcoAtlas. Having been reinvented in

2013, the tool is effectively on a trajectory from pilot project to an institutionalized instrument. Yet, the funding needed for such a transition is not yet available. US EPA and other governmental agencies have largely funded development of the EcoAtlas toolset through Wetland Program Development Grants and other in-kind contributions, which are designed to build state capacity but not to implement the toolset. Considering that state agencies presently depend on the tool for information resources, how do we ensure that EcoAtlas remains meaningfully connected to the stakeholders and public programs that have lent the toolset such vitality over the years?

The challenge is therefore chiefly a matter of process, people, and resources, rather than one of technology.

Solution

The toolset adheres to the concept that no one tool can comprehensively address all information gaps across the watershed and therefore collectively produces a synthesized "whole watershed approach." Whether estimating the ideal riparian buffer width for a given stream or assessing the health of a wetland at the edge of the estuary, the EcoAtlas tools allow practitioners to deploy the right tool for the job in scientifically defensible ways, thereby producing a credible picture through composite outputs.

The following business plan requires a combination of new state investment through a combination of in-lieu-fee agreements, participant fees, and continued project-based funding. It describes both the approach for ensuring the continued development of the toolset in alignment with stakeholder goals and the appropriate funding model to support the sustainable operations and maintenance of the tool. The result is a hybrid funding model that leverages agreements, participant fees, and project-specific funding, all of which will collectively facilitate the continued scientific and technological evolution of the toolset. The hybrid model will provide a diversification of the budgetary infrastructure, allowing for greater sustainability and resilience against unforeseen shortfalls. Furthermore, the regionalization of the tool will operationalize a customization strategy and allow the tool to meet stakeholder demands. In this way, innovation can also continue.

The plan provides an annualized budget for key tasks, including user support, training, outreach, database management, upgrades, and quality assurance, amounting to $365,000. This serves as a set amount that is reassessed annually. The more contributors pay into this common fund, the less each contributor must pay. New development, on the other hand, would continue as funded by individual grants, foundations, and other sources.

Current Stakeholders and Governance

The toolset has a strong user-base comprising different programs and organizations across California's varied governmental terrain. These groups include:

- regulatory agencies with regional jurisdictions, such as the Lahontan, North Coast, and San Francisco Bay Regional Water Quality Control Boards,
- state agencies with statewide jurisdiction, such as the State Water Board, CalTrans, and California Department of Fish and Wildlife,
- federal agencies, such as the US Army Corp of Engineers and NOAA-NMFS who stores its Southern California eelgrass restoration projects,
- conservancies, such as the State Coastal Conservancy and Sacramento-San Joaquin Delta Conservancy
- Joint Ventures, such as the San Francisco Bay and Central Valley Joint Ventures with whom SFEI signed a three-way MOU of continuing support for EcoAtlas, and
- wetland groups, such as the Central Coast Wetlands Group.

In addition, EcoAtlas, CRAM, CARI and Project Tracker were included in Proposition 1 guidelines for managing information on restoration projects.

The CWMW and its associated Level 1, Level 2, and Level 3 committees will continue to exercise authority for directing the development of the toolset's various core components. Meanwhile, projects that modify peripheral modules can be guided by individual funders.

Roadmap

The future of EcoAtlas requires a strategy for both the continued maintenance and new development of the toolset. The stakeholders of the toolset depend upon reliable updates (software and data) and upgrades (major revisions). These demands are only likely to increase.

For the most part, the toolset is highly centralized and singular. The roadmap calls for a strategic regionalization of the tools that meets specific regional needs while maintaining the consistency of the data and core functions to leverage past investments and retain scientific credibility for the toolset.

Implementation of this plan will require the CWMW to test the viability of the hybrid funding model and then, while clearly illustrating the future opportunities, secure contributions from its target clients.

Business Plan for the Sustainable Maintenance and Advancement of EcoAtlas

As a business plan, this document provides background and justification for the continued advancement of the suite of tools known as EcoAtlas. It describes the toolset with reference to other memos that have been developed to chart the history and purpose of EcoAtlas as its tools relate to various programmatic needs. It also appeals to a funding model document that describes the alternative models available for consideration. Most importantly, however, it endeavors to detail a plan for the future, with the recognition that the demand for its tools is growing, and EcoAtlas must rise to meet the challenge through adequate funding and support.

A conventional business plan must articulate the goals and objectives of a product or initiative, bearing in mind the market opportunity and a roadmap for strategic achievement. However, it should be noted that this business plan, crafted for a public resource, lacks one of the primary metrics of success in a private enterprise: profit. In fact, the product in this case, EcoAtlas, must not serve to achieve greater "market share," but rather advance the programmatic goals and scientific rigor of a wetlands program and policy that is still developing at the state level. The business, in this sense, is not fundamentally capitalistic; yet, the plan can help our organizations to benefit from essential business management lessons.

Moreover, because the target audience for this plan might be more familiar with either science, public service, or technology than with business, we wish to define our terms. After all, the target audience for this business plan are members of the California Wetland Monitoring Workgroup, whose affiliations range from public to non-profits to private, as well as potential funders who may come from various other sectors. These current and future readers, given the anticipated diversity of their backgrounds, may not be intimately familiar with a business plan format.

Definitions

For the purposes of this plan, a business model is inclusive of the structure, processes, mission, goals, and funding that lead to successful adoption of the product. In this case, the "product," so to speak, would be the EcoAtlas toolset and all of the scientific and programmatic innovation that it affords. Whereas the business model captures the

framework for the product's daily operation and continuing evolution, the funding model describes the specific mechanism by which the business model might be financially supported without interruption. We might call this form of support a resilient and sustainable funding model -- not unlike the resilience we pursue in natural resource management.

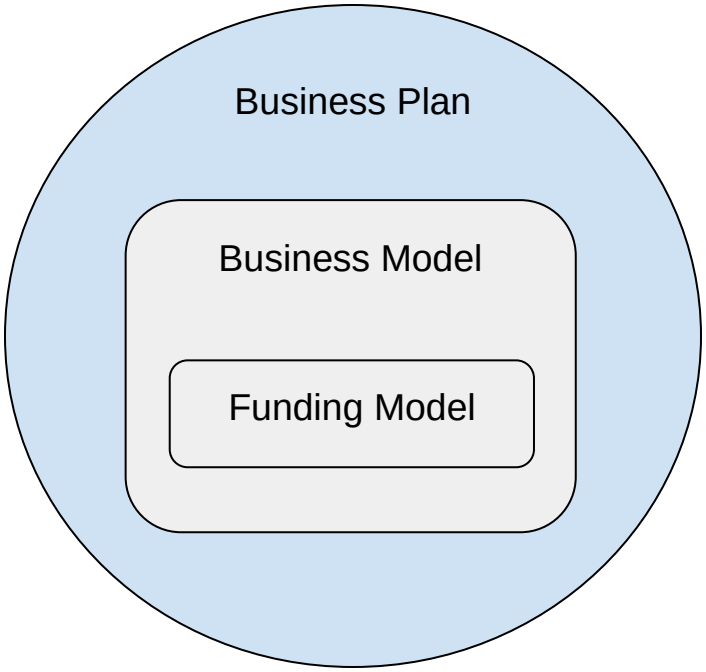

Figure 1: Illustration of the business plan

This document will describe both the business model and the funding model in some detail. As much as it attempts to prescribe the ideal road ahead, however, we should recall the old adage that a "battle plan never survives first contact with the enemy." This is to say that the document should be regarded as "living" and subject to change as the many elements of the programs it serves adapt to evolving needs. In other words, the principles of adaptive management that are key to natural resource stewardship programs must be applied to data lifecycle management as well. To the extent that these two cycles are aligned, then we should recognize success in achieving our goals.

Goals and Core Principles

EcoAtlas provides critical, scientifically valid information about the condition and location of California's aquatic resources with a special focus on the state's wetlands. It was developed by the San Francisco Estuary Institute - Aquatic Science Center (SFEI) under the direction of the CWMW as a precursor to a state-level wetlands monitoring program.

Why EcoAtlas?

EcoAtlas effectively operationalizes the framework and toolset of the Wetland and Riparian Area Monitoring Plan (WRAMP) of the California Wetland Monitoring Workgroup (CWMW). EcoAtlas enables users to assess the abundance, distribution, diversity, and condition of surface waters in the landscape or watershed context. It is the only tool structured in such a way as to afford data collection and display in alignment with the scientifically vetted framework. EcoAtlas has been uniquely used to apply the WRAMP framework for wetland and stream protection in a variety of California watersheds, and it can be adjusted to more generally support natural resource planning, assessment, monitoring, and reporting (http://sfei.li/cwmw1). EcoAtlas, in essence, represents a distillation of the best science-based, rigorous thinking and planning conducted by the CWMW over the course of many years.

Core Principles

Whatever direction the toolset takes, it must adhere to key core principles that have informed its development from its earliest phases until now. These principles emerge from the CWMW's own mission and the source of the workgroup's success.

- Openness: The toolset must serve the public and therefore serve data, whenever possible, that enters into public use
- Consistent data quality: Tools such as CRAM produce data of consistent quality due to its standards for training and its carefully structured user-interface
- Scientific rigor: CRAM, CARI, and RipZET represent expressions of the WRAMP framework, as vetted by the technical subcommittees of the CWMW
- Cost-effectiveness: From the selection of technology to the maintenance of its host hardware, EcoAtlas offers value for its unique benefits
- Programmatic alignment: EcoAtlas is currently bound to the WRAMP framework as a precursor to a Wetlands program, and to maintain its integrity, it should maintain alignment with environmental program objectives

EcoAtlas Background

Origins

The term "EcoAtlas" has been in use since 1998 in association with the study, assessment, and reporting of aquatic resources in California. What began as "Wetland Tracker" in 2000, with its goal of recording essential information about wetland restoration projects in the greater Bay Area, later blossomed into a broad technological ecosystem of interrelated tools, each focused on delivering specialized, program-focused features, as defined by key stakeholder groups. Having evolved over time, EcoAtlas comprises a diverse toolset, but the collection shares common libraries, common approaches, and common development methodologies. Though each emerged from different funding opportunities and requirement drivers, the toolset collectively addresses a synthesized "whole watershed approach." Whether estimating the ideal riparian buffer width for a given stream or assessing the health of a wetland at the edge of the estuary, the EcoAtlas tools allow practitioners to deploy a tool best suited for the right assessment across a broad spectrum of watershed functions.

Funding Model to Date

The development of EcoAtlas has been a process of chaining together individual projects, funded by a range of public and philanthropic interests. Each investment forms a new enhancement shared by all of the tools' users. In this way, the application development has advanced the tools as new needs have been expressed, new scientific frameworks have been produced (as was the case with CRAM modules), and new innovations in geospatial technology paved the way for new possibilities. Below is a list of federal, state and non-governmental sponsors who have contributed funding to EcoAtlas development since 1995.

Sponsor Name	Amount	Date period	Description
Federal Sponsors:			
US Environmental Protection Agency	$206,380	2016-2018	Advance performance measures tracking and integration
	$499,969	2015-2017	Develop site mitigation tool, integrate USACE's project tracking system, and perform system upgrades to EcoAtlas
	$300,000	2015-2017	Build state capacity and develop business model for EcoAtlas
	$210,000	2014-2017	Visualize and aggregate intensive datasets to better understand the cumulative effects, and develop a dashboard for summarizing project information
	$68,035	2014-2016	Transfer use of EcoAtlas in Lahontan, update the Tahoe base map, and integrate other project information into EcoAtlas
	$254,119	2013-2015	Develop Project Tracker data entry/edit forms and integrate display of data on EcoAtlas
	$123,820	2013-2015	Develop monitoring and assessment plan for the Natural Community Conservation Plans and 401 framework
	$131,622	2010-2015	Develop CARI Editor and BAARI v2.0
	$346,091	2010-2014	Develop performance curves for wetland restoration tracking and the Landscape Profile report

US Army Corps of Engineers		1994	San Francisco District of USACE funds first version of EcoAtlas to support comprehensive planning of the beneficial reuse of sediments dredged from San Francisco Bay and to implement San Francisco Estuary CCMP Wetlands Action 1.1: Establish regional wetland habitat goals of a regional wetlands management plan (Baylands Ecosystem Habitat Goals Project).
US Fish and Wildlife Service	$125,000 ($25,000 per year for 5 years)	2015-2019	Manage San Francisco Bay and Central Valley Joint Venture project data and develop enhancements to better meet Joint Venture tracking and reporting needs
National Oceanic and Atmospheric Administration–National Marine Fisheries Service	$22,000 $22,290	2015-2017 2011-2014	Phase 2 Phase 1 Manage eelgrass data and disseminate survey and restoration project data in EcoAtlas
California State sponsors:			
California Coastal Conservancy	$3,000 $19,200	2017 2016	Integrate Project Tracker information into the Wetlands Recovery Project Data Decision System Develop bar-built estuarine eCRAM module and display results on EcoAtlas
California Department of Transportation	$628,914	2014-2016	Conduct depressional wetland studies, develop Habitat Development Curves for estuarine and depressional wetlands, and develop Cumulative Distribution Functions for riverine

California Department of Water Resources	$16,328 in-kind	2014 2013-2015	Add Laguna de Santa Rosa and North Coast Aquatic Resource Inventory to CARI and EcoAtlas Participate in workgroup to guide the development of the Project Tracker data entry/edit forms
California Department of Fish and Wildlife	in-kind	2013 - present	Participate in workgroup to guide the development of the Project Tracker data entry/edit forms and integrate display of data on EcoAtlas
California Natural Resources Agency	$795,000	2011-2014	Revise CRAM database, enhance display and reporting of CRAM results, improve integration of CRAM and Tracker information, calibrate CRAM for seasonal depressional systems, and develop eCRAM module
California State Water Resources Control Board	$38,000 $599,583	2012-2014 2010-2013	Upload mitigation projects for Regional Board 9 (San Diego) to the Wetlands Portal Develop Wetlands Portal and integrate with EcoAtlas
Sacramento-San Joaquin Delta Conservancy	in-kind	2013 - present	Participate in workgroups and manage USEPA- funded contracts for EcoAtlas development
Non-governmental organization sponsors:			
Central Valley Joint Venture (JV)	in-kind	2013 - present	Participate in Project Tracker workgroup, manage JV project data, and assist with EcoAtlas enhancements to better meet JV tracking

			and reporting needs
San Francisco Bay Joint Venture (JV)	$75,000 ($15,000 per year for 5 years) and in-kind	2013 - present	Participate in Project Tracker workgroup, manage JV project data, and assist with EcoAtlas enhancements to better meet JV tracking and reporting needs
Packard Foundation	$100,000	1996-1998	Provide science support for the Bay Area Wetlands Ecosystem Goals Project
Rose Foundation	$15,000	2001	Develop Bay Area Watersheds Contaminant Profiles and EcoAtlas storyboards

In addition, abundant in-kind services have greatly benefited EcoAtlas development, including federal, state, regional and local sponsors from public agencies for water quality, agriculture, flood control, public parks, and land-use planning.

Scientific Background and Purpose

EcoAtlas is the toolset of the Wetland and Riparian Area Monitoring Plan (WRAMP) developed by the California Wetland Monitoring Workgroup (CWMW). The toolset's functions, data, and resulting outputs -- maps, charts, and analyses -- reflect the methods and peer-reviewed studies that emerge from WRAMP. The WRAMP Framework page, http://sfei.li/cwmw1, contains a trove of studies, reports, and presentations that demonstrate the support the WRAMP framework and EcoAtlas.

A central aspect of the WRAMP framework is a classification of environmental data, their methods of collection, and their stated purposes into the following three levels.

- **Level 1 data: Maps and spatial information.** These data consist of map-based inventories of aquatic areas and related resources, including rivers, streams, lakes, bays, wetlands, and their riparian areas, plus events and activities that have a direct effect on the distribution, abundance, diversity, or condition of aquatic resources. Level 1 maps may serve to plan and conduct landscape and watershed profiles of aquatic resource condition.
- **Level 2 data: General wetland condition information.** This extensive dataset comprises rapid, field-based semi-quantitative measures of the overall condition of aquatic resources. In California, the California Rapid Assessment Method (CRAM) is the most widely used Level 2 method for assessing the conditions of wetlands and streams. Other Level 2 assessments exist and may also be used when needed.
- **Level 3 data: Specific condition information.** These datasets are quantitative, field measurements of specific aspects of condition. Plant species composition, nesting bird surveys, spawning success, and groundwater recharge rates are examples of Level 3 data types. Level 3 methods can vary from site to site for the same kinds of Level 3 data (http://www.mywaterquality.ca.gov/monitoring_council/wetland_workgroup/index.html)

For this document, we will not feature in-depth descriptions of the WRAMP framework (which may be found on the WRAMP details page: http://www.mywaterquality.ca.gov/monitoring_council/wetland_workgroup/wramp/index.html), but rather we will describe the nature of the individual EcoAtlas tools, their purposes, the detailed history of their enhancements, their target audiences, and their underlying infrastructure.

In addition to being a set of tools, EcoAtlas can aggregate data from its toolset alongside other information sources to increase their mutual utility. The California Aquatic Resource

Inventory or **CARI** (http://sfei.org/cari) forms the base map that identifies and classifies all surface waters of the state.[1] **Project Tracker** (http://ecoatlas.org/about/#project-info) represents the latest generation of the Wetland Tracker functionality by tracking planned or completed activities that modify habitat, such as wetland restoration, mitigation, or habitat conservation. Project Tracker retains this information in its local database, which in turn can be distributed to other tools throughout the state and beyond. This tool benefits from a broad-based collaboration and now offers a diverse collection of habitat project data throughout California. By assembling and tracking information about landscape change, Project Tracker can help to inform future versions of habitat classification through CARI. CARI and Project Tracker facilitate "Level 1" inventories of aquatic resources and habitat projects according to the US EPA framework. The California Rapid Assessment Method or **CRAM** (http://sfei.org/data/cram) is the most widely used "Level 2" means for assessing the overall condition or health of wetlands and streambeds. Different types of wetlands, as defined by CARI, are assessed using different CRAM modules. Modules can be revised or added as needed to reflect changes in the CARI classification system. CRAM assessments comprise one of the statewide datasets summarized within the **Landscape Profile Tool** (http://ecoatlas.org/about/#landscape-profile), an innovative geospatial selection and reporting interface that permits users to identify and map an area of interest on their computer screens, automatically assemble a variety of information associated with the area, and generate summary reports tailored to programmatic needs. Although currently not displayed in EcoAtlas, the Riparian Zone Estimator Tool or **RipZET** (http://sfei.org/projects/ripzet) is a "Level 1" method for determining the likely existing or planned extent of riparian areas based on the concept of "functional riparian width."

The following figure distinguishes between the data sources housed in the toolset, along with the related components that offer both output and analytical functionality.

[1] Currently restricted to surface waters, data and information on groundwater resources can conceivably be added in the future through the appropriate resources.

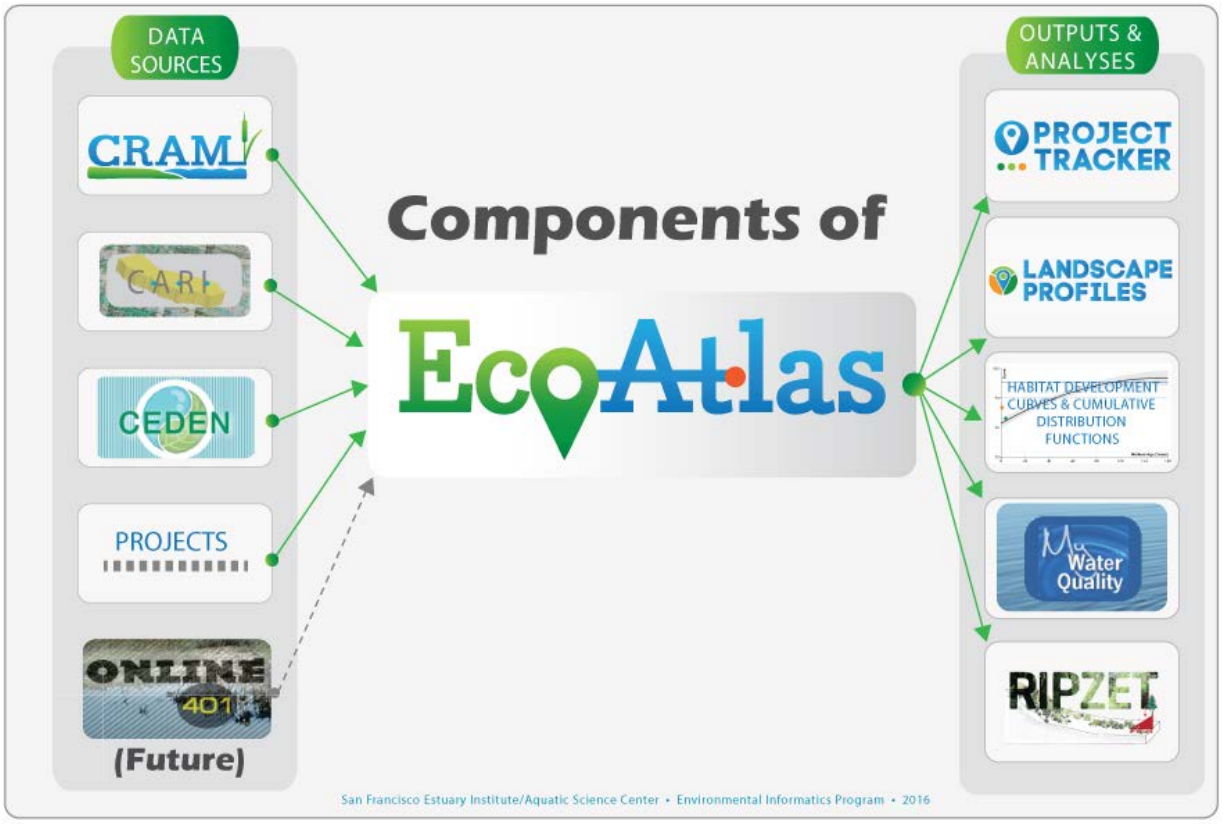

Figure 2: Illustration of the EcoAtlas Toolset

The different components of the toolset work in concert with each other to produce and display syntheses reflecting ecosystem functions. However, it is useful to distinguish between centrally stored information and those data leveraged from external sources.

Stored information

EcoAtlas collects and stores some information in centralized databases. Examples include:

- **CRAM:** The California Rapid Assessment Method collects assessments from practitioners and displays those approved for public display on the EcoAtlas map viewer and Landscape Profile Tool.
- **CARI**: The California Aquatic Resources Inventory forms the basemap classifying all of California's salient aquatic resources, with areas of intensification in the San Francisco Bay Area, Lake Tahoe Basin, and soon, the Sacramento-San Joaquin Delta.
- **Projects:** Featured in EcoAtlas are data for wetland restoration, compensatory mitigation and habitat conservation projects, which are then further editable through the Project Tracker component. Project Tracker also furnishes an ability to enter new projects.

Information stored in centralized databases are accessible as web mapping services for display on other servers (CRAM, Projects), application programming interfaces for tighter integration into related information management systems (Projects), or for download as needed by site visitors (CRAM, CARI, Projects).

External Sources

In addition to the information stored directly in databases and managed within the toolset, EcoAtlas also connects to external data sources, such as CEDEN, USGS Streamstats, Lake Tahoe INFO, and others, incorporating them, where appropriate, into tools such as the Landscape Profile Tool. Information from these external sources are retrieved via modern techniques such as web services, whenever such vehicles for data exchange are available.

The following figure describes in more detail the "technology ecosystem" in which EcoAtlas is situated, with both inward- and outward-bound forms of information exchange.

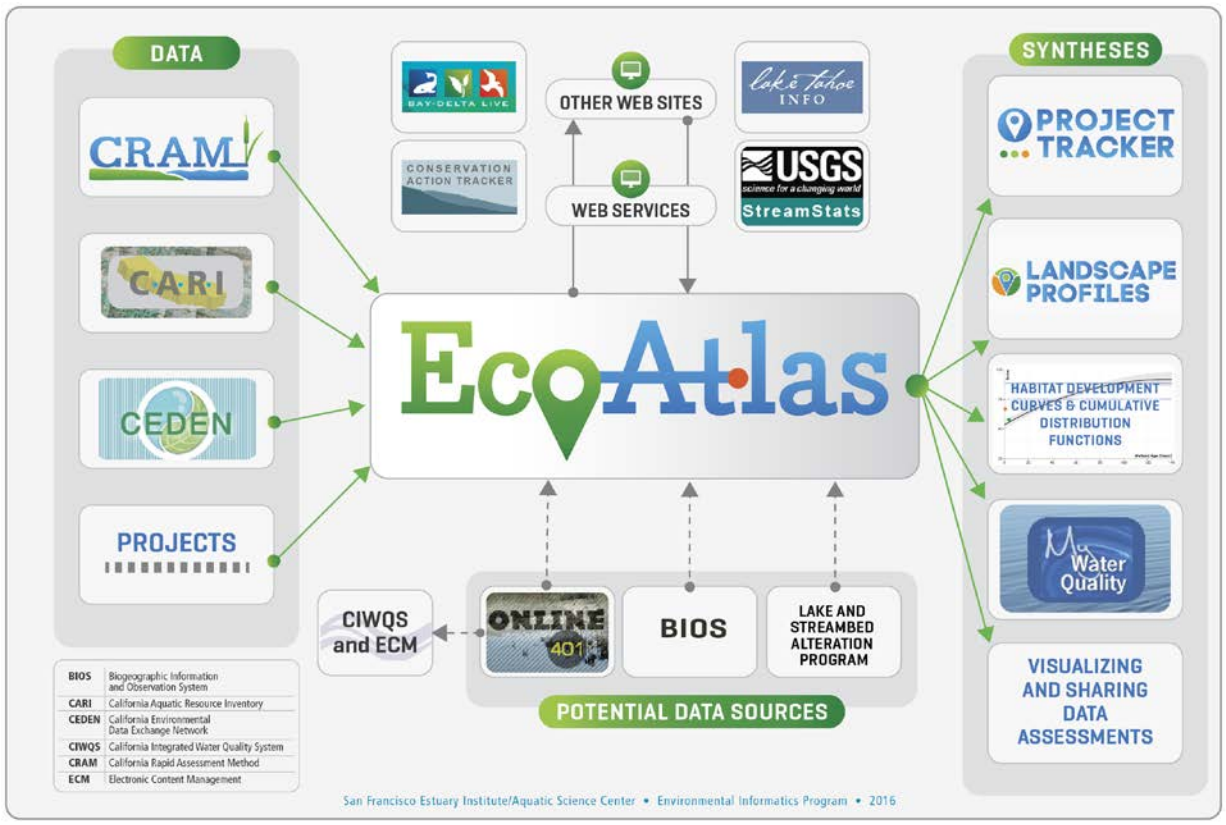

Figure 3: The EcoAtlas Technology Ecosystem

The complex exchange of information described in Figure 2 describes the named parts of

the toolset -- CRAM, CARI, Project Tracker, Landscape Profiles. It also identifies known sources and destinations for EcoAtlas data such as the My Water Quality portals, USGS Streamstats, and Bay Delta Live. Together, these tools constitute a purpose-driven community or ecosystem of interrelated tools.

That said, although the toolset functions as part of an integrated approach to managing landscapes and watersheds, each EcoAtlas tool can operate more or less independently, yielding desired information for a particular purpose and user community.

The detailed descriptions for each tool follow below.

Detailed Tool Descriptions

- **California Aquatic Resource Inventory (CARI) (http://sfei.org/cari)**

  CARI is a Geographic Information System (GIS) dataset of surface waters and their riparian areas consisting of polygon and line features with data-rich attributes that can be used for developing broad- or fine-scale landscape summaries of aquatic features. CARI is a seamless statewide map compiled from multiple data sources and standardized to a common classification system. This statewide dataset provides the best available map of state surface waters and serves as the base map in EcoAtlas to coordinate monitoring and assessment at the landscape scale across federal, state, and local agencies, while providing enough detail to inform local land use planning. Accompanying CARI is the CARI Editor, an interactive, online GIS mapping interface that facilitates user-generated updates to information associated with the CARI dataset. When users encounter any discrepancy between CARI details and actual landscape conditions, they can suggest changes that can be reviewed and incorporated into the authoritative CARI data, thereby maintaining CARI's currency and ready applicability to decision making.

- **Project Tracker (http://ecoatlas.org/about/#project-info)**

  EcoAtlas tracks planned activities that modify habitat, such as wetland or stream restoration, mitigation, or habitat conservation. Projects are viewable on the interactive map and summarized in individual project pages. Project information is available for the San Francisco Bay Area, Sacramento-San Joaquin Delta, North Coast, Central Coast, South Coast, and Lake Tahoe area. New projects can be uploaded using the Project Tracker data entry forms. Project details can be entered online and accessed by environmental managers, planners, and stakeholders to

inform wetland management and planning decisions. An easy-to-use mapping tool enables project managers to draw project sites using aerial imagery or upload an existing map file of the project site.

Public information is available on EcoAtlas where projects can be viewed on a common base map to help inform wetland management and planning decisions.

In the San Francisco Bay Area, project information is collected for all new 401 certified projects through the Wetland and Riparian Project Form. Submission of this form is a 401 permit condition of the San Francisco Bay Regional Water Quality Control Board. In 2016, the Lahontan Water Board (Regional Water Board 6) formally adopted the use of Project Tracker and requires applicants for 401 Certifications and Waste Discharge permits to upload project information into Project Tracker.

Project Information Page (PIP)

Each PIP includes information on the project's location, type (mitigation or non-mitigation), identification numbers, habitat plan, site status, restoration events, contacts, funding sources, and performance criteria. If available, related habitat impacts and CRAM assessments are also summarized.

Files & Links

Project Tracker serves as a repository for files and web links. A project's file library provides access to reports, data, photos, videos, and other files related to a project. Project managers and members of the public can submit reports and project-related files to share with others.

Project Maps

When available, project maps and site boundaries are displayed on EcoAtlas. In a few cases, information on a project's size and general location is known, but a detailed boundary has not been provided. In such cases, the project is mapped as a dashed circle, centered on the project's location, and with a size equal to the known project area. These dashed circle approximations provide EcoAtlas users a visual representation of a project's size and location, and are replaced with an actual boundary when this information becomes available.

Habitat Development Curves

Wetland Habitat Development Curves (HDCs) are used to evaluate the rate of habitat development for restoration and mitigation projects, and how they compare to other projects of the same age and habitat type, based on CRAM. HDCs have recently been developed for three CARI wetland types (riverine, estuarine, and depressional) using existing CRAM assessments from wetlands across California. Each curve represents the average rate of development bounded by its 95% Confidence Interval (CI), plus the average condition and 95% CI for the reference sites. Projects that are well-designed for their location and setting, and well-managed tend to be on or above the curve. In general, as projects age, their habitats should mature, gaining similarity to the reference sites, such that the project's CRAM scores increase. HDCs for the CRAM Attributes and Metrics can be used to understand and correct habitat developmental problems.

The HDC is available as a separate tab in the Project Information Page and is only visible when a project has a recorded construction end date (groundwork end date), and there are existing CRAM assessments for the project boundaries in the statewide CRAM database.

- **California Rapid Assessment Method (CRAM) (http://cramwetlands.org)**

  CRAM is a cost-effective and scientifically sound rapid assessment method for monitoring and assessing the ecological conditions of wetlands and streams throughout California. It takes less than half a day to assess a site, based on its landscape setting, hydrology, physical structure and biological structure. A single, standardized CRAM module exists for each of the eight major types (and some sub-types) of wetlands and streams identified by CARI. Standardization facilitates comparing individual wetland areas of the same and different types. It also enables statistical comparisons between groups of the same or different types at any spatial scale for which the necessary data are available, including local, regional and statewide scales. CRAM can also be used to assess the performance of compensatory mitigation projects and restoration projects, relative to impact sites, reference sites, or average conditions (see HDC above). The easy-to-use, online data entry forms ensure that all of the appropriate site information and field data associated with CRAM assessments are entered. Practitioners can draw CRAM assessment sites online using aerial imagery of the site and make public

information available on the EcoAtlas map viewer to help inform wetland management and planning decisions. In essence, cramwetlands.org houses the complex business rules for validating assessments according to peer-reviewed scientific principles. The site accordingly serves as the entry point for wetland condition assessments, whereas the EcoAtlas map viewer (http://ecoatlas.org) serves as the logical point of information viewing, querying, and distribution.

- **Landscape Profile Tool (http://ecoatlas.org/about/#landscape-profile)**

  The Landscape Profile Tool summarizes ecological information at various spatial scales for planning, assessment, and reporting. Based on the user-specified area of interest, the tool generates graphical summaries of the following data sources:

  - abundance and diversity of existing aquatic resources based on California Aquatic Resource Inventory (CARI);
  - abundance and diversity of historical aquatic resources and terrestrial plant communities;
  - survey and project summary statistics for eelgrass aquatic resources;
  - ecological restoration based on Habitat Projects;
  - aquatic resource condition based on California Rapid Assessment Method (CRAM);
  - human population based on 2010 Census and language spoken at home based on the 2008-2012 American Community Survey;
  - species of special status (both federally and California listed species) based on California Natural Diversity Database (CNDDB) (currently an unavailable service); and
  - developed land cover by the 2011 National Land Cover Database (NLCD).

  Users have several options for determining their area of interest. These include using USGS StreamStats to delineate an upstream catchment from a pour point; drawing and editing a polygon through a series of map clicks; selecting a pre-defined area for a congressional district, county, or hydrologic region (HUC8, HUC10, HUC12); or uploading an existing KML or Esri shapefile.

  Users may view a Landscape Profile in a pop-up box or print a detailed PDF report that also includes background information on each of the data sources. The Print Map feature allows users to download a PDF and share a map view with

accompanying notes.

- **Riparian Zone Estimator Tool (RipZET) (http://sfei.org/projects/ripzet)**

  RipZET is a decision support tool developed by the San Francisco Estuary Institute and Aquatic Science Center for the California Riparian Habitat Joint Venture and the California Water Resources Control Board to assist in the visualization and characterization of riparian areas in the watershed context.

  RipZET works within a Geographic Information System (GIS) to estimate the likely extent of riparian areas based on the concept of "functional riparian width." According to this concept, different riparian functions can extend different distances from their adjacent surface waters, depending on topographic slope, vegetation, land use, and position along a drainage network. RipZET translates this concept into estimates of riparian width for selected riparian functions, and the tool is modular so that new functions can be added as needed. RipZET provides reach-scale estimates of the riparian width associated with the relevant riparian functions (e.g., large woody debris supply in wetlands and in headwater channels or floodwater storage in low-gradient alluvial channels). RipZET's ability to visualize and quantify riparian widths and lengths for selected riparian functions makes it a powerful tool for assisting in the development of effective riparian management and restoration approaches throughout the state.

EcoAtlas History

We have assembled a lengthy memo detailing the essential history and background on the EcoAtlas suite of tools, charting how EcoAtlas began as Wetland Tracker in the late 1990s and evolved geographically beyond its origins in the San Francisco Bay Area throughout the state. It also gained new purpose and functionality along the way. Learn more about this journey from conception to science in Appendix A or in the document, "EcoAtlas, Applied Aquatic Science: Background and History" (http://sfei.li/ecoatlasbackgrd).

EcoAtlas Serves Program Needs

Programs throughout the state depend on various aspects of EcoAtlas. The table below summarizes how EcoAtlas serves current and future needs of these various federal, state and local programs.

	Habitat Restoration	Proposition 1 Grant Programs	Eelgrass Mitigation and Monitoring	Southern California Wetlands Recovery Project	Best Management Practices or LID	401 Certification Program	404 Program	Mosquito Vector Control	Storm Water Program	Forest Activities Program; Lake and Streambed Alteration Program	Biological Studies	404, 401, Nonpoint Source, Storm Water, HCP, NCCP
EcoAtlas Services	SFBJV, CVJV, DSC, LT-INFO	CDFW, SSJDC	NOAA-NMFS	SCC	KTAP	SWRCB and Regional Boards	USACE	Mosquito Abatement Districts	SWRCB	CDFW, SWRCB and Regional Boards	Caltrans	Inter-program
Enable **data entry**, management, display, and access	current	current	current	current	current							
Map, track and **view projects on common map** in context of other habitat projects	current	current	current	current	future	current for 1,2, 6		future	future	future		
Deliver data and reports to public	in-progress	current	current			in-progress	future					
Summarize information in **Landscape Profile Report**	current	current	current					future				
Track and report **costs and funding needs**	current	current										
View **change in distribution over time**	future		current			future	future					
Customize map tools for better visualization of data	current		future					future				
Standardize reporting of regional progress of at project and regional scales	in-progress	in-progress			future							

Integrate with projects stored in **other databases**	current	future	future	in-progress		future	in-progress	future	future			
Use **CRAM to assess wetland condition**	future	future		current		future	future					
Support mitigation checklists with landscape and project information						in-progress	in-progress				future	
Map, interrelate, and **view impact sites and mitigation sites on common map** in context of other habitat projects						in-progress	in-progress					
Automate the **tracking and receipt of Monitoring Reports**						future						
Analyze **cumulative impacts** in watersheds and develop **scenario planning tool**						future						
Develop regional plans to identify and avoid known aquatic resources											future	
Support coordinated project design, permitting, and assessment for watersheds												future

Note the distinction among current, in-progress, and current usage statuses for the given features. Regarding “future” uses, stakeholders in the given programs have expressed interest in applying a particular enhancement or implemented feature if funding sources can be identified. Interest in the tool continues to grow among the user base.

In addition to established programs, there are also several still-nascent programs that closely rely on EcoAtlas and the Level 1 (remotely sensed) information it facilitates. The Status and Trends program for California Wetlands is one such example. Its "Complete Level 1 Strategy" calls for a combination of permit and restoration accounting, intensive regional maps, and comprehensive mapping to generate a snapshot and trend-line for our state's types of wetlands. These can be derived from information found in EcoAtlas, but which require funding to support. In an effort led by the Southern California Coastal Water Research Project (SCCWRP), in partnership with the CWMW and others, Eric Stein and Leila Lackey described the features of a Status and Trends program robust enough to serve California's interests.[2] This is one instance of a critical program that would benefit from the continued development of the Toolset.

Background on User Base

Starting in its days as Wetland Tracker, the target audience for EcoAtlas was historically the stakeholders of the tool: the wetland restoration practitioners. This constituency remains. However, with the advent of more advanced geographic information systems (GIS) features and the operationalizing of CRAM, the EcoAtlas audience grew more diverse.

We should note that this reflects one mode of interaction with the site. We might call this the "front-end" interactions. In addition, EcoAtlas landscape restoration projects and CRAM assessments have been shared via "back-end" processes. Since 2014, EcoAtlas data -- both restoration project information and rapid condition assessments -- have found their way into a number of other information systems connected to the toolset by way of direct, server-to-server communication, also known as "web services." Systems such as Bay Delta Live, the Wetlands Portal of the California Water Quality Monitoring Council, and the Central Coast Conservation Action Tracker subscribe to "data feeds" from the EcoAtlas servers. Furthermore, new systems developed under guidance from the Lahontan Regional Water Quality Control Board and the Delta Stewardship Council will rely upon EcoAtlas's project data to ensure information currency and accuracy.

To encounter users beyond the direct awareness of the CWMW or its associates, however, we can use other measures to determine some of their interests. The following figures

[2] Stein, E., Lackey, L. 2012. Development of a Wetland Status and Trends Program for California. https://www.waterboards.ca.gov/water_issues/programs/swamp/docs/cabw2012/seven_prob_status_trends.pdf. Accessed Oct 20, 2017.

offer a perspective on the current audience for EcoAtlas as yielded through web site analytics for the period July 2013 through January 2017. We can analyze logs and determine some basic demographic information about our users, such as from which city they travel to the site. The first reports show “front-end” traffic followed by a brief summary of “back-end” usage of the data.

EcoAtlas.org

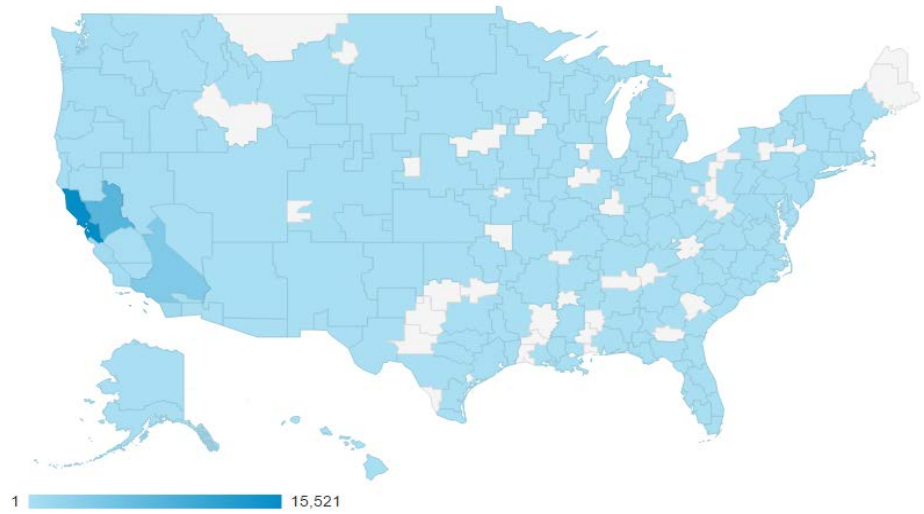

Figure 4: Visits to EcoAtlas.org by Region, Nation-wide (7/1/2013-1/1/2017) (image courtesy of Google Analytics)

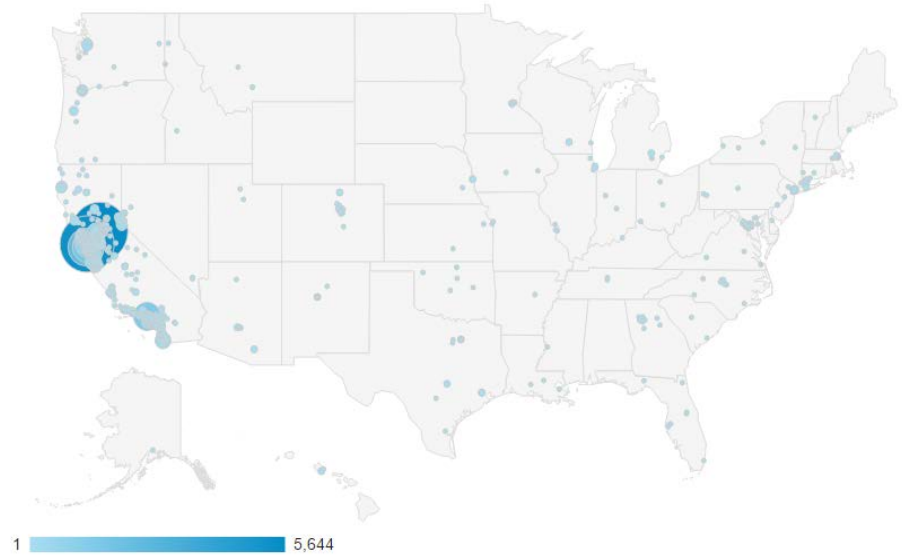

Figure 5: Visits to EcoAtlas.org by City, Nation-wide (7/1/2013-1/1/2017) (image courtesy of Google Analytics)

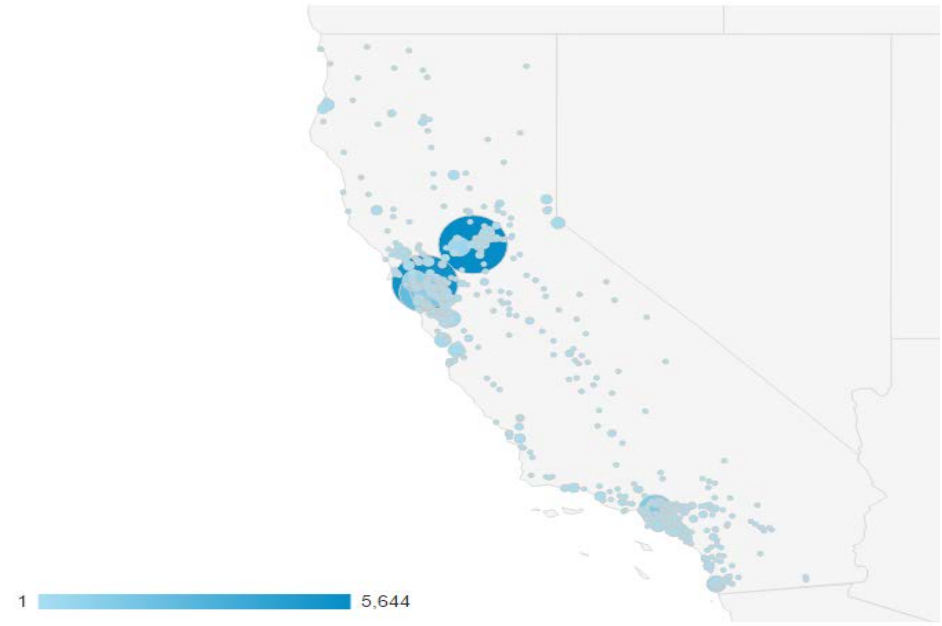

Figure 6: Visits to EcoAtlas.org by City, California-wide (7/1/2013-1/1/2017) (image courtesy of Google Analytics)

Metropolitan Area	Sessions	% New Sessions	New Users	Avg. Session Duration
San Francisco-Oakland-San Jose CA	15,521	41.43%	6,430	0:05:14
Sacramento-Stockton-Modesto CA	7,750	47.17%	3,656	0:04:25
Los Angeles CA	3,884	65.11%	2,529	0:03:47
San Diego CA	922	72.89%	672	0:02:24
Monterey-Salinas CA	752	47.21%	355	0:03:07
Santa Barbara-Santa Maria-San Luis Obispo CA	487	67.15%	327	0:03:25
Eureka CA	302	59.27%	179	0:04:09
Chico-Redding CA	246	62.20%	153	0:03:16
Reno NV	227	55.51%	126	0:05:41
Fresno-Visalia CA	168	83.93%	141	0:02:37
Bakersfield CA	47	80.85%	38	0:02:59

(not set)	31	41.94%	13	0:04:19
Palm Springs CA	21	61.90%	13	0:03:43
Medford-Klamath Falls OR	20	80.00%	16	0:03:40
Yuma AZ-El Centro CA	4	100.00%	4	0:02:48
	30,382	48.23%	14,652	0:04:38

Table 1: Visits to EcoAtlas.org by Metropolitan Area (7/1/2013-1/1/2017)

While there are occasional visits to EcoAtlas.org from around the country from curious eyes, the majority of traffic to EcoAtlas.org comes from the Bay Area. Given the recent collaborations with the Lahontan Regional Water Quality Control Board and Tahoe Regional Planning Agency (TRPA), we are not surprised to see the Reno, Nevada area represented in the logs.

Of course, with the usage expanding southward due to the loading of wetland restoration projects, we see Los Angeles, San Diego, Santa Barbara, and Fresno also represented.

The northern reaches of California appears as Eureka and Chico show interest in the tool. This is likely tied to the North Coast and Central Valley Regional Water Quality Control Board's usage of the tool.

"Sacramento-Stockton-Modesto" appears as the second most common region of origin, which should be expected, considering the use by EcoAtlas as a vehicle for the state's 401 program.

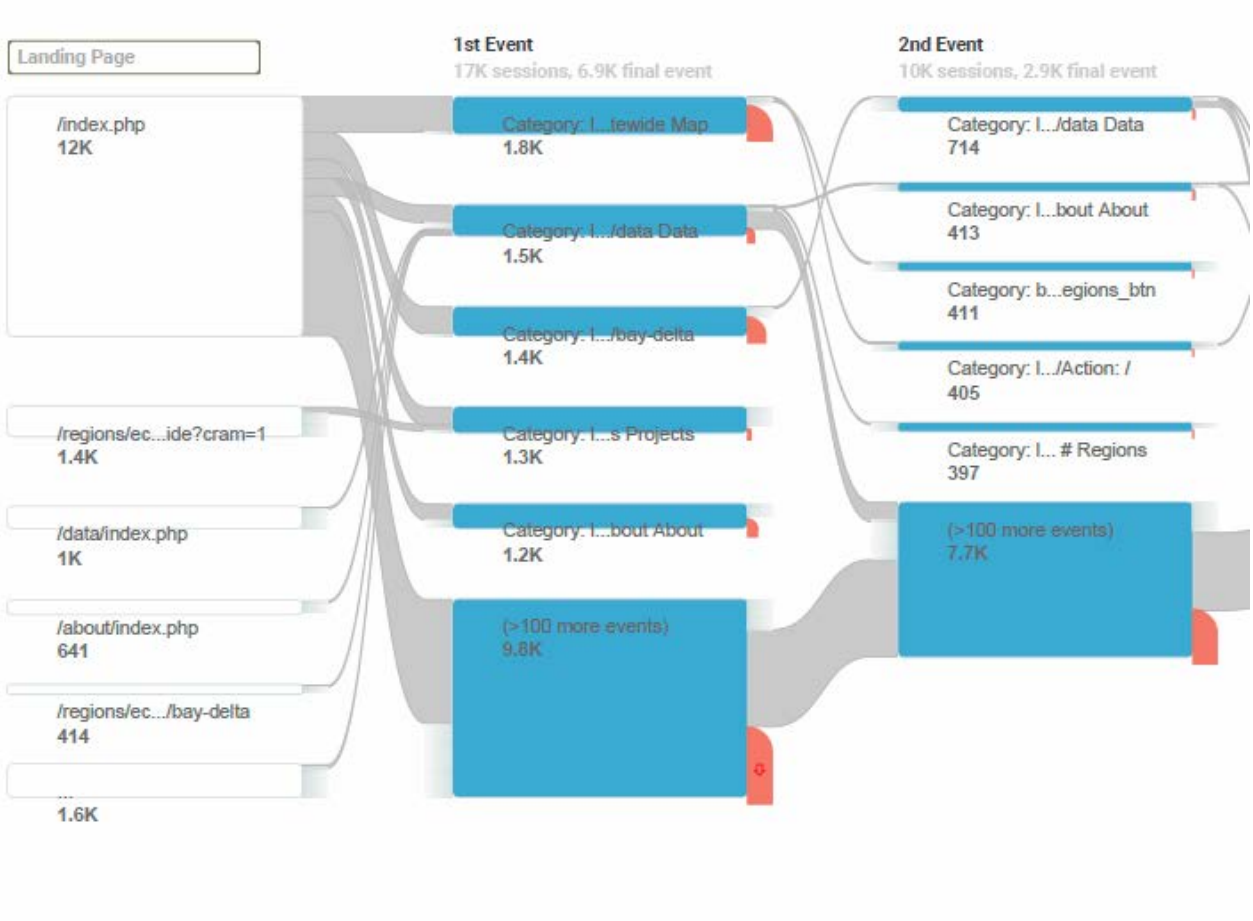

Figure 7: Site flow in EcoAtlas.org by user experience (7/1/2013 - 1/1/2017) (image courtesy of Google Analytics)

We can sometimes learn about user interactions with the site by observing their behavior through interrogating the logs. This “site flow” diagram illustrates the most common pathways used by visitors as they navigate the web site, moving from site entry on the left to departure on the right. One might think of this diagram as charting the “roads most traveled.” In this case, we see that the most common action, after arriving on the EcoAtlas.org site (the home page is represented by the page called “index.php”) is to visit the statewide map. The second most common is to learn more about the data, followed, in third place, by a visit to the Bay-Delta-focused map. Habitat restoration and mitigation “Projects” and the “About” pages form the third and fourth most common destinations, respectively.

There are more than a 100 other actions that people take, which cannot be explained here. Collectively, they represent the majority of forms of interaction with the site. It is unclear from the records how intentional the journeys are, but it is encouraging that people do find

the map, data, or projects most often.

As you may recall from the description above, Cramwetlands.org provides an entry and information management point for wetland condition assessments. Visitors arrive at Cramwetlands.org, typically as they receive CRAM training or soon thereafter, where they input their assessments according to rigorous scientifically based data validation rules. Once reviewed and approved, the recorded assessments are then displayed on EcoAtlas. In the following analysis, we examine the logs on the information entry point: Cramwetlands.org.

Cramwetlands.org

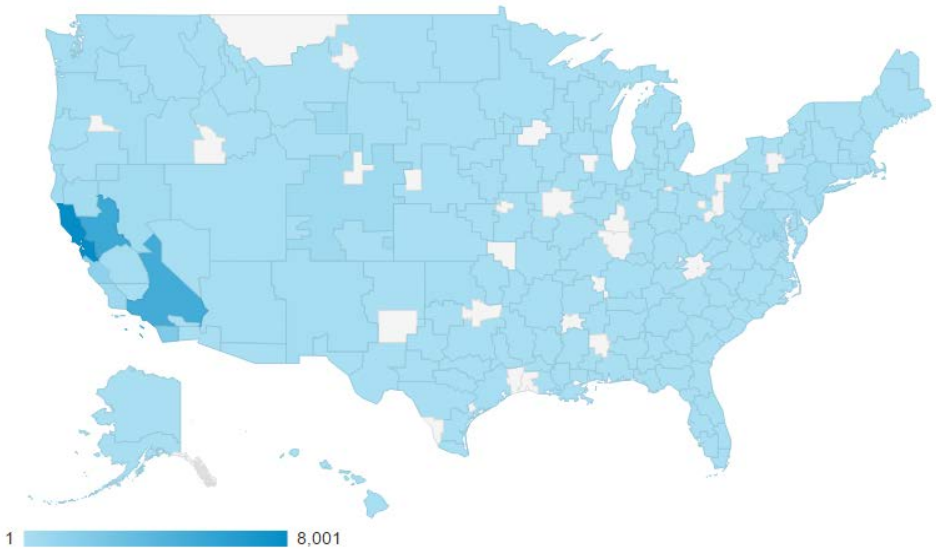

Figure 8: Visits to Cramwetlands.org by Region, Nation-wide (7/1/2013-1/1/2017) (image courtesy of Google Analytics)

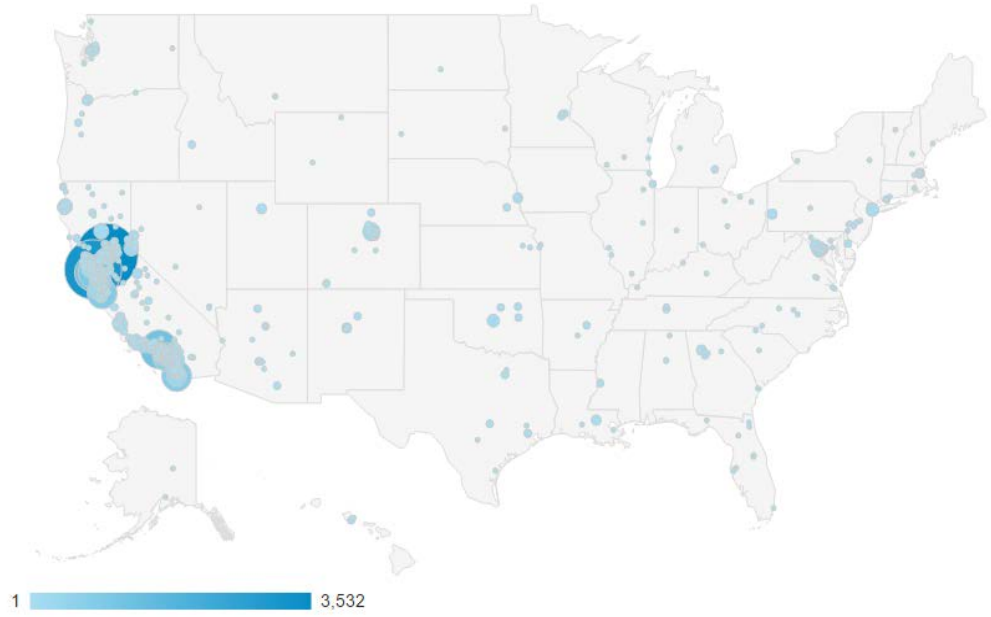

Figure 9: Visits to Cramwetlands.org by City, Nation-wide (7/1/2013-1/1/2017) (Image courtesy of Google Analytics)

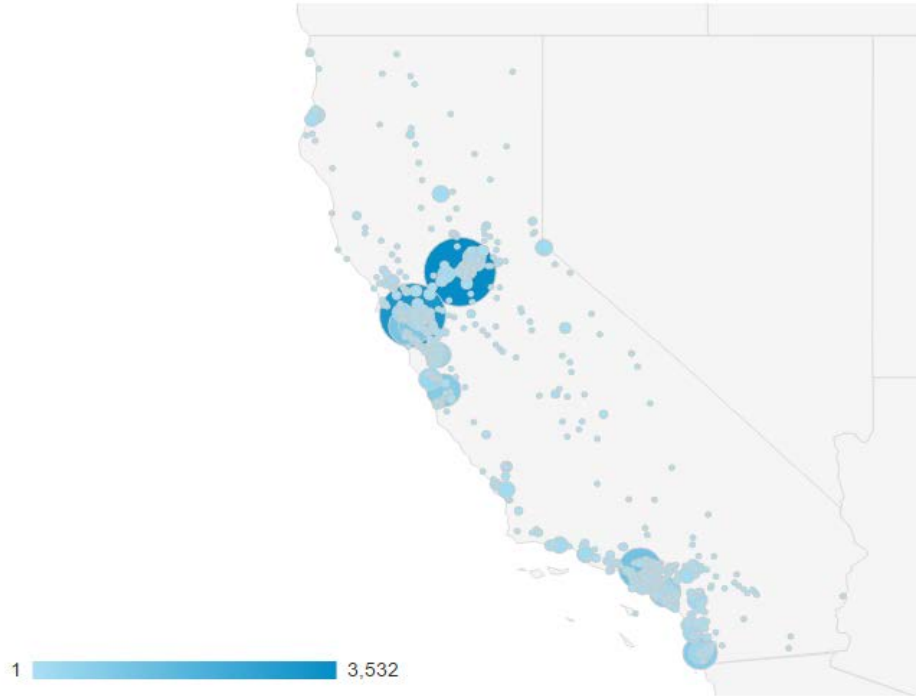

Figure 10: Visits to Cramwetlands.org by City, California-wide (7/1/2013-1/1/2017) (Image courtesy of Google Analytics)

Metropolitan Area	Sessions	% New Sessions	New Users	Avg. Session Duration
San Francisco-Oakland-San Jose CA	8,001	34.50%	2,760	0:06:01
Sacramento-Stockton-Modesto CA	5,315	43.57%	2,316	0:04:48
Los Angeles CA	4,963	42.80%	2,124	0:05:54
San Diego CA	1,976	44.43%	878	0:05:22
Monterey-Salinas CA	1,327	25.32%	336	0:09:15
Santa Barbara-Santa Maria-San Luis Obispo CA	608	47.70%	290	0:05:01
Eureka CA	402	57.96%	233	0:04:00
Chico-Redding CA	229	48.47%	111	0:11:33
Reno NV	224	35.27%	79	0:09:06
Fresno-Visalia CA	207	41.06%	85	0:11:57
Palm Springs CA	32	50.00%	16	0:03:08
(not set)	23	60.87%	14	0:03:45
Medford-Klamath Falls OR	14	57.14%	8	0:11:07
Bakersfield CA	12	83.33%	10	0:00:48
Yuma AZ-El Centro CA	3	33.33%	1	0:04:19
	23,336	39.69%	9,261	0:05:55

Table 2: Visits to Cramwetlands.org by Metropolitan Area (7/1/2013-1/1/2017)

By comparison to EcoAtlas.org, Cramwetlands.org has an audience fewer in number but more geographically disparate. This should be expected. Visitors to Cramwetlands.org are typically CRAM practitioners and/or trainers.

Regarding the comparatively large geographic spread, this demonstrates the broad adoption of CRAM as an approved method for landscape assessment across the nation, with many people around the country expressing interest in California's established method and associated technology. Trainings occur regularly throughout the state, and the

CRAM modules are updated as funding allows, to help develop new assessment capabilities or update our shared knowledge.

CRAM is currently incorporated into the Clean Water Act Sections 401 and 404 programs. Accordingly, it has now formed a critical lynchpin in the determination of landscape condition from a programmatic perspective.

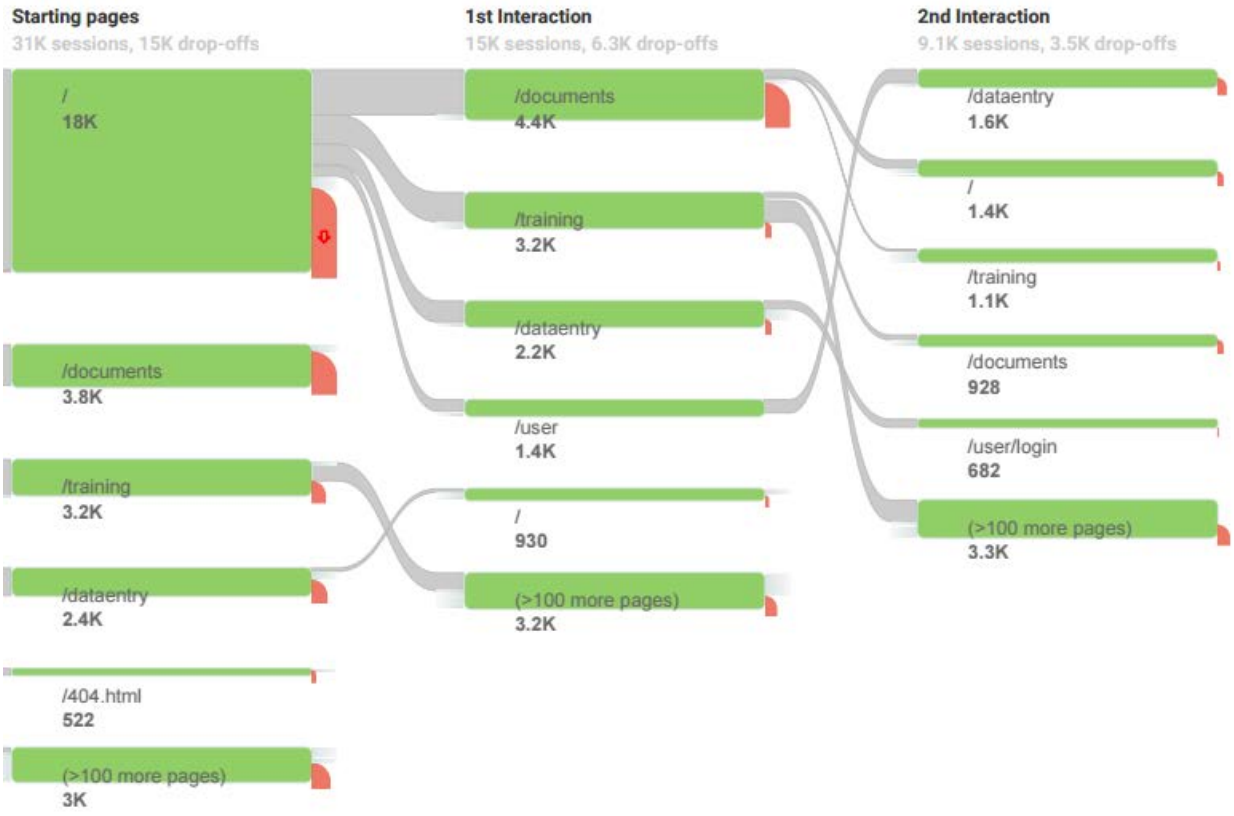

Figure 11: Site flow in Cramwetlands.org by user experience (7/1/2013 - 1/1/2017) (image courtesy of Google Analytics)

As in Figure 7 above, this "site flow" diagram charts the most common pathways used by visitors as they navigate the Cramwetlands.org web site, moving from site entry on the left to a departure on the right. We can learn which pages are most popular in the course of common navigation. A cursory examination of traffic flow through the site reveals that site visitors often wish to retrieve documentation, learn about training opportunities, or wish to enter a new CRAM assessment in the system (data entry). The login functionality is represented by the "user" page, which indicates that 1.4k visits to the site were from those seeking or possessing CRAM accounts.

The documentation and especially training pages are updated regularly. CRAM

practitioners receive regular communication on new content and are likely channeled to those pages via links from these email notifications.

Web Services

In addition to interactions through the web interface, EcoAtlas and Cramwetlands.org serve their data through back-end channels. These server-to-server based communications automatically render restoration project data and CRAM assessments on maps managed by entities outside of the CWMW's direct influence. This is by design, of course.

Some data systems become "data cul du sacs." EcoAtlas has always sought to be a "data hub," a resource serving the common good through the broad distribution of its critical, publicly available information.

Liberating data in this way encourages others to value the information the data can yield. For instance, the Central Coast Conservation Action Tracker, a system designed by GreenInfo Network, displays publicly accessible CRAM scores mined from the EcoAtlas suite. These data are absolutely current since they are pulled directly from the primary CRAM database.

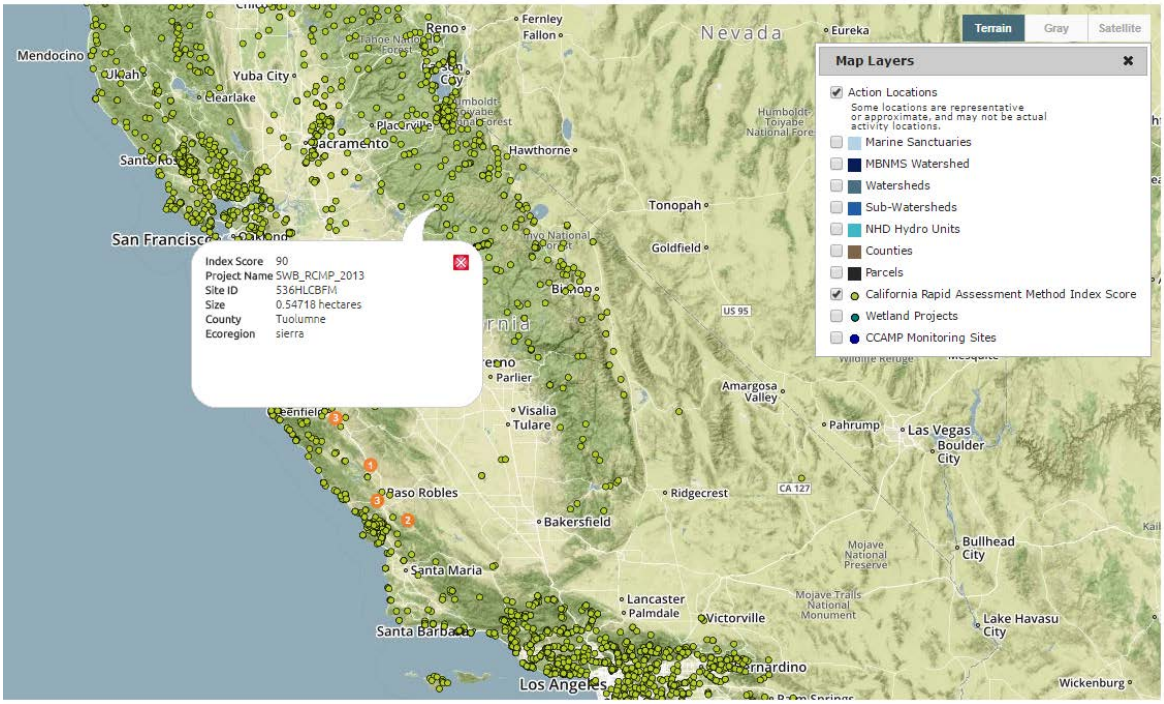

Figure 12: CRAM assessment sites displayed on Conservation Action Tracker (https://www.ccactiontracker.org/site/map)

This sharing of data is something to be encouraged, rather than discouraged. The display of CRAM assessments in the Central Coast Conservation Action Tracker or EcoAtlas project data in Bay Delta Live demonstrates how stakeholders can leverage the high quality of data recorded in EcoAtlas' tools and extend their impact beyond the immediate vicinity of the tools themselves.

By the same token, however, we must do a better job of attribution. Maintaining provenance by linking to the authoritative source of the information lends greater credibility and transparency to the information, while also ensuring that credit is provided to the data creators.

Moving forward, we will be integrating with the Lake Tahoe Environmental Improvement Program's reporting system and the Delta Stewardship Council's Delta View, which further confirms the attractiveness of this form of server-to-server data sharing.

Hits (2/1/2016-2/1/2017)	
Total Hits	2,282,214
Visitor Hits	12,268
Spider Hits	2,269,946
Average Hits per Day	6,252

Table 4: Numbers of hits on web services for Habitat Projects and CRAM Assessments

The numbers of visitors via the back-end are fairly substantial and will only grow with additional systems integrations.

Please note: the high number of hits by so-called "spiders" reveals the need to maintain a strong security posture for all of our resources on the internet. While many spiders might be benign, there are some with bad intentions. In this case, an unpatched server is a vulnerable server.

Business Model

As we continue our data-sharing efforts, we will be challenged to support the necessary demands on time, energy, and resources. Traditional financial support -- chiefly, grants tied to projects -- might be scarce. We must accordingly adopt more sustainable methods for software development, conducting operations, performing maintenance, and encouraging further scientific innovation.

EcoAtlas emerged from a regional effort. But since its origination as Wetland Tracker around 2000, it has been directed to serve the entire state in a number of sensible, important ways: through its common basemap, inventory of wetland assessments, and wetland project tracking, just to name a few key statewide, essential functions. At the same time, however, it must again meet the specific demands of regionalized, customized endeavor through smart modularization. By this modularization, we are referring to the process of distinguishing core software functions from customized ones and ensuring that software development practices adhere to principles of modular programming, or dividing into logical programs different sets of functions. SFEI has already begun implementing such structural changes to the EcoAtlas map viewer in recent projects. For instance, the distinctive mapping libraries that afford so much interactivity are now custom packaged as a module and shared across multiple software products. This allows our toolset to leverage common functions among its different modules while affording lower-cost maintenance plan for upgrading and continuing the support for the software. These common libraries help to define the commonalities across the suite of tools. We will continue to develop such software libraries as funding allows.

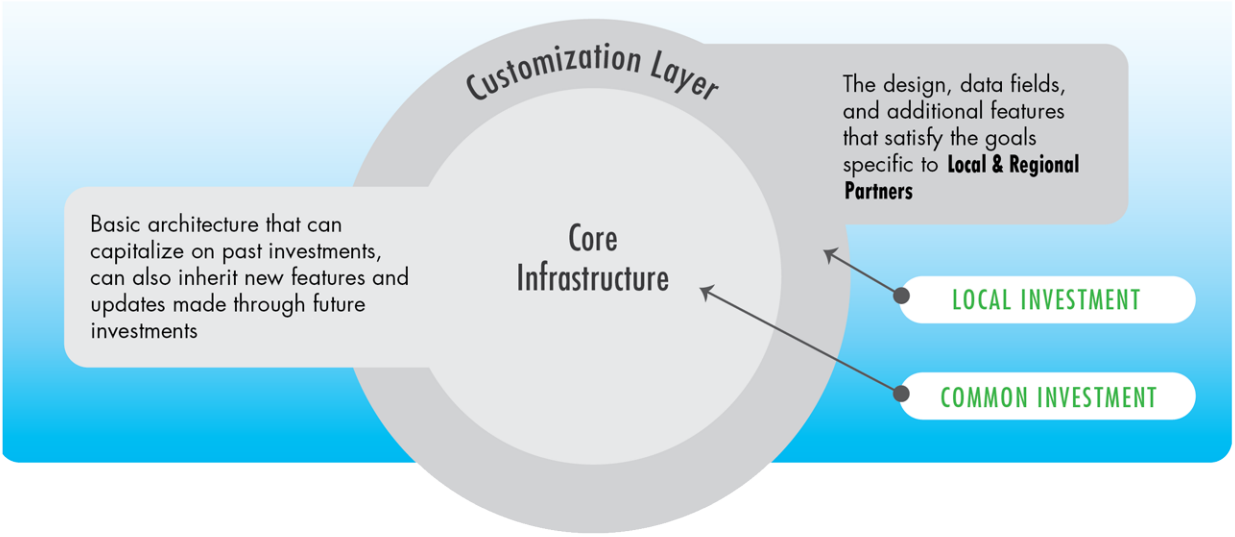

Figure 13: Proposed Software Development Model (graphic by Linda Wanczyk)

More importantly, a peripheral set of customizations, interacting with these common libraries can afford a high degree of customization by regional and local partners who wish to see their own programmatic objectives reflected in the toolset. This is a common strategy in the world of software development.[3]

For the purposes of our model "regionalization" stands for the tools interest as represented by both a specific California region such as the Sacramento-San Joaquin Delta and local programs or interests. We can consider a water district's requests for customization, in other words, as an opportunity to regionalize EcoAtlas. Likewise a regional water board's interests might also provoke a regionally customized view.

The Landscape Profile Tool, by way of example, is a unique form of map integration that allows users to wrap a "lasso" around a landscape of virtually any size and summon all of the information in EcoAtlas -- its landscape restoration projects, CRAM assessments, CARI features, and even US Census data -- into a Landscape Profile report. This feature in particular opened the audience for EcoAtlas beyond those close to individual programs. This tool offers an example of two "toggled" modes: "standard" and "CRAM & CSCI." The former focuses on items other than landscape condition, whereas the later includes CRAM assessments and stream condition scores. This toggled view is a form of customization, but it does not necessarily serve regional interests. It does, however, illustrate the demand for custom views, dashboards, analyses of data in the system, and how those demands might be met.

[3] Cf Crowston, K., Wei, K., Li, Q. and Howison, J., 2006, January. Core and periphery in free/libre and open source software team communications. In *System Sciences, 2006. HICSS'06. Proceedings of the 39th Annual Hawaii International Conference on* (Vol. 6, pp. 118a-118a). IEEE.

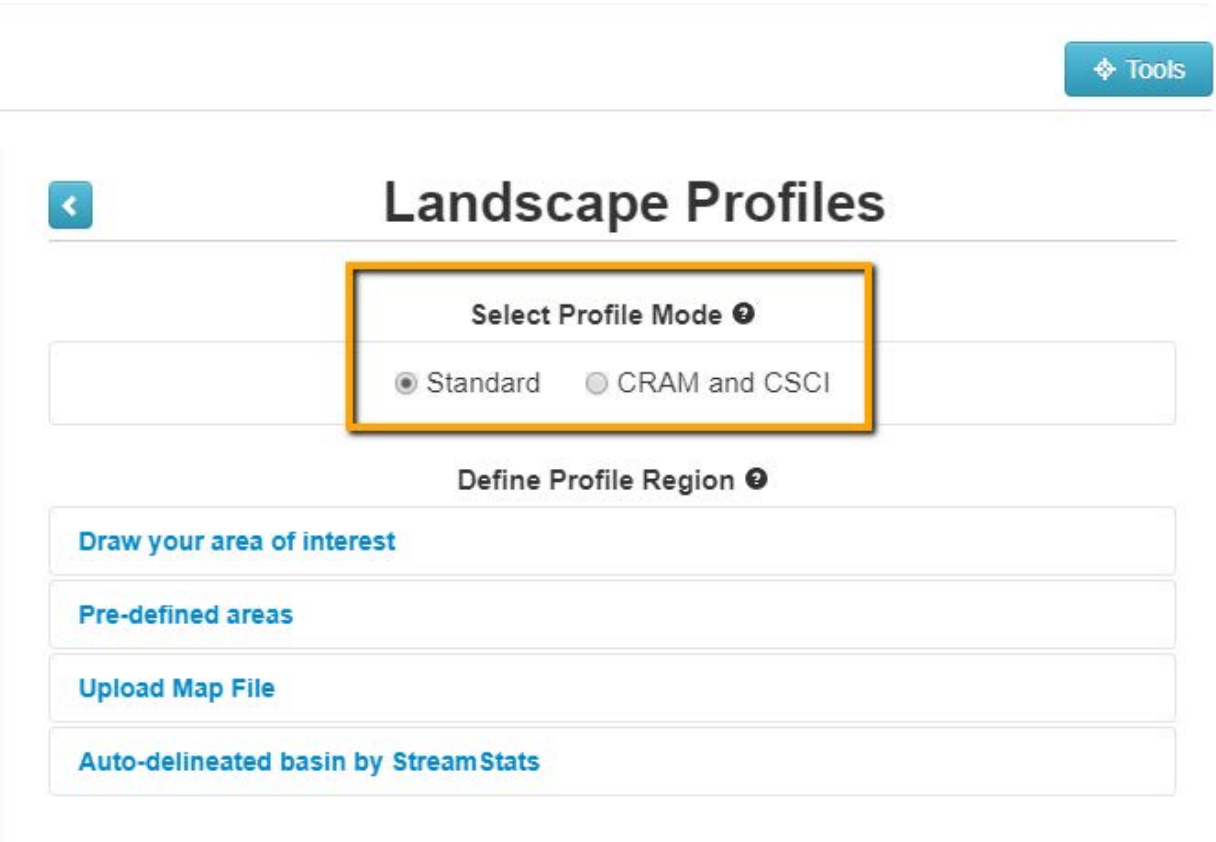

Figure 14: Toggle Modes for the Landscape Profile Tool

In the future, we anticipate greater "market segmentation" through the creation of individual Landscape Profile Reports. For instance, programs can develop their own Landscape Profiles suited to their needs. And individual users can also exert influence over which components might appear in the own profiles. As the tool is customized, so will the tool attract a broader diversity of users. A diversity of users will result in a diversification of the product funding portfolio.[4]

User Experience

Achieving customized views of information is about tailoring the information to the user. In furnishing greater choice, we wish to avoid any unnecessary hardships to ensure a high degree of usability and ease. Having ample experience in authentication and authorization (logging into information management systems), we try, whenever possible, to avoid setting up the hurdle of a requisite log in. Users often regard authentication as a

[4] Cf Irani, G.N.H. and Nejad, G., 2012. Decentralized Principles: New Modular Software Development Principles, a Robust Object Oriented Approach. *International Journal of Computer Applications*, *44*(13).

prohibitively onerous step, so we have developed options to achieve customized experiences. Depending on the specific use case, one option might be selected over another, but it is not an either-or proposition. Different solutions can be deployed for different forms of customization. As such, what follows are some potential options that might be undertaken to offer customized views of complex information.

User-Selected Views

The case cited above with the toggle on the Landscape Profile Tool is an example of a user-selected view. This toggled selection might also take the form of a list of roles someone might occupy -- eg, CRAM practitioner, CRAM trainer, researcher, etc. The ability to self-identify and then view the results assembled for the user's role is very common and might serve as the basis for customization.

In addition to the options currently available in the Landscape Profile Tool, the EcoAtlas Dashboard, to be released in September 2017, will also provide selectable options for an experience tailored to a user's role.

Further regionalization opportunities, depending on the user requirements, might expand the use of this form of customization.

Parameter-Driven Views

Another option to facilitate customization is a custom URL (web address) that customizes the experience. For instance, http://delta.ecoatlas.org would deliver a map-based focus on the Sacramento-San Joaquin Delta and also assemble a suite of tools determined by Delta-focused agencies and stakeholders. This is already available, in a sense, through a longer URL (http://ecoatlas.org/regions/ecoregion/bay-delta) that immediately delivers users to the appropriate ecoregion. In the future, however, the tools and analyses might also be customized to meet regional needs.

URL-based customization is useful for its open and unrestricted ability to grant different experiences and furnish different information based on the point of entry.

Authentication-Based Dashboards

Another option for a customized user experience is authentication-based dashboards. Users would log into EcoAtlas and then see information tailored to them or their associated role. As mentioned above, these are among the more common options for committed

users. By "committed," we are referring to site visitors who have a deep and abiding stake in editing the information contained in the system.

We are careful to mention "editing" because generally this technique is most important when the site users are contributing information that is important to associate with individual users. In fact, we already employ individual accounts for users of Project Tracker, a tool that allows individual project practitioners to upload information about their landscape restoration and mitigation projects. Project Tracker also provides the ability for regional administrators subsequently to review, alter, and approve the data furnished by individual practitioners. The same quality assurance technique is available on eCRAM, which provides the ability of CRAM practitioners to upload their assessments for review.

The authentication (who you are) and authorization (what can you do) protocols associated with these data entry systems are critical to ensure data of a known quality. The primary purpose is not a customized experience, but if we wished to extend the functionality, we could provide custom dashboards for analysis, assembled and maintained on a user-by-user basis. However, this would set a certain barrier for those who do not wish to log in. Based on our project development experience, many of our users find logins to be an annoying barrier. Openness and ease of access are the usual modes of our work.

If the use case demanded it, though, we could certainly leverage the accounts established for these other services to render custom views.

Whatever the mode or portfolio of modes adopted, these customizations, done correctly, should not compromise software and data integrity. To the contrary, we should be able to achieve a greater level of sustainable development.[5]

A Role for Adaptive Management

This software development structure, proposed above, facilitates a high degree of adaptation to regional programmatic interests while still maintaining a common core of software and data. Software customization, as imagined here, addresses a need to accommodate the conditions presented by the adaptive management life cycle.

All software must adapt. After all, upgrades are now so commonplace as to be invisible to most users. A smart phone, for instance, will upgrade itself overnight without user

[5] Cf Conley, C.A., 2008. *Design for quality: The case of open source software development*. ProQuest.

intervention. However, those upgrades do not happen without a lot of planning and careful execution by the business professionals and programmers. It is therefore important to consider now how the complex suite of EcoAtlas tools will adapt to changing needs in a sustainable way.

Likewise, natural resource management must adapt to accommodate changing conditions and innovations in the knowledgebase, particularly as we face new challenges from climate change and other stochastic forces, which compel us to invoke our practices of adaptive resource management. Through those methods, we can optimize our relationship to the landscape and our anticipated programmatic outcomes.

Science and technology share this common need to adapt, which should make them natural partners. However, their respective cycles of renewal and adaptation sometimes occur at different times and rates. Aligning these two adaptation cycles is a challenge often faced by natural resource managers. The National Water Quality Monitoring Council offers us a significant perspective on the integration of data, software tools, and monitoring needs by way of its Monitoring Framework, which illustrates a form of adaptive management.

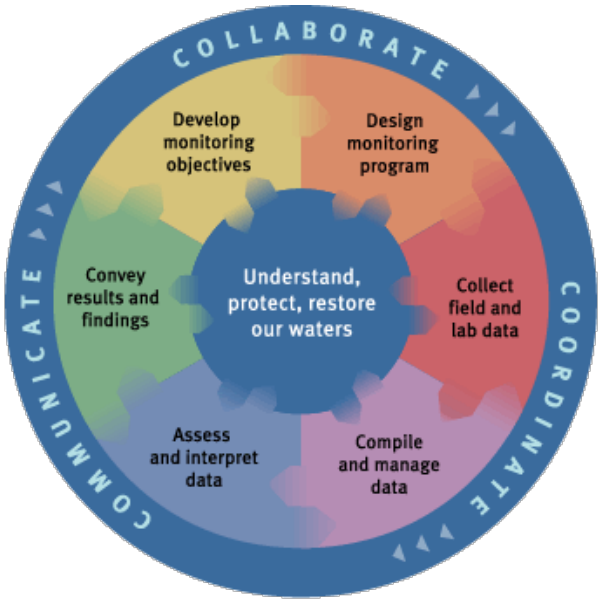

Figure 15: The Monitoring Framework from the National Water Quality Monitoring Council[6]

We must note that the framework, as illustrated, is a true cycle. Its operation is not linear. It

[6] The National Water Quality Monitoring Council. 2017. The Monitoring Framework. (https://acwi.gov/monitoring/about_the_framework.html).

would begin with the development of monitoring objectives and then move into the design of the monitoring program. But the cyclical format is key to understanding adaptive management. The conveyance of results and findings would in turn influence the next round of development on new monitoring objectives. There is, in other words, an implicit feedback loop and adaptation to accommodate new scientific insights and changed conditions.

Technology development shares points of commonality with this cycle. In fact, within the framework appear several items related to data:

- Collect field and lab data
- Compile and manage data
- Assess and interpret data

Given the need for the best available data, technology obviously has a very prominent role to play in the framework published by the National Water Quality Monitoring Council. The Council contends that the framework should "[f]acilitate communication among professionals and volunteers working on different elements of monitoring programs (e.g. laboratory analysis and data analysis / interpretation)." It can also emphasize the need to ensure that the tools employed reflect the latest monitoring goals. Therefore, taking the converse, relying on out-of-date or inadequately resourced tools can prove to be obstacles to nimble programmatic adaptation.

Turning to a California-based source, the Delta Science Program (Delta Stewardship Council) has its own influential adaptive management lifecycle.

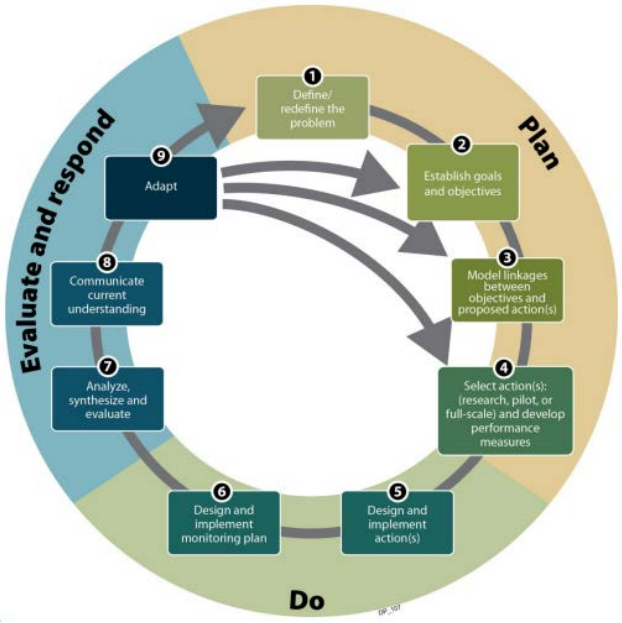

Figure 16: The Delta Plan's Nine-step Adaptive Management Framework (Delta Stewardship Council, 2013).

This adaptive management framework should be familiar to most scientists and agency staff who conduct work in the Delta and nearby ecosystems (Figure 16). Interestingly, the relationship to data and tools is less pronounced in this example than in the Monitoring Framework, cited above, with only #7 "analyze, synthesize, and evaluate" offering some allusion to the need for technological alignment.

Figure 17: Data Life Cycle (DataONE)

Within the world of information management, another cycle prevails. The data lifecycle, best expressed through Data One's Life Cycle (Figure 17) shares some key aspects in common with the familiar cycle of adaptive management. Explicit within this cycle are planning, collecting, and analyzing, but in addition, you can also find steps that are specific to data management, including "assure," "describe," "preserve," "discover," and "integrate." Despite the differences, however, the points of commonality present an opportunity to bring the monitoring framework and data lifecycle into conversation with each other, if only to emphasize the need for cyclical evaluation and renewal.

This potential alignment is important because it illuminates an opportunity to speak the same language across the knowledge domains of agency program and technology

concerns. It also helps to achieve a governance consistency across both lifecycles, with the functional revisions reflective of resource management adaptation feeding into the data lifecycle at the appropriate place.

Nonetheless, although the data lifecycle and software development lifecycle share key points in common, we rarely seek to synchronize them. As many will admit, both models are what we might call “aspirational” since they inform the ideal process by which each domain of practice adapts to change.

The CWMW, through active governance and stewardship of EcoAtlas, has the opportunity to achieve a much clearer vision for alignment between an adaptive management cycle and a data lifecycle. It begins with planning, as the element common to all frameworks indicate. And we must then embrace adaptation and change as new goals emerge for the program and the technology -- ideally, in synchrony.

In practice, when new objectives for monitoring are considered, the governing authority should perform an abbreviated assessment of the technology available to determine if, in addition to the monitoring plans, the technology requires adaptation.

Governance

In practical terms, these functional considerations emerge regularly in the Level-2 subcommittee of the CWMW, where CRAM practitioners help to develop new CRAM modules or revise existing ones. We might think of the science that informs these innovations as the functional decision predicating a technical decision and associated labor allocation in response.

We recommend further extending this model of programmatic adaptation and oversight to accommodate further changes to the toolset, particularly where there is a strong intersection between the subcommittee and the toolset component. Those relationships might apply in the following ways:

- The Level 1 subcommittee is concerned with the salience of remotely sensed information to the EcoAtlas toolset. It was most active during the development of CARI (the California Aquatic Resource Inventory) It empowered a technical advisory committee to provide guidance on the technical aspects of the classifications. Before that, the subcommittee advocated for CARI’s existence in the first place to align scientific goals with information management tools.

- The Level 2 subcommittee oversees wetland condition assessments and accordingly exerts influence over CRAM and its continued scientific and technological evolution. As described above, the Level 2 subcommittee has a track record of sponsorship for CRAM's new module development and associated scientific studies.
- The Level 3 subcommittee helps to advance the integration of intensive data assessments into the toolset through the establishment of common standards and new modes of analysis. Most recently, the subcommittee provided feedback on new visualizations integrated into EcoAtlas and associated with Level 3 data.

There are distinct advantages in leveraging the existing subcommittees and formalizing their governance roles rather than originating new subcommittees dedicated to EcoAtlas governance. First of all, the committees have already been exercising a governance or advisory role in many cases. Secondly, they are often the strongest authorities on the goals for a wetland monitoring program and the associated information needs. Finally, as an interagency set of bodies, they reflect a consensus among disparate parties.

However, because the subcommittees are interagency by their nature, they do not necessarily express the need for local and regional adaptation. This underscores the necessity of the core-and-periphery software structure described above, whereby the core reflects the modules held in common among the EcoAtlas modules and the periphery represents the customizations needed to meet regionalization goals.

As we adopt a new, modular, core-and-periphery software structure, the governance by the CWMW must attend primarily to the core. In the periphery lie the customizations for individual programs. Accordingly, the chief concern of the CWMW's governance over the toolset will be maintaining the integrity of the core. In other words, the CWMW will not necessarily oversee all customizations, insofar as they do not have direct bearing on the core programming. However, to the extent that any enhancements impact the core operations, then the CWMW would exert its governance role. This will foster nimble development of the peripheral customizations while ensuring that information and tools common to all are salient, scientifically valid, and practical.

Toolset Diversity

In a practical sense, the cycles of revision operate at different speeds for the various components of the EcoAtlas toolset. This has implications for both governance and funding options.

For instance, EcoAtlas and CRAM require quarterly security patches while CARI and its associated editor can go a year without such security intervention.

The following table reflects the anticipated update cycles for toolset maintenance:

Tool	Update Frequency	Oversight Body/-ies
EcoAtlas Map Viewer	Quarterly	L1 Subcommittee
CARI / CARI Editor	Annually (with ongoing data processing)	L1 Subcommittee
eCRAM	Quarterly (with ongoing data processing)	L2 Subcommittee
Landscape Profile Tool	Annually	L1, L2, L3 Subcommittees
Project Tracker	Quarterly (with ongoing data processing)	L3 Subcommittee
RipZET	Biennially	L1 Subcommittee

Table 5: Anticipated update frequency for tool components

For modules with high rates of update, we must ensure that we distinguish between routine updates -- security patches, for example -- and new modules development. This is best illustrated by the eCRAM interface, which, as a sophisticated application, requires quarterly security patching and incremental system updates. In parallel to these regular operations would be the development of new CRAM modules, which are still core to the tool, to use the new language, and occur much less frequently. Such CRAM modules are labor-intensive to create and revise. As a result, they are updated on an annual or biennial basis, with close oversight by the Level-2 Committee.

In short, frequent operational updates should occur without close governance for expediency's sake, while less frequent changes with impacts on functions, features, and usability should be exposed to the appropriate level of oversight. In terms of consistent nomenclature, we might call the former, frequent changes "operational" and the later, more impactful ones "strategic."

Funding Model

The funding model must complement the changes proposed in the business model. With the regionalization of EcoAtlas and its application, new opportunities emerge.

The categories of new potential support include:

- Integration with key programmatic tools such as the Lake Tahoe Environmental Improvement Program's reporting system, The Delta Stewardship Council's Delta View, and even potentially the California Integrated Water Quality System (CIWQS) to enhance the wetlands mitigation program
- Service to HCPs / NCCPs throughout the state
- Project tracking by the SF Bay Restoration Authority
- Data management for the still emergent SF Bay Wetlands Regional Monitoring Program

The suggested software model renovations leave us better poised to serve these needs with greater project management dexterity and software development agility.

Financial Budgeting

The following budget represents estimates for annual costs associated with the toolset, inclusive of all components except the Riparian Zone Estimator Tool, which is not an online tool and therefore in another category of development:

Category			Annualized Costs (In Thousands)
Core Technology			
	1. User Support, Training, and Outreach		
		EcoAtlas, Project Tracker, and Landscape Profiles	65
		California Rapid Assessment Method	90
		California Aquatic Resources Inventory	30
	2. Database Management, Upgrades, and General Maintenance		
		EcoAtlas, Project Tracker, and Landscape Profiles	75

		California Rapid Assessment Method	65
		California Aquatic Resources Inventory	25
	3. Quality Assurance		
		Quality Assurance / Quality Control Operations	15
	Subtotal		**$365**
New Development			
	4. Planned Enhancements (Innovations and Customizations)		
		EcoAtlas, Project Tracker, and Landscape Profiles	70
		California Rapid Assessment Method	35
		California Aquatic Resources Inventory	15
	Subtotal		**$120**
Governance			
	5. Programmatic Connections		
		Subcommittee meetings	25
	6. Quality Assurance Validation		
		Technical Oversight and Coordination	15
	Subtotal		**$40**
Grand Total			**$525**

Table 4: Proposed budget for EcoAtlas Suite of Tools

The prospective budgetary numbers recorded in the table above reflect a summary of the last three years of operational expenditures through projects, overhead and in-kind support for each product, and a modest supplemental percentage of growth.

The “Core Technology” section focuses on the operations and maintenance of the toolset. One might consider these the routine, recurring activities that are non-discretionary and needed to keep the toolset secure, high in quality, and functional. Without core technology support, the systems would cease to exist.

"New Development" provide enhancements to the systems, adding new features, customizations, or innovations to align the toolset with programmatic or regional needs.

Under "Governance," we have sought to capture estimated costs associated with a more frequent meeting schedule and quality assurance oversight capacity to afford a more robust governance of the toolset.

The following is a description of each budgetary item along with details regarding the estimates.

Core Technology

- *User Support, Training, and Outreach*

Under "User Support, Training, and Outreach," you would find helpdesk services to support Project Tracker users, approving their accounts as necessary and instructing them in the use of the tool.

CRAM training offers a robust and well-documented training regimen to CRAM practitioners and managers, critical to the integrity of the data we find in the CRAM database. It is estimated to be $90k, based on the past three years' training patterns. The training is not an optional component, but must be offered regularly to ensure compliance with the practice of performing CRAM assessments.

To support the regular loading of CARI revisions into the inventory, we have allotted $30k. Also included in this calculated value would be the updating of classifications in accordance with requests from regions.

- *Database Management, Upgrades, and General Maintenance*

This item, "Database Management, Upgrades, and General Maintenance," articulates the system-level, server-based hosting, and database maintenance and general operations associated with the toolset. Because these activities are related to non-discretionary support, they are less variable than the other costs. At $165k, they represent labors of a database administrator, project manager, data processor, in addition to the hardware costs to support the server, storage, and bandwidth. Until now, these tasks have been

shouldered by the overhead associated with projects and ample in-kind contributions. Further restrictions from the state on overhead allowances have constrained the accommodations for this necessary work.

- *Quality Assurance*

The Quality Assurance budget item is expected to cover the basic quality assurance operations needed to provide data of a known quality. This facilitates basic quality controls for eCRAM, Project Tracker, and CARI, subject to guidance and oversight by the governing subcommittees.

New Development

- *Planned Enhancements (Innovations and Customizations)*

We can expect that new projects will continue to foster new enhancements in the EcoAtlas toolset. In fact, these enhancements will help grant the possibility for continued regionalization and programmatic customizations. Presuming a reduced role of EPA in supporting the toolset, this budget item predicts a 60% annualized reduction in project-based funding. The shortfall, in this model, is partially compensated by the more accurate support for operations and maintenance.

Governance

- *Programmatic Connections*

Under “Governance,” you will encounter a modest budget for the activities necessary to support the review of proposed innovations, changes to the WRAMP framework, and requisite revisions to the core software. This budgetary item accounts for meeting time and related expenses for the subcommittees named in the Governance section above.

- *Quality Assurance Validation*

Also under “Governance,” the Quality Assurance Validation budget item that specifically identifies the need for ongoing oversight of quality assurance measures, if only to provide assurance of compliance.

Hybrid Model

The proposed funding model would be hybrid in nature, insofar as it must seek multiple sources and types of funding. This hybridity would serve as a form of "financial portfolio diversification" to ensure that the viability of the product is not subject to interruption from a single disrupted source. In essence we are proposing a more complex, but more sustainable, resilient model.

Budget Fulfillment

Although the budget, as described above, is divided into three discrete sections -- "Core Technology," "New Development," and "Governance" -- we might, for the purposes of budget fulfillment, further simplify them by grouping non-discretionary, recurring budget items together. These items constitute the "Core Technology" and "Governance" sections which, combined together, represent a recurring budgetary need of $405k. The remaining budget of $120k under "New Development" anticipates the need for ongoing project-based enhancements, which might be called discretionary, based on demonstrated need.

To address the recurring budgetary need, we would require agencies and/or organizations to pledge a certain amount of funding towards support for a diverse toolset. Already, there are three organizations that have pledged modest amounts in recurring support. The US Fish and Wildlife Service pays $25k per year to support the maintenance of Project Tracker, The San Francisco Bay Joint Ventures pays $15k per year for the same kind of support, and the National Oceanic and Atmospheric Administration–National Marine Fisheries Service pays $11k per year for the maintenance of Level-3 eelgrass data for everyone's common benefit. Combined, this accounts for $51k of the $405k overall budgetary need, leaving $354k unfulfilled.

If we set an initial target of **four additional partners** who recognize the value of EcoAtlas, as did the partners named in the paragraph above, and divide the need evenly among them, then each would pay $88k for the service. We believe that this is a reasonable target as a start.

If an additional partner is recruited, however, the burden is spread among more participants and reduced overall to $71k. In this way, the budget remains the same, but more participants in the recurring support reduce the per-participant burden.

Non-Paying Clients

We might reasonably ask, "What happens to so-called 'non-paying customers'? Are they excluded from using EcoAtlas?" The CWMW adheres to a series of principles outlined above that emphasize transparency, public access, and scientific credibility. To remain true to these principles, we recommend that we preserve continued access to core data inputted into the system for everyone, even non-paying clients. However, to ensure that people know what they get for their money, and to provide equity among contributors, we will not provide some basic services to such clients: they will receive no user support or special trainings. Any customizations they developed might be deactivated if the core data remain available.

Funding Vehicles

The following list of funding vehicles offer descriptions of those vehicles and how they might be used to facilitate participation by potential partners. Certain sources of funding would be better suited to address different partners' needs -- whether a state or federal program, state or federal agency, regional interest, or private entity -- vis-a-vis the proposed business model.

(For your reference, included in an appendix is a broader range of funding vehicles, intended to capture descriptions of the broadest viable list.)

Project- and Grant-Based Funding

As local, regional, and state organizations require enhancements, we will continue to facilitate these through conventional project-based and grant funding. These consist of arrangements with strict budgets, scopes of work, and deliverables decided in advance. In essence, we use the term "conventional" because it has formed the vast bulk of all funding received to date to support the continued development of EcoAtlas.

The new business model with funding for the core infrastructure would leave notable gaps in application development resources, which can continue to be fulfilled through project-based funding. The budget described above anticipates $120k in project-based funding to support enhancements, innovations, and substantial augmentation of the toolset. New tools or tool functions can be developed under projects, as they have been in the past.

In accordance with the governance proposed above, the appropriate subcommittee would

review and approve any project designed to modify the core programming. Projects complementing the peripheral programming would not trigger subcommittee review.

Participant Fees

The participant fee funding model describes how individuals, organizations, or programs pay a fee to be included in a larger program. Sustainable and reliable funding supports the operations of the program and its objectives. The toolset, in this sense, becomes a feature of the program and funded accordingly. Participant fees will be collected from organizations or programs that are using the tools for tracking, reporting, and managing data, and are not contributing funds through another mechanism (e.g., project-based or grant funding). The amount of the fees will be based on the amount of data and services used and the total number of participants contributing funding. Fees will be collected on an annual basis through contracts with SFEI. While the funds will be managed by SFEI's accounting department, use of the funds will need approval by EcoAtlas' governance teams (CWMW and appropriate subcommittees).

This funding model holds promise in funding some of the core functions of the toolset. We include two examples below of successful participant fee-based programs based on permit requirements. At this time, we do not have an example that does not involve permit requirements or for an agency considering adding a permit requirement to pay EcoAtlas participant fees.

Example 1: Regional Monitoring Program for Water Quality in San Francisco Bay

An example of this funding model is the Regional Monitoring Program for Water Quality in San Francisco Bay (RMP; www.sfei.org/rmp). From its inception, the RMP has been funded by permitted dischargers by means of fees paid in lieu of individual monitoring requirements. Each year, almost seventy dischargers contribute participant fees to the RMP, and each of these entities possesses a National Pollutant Discharge Elimination System (NPDES) permit or Clean Water Act Section 401 Water Quality Certification to discharge to the Bay. The permit includes a provision for the permit-holder to participate in the RMP. Local funding of the RMP largely insulates the Program from waxing and waning cycles of state and federal budgets (Trowbridge et al., 2015).

In addition to fulfilling the monitoring requirements, activities related to Program management, governance (for both technical content and program direction), annual reporting and communications, and QA and Data Services are also funded. This includes

funding to maintain and enhance CD3, the Contaminant Data Display and Download tool (cd3.sfei.org), for accessing and visualizing the RMP's standardized 25 year dataset. An important benefit of participant fee funding is it provides a stable funding source that enables the program to develop long-term goals and roadmaps to accomplish the goals.

Example 2: Southern California Stormwater Monitoring Coalition Regional Watershed Monitoring Program

Another similar example of participant fee funding is the Southern California Stormwater Monitoring Coalition (SMC) Regional Watershed Monitoring Program (http://www.sccwrp.org/ResearchAreas/RegionalMonitoring/RegionalWatershedMonitoring.aspx).

The Southern California Stormwater Monitoring Coalition (www.SoCalSMC.org) is a consortium of 14 regulated, regulatory, and research agencies covering the coastal counties and Regional Boards of southern California. Formed in 2003, the SMC's mission is to better understand stormwater dynamics and effects at a technical level, and develop tools to support effective and efficient stormwater management decision-making. The SMC regularly funds and implements cooperative projects to improve knowledge of stormwater quality management. (http://ftp.sccwrp.org/pub/download/DOCUMENTS/FactSheets/SMC_FactSheet_RegWatMon_1stYr_web.pdf)

The SMC was formed by a Cooperative Agreement of the Phase I municipal stormwater NPDES lead permittees, the NPDES regulatory agencies in southern California and the Southern California Coastal Water Research Project. This Cooperative Agreement is renewed on a five year basis. The SMC is managed by a Steering Committee of its members that meets quarterly to review new projects and assess progress on ongoing projects (http://socalsmc.org/about/).

The SMC also has a cooperative Memorandum of Understanding with the United States Environmental Protection Agency Office of Research and Development to facilitate the development of scientific and technical tools for stormwater program implementation, assessment, and monitoring.

In-Lieu-Fee Program

An in-lieu-fee (ILF) is a method of "compensatory mitigation" used to compensate for impacts or unavoidable losses to wetlands and streams due to development, road-

construction, or other projects, where a program sponsor pools resources to maintain a mitigation site (Berahzer 2015). The US Army Corps of Engineers (USACE) defines an in-lieu-fee agreement as the collection of funds by the mitigation sponsor from permittees in-lieu of providing permittee-responsible compensatory mitigation required under the Corps or a state or local aquatic resource regulatory program. The sponsor uses the funds pooled from multiple permittees to create one or more sites under the authority of the agreement to compensate for aquatic resource functions lost as a result of the permits issued. (http://www.nae.usace.army.mil/Missions/Regulatory/Mitigation/In-Lieu-Fee-Programs/). In addition, mitigation banks could also contribute to the mitigation of impacts.

There is a wide range of in-lieu-fee programs in terms of the geographic area and mitigation options, however, possibilities remain on the applicability of this funding model to assist with supporting the EcoAtlas toolset and ILF management. For example, ILF programs could include EcoAtlas funding in their fee structure (i.e., a portion of each credit sale would be allocated to EcoAtlas funding). The USACE and USEPA would need to determine whether these costs are considered "administrative costs" under the Mitigation Rule, since the rule only allows for a small percentage of money collected to be used for administrative costs. ILF sponsors could fulfill their credit obligations through EcoAtlas funding for costs not allowable under the Mitigation Rule (i.e., there must be an on- the-ground project for each credit sold). ILF examples include the USACE and the National Fish and Wildlife Foundation's Sacramento District California In-Lieu Fee Program (http://www.nfwf.org/ilf/Pages/home.aspx).

Proportions

With the adoption of a hybrid funding model, some funds will be best suited to pay for certain functions while other funding sources might be allocated for other functions. For instance, a participant-fee-based model can address core (operations and maintenance, training, etc) as well as enhancements and upgrades, whereas project-based funding might exclusively cover enhancements designed to meet new needs or special customizations.

If we consider the **Core Technology** functions to comprise the categories of "User Support, Training, and Outreach" and "Database Management, Upgrades, and General Maintenance," then these functions collectively represent an annual investment of $365k. These tasks might be otherwise characterized as "overhead." In addition to paying material expenses related to the cost of servers and bandwidth, these tasks help to ensure that the

data are maintained securely, the software code remains well-documented, and the application performs well. Upgrades must occur on a regular schedule and new basic software added to ensure continuity with changes in the core technology. Of the forms of funding eligible to cover these costs, the most promising ones include:

- Participant Fee
- In-Lieu Fee Program

The **Governance** tasks, concerning programmatic connections and quality assurance, would also be funded by these instruments for overhead expenses. They would collectively require an additional $40k. Together, these two categories amount to $405k.

Separate would be the **New Development** for the toolset, which would be nevertheless critical to support the proposed business model. Although speculative in outlook, we anticipate the annual needs to be $120k, based on historical patterns and expressions of continued demand. For this category, covering enhancements, innovations, and customizations, the project- and grant-based funding vehicle would apply.

These project-based contractual vehicles would be constructed for specific deliverables and enhancements. Some might only serve a single organization, project, or program. These contracts, like projects themselves, typically have firm start and stop dates with clear deliverables. They seldom cover ongoing overhead costs or governance needs.

Excluded models

In addition to these promising models, we considered several other funding models and heavily discounted the following models as impractical due to specific reasons.

Transaction-based

Another model we considered was one of transaction-based funding. This offsets the cost by placing the funding burden more directly on the users. A notable example of this model includes the California Natural Diversity Database, as administered by the Department of Fish and Wildlife.

We deemed this model **infeasible** after discussions with contacts in DWR who remarked that this model is fraught with challenges. They struggle to handle the many restrictions on

use and the e-commerce-related matters that accompany this model. The overhead is fairly heavy, diminishing the return on investment.

Advertising

The advertising model works by including paid ads placed prominently on the EcoAtlas products. These ads could include any accepted advertiser's messages. This funding model, by evoking for-profit commercial enterprise, would run contrary to some of the core principles of the product and diminish the credibility of the data hosted on the tool.

For these reasons we would not consider the advertising model or any of the other excluded models for funding either the operations or continued enhancements of the toolset.

State-Approved Procurement: STAR Process

Under certain circumstances, we anticipate that public agencies may wish to invoke the STAR Process to ensure the proper review and acceptance of the EcoAtlas toolset.

In 2015, California's Chief Information Officer, Carlos Ramos, prioritized the use of the State Technology Approval Reform (STAR) process as part of an initiative aimed at reducing the risks and costs for statewide information technology (IT) projects. Embedded within the STAR process, the Project Approval Lifecycle (PAL) is a four-stage process that includes the detailed review of the business analysis (Stage 1), alternatives analysis (Stage 2), solution development (Stage 3), and project readiness and approval (Stage 4) before a contract is awarded to begin a new IT project (http://marketing.dts.ca.gov/star/docs/stage_gate-model_rev_2016-0616.pdf). The different stages are separated by gates, which prohibit advancement to the next stage until the California Department of Technology (DIT) approves the progress on the current stage (http://statescoop.com/california-cio-puts-priority-on-star-project-management-plan; http://marketing.otech.ca.gov/star/november2014.html).

With this business plan, we have effectively begun the work of the first stage. (Of course, the specific form of the business analysis might require additional work, but much of the "raw materials," as it were, are available for such an analysis.) It remains to be seen whether or not the state will require the completion of this process in accordance with current procurement rules.

Overall Assessment

Of these funding options, project-based funding is the easiest to establish, but it is fraught with limitations, as described above. The difficulty in establishing this arrangement is not very great. However, as noted, these agreements typically cover overhead expenses only minimally.

Participant fees and in-lieu-fees programs require close programmatic coordination and broad buy-in across state and federal agencies. The CWMW has earned this purchase among its peers; accordingly, the time may be opportune to establish these relationships. Governance needs are all the more heightened with these options, we should note, as all decisions regarding the toolset's fate will be scrutinized by an ever-expanding collection of constituents. In our opinion, this would not be a bad outcome.

Roadmap / Next Steps

We recommend the immediate exploration of participant fees and in-lieu agreements to provide immediate support to the core software for the EcoAtlas suite of essential tools. This entails discussing the matter with the appropriate agency representatives who oversee water quality and ecosystem restoration programs. Likely partners would include:

- CalTrans
- USFWS
- USEPA
- SWRCB
- Delta Stewardship Council
- DWR
- EIP
- DFW
- GovOps
- Coastal Conservancy
- Army Corps of Engineers

With smaller, regional or local organizations, we can broach the subject of participant fees or, if their objectives are clear, then project-based funding. Some likely candidates for these solicitations include:

- Local HCPs / NCCPs

- Municipalities
- Restoration Authority
- Water Districts

Implementation and Outreach

Upon review of the plan, the CWMW recognized the need for additional resources for plan implementation and associated outreach efforts. Depending on the specific partners identified in the "coalition of the willing," the outreach and implementation can take various pathways.

From the development of a hybrid funding model to the regional customization of the toolset, there will likely be a near-term resource gap addressed through continued negotiations with partners on the development of in-lieu-fee and participant fee programs.

The CWMW, leveraging its strong track-record as a productive and influential workgroup, can petition already-indoctrinated state, federal, regional, and local agencies for attention to the plan's objectives while seeking interim funding.

In the meantime, a business plan implementation committee, authorized by the CWMW, can cultivate new targets for the toolset, culled from the list above or added to it, that might spur additional growth and jump-start the customization efforts. A memo, describing their implementation steps, would be among the first products of the new committee.

To assist with outreach, the CWMW has developed several slide presentations, leveraging information from this business plan, to accompany representatives who will engage potential EcoAtlas partners. These resources were developed in consultation with the broader CWMW workgroup to help inform high-level committees and agency executives regarding the business plan and its progress to date.

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Figures and Tables

List of Figures

Figure 1: Illustration of the business plan
Figure 3: The EcoAtlas Toolset
Figure 3: The EcoAtlas EcoSystem
Figure 4: Visits to EcoAtlas.org by Region, Nation-wide (7/1/2013-1/1/2017)
Figure 5: Visits to EcoAtlas.org by City, Nation-wide (7/1/2013-1/1/2017)
Figure 6: Visits to EcoAtlas.org by City, California-wide (7/1/2013-1/1/2017)
Figure 7: Site flow by user experience in EcoAtlas.org (7/1/2013 - 1/1/2017)
Figure 8: Visits to Cramwetlands.org by Region, Nation-wide (7/1/2013-1/1/2017)
Figure 9: Visits to Cramwetlands.org by City, Nation-wide (7/1/2013-1/1/2017)
Figure 10: Visits to Cramwetlands.org by City, California-wide (7/1/2013-1/1/2017)
Figure 11: Site flow by user experience in Cramwetlands.org (7/1/2013 - 1/1/2017)
Figure 12: CRAM assessment sites displayed on Conservation Action Tracker (https://www.ccactiontracker.org/site/map)
Figure 13: Proposed Software Development Model (graphic by Linda Wanczyk)
Figure 14: Toggle Modes for the Landscape Profile Tool
Figure 15: The Monitoring Framework from the National Water Quality Monitoring Council
Figure 16: The Delta Plan's Nine-step Adaptive Management Framework (Delta Stewardship Council, 2013)
Figure 17: Data Life Cycle (DataONE)
Figure 18: The PAL Stage/Gate Model Diagram (California Department of Technology, 2016)

List of Tables

Table 1: Visits to EcoAtlas.org by Metropolitan Area (7/1/2013-1/1/2017)
Table 2: Visits to EcoAtlas.org by Metropolitan Area (7/1/2013-1/1/2017)
Table 3: Numbers of hits on web services for EcoAtlas Projects and CRAM Assessments
Table 4: Proposed budget for EcoAtlas Suite of Tools
Table 5: Existing Tools and their Funding Models

Appendix A: Additional Background for the Toolset

EcoAtlas has evolved over two decades through multiple user communities representing different but integral aspects of the watershed approach to comprehensive aquatic resource protection.

Milestones (http://sfei.org/ecoatlas)

The pathway to the present status of EcoAtlas can be understood via a timeline, recounted below. The many features of the toolset took shape through its multi-year development, which has witnessed the steady accrual of stakeholders and investment as more organizations recognized the essential utility of EcoAtlas and the advantage of enhancing it to meet new demands.

- ### 1993, EcoAtlas Proposed

  EcoAtlas proposed by SFEI as a GIS-based system to track actions to implement the 1993 Comprehensive Conservation and Management Plan (CCMP) of the San Francisco Estuary Project.

- ### 1994, USACE funds EcoAtlas

  The San Francisco District of USACE funds first version of EcoAtlas to support comprehensive planning of the beneficial reuse of sediments dredged from San Francisco Bay and to implement San Francisco Estuary CCMP Wetlands Action 1.1: Establish regional wetland habitat goals of a regional wetlands management plan (Baylands Ecosystem Habitat Goals Project).

- ### 1995, Local, state, federal and NGO support for base maps

  Various local, state and federal programs and foundations fund the creation of Bay Area EcoAtlas base maps of historical and present-day aquatic habitats to support the multi-agency Baylands Ecosystem Habitat Goals Project, and watershed-based assessments of sediment sources and aquatic resource abundance, distribution, and diversity.

- ### 1998, First online version of EcoAtlas

  Various local, state, and federal programs and foundations fund first online version

of EcoAtlas coinciding with release of the Baylands Ecosystem Habitat Goals Report by USEPA and the San Francisco Bay Water Board.

- 1998, CCMP signatory agencies develop a plan

  CCMP signatory agencies meet to decide next steps for EcoAtlas, yielding a Beta Test Group and conceptual plan to develop Bay Area EcoAtlas through SFEI as a full service wetland and stream data and information exchange system.

- 2000, Visualizing wetland projects in Wetland Tracker

  Various local, state and federal programs and foundations fund Wetland Tracker functionality for visualizing wetland projects and sharing project information through web-based interactive map.

- 2000, "Wetland Tracker" named as a product of the strategic plan

  SFEI produces strategic plan for EcoAtlas as a set of web-based applications to support environmental planning, regulation, and management in the Bay Area. The first application was called “Wetland Tracker” to support interagency wetland restoration planning and 401/WDR program of the San Francisco Bay Water Board.

- 2005, Functionality and updates to support 401/WDR

  State Board Consolidated Grants Program funds updates of Bay Area EcoAtlas’ base map of existing aquatic resources plus new Wetland Tracker functionality for accessing wetland project information. This results in SOP for aquatic resource mapping and new Wetland Tracker functionality to support 401/WDR at San Francisco Bay Water Board.

- 2006, Project mapping tied to WDRs in SF Bay

  San Francisco Bay Water Board makes project mapping through Wetland Tracker a condition of 401 and WDRs (Waste Discharge Requirements), thus enabling regional wetland change detection through regulatory procedures.

- 2008, Riparian Zone Estimator Tool

  Various local, state and federal programs and foundations fund development of the Riparian Zone Estimator Tool as EcoAtlas application to visualize riparian zones.

- 2008, EcoAtlas made statewide under guidance of California Wetland Monitoring Workgroup

  California Wetland Monitoring Workgroup of the California Water Quality Monitoring Council established with priority to grow Wetland Tracker of EcoAtlas statewide.

- 2008, USEPA funds statewide expansion

  USEPA funds first effort to extend Wetland Tracker as first statewide application of EcoAtlas.

- 2009, Aquatic Resource Mapping SOP

  Aquatic Resource Mapping SOP co-developed with NWI of USFWS and NHD of USGS as California Aquatic Resource Inventory SOP.

- 2010, Landscape Profile Tool funded

  Various federal programs fund Landscape Profile Tool of EcoAtlas to support the watershed approach to 404/401.

- 2010, USEPA funds South and Central Coast expansion

  USEPA funds implementation of Wetland Tracker as EcoAtlas application in the South and Central Coasts.

- 2011, CRAM integrated and statewide base map developed

  State Water Board funds development of statewide EcoAtlas base map for statewide application of Wetland Tracker and for integrating CRAM database into EcoAtlas through CEDEN Regional Data Centers.

- 2011, First National Wetland Condition Assessment

  USEPA funds the first National Wetland Condition Assessment. CRAM data collected as side-by-side comparison with USRAM for sites in California.

- 2011, Riparian Area layer developed for San Francisco Bay

  Vegetation and hillslope layers were generated using the Riparian Area Mapping

Tool (RAMT), which models the functional area for different ecological and geomorphic processes that contribute to create the riparian zone.

- 2012, Broader pilots by regional water boards

  USEPA funds applications of Wetland Tracker, eCRAM, and Riparian Zone Estimator Tool of EcoAtlas for North Coast, Central Coast, and Lahontan Regional Boards with their partnership.

- 2012, Pilot of "Online 401"

  State Water Board funds statewide pilot of “Online 401” tool as an application of EcoAtlas to enable online application and tracking of 401 Certifications based on San Francisco Bay Water Board experience.

- 2013, Database consolidation into EcoAtlas

  USEPA funds consolidation of the San Francisco Bay Joint Venture, Central Valley Joint Venture, and Delta Conservancy's databases into EcoAtlas.

- 2014, CIAP funding to enhance restoration project database

  Coastal Impact Assistance Program (CIAP) funds the development of restoration project submission forms to provide self-service access to EcoAtlas project database.

- 2014, USEPA funds enhancements to the Landscape Profile Tool

  Landscape Profile Tool v2 includes the ability to upload a KML or Esri shapefile for an area of interest and to download/share maps.

- 2014, EPA funds the creation of a CARI Editor Tool

  The CARI Editor enables individuals to submit suggested updates, deletions or additions of stream and wetland features classified in the California Aquatic Resource Inventory (CARI). CARI serves as the common statewide map in EcoAtlas and was developed using the best available data sources, including several different map intensification efforts that standardized the level of detail for aquatic resources based on similar mapping protocols. It is important to have the mapped aquatic resources as accurate as possible, since amounts are summarized in various reports

and the Landscape Profile Tool.

- 2014, MOU signed with SFBJV and CVJV

  SFEI, SFBJV, and CVJV signed an MOU, pledging support for the continued development of and outreach for EcoAtlas.

- 2014, NOAA funds the enhancement of data layers and reporting

  Funding allows the expansion of eelgrass layer, addition of new projects, and incorporation of relevant eelgrass information into Landscape Profile Report.

- 2014, USEPA funds continued application of EcoAtlas to the Lahontan Water Board

  Training efforts will begin soon in the application of EcoAtlas' resources to the needs of the Lahontan Water Board.

- 2014, USEPA funds compilation and visualization of water quality monitoring data in the Delta

  USEPA funds a process for collecting and processing data to facilitate Delta Conservancy's restoration efforts and those of its stakeholders.

- 2014, USEPA funds visualization and data sharing

  USEPA funds integration of various Delta environmental data into EcoAtlas for visualization and sharing and development of a summary dashboard.

- 2015, Web services added to provide broader access to Project and CRAM data

  To demonstrate principles of transparency and accessibility, web services have been enabled for data about both Project Tracker habitat projects and CRAM assessments (http://sfei.org/content/web-services-sfei). This innovation effectively shares the data with any internet-enabled machine. These project and CRAM data were immediately consumed and displayed by the Central Coast Conservation Action Tracker and Bay Delta Live.

- 2015, USEPA funds business plan

  USEPA funds development of EcoAtlas business plan as prioritized by California Wetland Monitoring Workgroup within the Water Quality Monitoring Council.

- 2015, SWAMP develops SOP for sampling depressional wetlands

  SWAMP developed standard operating procedures (SOP) to sample the biological, chemical, and physical condition of freshwater wetlands within California entitled "Standard Operating Procedures (SOP) for Collection of Macroinvertebrates, Benthic Algae, and Associated Physical Habitat Data in California Depressional Wetlands" [http://www.waterboards.ca.gov/water_issues/programs/swamp/tools.shtml#methods].

- 2015, WRAMP tools included in Prop 1 guidelines

  EcoAtlas, CRAM, CARI and Project Tracker are cited as examples of monitoring and assessment tools for tracking progress on wetland and riparian restoration projects.

- 2016, Second National Wetland Condition Assessment

  USEPA conducts the second National Wetland Condition Assessment. There are more sites in California since the West was under-represented in 2011 assessment.

- 2016, Get on the curve: Habitat Development Curves help determine the performance of on-the-ground projects

  How do you know whether your project assessment, conducted by the California Rapid Assessment Method, reflects an improvement that is aligned with ecosystem goals? Habitat Development Curves (HDCs) help to visualize and measure the performance of on-the-ground projects relative to ecosystem goals.

- 2016, Cumulative Distribution Functions released with CalTrans funding

  In recognition of the importance of regional processes and functions, wetland managers must have ready access to information about the extent and condition of wetlands in the context of the surrounding landscape to better evaluate the performance of compensatory mitigation projects within its regional context. To that purpose, regional cumulative distribution function plots (CDFs) have been developed for wetlands using CRAM data. Projects that use CRAM to monitor ecological condition of their wetlands can compare their project scores to the expected HDC and/or the ecoregional CDF using the Landscape Profile tool on EcoAtlas.

Caltrans provided funding to SFEI to enhance EcoAtlas' analytical tools to allow users to compare project and non-project assessments to the ecoregional Riverine CDF for 6 regions across the state.

- 2016, Uploaded new eelgrass baywide surveys

  Several new eelgrass baywide surveys, provided by NOAA-NMFS, were uploaded to EcoAtlas, including Mendocino Coast (2014-2015), Tomales Bay (2015), Drakes Estero (2005), San Francisco Bay (2014), Santa Monica Bay (2015), and Santa Cruz Island (2015).

- 2016, Presentation at the Southern California Academy of Sciences Annual Meeting

  Adam Obaza, NOAA-NMFS, presented "EcoAtlas: An Online Visualization Tool for Eelgrass Distribution" at the Southern California Academy of Sciences Annual Meeting. 26 baywide eelgrass surveys from Humboldt Bay to San Diego and 56 eelgrass mitigation projects in Southern California are displayed on EcoAtlas.

- 2016, New search and pagination features

  Now that there are over 2,000 projects in Project Tracker, we've added two new features that will help you quickly find your projects from your Project List. A Search field allows you to search the list of projects by one or more keywords in the project name.

  Pagination allows you to order your projects by name, last updated date or creation date, and scroll through pages of projects. This feature also improves the performance and loads the Project List faster.

- 2016, EcoAtlas used in a high school classroom

  "I used EcoAtlas today in my classroom and the kids LOVED it! We used the polygon drawing tool and studied the landscape profiles that got generated. They found it really accessible and were getting really into it. Thanks so much for creating such a user-friendly and engaging tool!" -- 11th grade Environmental Science class at College Coliseum Prep Academy in Oakland

- 2016, Final Wetland Policy Draft Issued by SWRCB

Final Wetland Policy draft entitled "Procedures for Discharges of Dredged or Fill Materials to Waters of the State" released by State Water Resources Control Board for public comment.

- ### 2016, Lahontan Water Board adopts Regional EcoAtlas Tools

  The Lahontan Water Board (Regional Water Board 6) formally adopted EcoAtlas and the California Rapid Assessment Method (CRAM). This will enable the Water Board to visually track and assess the extent of project impacts on a watershed basis throughout the region.

  Beginning August 1 of 2016, 401 Certifications and Waste Discharge Requirements will require applicants to upload project information into EcoAtlas. Applicants will be encouraged to to use CRAM in pre- and post- project assessments.

  CRAM assessments of riverine and slope wetland projects subject to 401 Certification or Waste Discharge Orders are expected to be required in the Truckee River, Lake Tahoe and Carson River watersheds beginning in 2017. This requirement will be expanded to other wetland types and watersheds in the future.

Appendix B: Categories and Descriptions of Related Tools

Categories of Tools

It is important to establish categories for the various services tools provide, since funding options are often different based upon this classification. The categories also dovetail with phases of the data life cycle presented in Figure 14. The table below summarizes the functionality offered by various tools according to the categories of mapping (provides the ability to generate and save geometries), data collection (provides the ability to enter and edit data), planning (provides summarized information needed for planning purposes), and analytical and reporting (provides tools for analyzing and reporting data). In addition, information on the funding model for each tool is summarized. The selection of tools listed below were chosen since they are currently used by the State's natural resource agencies and its partners.

Name of Tool	Mapping Tool	Data Collection Tool	Planning Tool	Analytical/Reporting Tool	Funding Model
Bay Delta Live	✷			✷ ◉	Project-based
California Rapid Assessment Method	✷	✷	✷		Project-based with public funding
Central Coast Conservation Action Tracker		✷		✷	Project-based
Contaminant Data Display and Download (CD3)				✷	Participant fees
Data Basin	✷	✷	✷	✷	Project-based

Delta View				✷	Dedicated funding by public agency
EcoAtlas	✷	✷	✷	✷ ◉	Project-based with public funding
Esri	✷	✷		✷	Licensing fees
GeoTracker		✷		✷	Dedicated funding by public agency
Kisters				✷	Licensing fees
Lake Tahoe Info Reporting Tool		✷		✷ ◉	Dedicated funding by public agency
Oracle, Microsoft SQL Server and Access		✷			Licensing fees
Our Coast, Our Future			✷	✷	Project-based

✷: Tool has functionality within specified category. ◉: Tool uses web services to obtain or serve data collected.

Table 5. Existing Tools and their Funding Models.

Descriptions of Tools

- ### Bay Delta Live

  Bay Delta Live (www.baydeltalive.com) is a data visualization and collaboration tool for sharing information essential to understanding the complex and dynamic ecosystem of the Sacramento-San Joaquin Bay Delta. Tool development is managed by a private consultant (34 North).

- ### California Rapid Assessment Method (CRAM)

  CRAM (www.cramwetlands.org) is a cost-effective and scientifically defensible rapid

assessment method for monitoring the conditions of wetlands throughout California. Its information management system includes online data entry forms, data access and visualization tools, and dynamic Habitat Development Curves that can be used for planning purposes. Tool development is managed by a non-governmental organization (SFEI/ASC).

- Central Coast Conservation Action Tracker

  The Central Coast Conservation Action Tracker (www.ccactiontracker.org) shares information about conservation projects on the Central Coast for project managers, conservation organizations, and the general public. Tool development is managed by a non-governmental organization (GreenInfo Network).

- Contaminant Data Display and Download (CD3)

  CD3 (http://cd3.sfei.org/) is a data access and visualization tool for contaminant data stored in SFEI's Regional Data Center and is the primary tool for accessing the Regional Monitoring Program for Water Quality in San Francisco Bay (RMP) data. Tool development is managed by a non-governmental organization (SFEI/ASC).

- Data Basin

  Data Basin (https://databasin.org/) is a science-based mapping and analysis platform that supports learning, research, and sustainable environmental stewardship throughout California. Tool development is managed by a non-governmental organization (Conservation Biology Institute).

- Delta View

  Delta View (http://deltacouncil.ca.gov/performance-measures-tracking-tools) tracks the progress of Delta projects and improves the accountability and transparency of Delta actions. Tool development is managed by a private consultant (Crusade).

- EcoAtlas

  EcoAtlas (www.ecoatlas.org) is a set of tools for generating, assembling, storing, visualizing, sharing, and reporting environmental data and information. It enables users to assess information on the abundance, distribution, diversity, and condition of wetlands in the landscape or watershed context and the project activities that are affecting the wetlands. Project Tracker (http://ptrack.ecoatlas.org/) is the data

collection and planning tool for managing information on projects or a planned effort that modifies habitat, such as wetland restoration, mitigation, or habitat conservation. Tool development is managed by a non-governmental organization (SFEI/ASC).

- Esri

  Esri (www.esri.com/) is proprietary software that provides mapping and a data management system for geospatial data. Tool development is managed by a private corporation (Esri).

- GeoTracker

  GeoTracker (https://geotracker.waterboards.ca.gov/) is the State Water Resources Control Board's data management system for sites that impact, or have the potential to impact, water quality in California, with emphasis on groundwater. Tool development is managed by a private consultant.

- Kisters

  Kisters (www.kisters.net/NA/) is a global information technology firm that provides proprietary software for the long-term management of environmental resources, including water, energy, air quality, and manufacturing industries. Tool development is managed by a private corporation (Kisters).

- Lake Tahoe Info (LT Info)

  The Lake Tahoe Info (https://laketahoeinfo.org/) is a reporting tool that connects people with information to improve decision making and sustain investments in the Lake Tahoe Basin. Tool development is managed by a private consultant (Sitka Technology Group).

- Microsoft SQL Server and Access, Oracle

  Microsoft (www.microsoft.com) and Oracle (www.oracle.com/) both offer priprietary software for relational data management systems. Oracle provides a wider range of data services from managing general business to geospatial data. Tool development is managed by a private corporation (Microsoft, Oracle).

- Our Coast, Our Future

  Our Coast, Our Future (OCOF; http://data.pointblue.org/apps/ocof/cms/) is a collaborative, tool for providing coastal California resource managers and land use planners maps and tools to help understand, visualize, and anticipate vulnerabilities to sea level rise and storms. Tool development is managed by a non-governmental organization (Point Blue).

Appendix C: Funding Models to Consider

Potential Funding Models

The third step for selecting and implementing a funding and revenue model is to identify a subset of funding model options to explore for their sustainability, replicability, and feasibility. Below are descriptions of some possible models that could be applicable to funding the EcoAtlas toolset.

- **Advertising**

  Advertising fees are periodic fees paid in exchange for advertisements posted on a site (https://definitions.uslegal.com/a/advertising-fee/). The conventional version is display-marketing, which is based on traffic, e.g., cost-per-click (CPC) or cost-per-action (CPX). Other online advertising variations are affiliate-marketing (advertising on many websites, CPX), search-engine-marketing (CPC), e-mail-marketing, and social-media-marketing. Examples include Google, Facebook and newspapers (http://en.ecommercewiki.info/fundamentals/revenue_models).

- **Cap-and-Trade**

  Cap-and-trade, or emissions trading, is a common term for a government regulatory program designed to limit, or cap, the total level of specific chemical by-products resulting from private business activity. Its purpose is to create a market price for emissions or pollutants to address the negative impacts of the activity (http://www.investopedia.com/terms/c/cap-and-trade.asp).

An example is the California Environmental Protection Agency's Air Resources Board's Cap-and-Trade Program (https://www.arb.ca.gov/cc/capandtrade/capandtrade.htm).

Data-Sharing Agreement

When working in the Californian public sector, SFEI, the developer of the WRAMP toolset, has learned that data systems are very difficult to develop, adopt, and/or implement. They require an extraordinary confluence of circumstances. This is largely because the State's various information technology divisions within various departments have been subject to numerous failed technical projects and are, as a result, highly risk averse. This is very understandable. At the same time, such an orientation does place large barriers between program and IT staff, as the former seeks to advance while the latter wishes to avoid risk.

Data-sharing agreements serve as a suitable work-around. While the state cannot easily purchase, lease, or fund a data system, it can purchase data. This invites the CWMW to seek an appraisal of its data by one or more State agencies.

In the era of open data, this method allows us to be compensated for the unique mechanisms we have designed to collect data while still sharing our data in accordance with CWMW principles.

General Services Agreement

A general services agreement can serve as a versatile source of funding. It is a contract between a servicer and a client that typically leaves the deliverables to be determined via individual work orders. SFEI has several such contracts in place.

In association with the proposed business model, a services agreement can help provide support for the peripheral customizations that can serve regional and local interests. In our experience, a services agreement can vary in size between $10k and $500k, depending on the size of the fulfillment team and the resources of the requesting organization.

Although the state has a GSA program, SFEI has found it easier to contract with the

federal or local agencies through this vehicle.

- Enforcement action fees

  An enforcement action is when a problem has been discovered by a state of federal agency and an official report of the problem has been prepared (https://mmcri.org/deptPages/hrpp/downloads/defineenforceable.pdf). For example, a Supplemental Environmental Project (SEP) is an environmentally beneficial project that is included as part of a settlement for environmental violations. Violators can voluntarily agree to undertake such projects in lieu of part of the penalty that they are required to pay for the violations. A SEP must improve, protect or reduce risks to public health or the environment. (http://www.calepa.ca.gov/supplemental-environmental-projects).

- In-lieu-fee program

  The US Army Corps of Engineers (USACE) defines an in-lieu-fee program as an agreement between a regulatory agency and a public agency or non-profit organization sponsor. Under an in-lieu-fee agreement, the mitigation sponsor collects funds from permittees in lieu of providing permittee-responsible compensatory mitigation required under the Corps or a state or local aquatic resource regulatory program. The sponsor uses the funds pooled from multiple permittees to create one or more sites under the authority of the agreement to compensate for aquatic resource functions lost as a result of the permits issued. (http://www.nae.usace.army.mil/Missions/Regulatory/Mitigation/In-Lieu-Fee-Programs/). There is a wide range of in-lieu-fee programs in terms of the geographic area and mitigation options, however, possibilities remain on the applicability of this funding model to assist with supporting the EcoAtlas toolset. Examples include the USACE and the National Fish and Wildlife Foundation's Sacramento District California In-Lieu Fee Program (http://www.nfwf.org/ilf/Pages/home.aspx).

- Participant fees

  The participant fee funding model is when individuals pay a fee to be included in a larger program. Sustainable and reliable funding supports the operations of the program and its objectives.

Example 1: Regional Monitoring Program for Water Quality in San Francisco Bay

An example of this funding model is the Regional Monitoring Program for Water Quality in San Francisco Bay (RMP; www.sfei.org/rmp). From its inception, the RMP has been funded by permitted dischargers by means of fees paid in lieu of individual monitoring requirements. Each year, almost seventy dischargers contribute participant fees to the RMP, and each of these entities possesses a National Pollutant Discharge Elimination System (NPDES) permit or Clean Water Act Section 401 Water Quality Certification to discharge to the Bay. The permit includes a provision for the permit-holder to participate in the RMP. Local funding of the RMP largely insulates the Program from waxing and waning cycles of state and federal budgets (Trowbridge et al., 2015).

In addition to fulfilling the monitoring requirements, activities related to Program management, governance (for both technical content and program direction), annual reporting and communications, and QA and Data Services are also funded. This includes funding to maintain and enhance CD3, the Contaminant Data Display and Download tool (cd3.sfei.org), for accessing and visualizing the RMP's standardized 25 year dataset. An important benefit of participant fee funding is it provides a stable funding source that enables the program to develop long-term goals and roadmaps to accomplish the goals.

Example 2: Southern California Stormwater Monitoring Coalition Regional Watershed Monitoring Program

Another similar example of participant fee funding is the Southern California Stormwater Monitoring Coalition (SMC) Regional Watershed Monitoring Program (http://www.sccwrp.org/ResearchAreas/RegionalMonitoring/RegionalWatershedMonitoring.aspx).

The Southern California Stormwater Monitoring Coalition (www.SoCalSMC.org) is a consortium of 14 regulated, regulatory, and research agencies covering all of southern California. Formed in 2003, the SMC's mission is to better understand stormwater dynamics and effects at a technical level, and develop tools to support effective and efficient stormwater management decision-making. The SMC regularly funds and implements cooperative projects to improve knowledge of stormwater quality management.

(http://ftp.sccwrp.org/pub/download/DOCUMENTS/FactSheets/SMC_FactSheet_RegWatMon_1stYr_web.pdf)

The SMC was formed by a Cooperative Agreement of the Phase I municipal stormwater NPDES lead permittees, the NPDES regulatory agencies in southern California and the Southern California Coastal Water Research Project. This Cooperative Agreement is renewed on a five year basis . The SMC is managed by a Steering Committee of its members that meets quarterly to review new projects and assess progress on ongoing projects (http://socalsmc.org/about/).

The SMC also has a cooperative Memorandum of Understanding with the United States Environmental Protection Agency Office of Research and Development to facilitate the development of scientific and technical tools for stormwater program implementation, assessment, and monitoring.

- Philanthropic funding

  Philanthropic funding involves charitable donations by an individual or organization based on an altruistic desire to improve human welfare. Examples include foundations established by wealthy individuals. (http://www.investopedia.com/terms/p/philanthropy.asp)

- Project-based funding

  Project-based funding is funding from an individual project grant or contract awarded by federal, state, local, or private funders. Each grant or contract has a detailed work plan and specific deliverables associated with the funding. An example is the USEPA's Wetland Program Development Grants 104(b)(3). (https://www3.epa.gov/region9/funding/funding-sources/wetlands.html)

- Public funding

  Public funding is generated by the government to provide goods and services to the general public. Examples include grants, propositions, and bond measures to address environmental issues such as climate change, wetland restoration, and monitoring. (http://www.businessdictionary.com/definition/public-funds.html)

- Subscription service fees

A subscription funding model is based on customers paying a periodic fee to have access to a product or service. Many sites combine free content with premium membership. Subscription fees do not depend on transactions, and there are no restrictions on the duration or frequency of using the content. Examples include magazines and newspapers (https://en.wikipedia.org/wiki/Subscription_business_model; http://en.ecommercewiki.info/fundamentals/revenue_models).

Another example of the subscription funding model is the California Department of Fish and Wildlife's annual subscription fee for use of its California Natural Diversity Database (CNDDB) (https://www.wildlife.ca.gov/Data/CNDDB/Subscribe).

- Transaction fees

  Revenue is generated by customers paying a fee for a transaction to the operator of a platform. A company or organization receives commissions based on the volume for enabling or executing transactions. The amount of the transaction fee can be fixed or a calculated percentage. Examples include eBay (www.ebay.com) and Amazon (www.amazon.com) (http://en.ecommercewiki.info/fundamentals/revenue_models).

Other Processes to Consider

In addition to reviewing funding models, formal procurement approaches and service agreements are also important to assess for lessons learned that could be relevant and applied to developing a funding and business model for the EcoAtlas toolset.

Data Sharing Agreements

A data sharing agreement is similar to a memorandum of understanding (MOU) and is an agreement between two or more parties that outlines the intended access and dissemination of data (https://www2.usgs.gov/datamanagement/acquire/datasharingagreements.php; https://en.wikipedia.org/wiki/Memorandum_of_understanding).

Data sharing agreements describe the authority under which the data sharing is conducted, access provisions outlining who can modify the data and what the methods of data access will be, confidentiality and disclaimers (e.g., the accuracy of the data), and time limit and method for modifying the agreement (https://www2.usgs.gov/datamanagement/acquire/datasharingagreements.php).

The benefits of developing these agreements include fostering strong partnerships with clear communication and establishing a clear process for data sharing and dissemination (Jarquín, 2012). The agreements ensure the reliability of data for longer term planning and could assist with securing requisite funding for data procurement, for example procuring a single, statewide license for a dataset with partner agencies contributing annual funding.

General Service Agreements

A general service agreement (GSA) is an agreement between two persons or organizations where one agrees to provide a specified service to the other (https://definitions.uslegal.com/s/service-agreement/). Examples of this arrangement are the GSAs established by the California Department of Water Resources and State Water Resources Control Board to assist with tool development and information management.

In-kind Services

In-kind refers to goods, services, and transactions not measured in monetary terms (https://en.wikipedia.org/wiki/In_kind). Examples include participation in workgroups, committees, and user groups. In-kind services often cover costs associated with partnership building among agencies and non-governmental groups.

STAR Process

In 2015, California's Chief Information Officer, Carlos Ramos, prioritized the use of the State Technology Approval Reform (STAR) process as part of an initiative aimed at reducing the risks and costs for statewide information technology (IT) projects. The Project Approval Lifecycle (PAL) is a four-stage process that includes the detailed review of the business analysis (Stage 1), alternatives analysis (Stage 2), solution development (Stage 3), and project readiness and approval (Stage 4) before a contract is awarded to begin a new IT project (Figure 3; http://marketing.dts.ca.gov/star/docs/stage_gate-model_rev_2016-0616.pdf). The different stages are separated by gates, which prohibit advancement to the

next stage until the California Department of Technology (DIT) approves the progress on the current stage (http://statescoop.com/california-cio-puts-priority-on-star-project-management-plan; http://marketing.otech.ca.gov/star/november2014.html).

The DIT provides oversight of this process along with collaboration from other state entities. The STAR process replaced the Feasibility Study Report (FSR) process previously used to ensure sufficient technical information was provided to demonstrate that the proposed solution is workable and realistic (http://www.cio.ca.gov/Government/IT_Policy/pdf/SIMM-20-Feasibility-Study-Report-Preparation-Instructions.pdf).

The STAR process is modeled after the Stage-Gate model developed by Robert Cooper and Scott Edgett. Each stage is designed to collect specific information to help move the project to the next stage or decision point. Preceeding each stage, a project passes through a gate, or quality-control checkpoint, where a decision is made whether or not to continue investing in the project (http://www.stage-gate.com/resources_stage-gate_full.php).

An advantage of a formal approval process is important details such as the technology stack, workflow, and long-term funding are identified before a project begins. However, it could take years for a proposed project to get through the entire review process, and the staged approach may not be flexible to take advantage of new opportunities identified during the process.

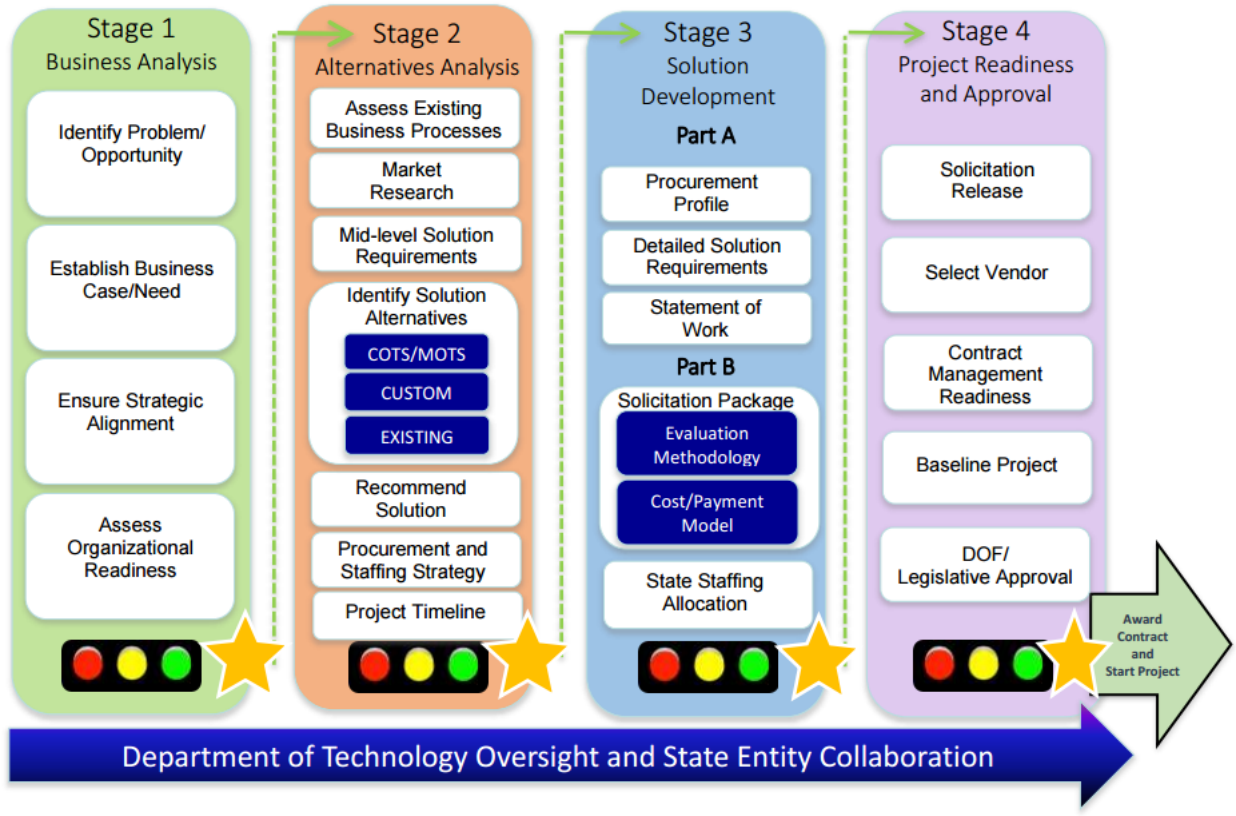

Figure 18: The PAL Stage/Gate Model Diagram (*California Department of Technology, 2016).*