Integration of National-Level Geospatial Ecological Tools and Data

DETAILS

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AUTHORS

ICF International and URS Corporation

The Second
STRATEGIC HIGHWAY RESEARCH PROGRAM

SHRP 2 REPORT S2-C40A-RW-1

Integration of National-Level Geospatial Ecological Tools and Data

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URS Corporation

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The Second Strategic Highway Research Program

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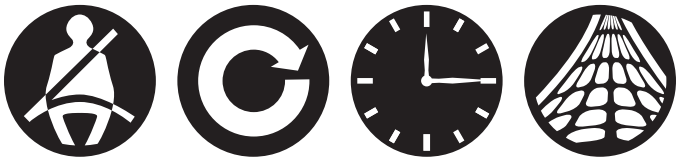

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The work documented in this final project report was supported and informed by an extensive group of people, agencies, and organizations. The project team specifically acknowledges the input from the pilot project leaders and user group members: Jacquelyn (Honig) Bjorkman, Richard Bostwick, David Diamond, Mary Gray, Patrick Huber, Mary Grace Lewandowski, Sharon Osowski, Greg Servheen, John Thomas, and James Thorne.

FOREWORD

Stephen J. Andrle, *SHRP 2 Deputy Director*

The Federal Highway Administration's (FHWA's) Planning Environment Linkages (PEL) initiative and the work done through SHRP 2 on integrating conservation and highway planning encourage addressing potential environmental issues early in the transportation planning process. However, there is often not enough environmental data available early on to have a meaningful discussion among stakeholders. The primary objective of Project C40A, Integration of National-Level Geospatial Ecological Tools and Data, was to develop an integrated, geospatial ecological screening tool for early transportation planning that produces results that can carry through and inform the environmental review process. This report and the geospatial tool named Eco-Plan will be of interest to anyone who works with environmental data to avoid, minimize, or mitigate the environmental impact of transportation or other infrastructure projects. Through web services, Eco-Plan accesses state and local data sets published by federal resource agencies and provides tools to integrate them with state and local data collected at that level. The idea is to provide an organized structure for all available environmental data within a context that can support early and fruitful discussion among transportation planners, resource agencies, nongovernmental organizations, and the public. The big picture objective is to improve the environment, not just mitigate impacts, and to expedite delivery of highway projects. This is accomplished by identifying and addressing potential environmental issues as early as possible so unexpected issues are less likely to emerge later and cause delays.

This report is the last in a series of SHRP 2 ecological projects conducted in support of FHWA's PEL initiative and is based on the 2006 document *Eco-Logical: An Ecosystem Approach to Developing Infrastructure Projects (Eco-Logical)*. *Eco-Logical* is an enabling document signed by nine federal agencies that encourages preservation of ecosystems—habitat, habitat connectivity, wetlands, and multispecies protection. Implementing these principles is difficult in practice. The two-volume SHRP 2 C06 report, *An Ecological Approach* to *Integrating Conservation and Highway Planning,* proposes a multiagency process, the Integrated Ecological Framework, to provide institutional structure. Volumes 1 and 2 are supplemented by the *Practitioner's Guide to the Integrated Ecological Framework,* a shorter *Manager's Guide to the Integrated Ecological Framework,* and four reports of pilot tests from the pilot team. This material is also contained in the web portal PlanWorks developed by SHRP 2 and hosted by the Federal Highway Administration.

In the fall of 2012, SHRP 2 conducted a multiagency workshop to determine if more work was needed in this area. The overwhelming response was that more complete environmental data and tools are needed early in the planning process to carry out the principles of *Eco-Logical* and the Integrated Ecological Framework.

Eco-Plan will help reduce the barriers to ecological-based environmental and mitigation planning. The C40A report contains extensive background on existing and emerging environmental tools and databases, an assessment of user needs, and an evaluation of each existing tool against the user requirements. None of the tools available at the time fully addressed the needs, so Eco-Plan was developed.

Eco-Plan is designed primarily for planning agencies that have not yet developed geospatial tools or extensive expertise for environmental analysis. Eco-Plan allows novice users to review maps of ecological data sets, find data, upload or draw planning areas, and explore conservation priorities. Eco-Plan Advanced, which is part of the same package, is implemented through ArcGIS Online and allows more advanced users to add data sets and prepared maps, conduct GIS analysis, create reports, and share maps. This report describes the functionality of Eco-Plan and provides a quick start guide for users.

In addition to this project, three concurrent proof-of-concept projects were conducted, in which agencies were asked to improve geospatial tools they already have, describe how they could be transferred to others, and contribute both to the design and the evaluation of Eco-Plan. These agencies were East-West Gateway Coordinating Counsel in conjunction with the University of Missouri; University of California, Davis, in conjunction with the California Department of Transportation; and Parsons Corporation in conjunction with Contra Costa County, California. Materials are available from SHRP 2 and from FHWA's GoSHRP2 website.

CONTENTS

Executive Summary

The purpose of this report is to document the methods and results of the C40A project, Integration of National-Level Geospatial Ecological Tools and Data. This project was carried out under the Transportation Research Board's (TRB's) second Strategic Highway Research Program (SHRP 2), within the Capacity focus area. The primary objective of the project was to develop an integrated, geospatial ecological screening tool for early transportation planning that produces results that can carry through and inform the environmental review process.

To meet the objective, the team completed several tasks to determine the needs for the tool, develop a vision, design the tool, coordinate with potential users and related research projects, build and test a beta version, and update the tool based on feedback. The resulting product of the research was the Eco-Plan website.

Eco-Plan is a central resource for current, national geospatial data that can be used to identify and avoid conflicts between ecological assets and transportation plans before the National Environmental Policy Act (NEPA) process begins. Eco-Plan supports transportation planning by providing prepared maps of national ecological data sets that can be used to avoid and minimize transportation impacts. Eco-Plan can be used to

- Review maps of national ecological data sets.
- Find data and other useful geographic information system (GIS) information.
- Upload or draw a planning area or transportation network.
- Allow novice users without GIS skills to explore conservation priorities.

The team also implemented Eco-Plan Advanced, a separate website hosted by Esri ArcGIS Online (AGO), which provides all of the information available through Eco-Plan as well as the (AGO) capabilities to

- Add any data set to the prepared maps of national ecological data.
- Set up groups to save, share, and comment on maps.
- Conduct GIS analysis and create reports.

When the project was completed, ICF participated in both a conference presentation at the 2014 GIS for Transportation (GIS-T) conference in Burlington, Vermont, and a SHRP 2 Tuesday webinar on Eco-Plan. Considering the results of the project and the feedback received at those two events, ICF has drawn the following conclusions:

- *There is a wealth of existing GIS data and tools, but they are hard to find.* Through research and discussions with the user group and beta test group, ICF has concluded that there are numerous federal data sets that would be useful to planners. However, GIS data and tools are owned

and managed by various federal agencies without centralized management and are therefore difficult to find. Tools like Eco-Plan and the Environmental Protection Agency's new EnviroAtlas do help to consolidate references to many of the existing GIS web services.

- *Eco-Plan does meet many of the needs identified early in the project for smaller state departments of transportation (DOTs) and metropolitan planning organizations (MPOs).* At the first Technical Expert Task Group (TETG) review meeting, the group decided to primarily target the smaller state DOTs and MPOs without significant in-house GIS resources. This decision informed the future design and functionality of Eco-Plan and resulted in a website that provides interactive maps, references to authoritative data sources, and links to supporting GIS tools.
- *Eco-Plan is easy to use and useful.* The beta test results show that more than 75% of the users felt Eco-Plan was easy to use, useful, and navigable.
- *Local data are still key for in-depth analysis.* Users still prefer local data over national, federal data when available for detailed analysis. Users expressed concern at solely relying on national data given their high geographic scale, frequency of updates, and accuracy.
- *Architecture decision appears to be in line with the direction of many states.* The research team struggled with designing an architecture that met users' needs, would be accepted by state DOTs and MPOs, and did not place a large administrative or cost burden on the future system owner. After much analysis, the team designed an architecture built around AGO. The decision to use AGO appears to be in line with the direction that many state DOTs, especially those in the growing American Association of State Highway and Transportation Officials (AASHTO) Technology Implementation Group (TIG) program, are taking to manage and publish GIS data.

To support full adoption of Eco-Plan, the following activities are suggested:

- *Continue the search for a final system owner.* The Federal Highway Administration has been investigating options for a final system owner. It would be desirable to find a viable system owner that uses a sustainable hosting model, which will allow Eco-Plan to grow and evolve.
- *Define the role of the future system owner.* The role of the future system owner needs to be defined and documented to set expectations. Ideally, the role would include more than just hosting the website. It would be best if the system owner could continually find new data sets and tools and update the website appropriately.
- *Finish the ecological screening tool prototype.* During the temporary hosting period of the research project, the ecological screening tool prototype was limited to six states and three main data sets to save disk space. The system owner may want to consider loading data for the remaining states.
- *Add more data sets to the ecological screening tool.* The ecological screening tool uses the critical habitats, wetlands, and protected areas data sets. Eco-Plan would be enhanced if additional data sets were added to the tool to better inform users during initial project screening.
- *Add official state, regional, and local data sets.* The scope of the research project was to focus on national data sets. However, many official state, regional, and local data sets are currently used in transportation planning. Adding those to Eco-Plan is a viable option for the system owner to increase the website's value as an authoritative source for transportation planning data.
- *Implement some of the user-recommended changes.* The beta test group made several recommendations for changes. The future system may want to review these and implement the cost-effective changes.

CHAPTER 1

Background and Purpose

1.1 Introduction

The purpose of this report is to document the methods and results of the project, Integration of National-Level Geospatial Ecological Tools and Data. This project was carried out under the Transportation Research Board's (TRB's) second Strategic Highway Research Program (SHRP 2), within the Capacity focus area. There are four chapters to this report. Chapter 1 presents the background and purpose of the project. Chapter 2 discusses the methods used to carry out the project and major outcomes of each task, and Chapter 3 describes the products. Chapter 4 lists the conclusions and insights for the future. References follow.

1.2 SHRP 2 Capacity Program

The charge from Congress to SHRP 2 Capacity is to develop approaches for systematically integrating environmental, economic, and community requirements into the analysis, planning, and design of new highway capacity. The scope of the SHRP 2 Capacity program extends from the early stages of the transportation planning process, when many potential alternatives are being considered, through project development.

1.3 Prior Research

Transportation practitioners are experts at planning, developing, designing, and building infrastructure projects that will address transportation needs. However, as stewards of the environment and the public interest, they must also consider the potential impacts of transportation on the environment. To do this well, partnerships are formed with agencies whose primary mission is to protect these resources. While this seems straightforward and simple, anyone who has been part of a complex environmental study understands the balancing act and trade-offs that result when trying to address a transportation need and protect resources. The challenges are further compounded by discrete agency missions, the lack of accessible data, and insufficient interagency collaboration.

Substantial strides have been made in addressing the process- and policy-related challenges that impede integrated transportation and ecological decision making. The development of *Eco-Logical: An Ecosystem Approach to Developing Infrastructure Projects* (*Eco-Logical*) initiated the necessary partnership (Bosworth et al. 2006). The nine signatory agencies of *Eco-Logical* recognized the mutual benefit of an ecosystem approach to infrastructure planning and development for both the environment and the transportation process. These partners worked to develop and articulate their ". . . shared vision of an enhanced and sustainable natural environment, combined with the view that necessary infrastructure can be developed in ways that are more sensitive to terrestrial and aquatic habitats" (Bosworth et al. 2006). The effort resulted in a conceptual framework to integrate plans across agencies and endorsed ecosystem-based mitigation.

While this conceptual framework had broad support at the executive level, implementation of the concept in practice was slow. To help advance the framework to practical implementation, SHRP 2 launched two projects: Integration of Conservation, Highway Planning, and Environmental Permitting Using an Outcome-Based Ecosystem Approach; and Development of an Ecological Assessment Process for Enhancements to Highway Capacity (TRB 2012 and 2013). The first project identified and addressed barriers to implementing the *Eco-Logical* approach. The second project developed a crediting approach to support ecosystem-based mitigation and examined supporting data and tools. Together, these projects resulted in the Integrated Ecological Framework (IEF), a nine-step process designed to bring about efficient, integrated consultation on natural resources to inform transportation and mitigation decisions. The nine steps in the IEF are supported by tools, case studies, and implementation guidance.

In addition to the work sponsored by the Transportation Research Board, federal agencies have been making their

individual strides by implementing the *Eco-Logical* approach. These initiatives complement the extensive work being done through nongovernmental organizations and at the state and regional level to do a better job of establishing the policy, process, tools, and information needed to support the integration of transportation and ecological decision making.

1.4 Project Purpose

The SHRP 2 work and the pilot projects meant to "field-test" the IEF contributed to a November 2011 summit bringing together transportation and resource agencies to determine the next steps for advancing the *Eco-Logical* approach to transportation decision making. The clear need that arose through this collaborative discussion was a national geographic information system (GIS) database and screening tool that would leverage the work being done by individual agencies, bring together national data sets, and allow states and regions to use this information as a complement to their own geospatial tools. This need informed the objective for this project.

The primary objective of this project is to develop an integrated, geospatial ecological screening tool for early transportation planning that produces results that can carry through and inform the environmental review process. This tool will advance both *Eco-Logical* and the IEF by providing the transportation community with the means to identify and analyze environmental impacts at a regional scale. The name of the tool created through this project is Eco-Plan.

CHAPTER 2

Methods and Outcomes

The project was carried out through nine tasks:

Task 1. Needs Assessment
Task 2. Vision Statement
Task 3. Architecture and Design Plan
Task 4. Beta Version
Task 5. Interface with Eco-Plan Pilot Teams
Task 6. Testing
Task 7. Midcourse Briefing
Task 8. Final Version
Task 9. Final Documentation and User Guide

The work that was conducted and the major outcomes of each task are summarized in this chapter.

2.1 Task 1. Needs Assessment and Task 5. Interface with Eco-Plan Pilot Teams

The purpose of Task 1 was to characterize the needs of the intended end users of Eco-Plan in support of an ecological approach to transportation decision making. The needs assessment was carried out through three subtasks: (1) establish a user group to inform all aspects of the project, (2) characterize the needs of the intended end users of Eco-Plan, and (3) perform an assessment of existing systems. The purpose of Task 5 was to collaborate with three separate teams funded to inform and pilot-test Eco-Plan. Since the interface with these teams began in Task 1, it is explained in this section.

2.1.1 Interface with Eco-Plan Pilot Teams and Formation of the User Group

TRB supported three separate but related projects during the development of Eco-Plan, referred to in the remainder of this report as the Eco-Plan Pilot Teams. A shared purpose among each of these projects was to inform and test Eco-Plan. The principal investigators of these projects were also members of an Eco-Plan user group. In this way, they informed the identification of needs and vision for Eco-Plan. They also participated in interim demonstrations throughout beta development. Finally, these teams participated in the beta test of Eco-Plan, which is explained in Section 2.6. In addition, the Eco-Plan pilot-test teams, the Eco-Plan project team, TRB, FHWA, and U.S. Fish and Wildlife Service (USFWS) collaborated during monthly coordination calls. During these conversations, each project team shared their progress, plans, and barriers, and any issues were also discussed.

The user group was envisioned as a small and engaged group of potential Eco-Plan users who could inform tool development and become champions for tool implementation. The project team established the following set of criteria or desired qualities for the user group:

- Are available and have leadership support for participation.
- Are leaders in the field and novices who have demonstrated interest in linking transportation and ecological decision making.
- Can provide an interface with transportation and resource agencies.
- Represent geographic and ecological diversity; as a group, participants work in a rich and varied ecological context and face a range of threats to ecological integrity.
- Represent a mix of areas adding capacity through large and small transportation projects and long and short temporal scales.
- Avoid overlap with the group of experts overseeing the project to provide a broad range of input.

Additional potential members meeting the criteria established for the user group were identified using recent grant funding and webinars highlighting projects with an ecological and a geospatial focus. A set of recommended user group members and a set of alternate user group members were

vetted with and approved by TRB. Potential members were contacted first by e-mail, to gauge potential interest, and then through a phone conversation about expectations and level of commitment. This process resulted in the final user group membership shown in Table 2.1.

The project team met with the user group at least once during each task, via teleconference and WebShare. The types of input the user group provided to each task were

- *Task 1. Needs Assessment:* Provided input on their specific needs and how they relate to a national-scale geospatial ecological screening tool for transportation.
- *Task 2. Vision Statement:* Validated data and analytic tools considered for incorporation in the tool. Provided feedback on the draft vision for the tool.
- *Task 3. Architecture and Design Plan:* Provided input on design previews.
- *Task 4. Beta Version:* Participated in demonstrations of tool development and provided input.
- *Task 5. Pilot Team Interface:* User group members designated and funded to pilot-test Eco-Plan provided feedback and insights from their project work.
- *Task 6. Testing:* Vetted information received from a separate beta test group and helped to prioritize modifications.
- *Task 7. Midcourse Briefing:* User group members designated and funded to pilot-test Eco-Plan participated in a midcourse workshop with FHWA, resource agency partners, and industry representatives to review progress and discuss implementation.
- *Task 8. Final Version:* Participated in demonstrations and provided input.
- *Task 9. User Guide:* Provided input on user help.

2.1.2 Identification of User Needs

The purpose of this subtask was to identify the anticipated needs of Eco-Plan users. These needs then informed the overall vision for the tool. User needs were identified through a five-step approach.

1. Team discussion, drafting, and revisions using multidisciplinary perspectives and information from the request for proposal (RFP) as a guideline;
2. User group review and discussion;
3. Revisions based on user group comments;
4. Review by the group of experts overseeing project work; and
5. Final revisions.

User needs were identified for each type of anticipated Eco-Plan user. Five user types were identified.

- *Transportation planner or environmental staff.* Encompasses all state and local agencies whose primary mission is to build

Table 2.1. Members of the User Group

User Group Member	Primary Member Organizations	State	Reason
Jim Thorne	University of California-Davis (working with Caltrans)	CA	Eco-Plan Pilot Teams
Mary Grace Lewandowski **David Diamond**	East-West Gateway Council of Governments and Missouri Resources Assessment Partnership	MO	Eco-Plan Pilot Teams
Mary Gray	Parsons Transportation Group (working with Contra Costa Transportation Authority)	CA	Eco-Plan Pilot Teams
Sharon Osowski	U.S. EPA Region 6	TX	U.S. EPA Region 6 and Texas DOT use a GIS-based, inter-state, ecological assessment tool for transportation planning and permitting. There are plans to integrate this tool with NEPAssist.
Richard Bostwick	Maine DOT	ME	Maine DOT has partnered with Maine Beginning with Habitat to use advanced GIS-based tools to integrate ecological and transportation planning and mitigation decisions.
John Thomas	Utah DOT	UT	Developed UPLAN, a publicly accessible, web-based, GIS tool with data sharing and analysis. UPLAN generates a Planning and Environmental Linkages report summarizing impacts of the long-range transportation plan.
Greg Servheen	Idaho Department of Fish and Game and Western Regional Governors' Association	ID	Idaho DOT, the Idaho Department of Fish and Game, and the Western Regional Governors' Association are in the process of developing Crucial Habitat Assessment Tools, or CHATs, designed to inform the preplanning of large-scale energy, transportation, and land use projects.

and maintain the transportation system. Includes the different staff-disciplines within metropolitan planning organizations (MPOs), regional planning organizations (RPOs), state departments of transportation (DOTs), and their consultants. These are the primary users of the tool. This user type was further defined as transportation planners and environmental staff who are equipped with little to no geospatial experience and support.
- *Federal Highway Administration (FHWA).* FHWA may use the tool for collaborative project oversight/review and support approval of decisions. It is expected that the needs of FHWA are representative of other federal transportation agency users.
- *Resource agency.* Federal, state, and local resource agencies generate data used in the tool and may access the tool for advisory and approval purposes.
- *Conservation organizations.* Nongovernmental organizations with a stake in the ecological impacts of transportation plans and projects may generate data used in the tool and could access the tool to provide input or advice.
- *System owner.* The eventual owner of the geospatial tool or the administrator of the tool for a specific agency user.

User needs were organized into seven categories:

1. Access the tool.
2. Import and export data.
3. View map data.
4. Analyze data.
5. Generate reports.
6. Save and share information.
7. Manage user and account settings.

The needs under each of these categories are listed in Appendix A, along with an indication of which users are expected to have this need for the geospatial tool. Specific comments made by the user group during the review process are provided in the last column of each table.

2.1.3 System Assessment

Initial System Assessment

The purpose of the system assessment was to determine whether there was an existing web-based tool or system that could address some or all of the needs identified for Eco-Plan. An existing tool that met the majority of the needs could have served as the basis for Eco-Plan if there were viable methods to license the software for modification and use. The assessment also gave the project team an opportunity to learn of evolving best practices with geographic information system (GIS) tools and find any creative and useful ideas developed by others.

For this assignment, the team started with the list of existing systems identified in the research proposal. Additional systems were identified by user group members and members of the project team and through review of FHWA's *Eco-Logical* website (FHWA 2013a). Other systems were discovered during the initial assessment and added to the list. In all, the project team initially identified 27 existing systems. Of those, two systems were not available during the assessment period and two were informational websites rather than geospatial tools. Subsequently, the initial assessment included 23 existing systems.

Initially, the following characteristics for each system were documented:

- *System configuration:* The hardware/software configuration.
- *Interoperability and standards:* Any method beyond direct user interaction with the interface for accessing the reporting, data delivery, or analytical functions of the tool. Whether the system adheres to any public standards for data format or interoperability (i.e., does the tool include functions that would allow the export of data into it, or directly exporting output from the tool?).
- *Analytical functions and reports available:* Analysis types, queries, and reports that are available (e.g., overlaying transportation plans, assigning ecological values, assessing impacts). This part of the assessment distinguished between:
  - Spatial query (list features within the analysis boundary);
  - Spatial analysis [additional scoring and weighting (e.g., the percent of wetlands within a boundary)]; and
  - Spatial analysis or data supporting enhanced ecological evaluation (e.g., overlay of many data layers with weighting, such as wetlands and endangered species layers combined to weight an area higher for the presence of both).
- *Data loading and downloading tools:* Whether users are able to upload or download information. If so, whether uploaded data could be used for analysis.
- *Data types or data sets used:* The types of data (i.e., species, water resources, etc.) or data sets available through the tool.
- *Technical support:* The user documentation, metadata, or other technical support that is available to the end user.
- *Highlights (if applicable):* Features which were unique or especially applicable to this project.

Next, the systems were rated in regard to whether or not they supported these general criteria:

- Interoperability
- Map Navigation
- Basic Spatial Query
- Customized Spatial Query
- Ecological Analysis Tools
- Reporting Tools
- Data Upload

- Data Download
- Ecological Model Results

For this rating, each system was simply assigned a "Yes" or "No" value for each of the criteria (indicating whether or not the system supported the functionality). Next, the number of "Yes" responses were counted for each system (i.e., the systems with more of the functions ranked higher). Of the 23 systems initially assessed, 16 received a rating of 5 or higher. The project team reviewed these in more detail, requesting more information or demonstrations from the system owners when necessary.

Finally, five of the systems were selected for a gap analysis—comparing the system to the user needs (see Appendix A) identified for Eco-Plan. This part of the assessment used a three-scale ranking system to indicate how well the system met each identified need. The ranking system is shown in Table 2.2. A weighted score was calculated for each of the five systems based on the numeric equivalents.

The results of the assessment are summarized in Table 2.3 and Table 2.4. A complete gap analysis showing how each assessed system addressed (or did not address) the identified user needs is provided in Appendix B.

Additional System Assessments

Two additional system assessments were conducted after the initial set. The first one was for the Environmental Protection Agency's (EPA's) EnviroAtlas tool, which was not available during the initial assessment, and the second one was for the Department of Energy's Eastern Interconnection States Planning Council (EISPC) EZ Mapping Tool, which was identified after the initial assessment was complete. These two systems were assessed using the same criteria used for the initial set.

EnviroAtlas has a simple web interface, making it very easy to navigate. In addition to the map viewer, there are other tools and resources organized on the website. All tools are well documented. Some of the map products would be helpful for Eco-Plan users, like protected versus not protected lands. EnviroAtlas handles data from sources outside of EPA well; for example, it pulls the National Hydrography Dataset (NHD) directly from the United States Geological Survey (USGS) map service. The tool also has a good example of a disclaimer (USEPA 2014).

The EISPC EZ Mapping Tool is also a website with a map viewer. The analytic tools and reports of model results are impressive but support energy applications rather than ecological and transportation applications. Therefore, they are not transferable to Eco-Plan. The system is accompanied by a well-documented user manual that also captures the features and functions of the tool and is provided in Appendix B (EISPC 2014).

The findings from these assessments, along with those completed in Task 1, will inform the development of Eco-Plan in Task 4.

Individual assessments of each system are provided in Appendix C.

Table 2.2. Ranking Approach for Existing Systems

Criteria	Numeric Equivalent	Symbol
Meets the need	2	
Partially meets the need	1	
Does not meet the need	0	—

2.1.4 Conclusions from Task 1

After developing and validating a list of user needs, assessing existing systems, and comparing them to the needs, the project team made several conclusions:

- There are numerous existing GIS tools to help with conservation planning. However, many are built with a specific subject matter or geographic focus and are not broad enough to support transportation planners nationwide. Also, most were developed as a one-way push of information to the user and not as a collaborative tool to allow dynamic additions of additional data.
- The existing federal systems that the team assessed were not good candidates for starting points for Eco-Plan. They typically do not provide the collaborative sharing of data, cross-discipline subject matter, ability to import user-defined data, or extensible frameworks for future analytical tools to address user needs.
- Two existing systems, UPLAN and Data Basin, far surpassed all other systems in the assessment of how they address user needs. These two systems were considered further as building blocks for the new Eco-Plan website in the development of Task 2—Vision Statement (UDOT 2013, CBI 2013).

2.2 Task 2. Vision Statement

The purpose of Task 2 was to create a vision for Eco-Plan. The vision was informed by the user needs and system assessment in Task 1, the project team's own expertise and experience in transportation and habitat planning, evolving best practices in GIS system and web design, and input from the user group and experts overseeing the project. It addressed the basic parameters of the system, including the inputs and outputs of existing tools, data sources that can be leveraged, analytical tools to be incorporated, and how users would access and use it.

Table 2.3. Initial Assessment of 23 Existing Systems

System Name	Interoperability	Map Navigation	Basic Spatial Query	Customized Spatial Query	Ecological Analysis Tools	Reporting Tools	Data Upload	Data Download	Ecological Model Results	Number of Criteria
Environmental Conservation Online System (ECOS) (USFWS 2014b)	Y	Y	Y	Y	Y	Y	N	Y	Y	8
Data Basin (CBI 2014)	N	Y	Y	Y	Y	Y	Y	Y	Y	8
ScienceBase (USGS 2014b)	Y	Y	Y	N	N	Y	Y	Y	Y	7
Southern Great Plains Crucial Habitat Assessment Tool (SGP CHAT) (Oklahoma et al. 2013)	Y	Y	Y	Y	N	Y	N	Y	Y	7
The Wyoming Interagency Spatial Database & Online Management (WISDOM) System (WISDOM 2014a)	N	Y	Y	Y	N	Y	Y	Y	Y	7
UPlan (AASHTO 2013)	Y	Y	Y	Y	N	Y	Y	Y	N	7
HabiMap™ Arizona (AGFD 2013)	N	Y	Y	Y	N	Y	N	Y	Y	6
Information Planning and Conservation System (IPaC) (USFWS 2014c)	Y	Y	Y	N	N	Y	Y	Y	N	6
NEPAssist (USEPA 2013b)	Y	Y	Y	Y	N	Y	Y	N	N	6
FWS Critical Habitat Portal (USFWS 2013a)	Y	Y	Y	N	N	Y	N	Y	Y	6
Areas of Conservation Emphasis (ACE-II) (CDFG 2013)	N	Y	Y	N	Y	N	N	Y	Y	5
ESA Webtool (FHWA 2013a)	N	Y	N	Y	N	Y	Y	Y	N	5
Integrated Resource Management Applications (IRMA) (NPS 2014a)	Y	N	N	N	N	Y	Y	Y	Y	5
NPScape (NPS 2013)	Y	Y	N	N	N	Y	N	Y	Y	5
NWI Website (USFWS 2014d)	Y	Y	Y	N	N	Y	N	Y	N	5
Washington's Department of Fish and Wildlife Priority Habitats and Species (PHS) (Washington DFW 2014)	N	Y	Y	Y	N	Y	N	N	Y	5

(continued on next page)

Table 2.3. Initial Assessment of 23 Existing Systems (continued)

System Name	Interoperability	Map Navigation	Basic Spatial Query	Customized Spatial Query	Ecological Analysis Tools	Reporting Tools	Data Upload	Data Download	Ecological Model Results	Number of Criteria
Montana Fish, Wildlife & Parks Crucial Areas Planning System (CAPS) (Montana FWP 2014)	N	Y	Y	Y	N	N	N	N	Y	4
NatureServe Explorer (NatureServe 2014b)	Y	N	Y	N	N	Y	N	Y	N	4
NPS Vegetation Inventory Map Viewer (NPS 2014c)	Y	Y	Y	N	N	N	N	Y	N	4
RIBITS (Regulatory In lieu fee and Bank Information Tracking System) (USACE 2014)	N	Y	Y	Y	N	Y	N	N	N	4
FWS Lands Mapper (USFWS 2014a)	Y	Y	Y	N	N	N	N	N	N	3
Alaska Department of Fish and Game (ADFG) Fish Resource Monitor (ADFG 2013)	N	Y	Y	N	N	N	N	N	N	2
Habitat and Population Evaluation Team (HAPET) (USFWS 2013b)	N	N	N	N	N	N	N	N	Y	1

Table 2.4. Summary of Gap Analysis Program (GAP) Analysis

User Need Category	UPlan	Data Basin	IPaC	NEPAssist	ESA Webtool
Access the tool	6	6	2	3	3
Import and export my data	8	8	1	1	0
View map data	25	25	17	21	12
Analyze data	14	12	9	7	6
Generate reports	8	8	8	8	1
Save and share information	14	14	3	3	9
Manage user and account settings	17	18	5	5	15
Overall Weighted Total	92	91	45	48	46

2.2.1 Identification of Data

Identifying data sets to provide through Eco-Plan was one aspect of developing the vision. Data were identified from a variety of sources, including:

- The SHRP 2 RFP, which listed specific data sets as well as broad categories of data that should be included in Eco-Plan;
- The relevant data in existing systems assessed in Task 1;
- Input from the project team;
- Information from federal stakeholders; and
- Input from the user group.

The data were organized into thematic categories and subcategories. The three main categories of data were

- *Natural Environment:* Data that describe the current or historic condition of land and water, habitats, and species distribution, as well as delineations of areas with varying types of protection and management.
- *Built Environment:* Data that describe how land is being used, along with environmental contamination of soil, water, and air.
- *Cultural/Social:* Demographic data and political boundaries.

These categories are shown in Figure 2.1, along with subcategories of example data sets. Note that the examples are not a comprehensive list of all data sets within the category. The full list of data sets provided through Eco-Plan is in Appendix D.

2.2.2 Assessment of Analytic Tools

The purpose of this subtask was to identify existing analytic tools that may be integrated with Eco-Plan. The inventory of tools captured through the SHRP 2 project, Development of an Ecological Assessment Process for Enhancements to Highway Capacity (TRB 2013) was used as a starting point, as these were already deemed specifically relevant to *Eco-Logical.* There were 154 distinct tools available through the Integrated Ecological Framework (IEF) application on the Transportation for Communities—Advancing Projects Through Partnerships (TCAPP) website (ICF 2013). (TCAPP is a beta version of PlanWorks, a web resource tool for collaborative decision making in transportation planning.) Each of these tools was screened to determine whether they were also relevant to integrate with Eco-Plan.

Factors considered in the screening were

- Is the tool current?
- Does the analytic tool have a geospatial component?
- Can the analytic tool be applied to any geographic area, or is it relevant only to a specific geographic area?

Based on the screening, the team identified 17 tools as primary candidates for integration. Note that there is some duplication among analytic tools and systems assessed. Both provide analytic capabilities.

- *Better Assessment Science Integrating Point and Nonpoint Sources (BASINS)* (USEPA 2013a). Multipurpose environmental analysis system designed for use by regional, state, and local agencies in performing watershed and water quality-based studies. Within the open-source MapWindow GIS interface are a data download tool, a project builder, watershed delineation routines, and data analysis and model output visualization tools. New features include plug-in interfaces for well-known watershed and water quality models Storm Water Management Model 5 (SWMM5), Water Quality Analysis Simulation Program (WASP7), and Soil and Water Assessment Tool (SWAT) 2005.
- *Nonpoint Source Pollution and Erosion Comparison Tool (N-SPECT)* (NOAA 2014a). Use OpenNSPECT, the open-source version of the Nonpoint Source Pollution and Erosion Comparison Tool, to investigate potential water quality impacts from development and other land uses and climate change. OpenNSPECT was designed to be

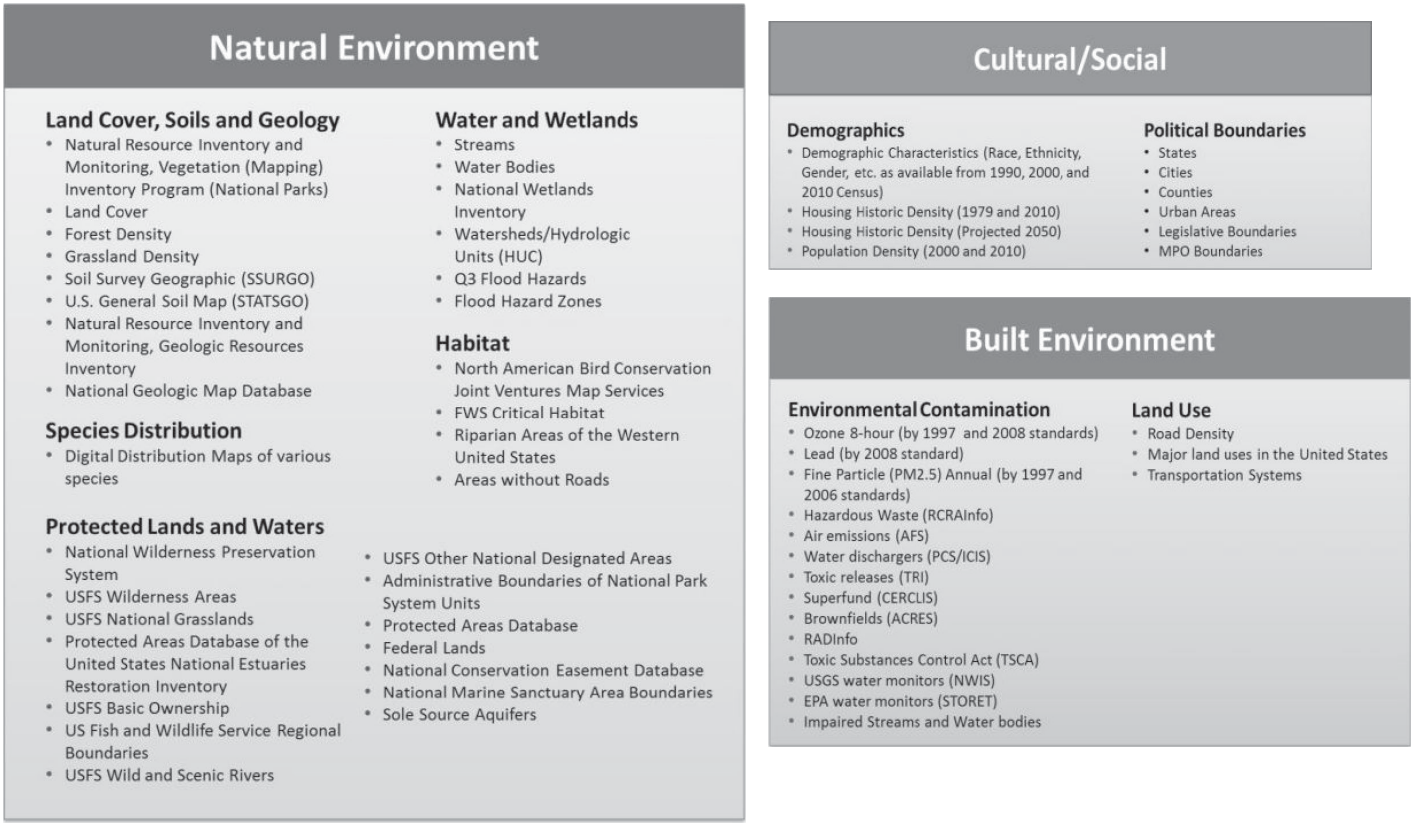


Figure 2.1. Data categories and organization.

broadly applicable. When applied to coastal and non-coastal areas alike, the tool simulates erosion, pollution, and their accumulation from overland flow. N-SPECT is a complex yet user-friendly GIS extension that helps coastal managers and local decision makers predict potential water quality impacts from nonpoint source pollution and erosion.

- *NEPAssist* (USEPA 2013b). NEPAssist is a tool that facilitates the environmental review process and project planning in relation to environmental considerations. These features contribute to a streamlined review process that potentially raises important environmental issues at the earliest stages of project development.
- *CommunityViz* (Placeways 2013). ArcGIS software extension widely used by planners; features flexible and interactive analysis tools, a rich set of presentation tools, and several options for 3-D visualization of future places.
- *Data Basin* (CBI 2014). Data Basin is a science-based mapping and analysis platform that supports learning, research, and sustainable environmental stewardship.
- *Ecosystem Management Decision Support (EMDS)* (UOR EMDS 2013). Application framework for knowledge-based decision support of ecological assessments at any scale. The Hotlink browser displays the evaluated state of a knowledge base. Users can navigate the networks of analysis topics to trace the logic of evaluations in an intuitive interface. More importantly, the presentation of results in this graphic format is sufficiently intuitive that users of the system can use the Hotlink browser as a powerful communication tool that effectively explains the basis of evaluation results to broad audiences.
- *Habitat Priority Planner (HPP)* (NOAA 2014b). HPP is a spatial decision-support tool designed to assist users in prioritizing important areas in the landscape or seascape for conservation or restoration action. Creates maps, reports, and data. Teams of people working on habitat decisions use this tool to share information and find answers to questions. The HPP packages spatial analysis and stakeholder engagement in one geospatial tool. This Esri-based toolbar has been used for strategic conservation planning, to create species monitoring plans, and to plan for climate change adaptation. Users can customize base data, select a series of spatial analyses, and work with stakeholders to prioritize areas for management action.
- *Land Change Modeler (LCM)* (LCM 2013). The LCM for Ecological Sustainability is an integrated software environment for analyzing land cover change, projecting its course into the future, and assessing its implications for habitat and biodiversity change. LCM is a vertical application developed by Clark Labs and integrated within the IDRISI GIS and Image Processing software package. The LCM for Ecological Sustainability is oriented to the pressing problem of

accelerated land conversion and the very specific analytical needs of biodiversity conservation.

- *Landuse Evolution and Impact Assessment Model (LEAM)* (Illinois 2013). Environmental, economic, and social system impacts of alternative scenarios such as different land use policies, growth trends, and unexpected events can be tested out in the LEAM modeling environment.
- *Marxan* (Australia UQ 2013). Marxan is a freely available conservation planning software that provides decision support to a range of conservation planning problems including the design of new reserve systems, reporting on the performance of existing reserve systems, and developing multiple-use zoning plans for natural resource management. It provides many good solutions to complex problems, offering several options and encouraging stakeholder participation. These features provide users with decision support to achieve an efficient allocation of resources across a range of different uses.
- *NatureServe Vista* (NatureServe 2014b). Free decision-support system that helps users integrate conservation with land use and resource planning of all types. Planners, resource managers, scientists, and conservationists can use NatureServe Vista to conduct conservation planning and assessments; integrate conservation values with other planning and assessment activities, such as land use, transportation, energy, natural resource, and ecosystem-based management; and evaluate, create, implement, and monitor land use and resource management scenarios designed to achieve conservation goals within existing economic, social, and political contexts.
- *Watershed Analysis Risk Management Framework (WARMF)* (USEPA 2013c). WARMF is a physically based watershed modeling framework and decision-support system for watershed management. It is suitable for applications including watershed stewardship, land use planning, climate change impact, mercury transport, and total maximum daily loads (TMDLs). It also includes a consensus module designed to bring scientific information to a stakeholder group and facilitate decision making on a watershed scale.
- *Automated Geospatial Watershed Assessment (AGWA)* (USEPA 2011). AGWA is designed to provide qualitative estimates of runoff and erosion relative to landscape change. A GIS provides the framework within which spatially distributed data are collected and used to prepare model input files and evaluate model results. AGWA uses widely available, standardized, spatial data sets that can be obtained via the Internet. The data are used to develop input parameter files for two watershed runoff and erosion models: Kinematic Runoff and Erosion Model (KINEROS2) and SWAT.
- *Envision* (ORST 2013). Created to conduct research about the nature and properties of coupled human and natural environmental systems in the context of climate change. Also created to develop alternative futures analysis used to model the landscape impacts of various policy scenarios on land use change and accompanying biophysical impacts. Strongest applications are mapping the cumulative effects of multiple actions at multiple sites as it tracks impacts over time. Envision has the ability to plug in evaluative models (e.g., credit calculators).
- *FRAGSTATS* (UMASS 2012). Computer software program designed to compute a wide variety of landscape metrics for categorical map patterns.
- *Land Transformation Model (LTM)* (PU 2011). The model uses landscape ecology principles, that is, patterns of interactions to simulate land use change process, to forecast land use change. Though the model can be used in any definable region, precedence is given to watersheds. It is useful for simulating land use/cover changes across large regions and can be used to simulate land change in areas that contain several million to even a few hundred million cells. It is thus a useful tool to couple to regional climate, hydrologic, and carbon sequestration models.
- *TransCAD* (Caliper 2011). TransCAD is a GIS system designed specifically for use by transportation professionals to store, display, manage, and analyze transportation data. It features 2-D and 3-D visualizations, cartography, buffering, region/cluster grouping, spatial statistics, and grid generation. Its strengths lie in the ability to create and model transportation networks and matrices, providing functions to develop an integrated Urban Transportation Planning System (UTPS).

In addition to these tools, 12 tools were identified as potentially applicable but in need of further investigation. Additional information for each of these tools and the remaining analytic tools considered in the screening is available in Appendix E. In the appendix, tools are categorized as primary candidates for integration, potential candidates needing further investigation, or not appropriate for integration.

2.2.3 Draft Vision

The next major work item was to develop the draft vision for Eco-Plan. Based on feedback from the initial user group call, the project team determined that a visual graphic was the best way to communicate these combined ideas:

- User needs;
- Appropriate data for analysis;
- Appropriate tools for analysis;
- Creative or useful ideas for other leading GIS or ecological assessment systems;
- Industry-standard GIS methodologies;
- Real-world experience in running Florida DOT's Environmental Screening Tool; and
- Emerging web standards and user expectations in usability and design.

A small subgroup of the project team met for a visual solution session to summarize the information into groups of users, inputs, types of functionality, and outputs. This subgroup drafted a diagram of the vision and shared it with the full cross-discipline team for review and comment. After updating the diagram based on the comments, a designer created a professional graphic, shown in Figure 2.2. Each additional section of the vision is explained in Table 2.5. The vision diagram shows the users, data, functionality, and outputs that can be used as a foundation for transportation planning, identifying and avoiding priority conservation areas, and identifying mitigation sites, and to support the eventual National Environmental Policy Act (NEPA) process.

2.2.4 Implementing the Vision

At the end of Task 2, the project team determined that there were two preferred implementation options, each with considerable advantages and disadvantages. The first option was based on an ArcGIS Online (AGO) application. The second option was a new custom tool. These two approaches are described in this section, along with advantages and disadvantages.

Option 1: AGO Implementation

One option explored was to build Eco-Plan as an AGO application. AGO is a web-based mapping platform provided by Esri, a major industry vendor of GIS solutions. This implementation model was pioneered in the transportation area by the Utah DOT (UDOT) and resulted in the UPLAN application (UDOT 2013). UPLAN, through standard AGO functionality, allows the UDOT to develop online interactive maps for planning and analysis; easily and securely share maps with other groups, states, and the public; and import up-to-date data sets with any organization already registered with AGO. Several states have followed the UPLAN model for their own transportation planning applications.

This cloud-based application model was highlighted in FHWA's May 2013 *Successes in Stewardship* newsletter (FHWA 2013b). Transfer of the technology to other state DOTs is also being supported by the American Association of State Highway and Transportation Officials (AASHTO) through a Technology Implementation Group (TIG) program (AASHTO 2013).

The envisioned implementation of this option was to package the appropriate data sets (while allowing the user to add others), provide exploration and analysis tools,

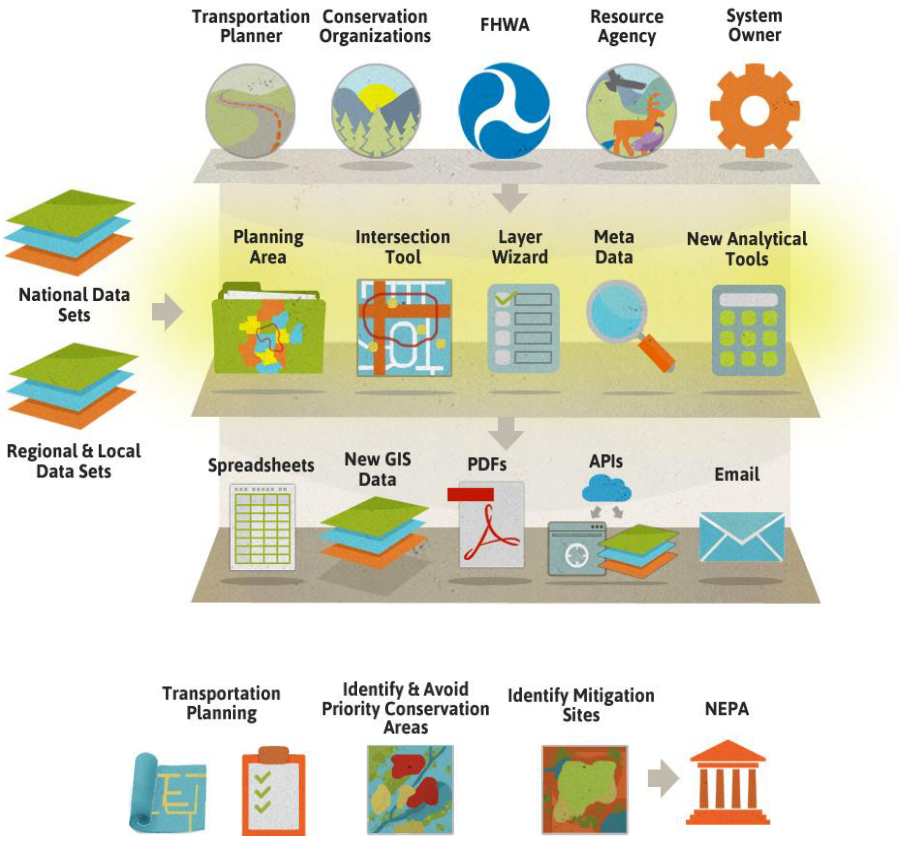
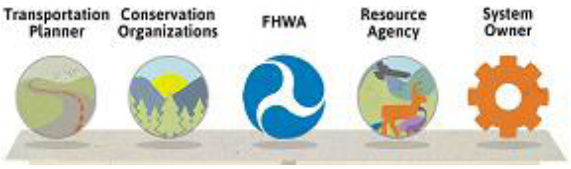


Figure 2.2. Vision for Eco-Plan.

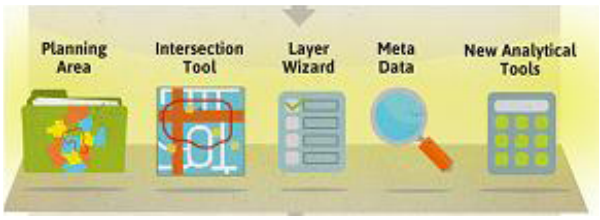
Table 2.5. The Components of the Vision

User Types:
The primary intended users of Eco-Plan are transportation planners, especially those without existing resources and tools (within their organization) to help them use ecological data during planning. Other users are anticipated to provide data, advice or to maintain the tool.



Data Inputs:
The primary data inputs are existing, web-based, federal data sets encompassing the natural environment, built environment, and cultural/social information. Eco-Plan will connect to these data sources using industry-standard web services to ensure timely and accurate data. Consolidating these data sets in a single location will allow novice users to use the wealth of data immediately. The tool must easily support the addition of new data sets over time as they are published by federal agencies.
Experienced users will need the ability to load additional regional and local data as well. To encourage collaboration and knowledge sharing, the tool must support easy and secure ways to share data sets across groups of users.

Functionality:
Eco-Plan was envisioned to have several major areas of functionality:
- **Planning areas to group and store map information;**
- **Intersection tool to determine items of interest within geographic boundaries of the buffered lines or polygons of projects;**
- **Layer wizard to allow users to select specific data sets based on topics or problem type without requiring the usual long list of data layer check boxes;**
- **Metadata to allow users to determine whether the data are current, are accurate, and the scale; and**
- **New analytical tools to enhance support for determining priority conservation areas and mitigation sites.**



Outputs:
Eco-Plan was envisioned to support several standard outputs of data such as Excel spreadsheets, GIS data, formatted PDF reports, APIs, and possible e-mail notifications.

Support Planning:
Eco-Plan was envisioned to serve as a foundation for integrated transportation and ecological planning.

provide an intuitive layer wizard to jump-start users into solving specific problems, and tailor the view to the planning task at hand.

The disadvantage identified for this option was that, while Eco-Plan can be packaged as a product in an AGO application, it would not be a stand-alone entity. It would exist within a third-party platform-as-a-service architecture. All users would need AGO accounts (free or paid depending on the level of data hosting).

Option 2: Custom New Tool

The second option explored was to build a new custom, stand-alone tool. This approach would be similar to Data Basin (CBI 2013). It would be a stand-alone tool, still built using Esri technologies, but hosted separately on Amazon cloud servers instead of within the AGO platform.

While this option would result in a stand-alone product, it could miss significant opportunities for adoption, engagement, and collaboration if more state DOTs implement systems based on the UPLAN model with AGO.

2.2.5 Conclusions from Task 2

After developing the draft list of data sets, evaluating existing analytical tools, and documenting the vision for the tool, the project team concluded:

- Easy and secure sharing of layers is essential to collaboration.

- There are several examples of local, regional, and state conservation prioritization tools, but none at the national level that could be scaled down to provide value to local planners.
- Most of the existing analytical tools were not built with future web integration in mind.
- Two general implementation approaches arose as preferred options: using the AGO platform similar to UPLAN or building a new tool following the Data Basin approach.

The project team presented these two options during a meeting with TRB and the group of experts overseeing the project. It was decided that the UPLAN implementation option should be investigated further in Task 3.

2.3 Task 3. Architecture and Design Plan

The purpose of Task 3 was to create an architecture and design plan for Eco-Plan to guide the development of the tool in Task 4. To do this, the team conducted an additional investigation of AGO as a platform for the tool, created a proposed design, developed a workflow demonstrating how the tool could be used to support the IEF, and created draft wireframes (sketches of page design) for the tool.

2.3.1 Review of AGO Application in Practice

As part of Task 3, the team further conducted an investigation and validation of AGO as a potential platform for Eco-Plan. The investigation included targeted conversations with states participating in the AASHTO TIG for UPlan and exploration of the use and acceptance of AGO by federal agencies.

The purpose of the calls was to validate the benefits and challenges of the AGO platform. Conversations were guided by the following general questions:

1. What is the status of their tool? (In development? Operational?)
2. How are they using it? (Have they mapped their long-range transportation plan? Have they used it to influence planning? Have they used it to identify or avoid important ecological resources?)
3. What ecological data are they accessing?
4. Are they using the tool collaboratively with regulatory agencies? How?
5. What are the major benefits of using AGO?
6. What are the major drawbacks of using AGO?

Conversations were held with key AASHTO TIG participants. In addition, Fact Sheets reporting the status of Pennsylvania's and Montana's applications of AGO were reviewed (PennDOT 2013, MDT 2012). Key findings are that

- TIG participants are hoping to make spatial data available to more users within the DOT; AGO has been a useful platform for this purpose.
- There are challenges associated with integrating custom code in an AGO application.
- Most data sets of interest are available through AGO.
- Participants are still in the early stages of tool development and implementation and are working through the details of user permissions, confidential data, analysis, and so forth.

AGO is also being adopted by federal agencies, including FHWA. Of the 125 proposed data sets for Eco-Plan, 73 are already hosted on AGO by agencies like the EPA, National Park Service (NPS), Fish and Wildlife Service (FWS), U.S. Department of Agriculture (USDA), U.S. Forest Service (USFS), National Oceanic and Atmospheric Administration (NOAA), Federal Emergency Management Agency (FEMA), and USGS.

Given the coverage of user needs and growing adoption by states and by federal agencies, the design approach created for Eco-Plan used AGO as the backend GIS server.

2.3.2 Tool Architecture and Design

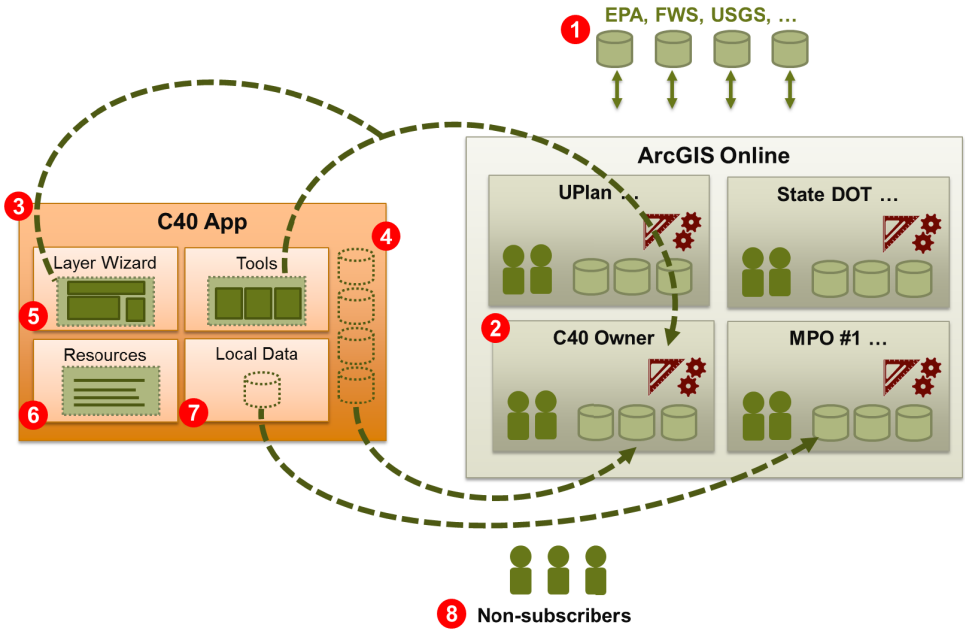
The proposed architecture and implications of using AGO are described in this section.

Design

The team used the findings from Tasks 1 and 2 and input from experts to develop a draft architecture and design for Eco-Plan. A hybrid solution incorporating a unique Eco-Plan application and using AGO as the data storage and sharing backbone was recommended. Figure 2.3 illustrates the proposed architecture and the planned connection points with AGO.

Pros and Cons of the AGO Approach

Using AGO will require the system owner and some organizations to pay for AGO subscriptions for some functionality. While TRB currently builds all research websites with license-free, open-source software, it is likely that previous TRB projects required specific software licenses for proprietary components, such as Oracle or SQL server databases. These products require licenses for the development team while the application is being built and the future system owner for hosting. The use of AGO presents a similar situation but with more flexibility (due to a scalable subscription model) compared to older, more expensive enterprise license models.



1. Federal agencies already publish much of their live GIS data in AGO directly or indirectly via web services.
2. The future Eco-Plan tool owner will host custom maps and applications within their instance of AGO.
3. A custom web application will display information on the IEF and link it to Eco-Plan.
4. Federal data sets will be available for use in Eco-Plan while actually being sourced from AGO.
5. Eco-Plan will embed custom AGO maps and applications.
6. Eco-Plan will have custom web content (not possible in AGO).
7. AGO subscribers will be able to upload their own local data or use data already loaded into their AGO instance.
8. Nonsubscribers will be able to use publically published functionality.

Figure 2.3. Proposed architecture of Eco-Plan.

Several advantages and disadvantages for the proposed solution using AGO are itemized in Table 2.6.

AGO pricing plans include annual per-user access plus organization service credits for some data processing services. Given the variability in how quickly service credits will be used, it is not feasible to accurately predict subscription costs.

It should be noted that the architecture work was an iterative process influenced by several external factors and goals, some of which competed against each other. During this task, there were several discussions about architecture, especially how uncertainty in final product ownership affects design decisions. There were also discussions to ensure that the architecture also meets the specific TRB goal of providing a distinct and unique SHRP 2 product, above and beyond just an AGO implementation.

Table 2.6. Advantages and Disadvantages of the AGO Platform for Eco-Plan

Pros	Cons
• Allows the project team to use AGO's out-of-the-box functionality to meet many of the user needs: ○ map viewing ○ basic map tools ○ data retrieval ○ data sharing ○ security groups • Increases chances for adoption with state DOTs given the growing popularity of AGO within that community. • Increases chances for adoption with FHWA given their recent investments in AGO. • Allows the system owner to use future AGO enhancements within Eco-Plan with minimal investment.	• Requires the use of a third-party, proprietary product. This is like using proprietary web controls and databases in an application instead of using all open-source technologies. • Requires the system owner to cover applicable AGO subscription fee. • Requires general users to have AGO subscriptions for data loads. • AGO's pricing includes a complex credit model for some intensive computations (like geo-encoding street addresses and large data transfers).

2.3.2.1 Draft Wireframes

Draft wireframes, or sketches of the different screens that could be available in Eco-Plan, were created in Task 3 to serve

as a starting point to guide the developers in their initial work. Figure 2.4 shows one of the wireframes for the main Eco-Plan page. Five wireframes are provided in Appendix F:

1. *Login:* Page where users enter their credentials to enter a personal or group workspace;
2. *Landing:* Main page where users can access all pages of their workspace;
3. *Map:* Map viewer only, without workflow;
4. *Map with Guidance:* Map viewer with workflow, detailed guidance collapsed; and
5. *Map with Guidance Expanded:* Map viewer with workflow, detailed guidance expanded.

The following architecture and design guidelines were used in developing the wireframes:

- The overall goal of the site is intended to help facilitate creation, collaboration, and completion of various GIS-related tasks.
- The framework of the site accomplishes this through the use of simple graphic prompts and icons as well as directions that are easy to understand and follow.
- The simple iconography and clean graphical presentation will help novice users perceive an intuitive and nonthreatening interface.
- Basic elements of navigation will remain consistent throughout the website but will not intrude on the core activities supported by the GIS.
- Users of the website will not be bound by specific steps but may optionally access additional guidance, help, and frequently asked questions (FAQs).
- All users will have access to targeted guidance for using the tool to support the IEF.
- Advanced users will be able to "hide" the guidance and maximize their workspace within the website but may reference the guidance at any time.
- Guidance will reference the steps involved with the IEF process but use web-friendly labels and verbiage.

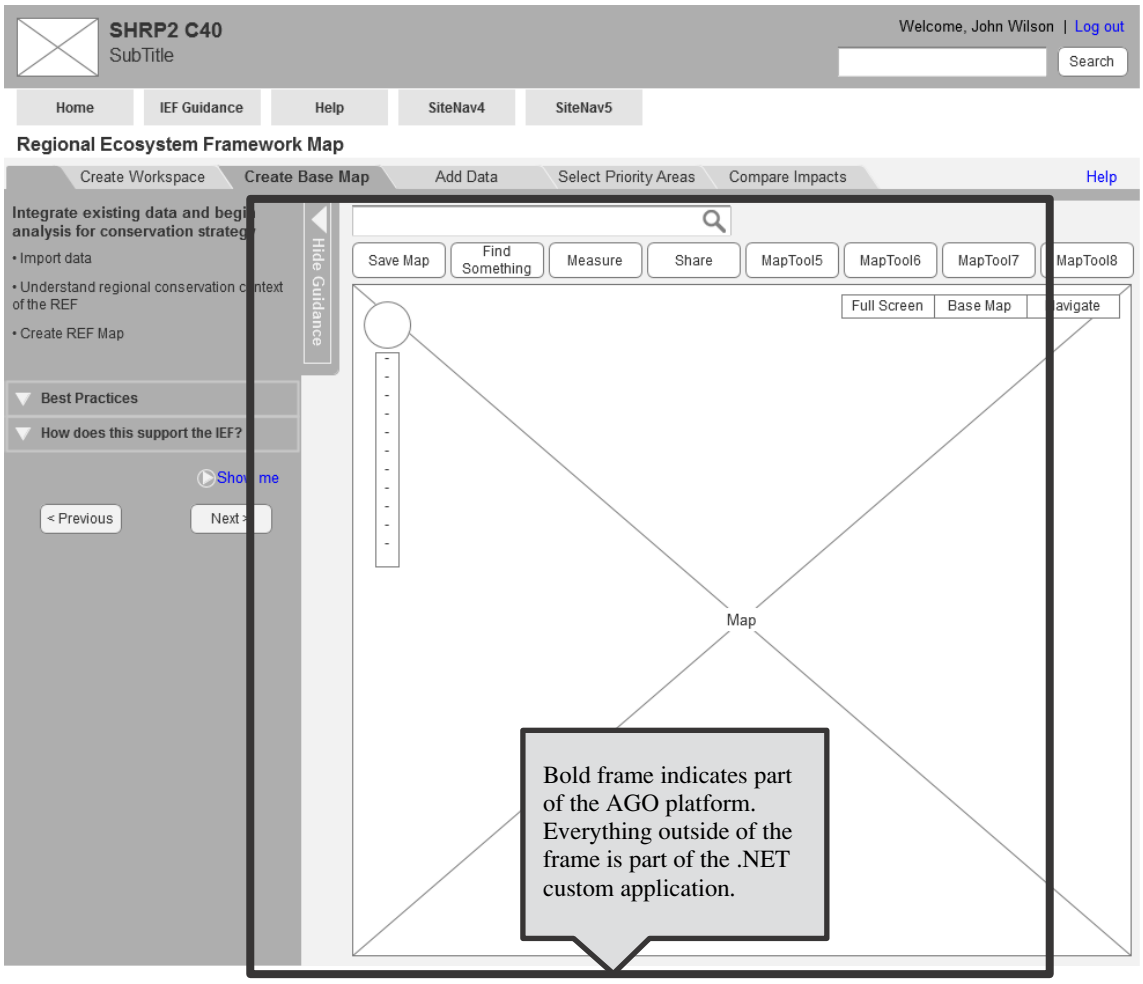


Figure 2.4. Wireframe of the main Eco-Plan page.

2.4 Task 4. Beta Version

The purpose of Task 4 was to create a beta (draft) version of Eco-Plan for testing and refinement in future tasks. The vision, architecture, and design guided the development of the beta tool. The team used an Agile approach to development. Simplified, this means instead of mapping out the entire development process and the expected outcome from start to finish, the team worked in sprints. Working in sprints, the team can be flexible to adjust strategies and approaches as new information is gathered, priorities are refined, and issues arise. Each sprint started with a planning session. During the planning session the team established the goal for the sprint, identified and assigned individual subtasks (or cards) to reach the goal, identified success criteria, and set an end date. During the sprint, the development team communicated on a daily basis to resolve any issues. The sprint ended with a demonstration during which each team member presented the results of their work. The beta version of Eco-Plan was developed in seven sprints. The overall goal and a brief description of tasks for each sprint are shown in Table 2.7.

During the course of beta development, it was determined that "Eco-Plan" would refer to the .NET website where all user help and guidance would be available and "Eco-Plan

Table 2.7. Goals and Tasks of Each Sprint Leading to the Beta Release of Eco-Plan

Complementary Activities	Eco-Plan Activities	Eco-Plan Advanced Activities
Sprint 1: Get organized		
Introduce development team to the project and schedule sprint meetings	Create wireframes for pages	Purchase AGO account
Determine approach for involving the user group in beta development	Create graphic design concepts	Find authoritative sources of data (from list developed in earlier tasks) on AGO and associate with Eco-Plan account
Sprint 2: Prove it!		
	Create a page with a dynamic map pulled from Eco-Plan Advanced showing authoritative data	Configure AGO account
	Build a data portal	Determine what AGO services will be used
	Finalize graphic design	
Sprint 3: Demo		
Acquire some Eco-Plan pilot team data to use in demonstrations	Create the wireframe for the Maps page	Add data sets to AGO groups
	Create the home page	Create theme maps
	Work on functionality to upload a data layer onto a theme map	
Sprint 4: Make it pretty		
Acquire additional Eco-Plan pilot team data	Design the home page	Make revisions to theme maps
Complete detailed information for data sets	Design the data gallery page	
	Design the map page	
	Publish development page	
Sprint 5: Make it work		
Create a prototype for a map that merges information from multiple theme maps	Complete styling for all pages	Review theme maps
Coordinate with NatureServe to determine if Landscope America data are published in AGO	Finalize home page text	
	Design map detail page and create HTML	
	Design data detail page and create HTML	

(continued on next page)

Table 2.7. Goals and Tasks of Each Sprint Leading to the Beta Release of Eco-Plan (continued)

Complementary Activities	Eco-Plan Activities	Eco-Plan Advanced Activities
Sprint 6: Prepare for TRB meeting with Eco-Plan Pilot Teams		
Finalize text for all data services	Write content for Getting Started page	
Develop scripts for testing	Design Getting Started page	
	Implement Getting Started page using an AGO story map	
	Implement text for download-only data sets	
	Set up staging environment	
	Investigate data/file upload function	
	Complete internal usability testing	
Sprint 7: Beta release—finish tasks needed for testing and publish Eco-Plan		
Complete test scripts for functional and usability testing	Make changes based on feedback from internal usability testing	
	Create placeholder text for pages that will not be ready for beta testing	
	Complete language and graphics explaining the difference between Eco-Plan and Eco-Plan Advanced	
	Complete upload Shapefile function for Data Detail and Map Detail pages	
	Complete a "Mail to" link that testers can use to provide feedback	

Advanced" would refer to the AGO application. The first column in Table 2.7 refers to activities supporting development of both applications, the second column refers to activities that supported only the development of Eco-Plan, and the last column refers to activities specific to Eco-Plan Advanced. The differences between Eco-Plan and Eco-Plan Advanced are explained further in the table.

- *Eco-Plan.* Supports transportation planning by providing prepared maps of national ecological data sets that can be used to avoid and minimize transportation impacts. Users can review maps of national ecological data sets, find data and other useful GIS information, and upload or draw a planning area or transportation network. No GIS skills are needed to use Eco-Plan, and it is free to all users.
- *Eco-Plan Advanced.* A separate website hosted by Esri AGO provides all of the information available through Eco-Plan with additional capabilities. Users can add any data set to the prepared maps of national ecological data; set up groups to save, share, and comment on maps; and conduct GIS analysis and create reports. Eco-Plan Advanced requires GIS skills. Users can access Eco-Plan Advanced through free or paid accounts with different levels of accessibility.

Not all of the functionality envisioned for Eco-Plan was in place at the time of the beta release. Input from the beta test would be used to prioritize and inform final development tasks.

2.5 Task 6. Testing

2.5.1 Objectives

The purposes of testing Eco-Plan and Eco-Plan Advanced were to receive comments on the beta version and gather input on the usefulness of planned functionality. Specifically, feedback from testers would identify any modifications needed to improve the usability of Eco-Plan and Eco-Plan Advanced and inform the utility of

- Building search capabilities so that content could be found by using keywords.
- Incorporating ways for users to draw or upload a project on Eco-Plan.
- Providing an intersection tool to allow users to see what important data layers intersect with their project.
- Building the About and Help pages.

2.5.2 Methods

Three groups participated in testing of Eco-Plan and Eco-Plan Advanced: (1) the user group described in Section 2.1.1, (2) the pilot teams described in Section 2.1, and (3) a separate beta test group that had no prior involvement in the development of the tool. The third group was established as a control, to see how a typical user who had no prior knowledge of Eco-Plan would approach and use it. The beta test group included multiple

individuals from North Front Range (Colorado) MPO, Charlottesville-Albemarle (Virginia) MPO, Alaska DOT, Rogue Valley (Oregon) Council of Governments (COG), and North Central Texas COG.

Each test began with a brief, initial introduction to present the purpose of the tool and test. During this conversation, no instructions were provided on how to use the tool. After agreeing to participate, each testing organization was sent a testing plan (Appendix G) and testing script (Appendix H). The testing plan fully explained the purpose of the test, how feedback would be used, and expectations for the level of effort. The test scripts asked testers to conduct specific tasks and provide feedback about them. The testers were also given an opportunity to provide general feedback.

The testing process was structured to test two different aspects of Eco-Plan: functionality and usability. Functionality testing served as a verification of the proper functioning of the system. In this test, the test scripts listed the steps testers need to take to successfully complete a task. Each step also described the expected result. Participants were asked to follow the scripts to perform a few tasks, mark whether the actual result matched the expected result, and record any difficulties, comments, or questions. A short questionnaire was included for participants to assess their overall experience and indicate how useful the content and functionality were. No moderation was needed. Participants were asked to complete this test within 2 weeks.

The goal of the usability test was to determine how well testers were able to use Eco-Plan and Eco-Plan Advanced on their own, uncover any usability issues, evaluate the participant's satisfaction, and identify opportunities for enhancements. The test participant joined an online meeting with one moderator and one or more silent observers. Participants were asked to perform a few realistic task scenarios without any instruction and verbalize their thoughts. The moderator initiated tasks and asked probing questions to understand the tester's perspective but did not provide assistance.

2.5.3 Test Results

ICF conducted beta testing from February 1, 2013, through February 17, 2013. The testing consisted of both functionality testing based on a provided test script and usability testing based on high-level verbal instructions. The testing involved the three C40B pilot organizations, FHWA, four MPOs, and one state DOT. The full details and results of beta testing are included in Appendix I.

Testers answered a questionnaire at the end of testing. Three of the questions asked users how satisfied they were with the ease of use, usefulness of content, and navigation. The results are generally positive and are illustrated in Figures 2.5 through 2.7.

The other questions were open-ended and asked for various feedback. Table 2.8 summarizes the responses per question.

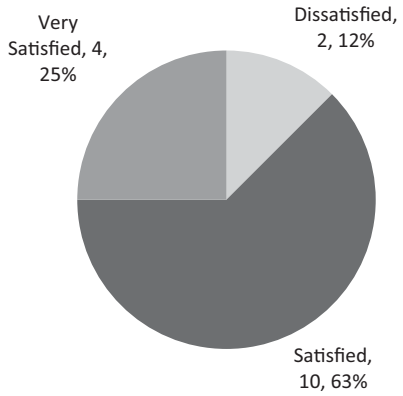


Figure 2.5. Ease of Use question results.

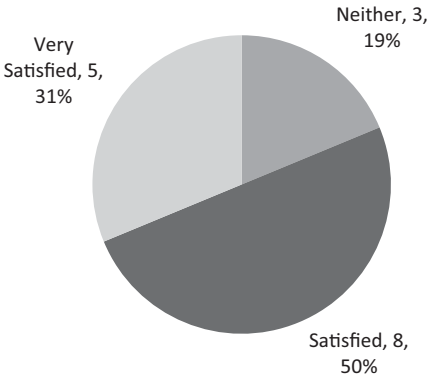


Figure 2.6. Usefulness of Content question results.

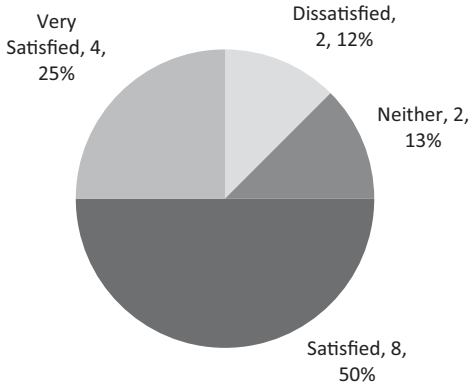


Figure 2.7. Navigation question results.

2.6 Task 7. Midcourse Briefing

Before the release of the beta version of Eco-Plan and Eco-Plan Advanced, the research team participated in a midcourse briefing hosted by TRB in Washington, D.C. Other participants included FHWA, AASHTO, the Council on Environmental Quality (CEQ), the committee of experts overseeing this project, resource agencies, the pilot-test teams, and private GIS

Table 2.8. Summary of Responses to Test Questionnaire

Eco-Plan	Count
Relevancy of the theme maps to your transportation planning	
Relevant	11
Already use the data	1
Too coarse	1
Relevant but some issues	1
Confusing content or terms	
Yes	5
No	6
Initially confusing	1
What do you like most?	
Information and Data	6
Ease/Simplicity	4
Getting Started	3
Maps	2
Speed	1
Design	1
What do you NOT like?	
Theme maps	2
Map legend	1
Map search not working	1
Map gallery	1
Navigation	1
Additional content or function you want	
Different data	4
Add maps to ArcDesktop	1
More layers	1
Keep location across pages	1
Geoprocessing tools	1
Dynamic legend	1
Full-screen maps	1
How would you use this site?	
Preliminary scoping	6
Data	2
Overview for nontechnical audience	2
Won't use	1
Eco-Plan Advanced	1

Eco-Plan Advanced	Count
What functions do you like most?	
Interact with maps and add data	7
Save own maps	3
Add own data	3
Data	3
Speed	2
Basemaps	1
Ease of analysis	1
What additional functions would you like to have?	
Link accounts	1
Sketch or draw	1
Export layers	1
Additional symbology	1
Attribute tables	1
Default to my location	1
Create communities	1
How would you use Eco-Plan Advanced web application in your planning efforts?	
Share maps	3
Create maps	2
Upload data	2
Develop LRTP	2
Find areas of concern	1
Basic corridor planning	1
Browse layers	1
Are the differences between Eco-Plan and Eco-Plan Advanced clear to you?	
Yes	14
No	0
Maybe	1

providers. The purpose of the briefing was to share results and the planned direction for Eco-Plan and discuss implementation scenarios. The event was used to inform Task 4 and will inform ongoing discussions about implementation of Eco-Plan and Eco-Plan Advanced.

2.7 Task 8. Final Version

After beta testing, the team executed three additional development sprints. The final version of Eco-Plan included the

- Intersection tool
- Intersection API
- Other Tools section
- About page
- Help page
- Map updates
- Usability enhancements included accordion styling on Get Started, additional clarifying text through the site, and additional links

Task 8 was the final development task of the project. The project did not include hosting a live, production version of the site. TRB and FHWA are investigating future ownership and hosting issues. Based on feedback during testing and the final state of functionality, the future owner may want to consider the following enhancements:

- Customize the default pop-up windows for each data layer. Most of the federal data layers publish the raw data, along with the original field labels. Most of the field labels and data are not clear and could be updated with more meaningful labels in the pop-up windows.
- Customize the symbology (symbols, colors, shapes), if possible. Many of the federal data sets do not allow the user to update the symbology. During user testing, many users complained that the symbology chosen by the data source did not look good or was confusing. For the few data sets that could be updated, the symbology should be changed to be more appealing and useful.
- Update the Data section to include interactive maps, instead of just the detailed information on the data set. This section was intended to be a resource for experienced GIS users to find information on authoritative sources of data, but many users wanted to be able to explore the data in a map right on the page.
- Determine a way to size the maps to full screen while still being responsive on mobile devices.
- Update the prototype intersection tool with additional data sets and coverage across all 50 states. During the project, the prototype intersection tool was only loaded with three major data sets (critical habitats, protected areas, wetlands) for seven states to conserve disk space during the interim hosting period. ICF estimates that 160 GB will be required to store data for all 50 states for the three data sets. The majority of the disk space required was for the wetlands data. Of the 22 GB used in the prototype, 98% of the space was for wetlands. Additional space will be required to load other data sets.

2.8 Task 9. Final Documentation and User Guide

The final task was to deliver this final report as documentation of the methods used to develop Eco-Plan and Eco-Plan Advanced and as help to transportation practitioners wishing to use these tools. The next chapter of this report serves as a quick-start guide. Further help can be found by accessing the tool.

CHAPTER 3

Using Eco-Plan and Eco-Plan Advanced

Use this chapter as a quick-start guide for Eco-Plan and Eco-Plan Advanced. Brief descriptions of the purposes of and differences between Eco-Plan and Eco-Plan Advanced are provided, along with instructions for accessing, navigating, and getting started with both tools.

3.1 Quick-Start Guide to Eco-Plan

Eco-Plan is a central resource for current, national geospatial data that can be used to identify and avoid conflicts between ecological assets and transportation plans before the process of complying with the National Environmental Policy Act (NEPA) begins. Eco-Plan supports transportation planning by providing prepared maps of national ecological data sets that can be used to avoid and minimize transportation impacts. Use Eco-Plan to

- Review maps of national ecological data sets.
- Find data and other useful geographic information system (GIS) information.
- Upload or draw a planning area or transportation network.
- Explore conservation priorities as a novice user without GIS skills.

Eco-Plan was designed for state and local transportation planners who need access to geospatial environmental and ecological data for transportation planning. It was designed for early project screening before NEPA.

Eco-Plan is well suited to support discussions and collaboration with nontechnical audiences since it easily displays map information. Eco-Plan can be used when trying to find relevant and authoritative national data sets and other tools to support transportation planning. Eco-Plan is not intended to replace detailed analyses using local or field-collected data.

3.1.1 Accessing and Navigating Eco-Plan

Access the beta version of Eco-Plan at http://c40-stage.icfwebservices.com/. The home page is shown in Figure 3.1.

On the home page:

1. Learn about the basic purpose of Eco-Plan and how it differs from Eco-Plan Advanced.
2. Access all features of Eco-Plan through the top navigation banner (Figure 3.2). The top navigation banner is accessible on all pages of Eco-Plan and is the best way to move from feature to feature.
3. Respond to three "calls to action": Use a Map, View Current Data, and Access GIS Systems (Figure 3.3). These calls to action correspond with "Maps," "Data," and "Other Tools" in the top navigation banner.

3.1.2 Eco-Plan Features

There are five main features in Eco-Plan, in addition to supporting help and information about the tool. Use this section to understand how to access and when to use each feature.

3.1.2.1 Get Started

Navigation: On any page, click "Get Started" in the top banner.
Description: This page provides an interactive view of several theme maps that can be quickly toggled. Using the map on the Get Started page (Figure 3.4), zoom in and out to find an area of interest. Use one click to move between theme maps showing protected areas, land cover, critical habitat and at-risk species, watersheds and wetlands, and density. A simple legend describes what is shown on each map.
When and how to use this feature: Get Started is for first-time Eco-Plan users.

1. Go to the page and allow all of the maps to load. The page loads seven maps with over 10 live data layers directly

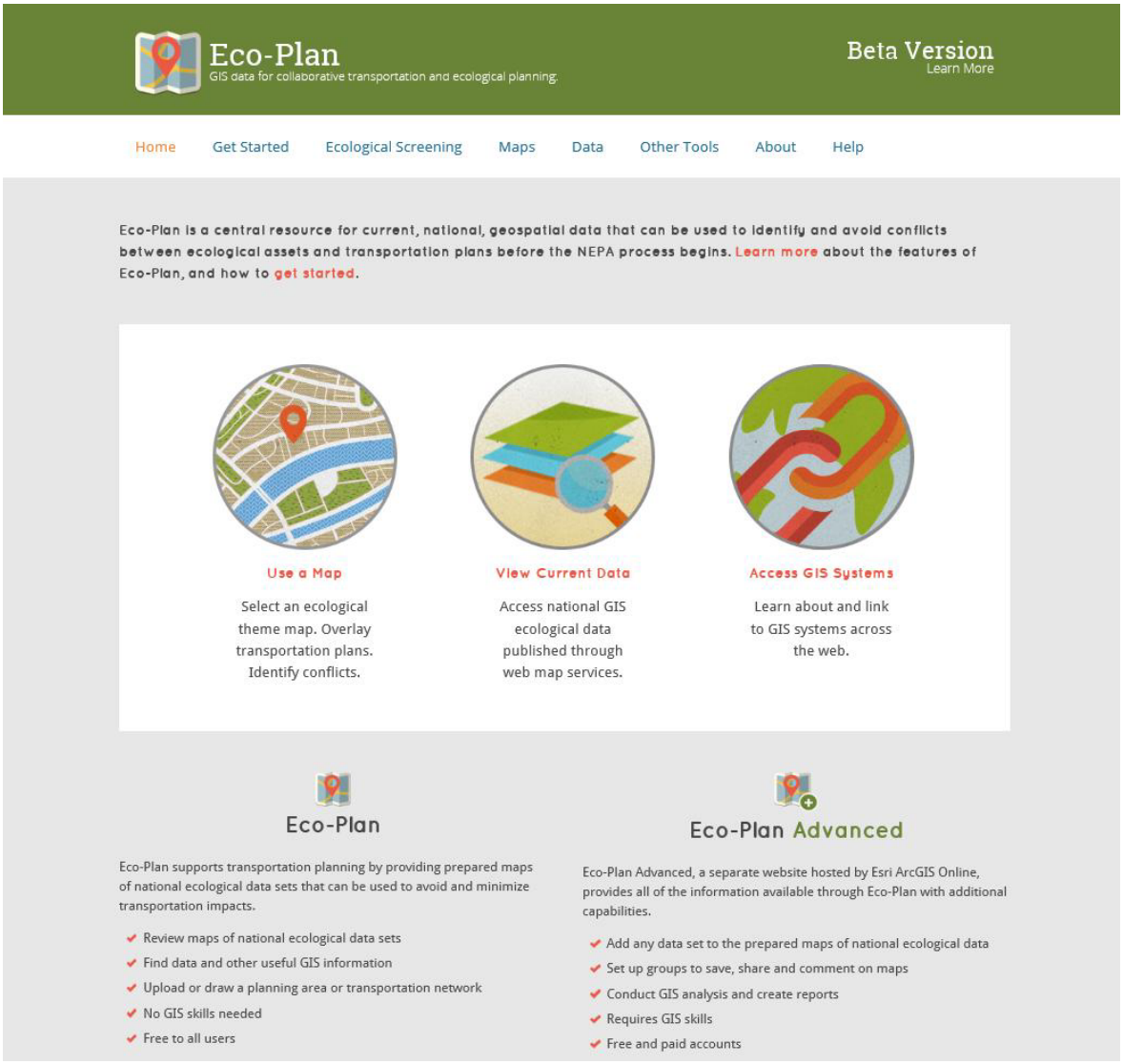


Figure 3.1. Eco-Plan home page.

from their federal sources. Some of the data layers may be slow to load. Once all seven maps have been loaded, the "7. Next steps" section of the map will appear.

2. Click the "1. Find your area" box and navigate to the area of interest by using the map zoom controls and dragging the map location. Or zoom far out and define a zoom-in box area by holding the Shift key while also pushing the left mouse button to draw a box outline from upper left to lower right. Use the streets map to understand the existing transportation network.
3. Click the "2. Review protected areas" box to see the exact same location with overlaying information about protected areas. Click the "Legend" box to show or hide the map legend.
4. Click the "3. Explore land cover" box to investigate land use planning for a habitat type.

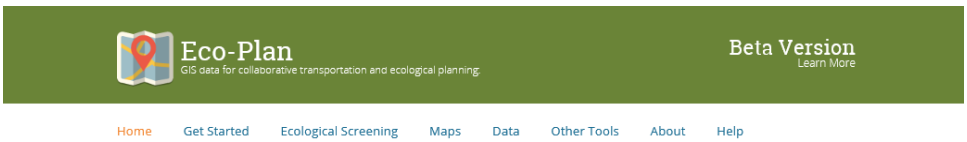


Figure 3.2. Eco-Plan top navigation banner.

Figure 3.3. Eco-Plan calls to action.

5. Click the "4. Identify Critical habitat and species at risk" box to view possible critical habitat locations and concentrations of species at risk.
6. Click the "5. View Watershed and wetlands maps" box to see wetlands, watershed boundaries, water monitoring locations, and shoreline in the United States.
7. Click the "6. Review the potential for development in unprotected areas" box to help visualize where environmental resources may be at risk due to activity density.
8. Click the "7. Next steps" box to view satellite imagery of the given area and find links to the detailed maps.

3.1.2.2 Ecological Screening

Navigation: On any page, click "Ecological Screening" in the top banner.
Description: Ecological Screening (Figure 3.5) is a prototype tool. Draw a shape on the map and find information about wetlands, critical habitats, and protected areas within that shape. Data are currently only available for a subset of states. More states and data sets will be added over time.

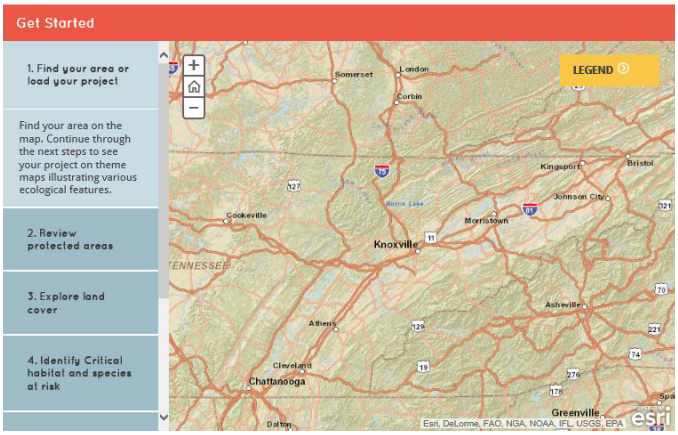


Figure 3.4. Get Started image on Eco-Plan.

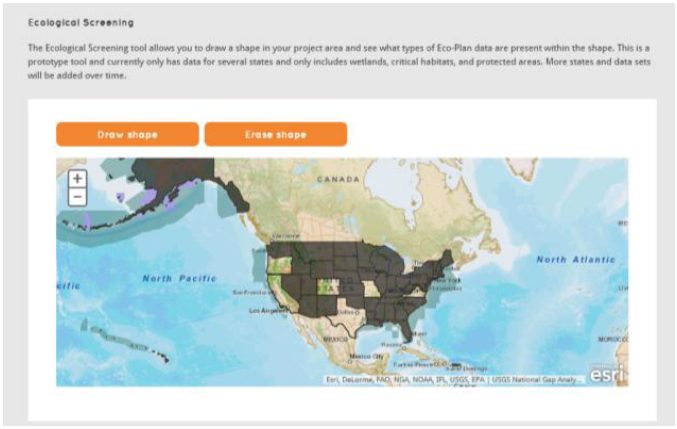


Figure 3.5. Ecological Screening image on Eco-Plan.

When and how to use this feature: Use Ecological Screening during early transportation planning as a quick look at available national ecological data within an area of interest.

1. Find an area of interest on the map by clicking, dragging, and using the zoom in/zoom out (+/–) buttons.
2. If the area of interest is shaded grey, Ecological Screening is not yet available. If the basemap is visible for the area of interest, click "Draw shape." Use the arrow to draw a shape on the map. Make a vertex with each mouse click. Double-click to complete the shape.
3. Available information about critical habitats, wetlands, and protected areas are displayed below the map. Note that if no information is provided, it only means data were not available and does not eliminate the possibility of the presence of critical habitats, wetlands, or protected areas.
4. Use the computer's "Print Screen" information to save the analysis.
5. Click the "Erase Shape" button prior to drawing a new shape.

3.1.2.3 Maps

Navigation: On any page, click "Maps" in the top banner.
Description: Maps (Figure 3.6) is a gallery of prepared theme maps combining useful sets of national map services published by authoritative data providers.
When and how to use this feature: Use these maps during early transportation planning as a quick look at available national ecological data sets within an area of interest. These maps provide access to more data sets than Ecological Screening, with national coverage, but do not provide a quantitative screening. Every map includes Summary, Description, How to Use the Map, User Tips, Things to be Aware of, Data Services, and a link to open the map in Eco-Plan Advanced.

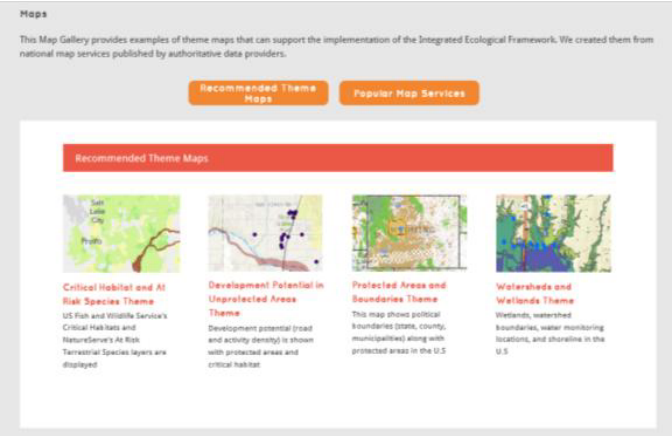


Figure 3.6. Maps image on Eco-Plan.

3.1.2.4 Data

Navigation: On any page, click "Data" in the top banner.
Description: Data (Figure 3.7) is a portal of authoritative, national, geospatial data sets that can support transportation planning. This portal only includes map services published by the data provider. This means that the data are current, but data not published through web map services are not available.
When and how to use this feature: Search for data, click a data set to view metadata, to learn how it can be used, and to open the data set in the provider's web map service. Access the data through Eco-Plan Advanced for functions like selecting multiple data sets to view on a map, adding state or local data, and conducting analysis.

3.1.2.5 Other Tools

Navigation: On any page, click "Other Tools" in the top banner.
Description: Other Tools (Figure 3.8) provides access to and descriptions of a range of other GIS tools that support integrated transportation and ecological planning.

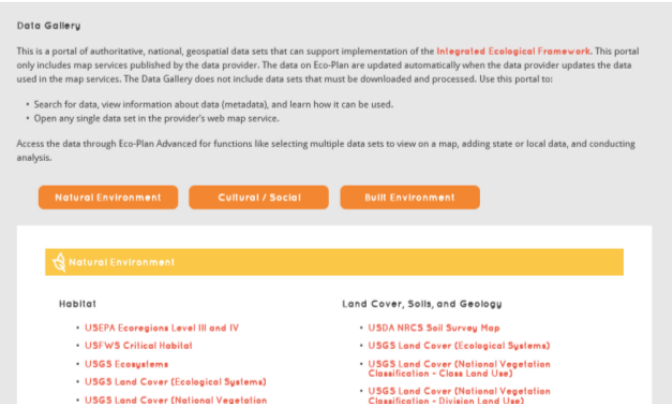


Figure 3.7. Data image on Eco-Plan.

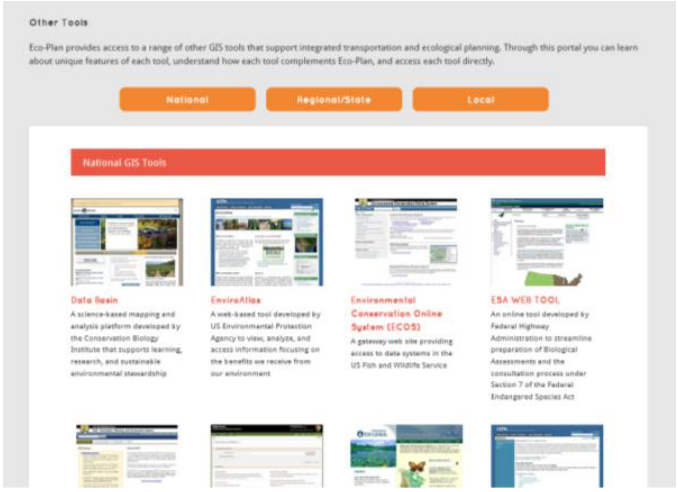


Figure 3.8. Other Tools image on Eco-Plan.

When and how to use this feature: Use this portal as a reference library to learn about unique features of available tools, understand how each tool complements Eco-Plan, and access each tool directly. Tools are grouped by their geographic coverage (National, Regional/State, and Local). Read highlights about each tool on the main page, or click an individual tool for detailed information like analytical functions and reports available, data types or data sets used, when to use the tool, things to be aware of, highlights, and accessing information.

3.2 Quick-Start Guide to Eco-Plan Advanced

Eco-Plan Advanced, a separate Esri ArcGIS Online organizational account, provides all of the information available through Eco-Plan with additional capabilities to

- Add any data set to the prepared maps of national ecological data.
- Set up groups to save, share, and comment on maps.
- Conduct GIS analysis and create reports.
- Perform detailed analysis as an experienced GIS user.

Eco-Plan Advanced is intended for GIS users experienced with adding layers to maps and modifying the display properties of map information.

3.2.1 Accessing Eco-Plan Advanced

Eco-Plan Advanced is an organization group of ArcGIS Online. It contains the data sets and maps used on the regular Eco-Plan site. To use the map editing features, you must sign up for an ArcGIS Online account. ArcGIS Online offers several pricing plans for new users, including a free plan. Existing

Esri customers may have AGO access already included with their current subscriptions. Contact your Esri representative for more information.

To create a free account, visit the ArcGIS sign-up page at https://www.arcgis.com/home/signin.html and click on the "Create a Public Account" link. Follow the form instructions to create your new account.

3.2.2 Eco-Plan Advanced Features

Eco-Plan Advanced has many features; a few of them are documented here. More information can be found on the Eco-Plan Help page at http://c40-stage.icfwebservices.com/Help or on the AGO Help page at http://www.arcgis.com/home/support.html.

3.2.2.1 Copy and Update a Theme Map

After logging into ArcGIS Online:

1. Use the Search box in the upper left to search for the term "ecoplan theme."
2. In the resulting list of theme maps, click the desired theme map to open it in the web map viewer.
3. In the map viewer, click the "Save|Save As" link in the top header menu to save a copy of the map to your local account.
4. Customize the map by showing/hiding layers, adding new data, or annotating the map as described below.

3.2.2.2 Create My Own Map

After logging into ArcGIS Online:

1. Click the "Map" link in the top header menu, and the typical map viewer will be displayed.
2. Click the "Save" link in the top header menu to save the map to your account. Note: ArcGIS does not automatically save your work, so be sure to save the map frequently as you customize it.
3. To add layers to the map:
   a. Click the "Add" link in the upper right.
   b. Click the "Search for Layers" link.
   c. Uncheck the "Within map area" check box if you want to find data that might not be in your current viewable area.
   d. Add search terms (like "population") in the "Find" box.
   e. Click the "Go" button.
   f. Click the "Add" link on any resulting layers that you want to add to your map. Note: Some layers may take a while to load onto the map.
4. To show/hide data layers on the map:
   a. Click the "Details" link in the upper right.
   b. Click the "Contents" link.
   c. Check/uncheck the data layers to show/hide data layers.
5. To format editable layers:
   a. Click the "Details" link in the upper right.
   b. Click the "Contents" link.
   c. Hover your mouse over the data layer to format, and click the drop-down arrow that appears.
   d. Select "Transparency" to increase the transparency (25%–30% is usually good) to a value that allows underlying data to be seen through the layer.
   e. Select "Set Visibility Range" to determine the zoom levels at which the data layer will appear. Data sets with lots of individual points often look better when only visible at levels below "County."
   f. Select "Configure Pop-up" to customize the layout, labels, and field data displayed on the Pop-up window.
   g. Select "Change Symbols" to change the color, size, and symbols used in the data layer.

3.2.2.3 Load My Own Data onto a Map

After logging into ArcGIS Online:

1. Click the "Add" link in the upper right.
2. Click the "Add Layer from File" link.
3. Follow the instructions to load your zipped shapefile (.zip) onto the map. A shapefile is a common GIS vector storage format that stores spatial data and associated attributes in the form of "points," "lines," or "polygons." Note: There may be restrictions like the file size (10 MB) or number of features (1,000) on the file upload.

CHAPTER 4

Conclusions and Insights for the Future

When the project was completed, ICF participated in both a conference presentation at the 2014 GIS for Transportation (GIS-T) conference in Burlington, Vermont, and a SHRP 2 Tuesday webinar on Eco-Plan. Considering the results of the project and the feedback received at those two events, ICF has drawn the following conclusions:

- *There is a wealth of existing GIS data and tools, but they are hard to find.* Through research and discussions with the user group and beta test group, ICF has concluded that there are numerous federal data sets that would be useful to planners. However, GIS data and tools are owned and managed by various federal agencies without centralized management and are therefore difficult to find. Tools like Eco-Plan and the Environmental Protection Agency's (EPA's) new EnviroAtlas do help to consolidate references to many of the existing GIS web services.
- *Eco-Plan does meet many of the needs identified early in the project for smaller state departments of transportation (DOTs) and metropolitan planning organizations (MPOs).* At the first Technical Expert Task Group (TETG) review meeting, the group decided to primarily target smaller state DOTs and MPOs without significant in-house GIS resources. This decision informed the future design and functionality of Eco-Plan and resulted in a website that provides interactive maps, references to authoritative data sources, and links to supporting GIS tools.
- *Eco-Plan is easy to use and useful.* The beta test results show that over 75% of the users felt Eco-Plan was easy to use, useful, and navigable.
- *Local data are still key for in-depth analysis.* Users still prefer local data over national, federal data when available for detailed analysis. Users expressed concern at solely relying on national data given their high geographic scale, frequency of updates, and accuracy.
- *Architecture decision appears to be in line with the direction of many states.* The research team struggled with designing an architecture that met users' needs, would be accepted by state DOTs and MPOs, and did not place a large administrative or cost burden on the future system owner. After much analysis, the team designed an architecture built around ArcGIS Online (AGO). The decision to use AGO appears to be in line with the direction that many state DOTs, especially those in the growing AASHTO Technology Implementation Group (TIG) program, are taking to manage and publish GIS data.

To support full adoption of Eco-Plan, the following activities are suggested:

- *Continue the search for a final system owner.* FHWA has been investigating options for a final system owner. It would be desirable to find a viable system owner that uses a sustainable hosting model, which will allow Eco-Plan to grow and evolve.
- *Define the role of the future system owner.* The role of the future system owner needs to be defined and documented to set expectations. Ideally, the role would include more than just hosting the website. It would be best if the system owner could continually find new data sets and tools and update the website appropriately.
- *Finish the ecological screening tool prototype.* During the temporary hosting period of the research project, the ecological screening tool prototype was limited to six states and three main data sets to save disk space. The system owner may want to consider loading data for the remaining states.
- *Add more data sets to the ecological screening tool.* The ecological screening tool uses the critical habitats,

wetlands, and protected areas data sets. Eco-Plan would be enhanced if additional data sets were added to the tool to better inform users during initial project screening.

- *Add official state, regional, and local data sets.* The scope of the research project was to focus on national data sets. However, many official state, regional, and local data sets are currently used in transportation planning. Adding those to Eco-Plan is a viable option for the system owner to increase the website's value as an authoritative source for transportation planning data.
- *Implement some of the user-recommended changes.* The beta test group made several recommendations for changes. The future system may want to review these and implement the cost-effective changes.

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APPENDIX A

User Needs

This appendix lists user needs identified by the project team, pilot teams, and user group. They are grouped into major areas of functionality. An "X" in a cell in Tables A.1 through A.7 indicates the applicability of that need to the general type of user defined in the column headings.

Table A.1. Access the Tool

Need	Transportation Planner or Environmental Staff	Resource Agency	Conservation Organization	FHWA	System Owner	Reviewer Comment
100—Easily be aware (via email) of updates to the tool and the data the tool includes so that I can stay current with new features and data.	X	X	X	X		
101—Choose to opt-out of email notifications about tool updates.	X	X	X	X		User group indicated the ability to opt out is essential if e-mail updates are part of the tool.
102—Filter my areas of interest (geographical areas, topics, data sets) to screen email notifications.	X	X	X	X		
103—Access the site with a single click through an icon on my desktop.	X	X	X	X		
104—Access the DOT or MPO local version of the tool so that I can collaborate in transportation decisions.	X	X		X		User group expressed interest in the ability to control permissions for who can view data. Also see 201.

Table A.2. Import and Export My Data

Need	Transportation Planner or Environmental Staff	Resource Agency	Conservation Organization	FHWA	System Owner	Reviewer Comment
200—Import my GIS data so that I can see it in combination with other data sets.	X	X	X	X		
201—Control whether or not, and with whom, to share my uploaded GIS data, so that I can share data sets as needed, and restrict dissemination of sensitive data to an approved list.	X	X	X	X		
202—Access and import my current data so that I know transportation decisions consider the most up-to-date information about the resources I protect.	X	X	X			
203—Select and export data layers from the tool and save them as GIS files so that I can use them with my own tools.	X	X	X			User group expressed interest in being able to export data in a few file formats.

Table A.3. View Map Data

Need	Transportation Planner or Environmental Staff	Resource Agency	Conservation Organization	FHWA	System Owner	Reviewer Comment
300—Select my planning area so that I can restrict data I use to that area.	X	X	X	X		
301—Change my area of interest/planning area so that I can accommodate new information and decisions, and view information in different areas.	X	X	X	X		
302—Import GIS coordinates or draw approximate location of my project/planning area so that I can identify high priority conservation, preservation, and restoration areas inside or within a specified distance from my project/plan.	X	X	X			
303—See my planning area on the map so that I can make decisions based on my area.	X	X		X		
304—Have the ability to easily jump from one of my planning areas to another [the different areas that encompass the multiple projects or plans I am working on].	X	X	X	X		
305—Select data layers relevant to my planning area so that I can make informed decisions.	X	X		X		
306—Select data layers relevant to my area of interest so that I can see transportation projects planned near conservation, preservation, and restoration areas that my organization is concerned about.	X	X	X			

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Table A.3. View Map Data (continued)

Need	Transportation Planner or Environmental Staff	Resource Agency	Conservation Organization	FHWA	System Owner	Reviewer Comment
307—View map data, including transportation plans and projects that others have uploaded so that I can make decisions and approvals.	X	X		X		
308—Use a tool (such as a layer wizard) to identify starter data sets so that I can see data that is available and how it might help me with my project.	X	X	X			One user group member suggested presenting a typical problem and then providing data sets appropriate for that problem. This may cause a concern that users will not know that other data is available—need to let users know that this is a starting point. Maybe allow them to add more layers of their own? User group expressed interest in saving these starter data sets to the Planning Area, with or without additional layers added.
309—View information about projects in the vicinity of conservation, preservation, and restoration areas that my organization is concerned about so that I can see project information and project contact information.	X	X	X			
310—View information (metadata) about the data I select so that I can validate quality and currency.	X	X	X	X		
311—View information (metadata) about the data I select so that I can identify organizations that have contributed data and may have special interest in my planning area.	X			X		
312—Be able to see the site's progress processing data/information (i.e., through an hourglass or progress bar) so that I know it is working.	X	X	X	X		

Table A.4. Analyze Data

Need	Transportation Planner or Environmental Staff	Resource Agency	Conservation Organization	FHWA	System Owner	Reviewer Comment
400—Use the analytic capabilities in the tool so that I can identify high priority conservation, preservation, and restoration areas.	X	X	X			Features discussed with the user group were (1) being able to upload results from another tool into ours as a GIS layer, (2) other methods of analysis beyond data set intersections, (3) integrating with existing websites via APIs, and (4) exporting data for offline analysis outside our tool. Consensus was that all of those options sounded good, though we would need to work out which file formats would be allowed—some work may be required by the user offline.
401—Use the analytic capabilities in the tool so that I can identify a transportation corridor of least ecological impact.	X	X				
402—Use the analytic capabilities in the tool so that I can identify potential transportation projects in the vicinity of conservation, preservation, and restoration areas that my organization is concerned about.		X	X			
403—Use the intersection tool so that I can view the intersection of data sets for an area of interest that I define.	X	X	X			
404—Configure any analysis and weighting tools so that I can define my own ecological priorities.	X	X	X			
405—Use a well-developed API so that I can create or customize tools.	X	X	X			
406—Use a scripting language tool so that I can create or customize tools.	X	X	X			
407—Use a plug-in extension architecture so that I can add tools.	X	X	X			

Table A.5. Generate Reports

Need	Transportation Planner or Environmental Staff	Resource Agency	Conservation Organization	FHWA	System Owner	Reviewer Comment
500—See lists and sources of available important ecological data for my project area so that I can evaluate data gaps that I may need to fill or supplement.	X	X	X			
501—See information in the form of a report for my planning area so that I can compare impacts.	X	X		X		
502—Include intuitively organized tabular and graphic/mapped report outputs so that I can easily understand my data and analysis to generate reports.	X			X		
503—See information in the form of a report for my planning area so that I can make decisions and approvals.	X	X		X		

Table A.6. Save and Share Information

Need	Transportation Planner or Environmental Staff	Resource Agency	Conservation Organization	FHWA	System Owner	Reviewer Comment
600—Remember the last view of data so that it is displayed by default when I log back on.	X	X	X	X		
601—Allow me to save a view of my data with a specific name (“My GIS Reports”) so that I can easily see my previous analysis or previous projects on specific resources.	X	X	X	X		
602—Allow me to share a link of any of My GIS Reports so that I can easily share that information with others.	X	X	X	X		
603—Allow me to save my default view of data so that I can see my important data sets when I log on.	X	X	X	X		
604—Select whether data that I import should or should not be publicly available so that I can restrict access to confidential information.	X	X	X	X		
605—Allow me to define and manage groups so that I can share data with different groups of users.	X	X	X	X		
606—Have the ability to save multiple projects so that I can easily navigate among them in my portfolio.	X	X	X	X		
607—Have the ability to “Save As” so that I can to copy a project to start a new one.	X	X	X	X		
608—Allow me to see the dates my data sets were last updated.	X	X	X	X		

Table A.7. Manage User and Account Settings

Need	Transportation Planner or Environmental Staff	Resource Agency	Conservation Organization	FHWA	System Owner	Reviewer Comment
700—Reset my password on my own so I don't need to wait for anyone.	X	X	X	X		
701—Receive technical support when I need it so that using the tool does not slow down my work.	X	X	X	X		
702—Create user accounts so that people can access the tool with appropriate read/write access to the appropriate data.					X	
703—Update read/write access on existing user accounts so that appropriate access can be assigned if the user's role changes.					X	
704—Delete obsolete user accounts so that the system doesn't keep trying to send notifications to invalid email addresses and people who are no longer authorized cannot access the tool.					X	
705—Update user account information and reset passwords.					X	
706—Compose notifications to users to keep them informed about new features and system maintenance windows, including notification on the tool itself and by email for those users who have subscribed to notifications.					X	
707—View and respond to feedback on the tool entered by users via on-line feedback functions.					X	
708—View statistics on specific pages or functions in the tool to monitor how frequently it is being used.					X	
709—View system logs to assist with troubleshooting problems.					X	
710—Upload new GIS data sets to make sure the system is always up to date.					X	
711—Check data sets 30 days after upload to see whether metadata has been added, and delete data sets for which there is no metadata.						This would enforce the metadata requirement while not burdening people if the data is temporary use only, and give the users time to add metadata after the initial upload.

APPENDIX B

How Systems Address User Needs

One of the initial project tasks was to evaluate existing tools to determine how well they met the needs of the intended end users of Eco-Plan. Tables B.1 through B.7 of this appendix present those results. For each identified need, a numeric score indicates how well the tool meets the need. A two indicates that the tool meets the need. A one signifies that the need is partially met. When the need is not met, the table cell is blank. The scores were then added for each category and summarized in Table B.8.

The user needs are grouped into seven categories:

- Access the tool
- Import and export my data
- View map data
- Analyze data
- Generate reports
- Save and share information
- Manage user and account settings

Table B.1. Access the Tool

Need	UPlan	Data Basin	IPaC	NEPAssist	ESA Webtool	Reviewer Comment
100—Easily be aware (via email) of updates to the tool and the data the tool includes so that I can stay current with new features and data.	2	2		1	1	IPaC—no notifications found. NEPAssist—EPA News releases available by region, but not just for NEPAssist. ESA Webtool—"What's New" page and BA status report is available in public-facing portion of the site. Online file cabinet e-mail folder, calendar, and task status updates provide updates on project-specific updates.
101—Choose to opt-out of email notifications about tool updates.		2				
102—Filter my areas of interest (geographical areas, topics, data sets) to screen email notifications.						
103—Access the site with a single click through an icon on my desktop.	2	2	2	2	2	
104—Access the DOT or MPO local version of the tool so that I can collaborate in transportation decisions.	2					Only applies if a DOT or an MPO local version is available.
Total for this category	6	6	2	3	3	

Table B.2. Import and Export My Data

Need	UPlan	Data Basin	IPaC	NEPAssist	ESA Webtool	Reviewer Comment
200—Import my GIS data so that I can see it in combination with other data sets.	2	2				Assumes "GIS data" means data other than the project.
201—Control whether or not, and with whom, to share my uploaded GIS data, so that I can share data sets as needed, and restrict dissemination of sensitive data to an approved list.	2	2				
202—Access and import my current data so that I know transportation decisions consider the most up-to-date information about the resources I protect.	2	2				
203—Select and export data layers from the tool and save them as GIS files so that I can use them with my own tools.	2	2	1	1		Partial means that data could not be directly downloaded from this application, but it had a link to the source where it could be downloaded (i.e., IPaC data available through ECOS and NEPAssist through EnviroFacts).
Total for this category	8	8	1	1	0	

Table B.3. View Map Data

Need	UPlan	Data Basin	IPaC	NEPAssist	ESA Webtool	Reviewer Comment
300—Select my planning area so that I can restrict data I use to that area.	2	2	2	2	2	ESA Webtool—polygon drawn on maps to identify other biological assessments (BAs) completed within the project vicinity.
301—Change my area of interest/planning area so that I can accommodate new information and decisions, and view information in different areas.	2	2	2	2	2	
302—Import GIS coordinates or draw approximate location of my project/planning area so that I can identify high priority conservation, preservation, and restoration areas inside or within a specified distance from my project/plan.	2	2	2	2	2	NEPAssist—the user can also paste coordinates in the "Draw" box.
303—See my planning area on the map so that I can make decisions based on my area.	2	2	2	2	1	ESA Webtool—able to see other BAs completed within project vicinity and view documents from completed consultations.

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Table B.3. View Map Data (continued)

Need	UPlan	Data Basin	IPaC	NEPAssist	ESA Webtool	Reviewer Comment
304—Have the ability to easily jump from one of my planning areas to another [the different areas that encompass the multiple projects or plans I am working on].	1	1	1	1	1	All of the systems have map navigation tools that allow the user to move from one area of the map to another. Some have tools that allow the user to zoom to a selected feature of a layer. None have specific tools to jump from one transportation planning area to another.
305—Select data layers relevant to my planning area so that I can make informed decisions.	2	2	2	2		
306—Select data layers relevant to my area of interest so that I can see transportation projects planned near conservation, preservation, and restoration areas that my organization is concerned about.	2	2	2	2	1	ESA Webtool—able to limit search of ongoing and completed ESA consultations according to geography, covered species, or other keywords.
307—View map data, including transportation plans and projects that others have uploaded so that I can make decisions and approvals.	2	2				
308—Use a tool (such as a layer wizard) to identify starter data sets so that I can see data that is available and how it might help me with my project.	2	2	1	1		UPlan and Data Basin have search tools that help users find data sets of interest. IPaC and NEPAssist use a table of contents to help users identify available layers.
309—View information about projects in the vicinity of conservation, preservation, and restoration areas that my organization is concerned about so that I can see project information and project contact information.	2	2	1	1	2	Partial means I could see my project but not other projects.
310—View information (metadata) about the data I select so that I can validate quality and currency.	2	2	1	1	2	ESA Webtool—metadata on the ongoing and completed ESA consultations.
311—View information (metadata) about the data I select so that I can identify organizations that have contributed data and may have special interest in my planning area.	2	2		2		
312—Be able to see the site's progress processing data/information (i.e., through an hourglass or progress bar) so that I know it is working.	2	2	2	2		
Total for this category	25	25	18	20	13	

Table B.4. Analyze Data

Need	UPlan	Data Basin	IPaC	NEPAssist	ESA Webtool	Reviewer Comment
400—Use the analytic capabilities in the tool so that I can identify high priority conservation, preservation, and restoration areas.	2	2	1	2		A 2 assumes a tool is currently available in the system to support this need. IPaC—a tool that partially supports this need is available. NEPAssist (secure version) has an "Add remote service" button that allows users to add data from an existing service and use it in the analysis.
401—Use the analytic capabilities in the tool so that I can identify a transportation corridor of least ecological impact.	2	2	2	1		A 2 assumes a tool is currently available in the system to support this need. NEPAssist—a tool that partially supports this need is available.
402—Use the analytic capabilities in the tool so that I can identify potential transportation projects in the vicinity of conservation, preservation, and restoration areas that my organization is concerned about.	2	2		2		A 2 assumes a tool is currently available in the system to support this need.
403—Use the intersection tool so that I can view the intersection of data sets for an area of interest that I define.	2	2	2	2	2	
404—Configure any analysis and weighting tools so that I can define my own ecological priorities.						None of these systems have a weighting tool.
405—Use a well-developed API so that I can create or customize tools.	2	1	1	1	1	Partial indicator used when API is available for the GIS component, but none is explicitly documented for the rest of the site. All of the sites use standard web application development tools implying that some sort of API is available.
406—Use a scripting language tool so that I can create or customize tools.	2	1	1	1	1	Systems marked 1 do not appear to have a special scripting language tool built into the system. However, they probably all use some sort of web development tools.
407—Use a plug-in extension architecture so that I can add tools.	2	2	2	2	2	All of the tools appear to be built with expansion in mind.
Total for this category	14	12	9	11	6	

Table B.5. Generate Reports

Need	UPlan	Data Basin	IPaC	NEPAssist	ESA Webtool	Reviewer Comment
500—See lists and sources of available important ecological data for my project area so that I can evaluate data gaps that I may need to fill or supplement.	2	2	2	2	1	ESA Webtool—provides links to USFWS and NOAA endangered species web pages/information.
501—See information in the form of a report for my planning area so that I can compare impacts.	2	2	2	2		
502—Include intuitively organized tabular and graphic/mapped report outputs so that I can easily understand my data and analysis to generate reports.	2	2	2	2		
503—See information in the form of a report for my planning area so that I can make decisions and approvals.	2	2	2	2		
Total for this category	8	8	8	8	1	

Table B.6. Save and Share Information

Need	UPlan	Data Basin	IPaC	NEPAssist	ESA Webtool	Reviewer Comment
600—Remember the last view of data so that it is displayed by default when I log back on.						
601—Allow me to save a view of my data with a specific name ("My GIS Reports") so that I can easily see my previous analysis or previous projects on specific resources.	2	2		2	1	ESA Webtool—users can create an online file cabinet to manage ESA consultation process. Current/revised drafts of documents can be uploaded and shared with the project team within the file cabinet.
602—Allow me to share a link of any of My GIS Reports so that I can easily share that information with others.	2	2	1	2	1	Partial means that the reports can be saved and shared but not through a direct link on the system. ESA Webtool—file cabinet administrators can invite other users to the file cabinet to share information and collaborate on preparation and review of consultation document.
603—Allow me to save my default view of data so that I can see my important data sets when I log on.	2	2				
604—Select whether data that I import should or should not be publicly available so that I can restrict access to confidential information.	2	2			1	ESA Webtool—once a consultation is complete, the file cabinet administrator can choose which documents and information to be made available for public access when the project is archived.
605—Allow me to define and manage groups so that I can share data with different groups of users.	2	2			2	
606—Have the ability to save multiple projects so that I can easily navigate among them in my portfolio.	2	2		2	2	
607—Have the ability to "Save As" so that I can copy a project to start a new one.						
608—Allow me to see the dates my data sets were last updated.	2	2	2	2	2	All systems have metadata where this information is available.
Total for this category	14	14	3	8	9	

Table B.7. Manage User and Account Settings

Need	UPlan	Data Basin	IPaC	NEPAssist	ESA Webtool	Reviewer Comment
700—Reset my password on my own so I don't need to wait for anyone.	2	2			2	IPaC and NEPAssist—applies to public-facing versions, which do not have user accounts.
701—Receive technical support when I need it so that using the tool does not slow down my work.	2	2	2	2	2	"When I need it" interpreted to mean normal working hours, not 24/7.
702—Create user accounts so that people can access the tool with appropriate read/write access to the appropriate data.	2	2		2	2	IPaC—applies to public-facing versions, which do not have user accounts.
703—Update read/write access on existing user accounts so that appropriate access can be assigned if the user's role changes.	2	2		2	2	IPaC—applies to public-facing versions, which do not have user accounts.
704—Delete obsolete user accounts so that the system doesn't keep trying to send notifications to invalid email addresses and people who are no longer authorized cannot access the tool.	2	2		2	2	IPaC—applies to public-facing versions, which do not have user accounts.
705—Update user account information and reset passwords.	2	2		2	2	IPaC—applies to public-facing versions, which do not have user accounts.
706—Compose notifications to users to keep them informed about new features and system maintenance windows, including notification on the tool itself and by email for those users who have subscribed to notifications.	1	2			1	IPaC and NEPAssist—apply to public-facing versions, which do not have user accounts. ESA Webtool—"What's New" section is used to provide updates to users.
707—View and respond to feedback on the tool entered by users via on-line feedback functions.	2	2	2	2	1	ESA Webtool—direct contacts (e-mail, phone) for technical support and ESA consultation guidance provided.
708—View statistics on specific pages or functions in the tool to monitor how frequently it is being used.	?	?	?	?	?	?—none documented, but system manager could be using diagnostic tools.
709—View system logs to assist with troubleshooting problems.	?	?	?	?	?	?—none documented, but system manager could be using diagnostic tools.
710—Upload new GIS data sets to make sure the system is always up to date.	2	2	1	2	1	Partial means that the data owner makes new GIS data available and keeps it up to date, and the application accesses the current data through web services or central repository.
Total for this category	17	18	5	14	15	

Table B.8. Summary

Need	UPlan	Data Basin	IPaC	NEPAssist	ESA Webtool
Access the tool	6	6	2	3	3
Import and export my data	8	8	1	1	0
View map data	25	25	17	21	12
Analyze data	14	12	9	11	6
Generate reports	8	8	8	8	1
Save and share information	14	14	3	8	9
Manage user and account settings	17	18	5	14	15
Overall Total	92	91	45	66	46

APPENDIX C

Individual System Assessments

Alaska Department of Fish and Game (ADFG) Fish Resource Monitor

http://gis.sf.adfg.state.ak.us/FlexMaps/fishresourcemonitor.html?mode=awc

Overview

This mapping application presents information to the public to help them visualize core Sport Fish Division data on top of topographic maps and aerial photography. Map Layers include Anadromous Waters Catalog, Fish Passage (Culverts), and the Alaska Freshwater Fish Inventory (AFFI). Users may navigate the map to an area of interest and then click map features with the Identify tool, which will lead to more detailed information about the selected features. Figure C.1 presents a screenshot of ADFG Fish Resource Monitor.

System Configuration

- Esri ArcGIS Server via a Flex
- Flash Player 11.5.502.146
- Flex SDK 4.5.1.21328
- Server is gis.sf.adfg.state.ak.us

Interoperability and Standards

None documented on website.

Analytical Functions and Reports Available

Spatial query using the Identify button; provides details about a particular feature and in some cases links to photos and reports.

Data Loading and Downloading Tools

There are no tools for loading data. Data are published in a map service: gis.sf.adfg.state.ak.us.

Data Types or Data Sets Used

This map viewer publishes spatial data about Alaska fish resources, including

- Anadromous Waters Catalog (AWC)
- Fish Passage (Culverts)
- AFFI

Technical Support

Map Viewer Help available online.

Reference

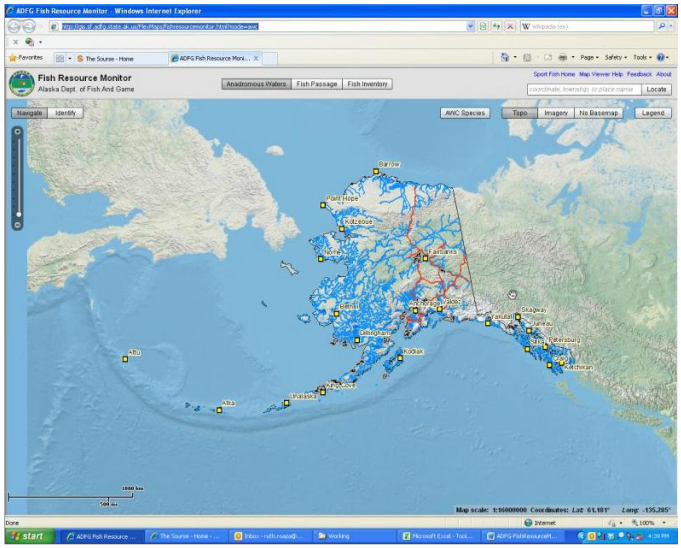
Alaska Department of Fish and Game (ADFG). Fish Resource Monitor. http://extra.sf.adfg.state.ak.us/FishResourceMonitor/. Accessed Dec. 20, 2013.

California Department of Fish and Wildlife Areas of Conservation Emphasis (ACE-II)

http://www.dfg.ca.gov/biogeodata/ace/

Overview

ACE-II project provides data to help guide and inform conservation priorities in California. Products of the ACE-II project include a set of tools for displaying biological and recreational data that can be used to identify areas of potential biological or conservation interest and may be useful during conservation prioritization. The data are available for viewing in an interactive, online ACE-II viewer. The viewer allows the ACE-II biological richness maps, ACE-II recreational demand and opportunities, stressors, protected status of lands, and connectivity and corridors to be overlaid. This viewer tool allows the user to display and contrast the arrangement and relative value of California's unique biological resources,



Source: http://gis.sf.adfg.state.ak.us/FlexMaps/fishresourcemonitor.html?mode=awc.

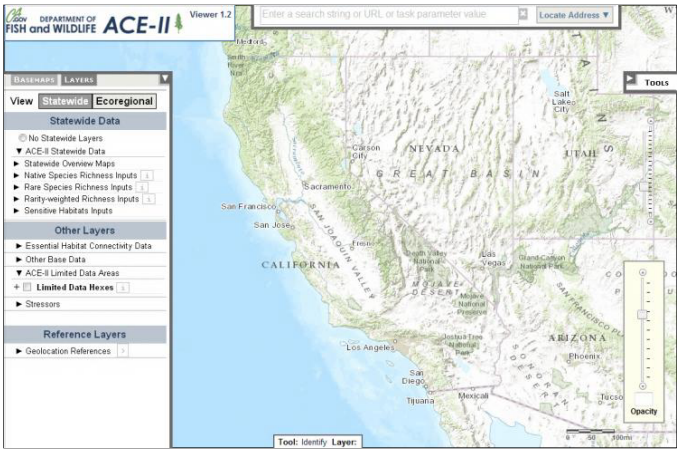
Figure C.1. Screenshot of ADFG Fish Resource Monitor.

providing a first step toward setting conservation priorities statewide. The viewer also provides a weighted-additive model interface that allows for custom calculation of a biological index using user-defined weights, which is a preliminary step in developing a flexible framework to address specific land acquisition or management questions.

The viewer is described as "beta" software, still under development and testing.

System Configuration

Figure C.2 presents a screenshot of Esri's Arc Internet Map Server and ArcGIS Server.



Source: http://www.dfg.ca.gov/biogeodata/ace/.

Figure C.2. Screenshot of Esri's ArcIMS and ArcGIS Server.

Interoperability and Standards

None.

Analytical Functions and Reports Available

- Spatial query by identify features.
- Spatial analysis: The weighted-additive model function allows users to apply their own weights to the ecoregional input layers and view the resulting maps in the viewer. (Further explained in the project report, available on the website.)

Data Loading and Downloading Tools

- All data are available upon request by contacting the Biogeographic Information and Observation System (BIOS) Coordinator.
- Data types or data sets used.
- Biological richness data include native richness and rarity layers developed for six taxonomical groups: birds, fish, amphibians, plants, mammals, and reptiles.
- Recreational data include harvest species richness, recreational access opportunities, hunting demand, and hunting use.
- Ecological Model results from an ecological analysis combining four biological richness indices, native species richness, rare species richness, rarity-weighted richness, and the presence of sensitive habitats, in a weighted-additive model to produce the ACE-II biological index surface. The model results show the areas of highest richness and rarity within each ecoregion of the state.

A listing of data layers is available here: http://www.dfg.ca.gov/biogeodata/ace/gisdata_ermodel.asp.

Technical Support

- ACE-II Project Report: detailed summary of the process and data sets developed
- Frequently Asked Questions (FAQs)
- ACE-II Uses and Limitations
- Biological Index Model Flow Chart
- ACE-II Interactive Viewer User Guide

Highlights

Weighted-additive model interface: A component of the ACE-II Interactive Viewer that allows the user to adjust the weights of the various layers and display a customized model result.

Reference

California Department of Fish and Wildlife. Areas of Conservation Emphasis (ACE-II). http://www.dfg.ca.gov/biogeodata/ace/. Accessed Dec. 20, 2013.

Conservation Biology Institute Data Basin

http://databasin.org/
136 SW Washington Avenue, Suite 202
Corvallis, OR 97333
info@consbio.org

Overview

A team of scientists, software engineers, and educators at the Conservation Biology Institute (CBI) built Data Basin with the strong conviction that our individual and collective ability can be expanded to develop sustainable solutions by empowering more people through access to spatial data, nontechnical tools, and collaborative networks.

The core of Data Basin is free and provides open access to thousands of scientifically grounded, biological, physical, and socioeconomic data sets. This user-friendly platform enables people with varying levels of technical expertise to

- Explore and organize data and information.
- Create custom visualizations, drawings, and analyses.
- Use collaborative tools in groups.
- Publish data sets, maps, and galleries.
- Develop decision-support and custom tools.

Figure C.3 presents a screenshot of Data Basin.

System Configuration

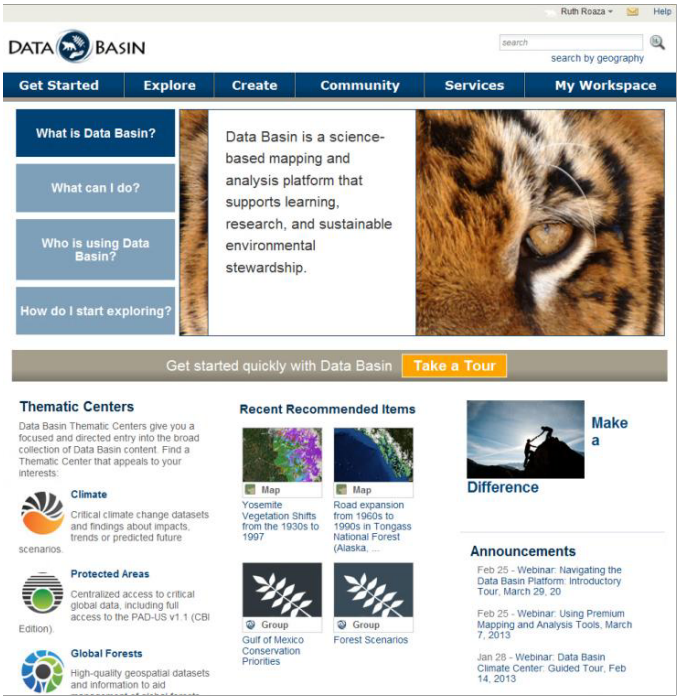
ArcGIS Server with customized map viewer using JAVA script application programming interface (API).

Interoperability and Standards

None apparent.

Analytical Functions and Reports Available

- Spatial query using the Identify tool.
- Buffer—takes a geometric shape (either a drawing or a set of selected data set features) along with a user-specified distance and creates a new drawing. This new drawing represents the original geometry surrounded by an area of the given distance.



Source: http://databasin.org

Figure C.3. Screenshot of Data Basin.

- The Project Impacts Calculator tool begins with a user-defined project location, which can be either a drawing or a selection. It then takes selected data sets and overlays them with the project location to determine where they intersect. The tool then generates a summary report showing the features in the data sets that intersect with the project location. From the summary report, the user can choose to generate a more detailed Portable Document Format (PDF) report, which will report details based on the attributes chosen from the data sets.
- Create Live View—export current map as PDF, Portable Network Graphics (PNG), or PowerPoint.

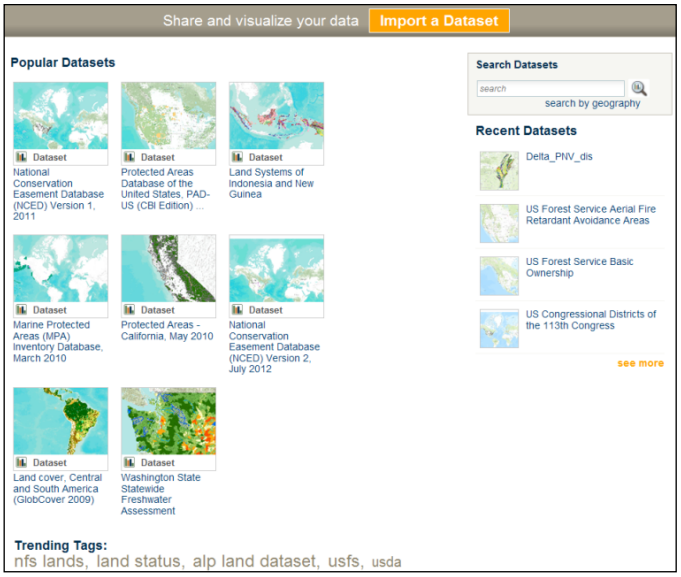
Data Loading and Downloading Tools

Figure C.4 presents a screenshot of the Import a Dataset tool.

Data download tool: Allows users to download zip file containing data set. Format varies by data set.

Data Types or Data Sets Used

Data Basin has 7,103 data sets. Data sets are member-uploaded spatial information, typically created using a geographic information system (GIS). They can be visualized and analyzed using mapping tools in Data Basin and downloaded for use in desktop GIS software. Data sets include shapefiles, ArcGRID files, Esri File Geodatabases, and network Common Data Form



Source: http://databasin.org/.

Figure C.4. Screenshot of the Import a Dataset tool (authorized users can import data sets).

(netCDF) files. Most data sets can be overlaid, styled, analyzed, and downloaded.

Technical Support

- Online help
- "Take a tour" feature
- Contact form to request assistance
- Videos and recorded webinars training and workshops available through CBI

Highlights

- Very user-friendly interface
- Analytical capabilities (Buffer tool and Project Impacts Calculator)
- Data search tools

Figure C.5 presents a screenshot of the choose analysis options in Data Basin.

Reference

Conservation Biology Institute (CBI). Data Basin. http://databasin.org/. Accessed Jan. 6, 2014.

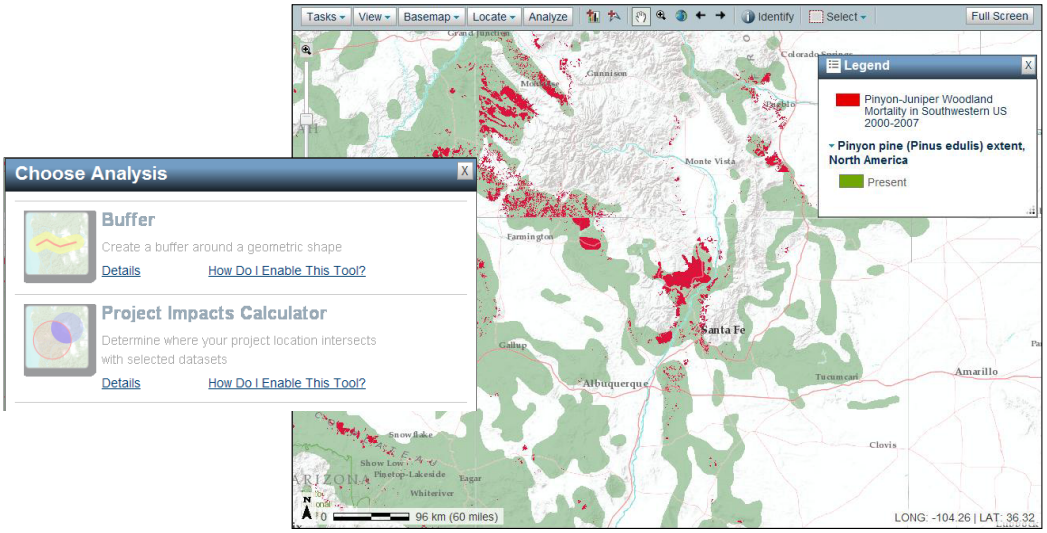
Environmental Conservation Online System (ECOS)

http://ecos.fws.gov/ecos/indexPublic.do

Help Desk
http://ecos.fws.gov/ecos/helpDeskPublicForm.do

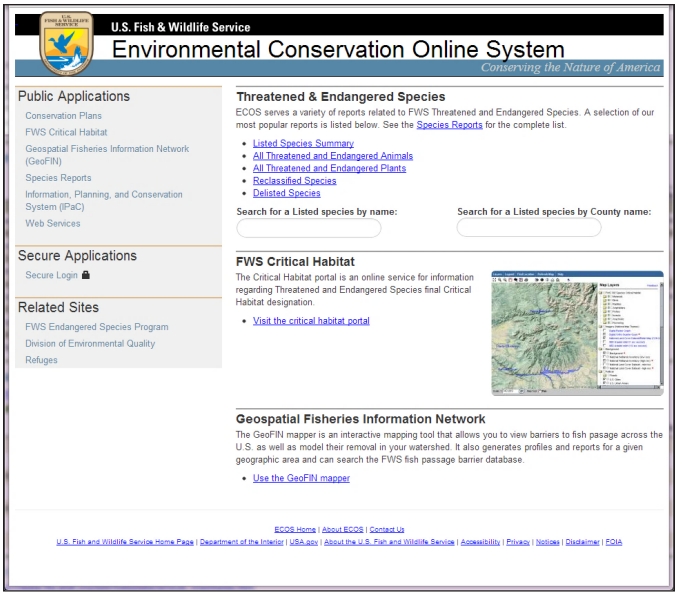
Overview

ECOS is a gateway website that provides access to information from numerous U.S. Fish and Wildlife Service (USFWS) databases. ECOS allows users to view and search data related to environmental conservation, such as threatened and endangered species; critical habitat for threatened and endangered species; fisheries and fish passages; and conservation plans and agreements. ECOS provides ways to visualize most information geospatially, through both online mappers and a suite of web services.



Source: http://databasin.org/.

Figure C.5. Screenshot of Analysis options in Data Basin.



Source: http://ecos.fws.gov/ecos/about.do.

Figure C.6. Screenshot of ECOS.

ECOS is capable of

- Single point access to multiple program data sets and information;
- Linking within and across programs according to the priorities of users; and
- Secure data entry and editing at the request of the data owner.

Figure C.6 presents a screenshot of ECOS.

System Configuration

- Web Pages
  - jQuery
  - Bootstrap
  - Adobe Shockwave Flash
- Map Viewers
  - Threatened and Endangered Species Profile
    - Esri ArcGIS Server REST viewer
  - FWS Critical Habitat Online Mapper
    - Esri ArcGIS Server FLEX viewer
  - Geospatial Fisheries Information Network (GeoFIN) Mapper
    - Esri ArcGIS Server FLEX viewer

Interoperability and Standards

ECOS Web Services

ECOS web services are available as both Open Geospatial Consortium (OGC) Web Mapping Services (WMS) and XQuery. All web services are offered free of charge and are available to those who may require ECOS data as a component of their own applications.

OGC WMS: Critical Habitat WMS

The Fish and Wildlife Service provides Critical Habitat data via an OGC WMS and Keyhole Markup Language (KML). The URLs for those services are

1. http://criticalhabitat.fws.gov/arcgis/services/crithab/usfwsCriticalHabitat/MapServer/WMSServer
2. http://criticalhabitat.fws.gov/arcgis/rest/services/crithab/usfwsCriticalHabitat/MapServer/kml/mapImage.kmz

For more information about Critical Habitat, visit the official USFWS Critical Habitat application at http://criticalhabitat.fws.gov/.

XQuery Web Services

ECOS offers the Threatened and Endangered Species System (TESS) Query (http://ecos.fws.gov/tat_services/TessQuery) web services via the extensible markup language (XML) Query Language XQuery (http://www.w3.org/TR/xquery/) to distribute Listed Species data to the public.

(Source: http://ecos.fws.gov/tat_services/)

Analytical Functions and Reports Available

- FWS Critical Habitat Mapper
  - Basic Identify, Drawing, and Measurement tools
- GeoFIN
  - Basic Identify, Drawing, and Measurement tools
  - Fish Passage Barrier Modeling
  - Highlights portions of waterway with projected impact from barrier
  - Area Profiles
  - Exportable to PDF
  - Report Components
    - Summary Data
      - Total Count of Fish Passage Barriers
      - Counts of Culverts, Dams, and Other Barriers
      - Stream Miles
      - Fish Passage Projects Completed
      - Barriers Removed
      - Stream Miles Opened to Fish Passage
      - Acres Opened to Fish Passage
    - Barriers, Species, and Fisheries Projects details tabs
  - Report by Area Type
    - Watershed
    - County

    - State
    - Congressional District
    - Landscape Conservation Cooperative
    - Army Corps of Engineers
    - Tribal Lands
    - FWS Regions

Data Loading

None found.

Downloading Tools

- Conservation Plans
  - Individual Plans
  - Regional (Summary) Report
- Species Reports (source: http://ecos.fws.gov/tess_public/)
  - Export options for comma-separated values (CSV), Excel, XML, and PDF
  - Search Categories (see Appendix for entire list)
    - Listed Species
    - Petitioned, Proposed, Candidate, and Delisted Species
    - Miscellaneous
  - Search for a Listed species by name
  - Search for a Listed species by County name
- Species Profiles (via link from Species Reports)
  - Bookmark or Print only—no export options
  - Profile Components
    - Species Classification/Taxonomy and Photo
    - General Information
    - Interactive Map of Species Occurrence
      - Pan, Zoom, Identify, Imagery/Streets/Topo
    - *Federal Register*
    - Recovery Plan Information
    - Critical Habitat
    - Conservation Plans
    - Petitions
    - Life History
    - Other Resources
      - NatureServe Explorer Species Reports
      - Integrated Taxonomic Information System (ITIS)
  - FWS Critical Habitat Portal
    - Zip file containing seamless composite layer and metadata for all species (download file: http://criticalhabitat.fws.gov/docs/crithab/crithab_all/crithab_all_layers.zip)
    - Zip file containing all individual shapefiles and metadata for submitted species (download file: http://criticalhabitat.fws.gov/docs/crithab/crithab_all/crithab_all_shapefiles.zip)
  - GeoFIN Mapper
    - Area Profiles exportable to PDF

Data Types or Data Sets Used

- Species Data
  - List of Taxonomic Groups in TESS: http://ecos.fws.gov/tess_public/html/db-group.html
- Critical Habitat
- Fish Passage Barriers Inventory
- Fisheries Facilities
- Hydrography and Wetlands
- Environmental Quality
- Land Use, Ownership, and Boundaries
- FISH Barrier Removal Projects
- USFWS Ecoregions, Regions, Refuges, and Landscape Conservation Cooperatives (LCCs)
- Reference Grids
- Political Boundaries

Technical Support

- ECOS Main
  - Help desk (see information above)
  - Information Search FAQ: http://www.fws.gov/endangered/esa-library/pdf/ROAR_FAQs%2008-05-09_FINAL.pdf
  - Embed TESS Data in Your Web Page Using XQuery: http://ecos.fws.gov/tat_services/TessQuery
  - Endangered Species glossary: http://ecos.fws.gov/tess_public/docs/glossary.pdf
- FWS Critical Habitat Mapper
  - User Help: http://criticalhabitat.fws.gov/html/map_help.html
- GeoFIN mapper
  - Overview of GeoFIN and National Fish Passage Program (NFPP)
  - Contact Web Form
  - Layer descriptions in tool tips

Highlights

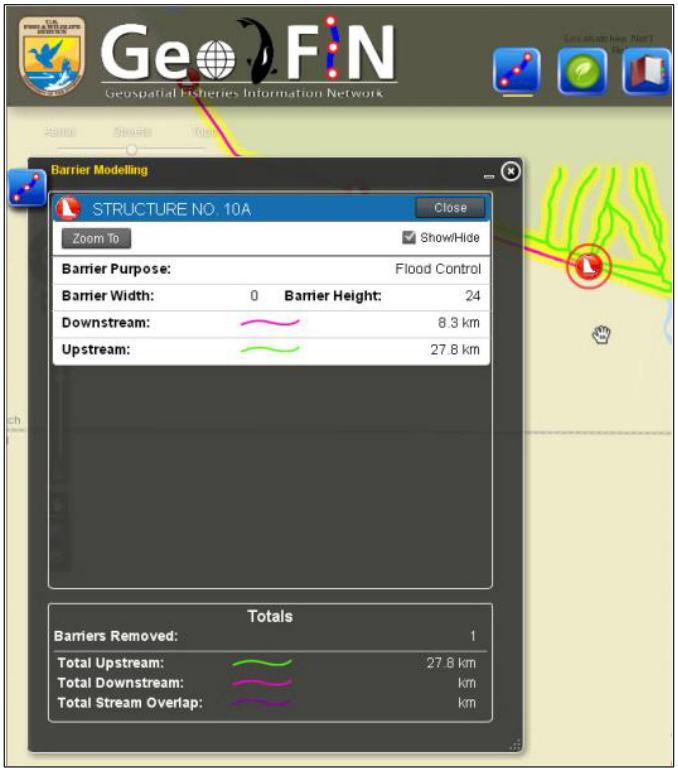
- Provides access to data from multiple program areas within the agency. Allows applications to dynamically pull information from these data sets.
- GeoFIN barrier modeling.
- GeoFIN Area Profile.

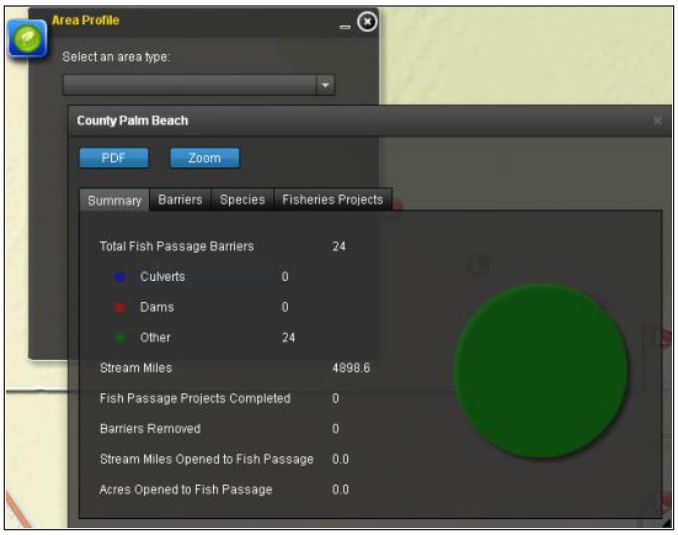
Figure C.7 presents screenshots of GeoFIN.

References

U.S. Fish and Wildlife Service. Critical Habitat Portal. http://ecos.fws.gov/crithab/. Accessed Jan. 6, 2014.

U.S. Fish and Wildlife Service. Endangered Species. Frequently Asked Questions. http://www.fws.gov/endangered/species/recovery-faq.html. Accessed Jan. 6, 2014.





Source: http://ecos.fws.gov/geofin/.

Figure C.7. Screenshots of GeoFIN.

U.S. Fish and Wildlife Service. Environmental Conservation Online System (ECOS). http://ecos.fws.gov/ecos/home.action. Accessed Jan. 6, 2014.

U.S. Fish and Wildlife Service. Environmental Conservation Online System (ECOS) Species Reports. http://ecos.fws.gov/tess_public/. Accessed Jan. 6, 2014.

U.S. Fish and Wildlife Service. Environmental Conservation Online System (ECOS) Web Services. http://ecos.fws.gov/tat_services/. Accessed Jan. 6, 2014.

U.S. Fish and Wildlife Service. Geospatial Fisheries Information Network. GeoFIN. http://ecos.fws.gov/geofin/. Accessed Jan. 6, 2014.

ESA Webtool

http://www.environment.fhwa.dot.gov/esawebtool/

Overview

The ESA (Endangered Species Act) Webtool is an online tool to streamline preparation of Biological Assessments (Bas) and the consultation process under Section 7 of the Federal ESA for projects where the FHWA is the lead federal action agency.

One of the tools provided by the site is an online file cabinet for BA documentation and collaboration. The Online File Cabinets provide a means for BA preparers to indicate the status of the BA, allowing FHWA to track the progress of submittals. Within the online file cabinet, the site also creates an inbox for storing e-mail communications and discussions between the project team, FHWA, and the services [USFWS and National Marine Fisheries Service (NMFS)]. Copying the file cabinet on e-mail communications provides a simple way to record key decisions, discussions, and agreements over the duration of the consultation.

Figure C.8 presents a screenshot of ESA Webtool.

System Configuration

ASP.Net, jQuery, Google Maps

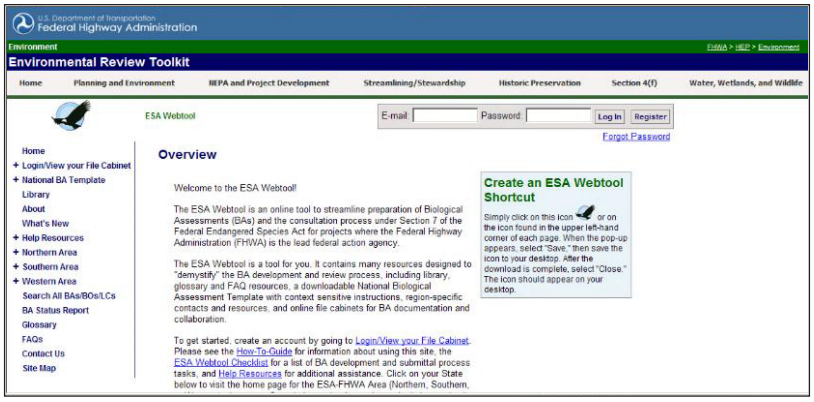
Interoperability and Standards

Not applicable.

Analytical Functions and Reports Available

This is an online file cabinet used for online collaboration and file exchange. Users are able to set up a file cabinet for each consultation, which creates a secure, project-specific workspace. The project manager is able to invite other users to access the file cabinet and assign roles, which have different levels of permission for accessing files in the file cabinet. For example, team members are able to view draft documents whereas agency reviewers are only able to view files in the "final" file drawer. After drawing a project on the map, an Information, Planning, and Conservation (IPaC) Species report is produced and filed in the project file cabinet.

The map interface and keyword search (accessible without a password) can be used to search active and archived consultations. Users are able to view archived consultations including the final BA and final decision from the services (Letter of Concurrence of Biological Opinion). For active consultations, the project name is displayed and project managers can select what other documents they would like to be available for viewing.



Source: http://www.environment.fhwa.dot.gov/esawebtool/.

Figure C.8. Screenshot of ESA Webtool.

Data Loading and Downloading Tools

- Upload and download project documents, pictures, and links that support the BA process using an online file cabinet.
- Draw project on a map.

Data Types or Data Sets Used

The file cabinet is designed to store documents (e.g., Microsoft Word or PDF files), pictures, and links. It retrieves species information from the USFWS IPaC system (described in separate system assessment).

Technical Support

Help resources available online include

- Templates and information about the ESA Section 7 consultation process and BA development.
- Online Library (http://www.environment.fhwa.dot.gov/ESAWebTool/Library.aspx), Glossary (http://www.environment.fhwa.dot.gov/ESAWebTool/Glossary.aspx), and FAQ (http://www.environment.fhwa.dot.gov/ESAWebTool/FAQs.aspx).
- Site How-To Guide (http://www.environment.fhwa.dot.gov/ESAWebTool/Site/HowTo.aspx).
- ESA Webtool Checklist (http://www.environment.fhwa.dot.gov/ESAWebTool/Site/checklist.aspx) for easy reference while working in a file cabinet.
- Search site content and project archives by accessing the site's Search (http://www.environment.fhwa.dot.gov/ESAWebTool/Site/FileCabinet/Search.aspx) feature.
- Contact Us (http://www.environment.fhwa.dot.gov/ESAWebTool/ContactUs.aspx) page to direct your questions or suggestions to improve the site.

Reference

Federal Highway Administration (FHWA), U.S. Department of Transportation. Environmental Review Toolkit. http://www.environment.fhwa.dot.gov/esawebtool/. Accessed Jan. 6, 2014.

FWS Lands Mapper

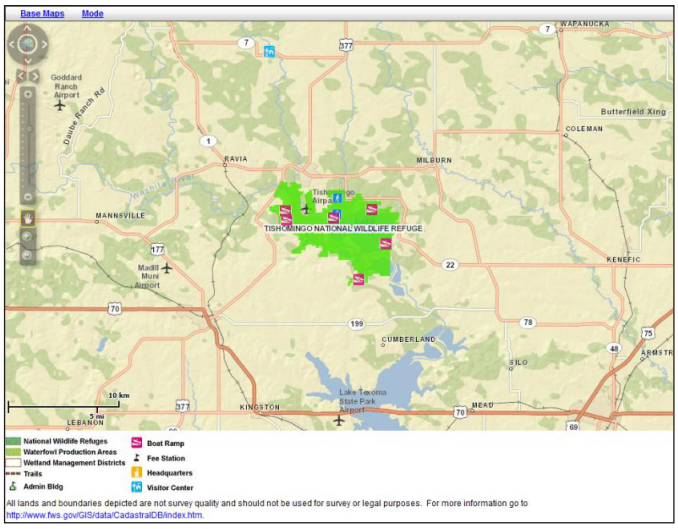
http://gis.fws.gov/FWSLands_Mapper_Lite/

Overview

Figure C.9 presents a screenshot of FWS Lands Mapper Lite.

FWS Lands Mapper Lite is a mapping application overlaying USFWS cadastral land data. These data sets depict the USFWS approved acquisition boundaries and USFWS managed lands (National Wildlife Refuge and Hatchery Boundaries).

This website is a simple viewer of what is contained in the public map service.



Source: http://gis.fws.gov/FWSLands_Mapper_Lite/.

Figure C.9. Screenshot of FWS Lands Mapper Lite.

System Configuration

Esri ArcGIS Server via Flex viewer (ArcGIS API for Flex Version 2.2).

Interoperability and Standards

USFWS Cadastral Data are also available through an OGC WMS at the following URL: http://gis.fws.gov/ArcGIS/rest/services/FWSCadastral_Internet/MapServer.

Analytical Functions and Reports Available

Mapper application includes an i-Identify tool that allows you to identify the name and region of FWS lands included in the map.

Data Loading and Downloading Tools

See the section on interoperability and standards. Data can be accessed directly through the mapping service.

Data Types or Data Sets Used

- National Wildlife Refuges (>3 million)
- Wetland Management Districts
- National Wildlife Refuges (<3 million)
- Waterfowl Production Areas (<3 million)

Technical Support

http://www.fws.gov/GIS/data/CadastralDB/index.htm
http://www.fws.gov/GIS/index.html

References

U.S. Fish and Wildlife Service. Branch of Data and System Services. FWS Lands Mapper Lite. http://gis.fws.gov/FWSLands_Mapper_Lite. Accessed Jan. 6, 2014.

U.S. Fish and Wildlife Service. Geospatial Services. National Cadastral Data. http://www.fws.gov/GIS/data/CadastralDB/index.htm. Accessed Jan. 6, 2014.

U.S. Fish and Wildlife Service. OGC. WMS. http://gis.fws.gov/ArcGIS/rest/services/FWSCadastral_Internet/MapServer. Accessed Jan. 6, 2014.

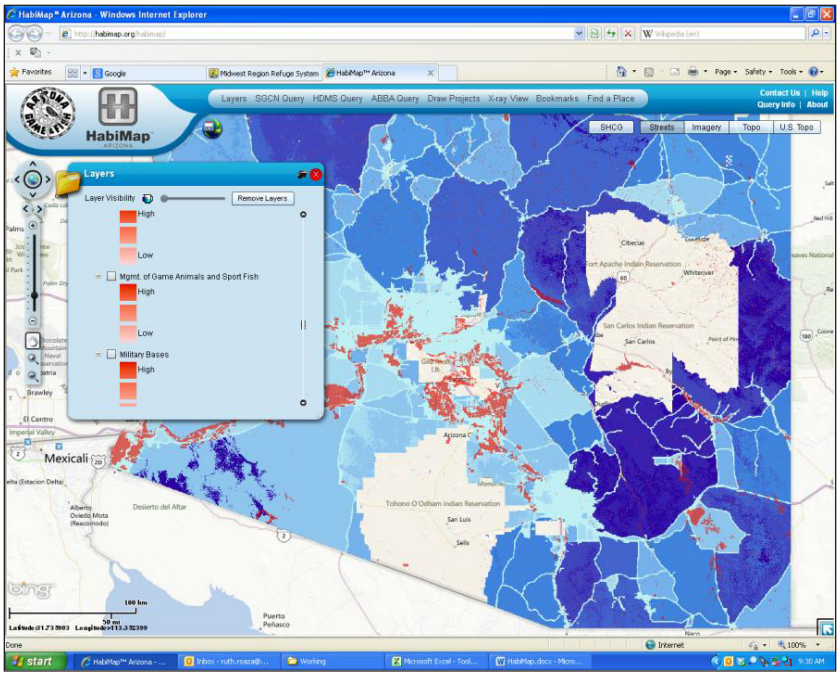
HabiMap™ Arizona

http://habimap.org/habimap/
webgis@azgfd.gov

Overview

HabiMap Arizona is an interactive map viewer intended to provide useful, landscape-level information during the early stages of project planning.

Figure C.10 presents a screenshot of HabiMap.



Source: http://habimap.org/habimap/.

Figure C.10. Screenshot of HabiMap.

System Configuration

The application uses ArcGIS API for Flex Version 2.4.

Interoperability and Standards

None.

Analytical Functions and Reports Available

- Query an area for Species of Greatest Conservation Need.
- Query an area for Special Status Species.
- Query an area for breeding bird species.

Data Loading and Downloading Tools

Users may query and download species lists in CSV or text format.

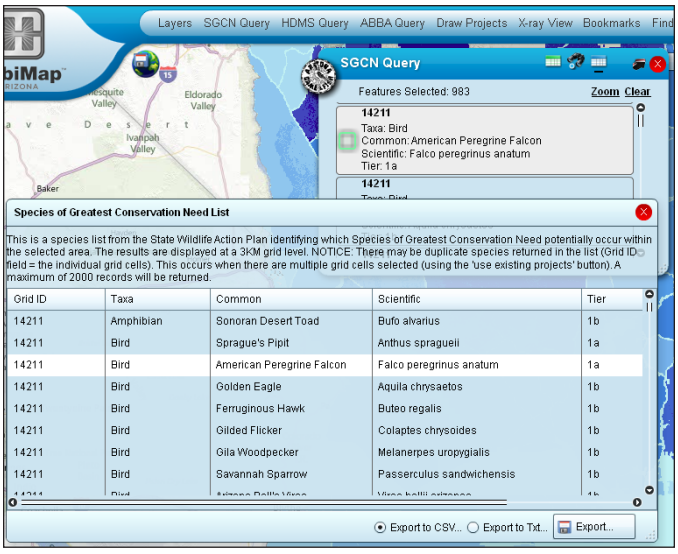
Data Types or Data Sets Used

The application displays a variety of wildlife habitat, distribution, and stressors information for the state of Arizona. See the layers list in the application for specific data sets.

Technical Support

- Videos
- Online help documentation
- Contact information (e-mail)

Figure C.11 presents a screenshot of the HabiMap Query tool.



Source: http://habimap.org/habimap/.

Figure C.11. Screenshot of HabiMap Query tool.

Highlights

Query tools to report Species of Greatest Conservation Need, Special Status Species, and Arizona Breeding Bird Species. The data listings may be exported to a spreadsheet.

Reference

HabiMap Arizona. http://habimap.org/habimap/. Accessed Jan. 6, 2014.

Habitat and Population Evaluation Team (HAPET)

http://www.fws.gov/midwest/hapet/

Overview

The USFWS HAPET provides biological support to USFWS Wetland Management Districts, National Wildlife Refuges, partners, and various conservation agencies and organizations in the Prairie Pothole portion of Minnesota and Iowa.

HAPET biologists develop biological models and apply them to spatial data using GIS technology. They use these models for strategic planning at regional scales to guide the delivery of conservation by management partners.

System Configuration

N/A

Interoperability and Standards

Nothing on the website indicates that the models developed by HAPET are available for use by other applications. The HAPET website publishes reports and maps developed by the team biologists using GIS.

Analytical Functions and Reports Available

HAPET biologists develop regional biological models and GIS data products to support strategic planning. Several reports and map products are available as a result of their research. These are listed on their website (http://www.fws.gov/midwest/hapet/StrategicMgmtAndMapping.htm).

Data Loading and Downloading Tools

None.

Data Types or Data Sets Used

HAPET research focuses on wildlife species and habitat data.

Technical Support

N/A

Reference

U.S. Fish and Wildlife Service. Habitat and Population Evaluation Team (HAPET). http://www.fws.gov/midwest/hapet/. Accessed Dec. 20, 2013.

Information, Planning, and Conservation (IPaC) Decision-Support System

http://ecos.fws.gov/ipac/

ECOS Help Desk:
http://ecos.fws.gov/ecos/helpDeskPublicForm.do

Overview

IPaC is a conservation planning tool for streamlining the environmental review process. It is available through ECOS. IPaC provides the ability to explore the landscape and help to site projects in a way that minimizes conflicts with natural resources.

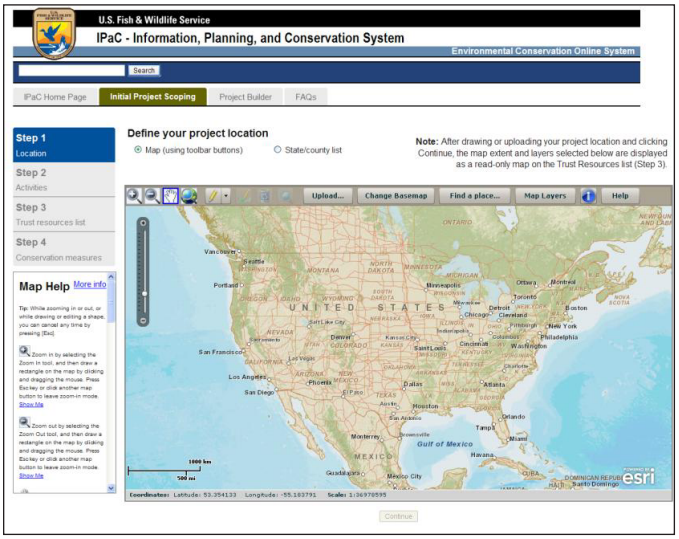
Figure C.12 presents a screenshot of IPaC.

System Configuration

ArcGIS API for Flex Version 2.5.

Interoperability and Standards

This appears to be using web services through ECOS.



Source: http://ecos.fws.gov/ipac/.

Figure C.12. Screenshot of IPaC.

Analytical Functions and Reports Available

- Spatial query (list features within the analysis boundary).
- Provides a report.

Data Loading and Downloading Tools

Upload a shapefile allows you to select an Esri shapefile from your computer's file system that defines the spatial boundary of your project location.

IPaC provides a preliminary USFWS species list, and in many locations across the United States, a USFWS Official Species list. Also available are links to species' life history information, the USFWS Migratory Bird program, Bald and Golden Eagle Protection Act information, and so forth. The report may be printed or saved as a PDF.

Data Types or Data Sets Used

IPaC's landscape explorer tool allows users to view wetlands, Gap Analysis Program (GAP) land cover, USFWS critical habitat, and other natural resource map layers. It provides lists of species and identifies resource conservation measures available in the project area.

Technical Support

User documentation available online.

Highlights

- Upload a shapefile of project location.
- Step-by-step interface.
- Provides report of species and additional information. Other applications can also query the report (see previous section on ESA Webtool).

Reference

U.S. Fish and Wildlife Service. Information, Planning, and Conservation System (IPaC). http://ecos.fws.gov/ipac/. Accessed Jan. 6, 2014.

Montana Fish, Wildlife & Parks Crucial Areas Planning System (CAPS)

http://fwp.mt.gov/gis/maps/caps

Overview

In 2008, Montana Fish, Wildlife & Parks (FWP) took the lead in conducting a Crucial Areas Assessment. The assessment evaluated the fish, wildlife, and recreational resources of Montana to identify crucial areas and fish and wildlife corridors. The result,

in part, is a web-based CAPS, a new FWP mapping service aimed at future planning for a variety of development and conservation purposes so fish, wildlife, and recreational resources can be considered earlier. (Source: CAPS User Guide).

Figure C.13 presents a screenshot of CAPS.

System Configuration

This tool appears to be using an Esri map viewer product, but the documentation provided online does not describe the software or hardware used. We will need to follow up to get more detailed system information. Looking at the website HTML source, references to the ArcGIS JavaScript API (Version 2.1) are noted.

Interoperability and Standards

- No apparent methods beyond direct user interaction with the interface for accessing the reporting, data delivery, or analytical functions of the tool.
- No functions to allow import or export of data.

Analytical Functions and Reports Available

The data sets themselves are analytical products. By querying the map, the user can learn more about the results of the crucial areas habitat assessment. The Identify tool returns detailed information about the active data layer at specific locations. The tool is located to the left of the layers name and appears when the layer is visible. When you click one of the Crucial Areas Habitat layers, it gives the FWP rating along with supporting documentation about how they arrived at that rating as well as FWP resource management objectives and recommendations.

Draw tools allow the user to draw points, polygons, and lines on the map. These appear to be for visual reference.

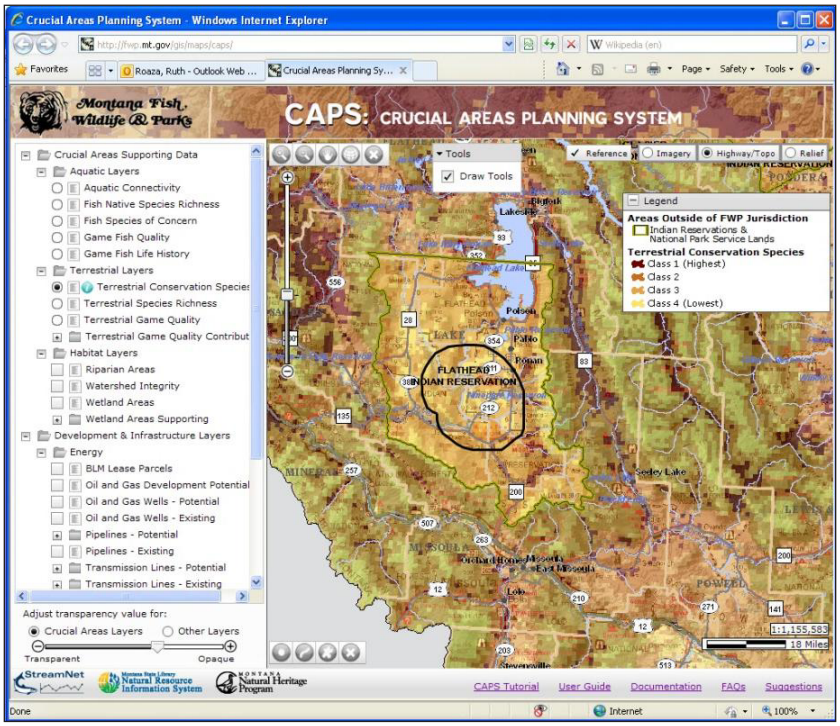
Lat/Long coordinates appear as the cursor moves over the map.

Data Loading and Downloading Tools

None.

Data Types or Data Sets Used

The map viewer provides overlays of data resulting from the FWP assessment. Each data layer was developed to address a specific value or concern related to fish and wildlife resources in Montana. Details about why each layer was made, and what data and methods were used to make the layer, are available at http://fwp.mt.gov/fishAndWildlife/conservationInAction/methodsSummary.html.



Source: http://fwp.mt.gov/gis/maps/caps.

Figure C.13. Screenshot of CAPS.

Technical Support

- CAPS tutorial available on the site
- Documentation
  - Data Layer Methodology
  - CAPS User Guide
  - Data Layer Methodology Summary
- Contact person listed on disclaimer that must be accepted to access the site.
- Tool tips appear when the user clicks on something or opens something new.

Highlights

The Identify tool does much more than a data record listing normally seen in map viewers. It provides additional information explaining the data.

Reference

Montana Fish, Wildlife & Parks. Crucial Areas Planning System (CAPS). CAPS. http://fwp.mt.gov/gis/maps/caps/. Accessed Jan. 6, 2014.

NatureServe Explorer

http://www.natureserve.org/explorer/
https://services.natureserve.org/index.jsp

Overview

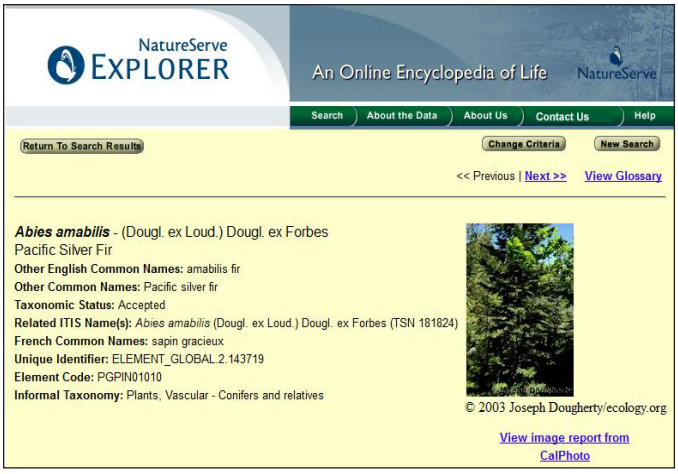
NatureServe Explorer is an authoritative source for information on more than 70,000 plants, animals, and ecosystems of the United States and Canada. Explorer includes in-depth coverage for rare and endangered species. It can be used to find

- Scientific and common names
- Conservation status
- Distribution maps
- Images of species
- Life histories and conservation needs

There is no interactive mapping component of this site; search and query are done by the attributes of the species and ecological communities tracked by the site.

In addition to the search and query tool, NatureServe offers web services, which enable the user to "create dynamic, customized Web applications that interact directly with NatureServe's biodiversity databases. Using Web Services, data users can

- Obtain near real-time access to the most recent biological inventories.
- Access and analyze data in [their] own applications, such as a GIS.
- Easily compare data developed across multiple states and provinces." (Source: https://services.natureserve.org/index.jsp)



Source: http://www.natureserve.org/explorer/.

Figure C.14. Screenshot of NatureServe Explorer.

Figure C.14 presents a screenshot of NatureServe Explorer.

System Configuration

Uses Representational State Transfer (REST)–style URLs and query strings.

Interoperability and Standards

NatureServe data are accessible via well-documented Web Services, described in Table C.1.

Analytical Functions and Reports Available

- Pseudospatial query by named U.S. state, Canadian province, U.S. county, and U.S. watershed. No interactive graphical (or other) method to input a more specific area of interest.
- Search by species name (scientific and common name)
- Search by ecological community.
- Detailed reporting of individual species, including ecology and life history, management summary, and population viability.
- Web services, described above.

Data Loading and Downloading Tools

None.

Data Types or Data Sets Used

Species and ecological communities, including conservation status, distribution (by state and province, some county level, but not more detailed than that), ecology and life history, population/occurrence, and references and citations.

Table C.1. NatureServe Data

Name	Type of Data	Version	Description
Global Comprehensive Species https://services.natureserve.org/BrowseServices/getSpeciesData/getSpeciesREST.jsp	Biological	1.1	NatureServe Explorer provides data on over 70,000 of the plant and animal species of the United States and Canada. The Global Comprehensive Species Service provides direct access to this species data in easy-to-manipulate XML format, ideal for further analysis.
Species Images https://services.natureserve.org/BrowseServices/getSpeciesData/getSpeciesImagesREST.jsp	Images	1.0	NatureServe Explorer provides access to a collection of species images. The Species Images Service provides direct access to the metadata for those images, including the URLs for the image files themselves. Searches may be conducted for a single species or by wildcarded scientific or common name. Since an image may be available at multiple resolutions, the service can be asked, for instance, for just the thumbnail version. The URLs for related versions at other resolutions are shown in the response.
Global Species List by Name https://services.natureserve.org/BrowseServices/getSpeciesData/getSpeciesListREST.jsp	Lookup	1.0	This service primarily enables the lookup of species Unique IDs (UIDs) by name. These UIDs are required for access to the more detailed services.

Source: https://services.natureserve.org/TechnicalResources/indexofservices.jsp.

Technical Support

Online help at http://www.natureserve.org/explorer/helptopics/index.htm.

Reference

NatureServe. NatureServe Explorer. http://www.natureserve.org/explorer/. Accessed Jan. 2, 2014.

NEPAssist

http://nepassisttool.epa.gov/nepassist/entry.aspx
nepassisthelp@epa.gov

Overview

NEPAssist is a tool that facilitates the environmental review process and project planning in relation to environmental considerations. The web-based application draws environmental data dynamically from EPA's GIS databases and web services and provides immediate screening of environmental assessment indicators for a user-defined area of interest. These features contribute to a streamlined review process that potentially raises important environmental issues at the earliest stages of project development.

Figure C.15 presents a screenshot of NEPAssist.

System Configuration

Web-based interactive mapping using Microsoft Virtual Earth, Microsoft Bing map background, served via an ASP.Net interface that incorporates Silverlight and jQuery technologies, running on IIS.

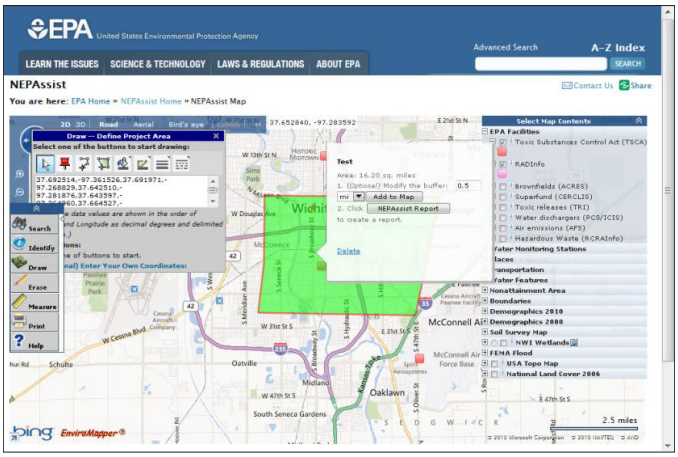
Interoperability and Standards

It appears (though more exploration is needed) that the analysis results can be returned from the site without going through the user interface directly—that a NEPAssist report can be generated by passing the boundaries (as a string of coordinates) to the report page. More investigation on the format of the request, and whether/which standards apply, is needed.

The Waterbody Report can be run by passing the unique ID of an impaired waterbody in the query string; for example: http://ofmpub.epa.gov/tmdl_waters10/attains_waterbody.control?p_list_id=TX-807&p_cycle=&p_report_type=T.

As noted in the next section, the project area defined within NEPAssist can be used to run reports from other systems.

The secure version of NEPAssist includes a tool to add remote services. This allows the user to add existing data to use in the maps and analyses.



Source: http://nepassisttool.epa.gov/nepassist/entry.aspx.

Figure C.15. Screenshot of NEPAssist.

Analytical Functions and Reports Available

- Ability to run a NEPAssist report, listing whether the user-provided project area intersects (or is within a buffered distance of) the features in the tool's library of data. It does not list the individual features, but rather simple presence/absence within the buffer area.
- Ability to run a Waterbody Report for impaired waterbodies.
- Ability to use the project area to run external EJView (Environmental Justice Information) Reports, including
  - American Community Survey (ACS) Summary Report
  - Census 2010 Summary
  - Census 2000 Summary
  - Health Report

Data Loading and Downloading Tools

- Data loading limited to the ability to enter a project area as a string of coordinates; for example: "37.692514, –97.361526, 37.691971,–97.268829, 37.642510,–97.281876, 37.643597, –97.364960, 37.664527,–97.361870, 37.670506,–97.361870, 37.692514, –97.361526".
- No data downloading tools apparent.

Data Types or Data Sets Used

Data include

- Sites reporting to EPA (e.g., hazardous waste sites, air emissions, water dischargers, toxic release);
- Evaluations of environmental quality (e.g., non-attainment areas, areas exceeding lead standards);
- Impaired waterbodies; and
- Other data sets, based on GNIS, including schools, hospitals, and so forth, and basemap data such as hydrography, waterbodies.

The complete list of all data sets can be found at http://nepassisttool.epa.gov/nepassist/help/layersDescription.html.

Technical Support

- http://nepassisttool.epa.gov/nepassist/help/help.html
- E-mail support at nepassisthelp@epa.gov
- On-screen tips and explanations

Highlights

NEPAssist enables users to enter a project location and produce a report from EPA databases. This report may be accessible to other applications.

Reference

U.S. Environmental Protection Agency, National Environmental Policy Act (NEPA). NEPAssist. http://nepassisttool.epa.gov/nepassist/entry.aspx. Accessed Dec. 19, 2013.

National Park Service IRMA: Integrated Resource Management Applications

http://science.nature.nps.gov/im/datamgmt/irma.cfm

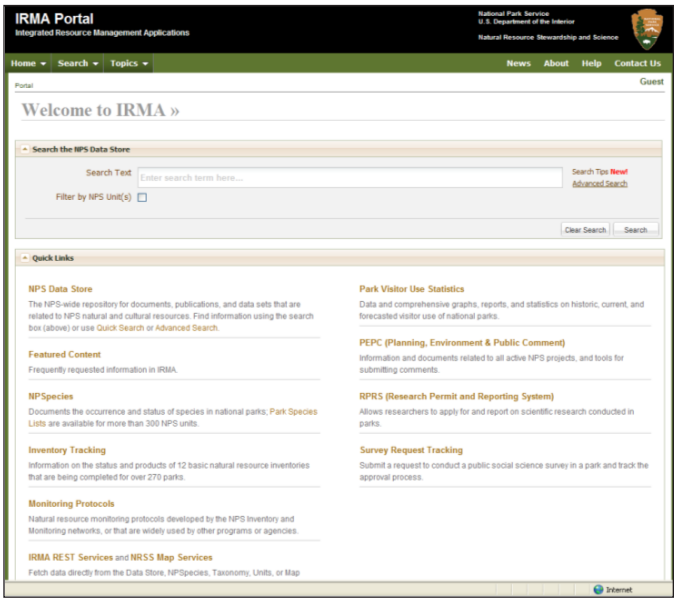
Overview

The IRMA system is the beginning of a web-based "one-stop" for National Park Service (NPS) resource-related data and information, including reports and other documents, data sets, species and taxonomic information, and more. IRMA brings together and integrates different data tools and sources, which makes it easier for users to search, view, download, and print information, all from a consistent user interface. IRMA is replacing many of the older, stand-alone information "silos" that were often difficult to use and duplicated effort and data. The goal is to streamline and simplify how park resource data are entered, managed, discovered, and shared. Additional NPS data systems will be incorporated into IRMA in subsequent releases.

Figure C.16 presents a screenshot of IRMA portal.

System Configuration

IRMA is based on service-oriented architecture (SOA), described as follows (from http://science.nature.nps.gov/im/IRMA/IRMA_project_summary_current.pdf):



Source: http://science.nature.nps.gov/im/datamgmt/irma.cfm.

Figure C.16. Screenshot of IRMA.

- .NET development environment using a blade server configuration, with distinct environments established for development, quality assurance (QA), preproduction, integration, and production.
- Team collaboration tools including Microsoft SharePoint, Project Server, Project Web Access, Team Foundation Server, and Hewlett-Packard (HP) Quality Center were evaluated and acquired.
- Each distinct group within the IRMA team works with specific software tools. Functional analysts use Visio and Balsamiq for documenting workflows, database table structures, and user interfaces. Developers work in the .NET Visual Studio environment using C# as the programming language. QA testers use HP/Mercury Service Test as their key testing tool and HP/Mercury Quality Center with Test Management as their communications tool. SQL Server 2005 or 2008 is used for the development and production databases.
- As IRMA has progressed, a series of extensions and plug-ins have been added to enhance either development or presentation, including Ajax.net, ExtJS (a JavaScript library), and XML Spy. The graphical user interface (GUI) developers create the user interface using Visual Studio, ASP.Net pages, and JavaScript.
- Geospatial functions use SQL Server 2008 spatial data types and WMS services for data storage and Geographic JavaScript Object Notation (GeoJSON) and Open Geospatial Consortium (OGC) standard well-known text (WKT) for data interchange. GUI clients are based on OpenLayers and ExtJS extensions. These GUI components are integrated into the overall Model-View-Controller (MVC) architecture of IRMA.

Interoperability and Standards

- Uses SOA; see http://science.nature.nps.gov/im/IRMA/SOA_ProjectBrief_v1.4.pdf.
- Uses Department of Interior (DOI) and industry standards to allow data exchange across multiple data systems; see http://science.nature.nps.gov/im/datamgmt/standards/data_standards_summary_20100610.pdf.
- REST-style web services allow users to fetch resources directly by using a URL composed with specific patterns, with the results returned as XML, comma-separated values (CSV), or Microsoft Excel files. For example, the following URL fetches, from IRMA, a certified species list for Yellowstone National Park plants, including park status, formatted in default Excel XML: http://irmaservices.nps.gov/npspecies/species/list/certified/YELL/vascular%20plant/ParkStat.
- The IRMA team is collaborating with other programs and agencies to develop web-based data sharing among multiple systems, which demonstrate how web services can be used to seamlessly share and integrate data across agency data systems. Demonstration projects include:
  - The USFWS Inventory and Monitoring Program is building a data discovery and retrieval system for the National Wildlife Refuge System (NWRS) that is based on IRMA.
  - The U.S. Geological Survey (USGS) and IRMA staff have successfully demonstrated integrating data from the USGS Publications Warehouse into the IRMA environment.
  - Preliminary data exchanges are taking place with the Integrated Taxonomic Information System (a multiagency partnership) as a means of populating the taxonomy service that supports NPS species applications.

Analytical Functions and Reports Available

IRMA is a searchable library of data, research, and publications. Common uses include

- Search the Data Store for documents or data pertaining to a specific subject in one or more parks.
- Create a bibliography by downloading the list of citations resulting from Data Store search.
- Download a document, Portable Document Format (PDF), or GIS data file resulting from a Data Store search.
- Create a Data Store record and upload the associated digital file: IRMA walks you through the process step-by-step.
- Get a park species list.
- Find out which species in a park are considered ozone-sensitive and also which are state-sensitive.
- Find out all the parks in which a species occurs.
- View and download a list of parks in a region.
- Find information on other natural resource topics.

Data Loading and Downloading Tools

- All NPS staff can search, view, create, and upload records in IRMA. Public users have access to records that are non-sensitive and have been reviewed for quality.
- Provides IRMA REST Services (http://irmaservices.nps.gov/) and Natural Resource Stewardship and Science (NRSS) Map Services (http://irmaservices.nps.gov/arcgis/rest/services). Fetch data directly from the Data Store, NPSpecies, Taxonomy, Units, or Map Services for use in your applications or websites.

Data Types or Data Sets Used

IRMA provides access to numerous NPS data and applications such as:

- *NPS Park Boundaries.* GIS data set of NPS administrative boundaries.
- *Species Lists.* Certified species lists for over 300 NPS units.

- *Monitoring Protocols.* Search for natural resource monitoring protocols.
- *Vegetation Maps.* Vegetation maps and associated products.
- *Vegetation Inventory Map Viewer.* Explore Vegetation Inventory data for an individual or multiple parks.
- *Geologic Resource Inventories.* Geologic maps and associated products.
- *Soil Resource Inventories.* Soils maps and associated products.
- *NPScape—Landscape Dynamics.* Landscape-level data for NPS units.
- *National-Level NPS Data Sets.* Frequently requested national-level data sets used by NPS.

Technical Support

- Send e-mail to: irma@nps.gov.
- IRMA listserv: http://webmail.itc.nps.gov/mailman/listinfo/irma.
- IRMA webinars for NPS personnel.
- Online help documentation.

Highlights

- Robust tools to search, view, download, and print information from multiple sources and systems, all from a consistent user interface.
- IRMA REST Services and NRSS Map Services. Fetch data directly from the Data Store, NPSpecies, Taxonomy, Units, or Map Services for use in your applications or websites. Multiple NPS applications use IRMA services.

Figure C.17 presents a screenshot of the IRMA Portal tools.

References

U.S. Department of Interior, National Park Service (NPS). Integration IRMA REST Services and Natural Resource Stewardship and Science Map Services. http://irmaservices.nps.gov/. Accessed Jan. 6, 2014.

U.S. Department of Interior, National Park Service (NPS). Integration of Resource Management Applications (IRMA). http://science.nature.nps.gov/im/datamgmt/irma.cfm. Accessed Jan. 6, 2014.

NPScape Metric Viewer

https://science.nature.nps.gov/im/monitor/npscape/

Overview

NPScape Metric Viewer is a landscape dynamics monitoring project that provides landscape-level data, tools, and evaluations for natural resource management, planning, and interpretation.

Figure C.18 presents a screenshot of NPScape Metric Viewer.

System Configuration

- Esri map services
- Silverlight user interface

Interoperability and Standards

Data are available for download through the NPS IRMA system.

Analytical Functions and Reports Available

The viewer displays mapped data; no query or analytical tools are provided.

Data Loading and Downloading Tools

Links to download GIS metric data are available at http://science.nature.nps.gov/im/monitor/npscape/gis_data.cfm.

NPScape has produced geo-enabled PDF and Google Earth maps of all of its landscape metrics, both by park (with 30 km buffer) and by Landscape Conservation Cooperatives (LCC)

Source: http://science.nature.nps.gov/im/datamgmt/irma.cfm.

Figure C.17. Screenshot of IRMA Portal tools.

Source: http://science.nature.nps.gov/im/monitor/npscape/.

Figure C.18. Screenshot of NPScape Metric Viewer.

region. These maps are available for download through IRMA (http://irma.nps.gov).

Data Types or Data Sets Used

- Landscape densities for population, housing, forest, roads, and grasslands;
- NPS boundaries;
- Land cover; and
- Protected areas with level of protection and ownership.

Technical Support

Online instructions available through an FAQ page.

Reference

Integration of National-Level Geospatial, Ecological Tools and Data. https://science.nature.nps.gov/im/monitor/npscape/. Accessed Dec. 20, 2013.

National Park Service Vegetation Inventory Map Viewer

http://science.nature.nps.gov/im/inventory/veg/mapviewer/mapviewer.html

Overview

The National Park Service has created the Vegetation Inventory to classify, describe, and map detailed vegetation communities in over 270 national parks across the United States. The Vegetation Inventory Map Viewer application harvests Vegetation Inventory data enabling interactive display of vegetation polygon and point data by individual park unit or multiple park units. The application includes functionality to display base layers and overlay layers that can be modified by the user, query content of the inventory products, and print maps, and allows for direct downloads of data sets in IRMA. The Map Viewer is an NPS servicewide application, and available parks include all completed Vegetation Inventory projects.

Figure C.19 presents a screenshot of the NPS Vegetation Inventory Map Viewer.

System Configuration

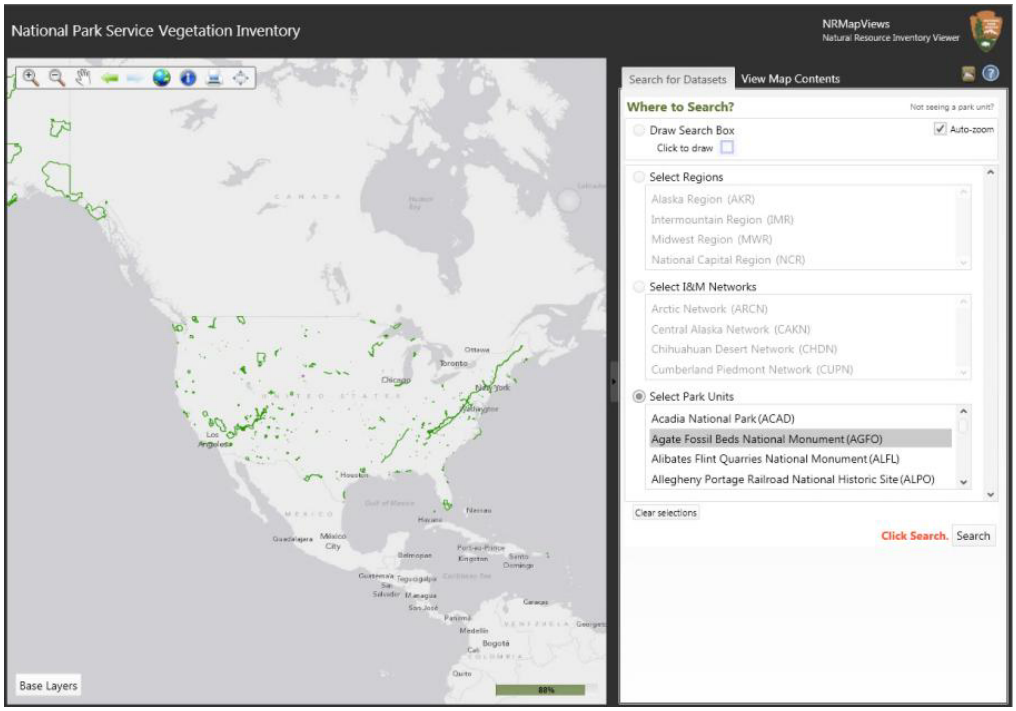
Map Viewer was developed in MS Silverlight. Though not documented, it appears to be using ArcGIS Server.

Interoperability and Standards

Data sets are available through published map services via links listed with each layer, and also via the IRMA site (see separate review on page 60, IRMA: Integrated Resource Management Applications).

Analytical Functions and Reports Available

The user searches for available data sets by NPS park or region. The selected data set is then displayed on the map. Links are available from the Map Contents to the reports and data used for the layer.



Source: http://science.nature.nps.gov/im/inventory/veg/mapviewer/mapviewer.html.

Figure C.19. Screenshot of the NPS Vegetation Inventory Map Viewer.

The map viewer also provides a basic spatial query tool (Identify).

Data Loading and Downloading Tools

Provides a link for each data set to download the data and metadata, access the park's map service, and display the data in Google Earth or ArcMap.

Data Types or Data Sets Used

As of May 2012, 129 NPS Vegetation Inventory (mapping) projects are complete and are being served on the Internet. The program has ongoing projects in 136 NPS units. The program is 46% complete. A complete vegetation mapping project for a park includes the following products:

- Detailed vegetation report;
- Digital vegetation map;
- Vegetation plot data;
- Accuracy assessment data and analysis;
- Dichotomous vegetation key; and
- Photo-interpretation key.

Technical Support

The FAQ page provides instructions for using the map viewer. It also contains links to the website describing the Vegetation Inventory program.

Highlights

- Allows users to search data services geographically and display on a map.
- The Map Contents tab provides a link to details about the data set including links to download the data and metadata or view it in Google Maps or ArcMap.

Figure C.20 presents screenshots of NPS Vegetation Inventory.

Reference

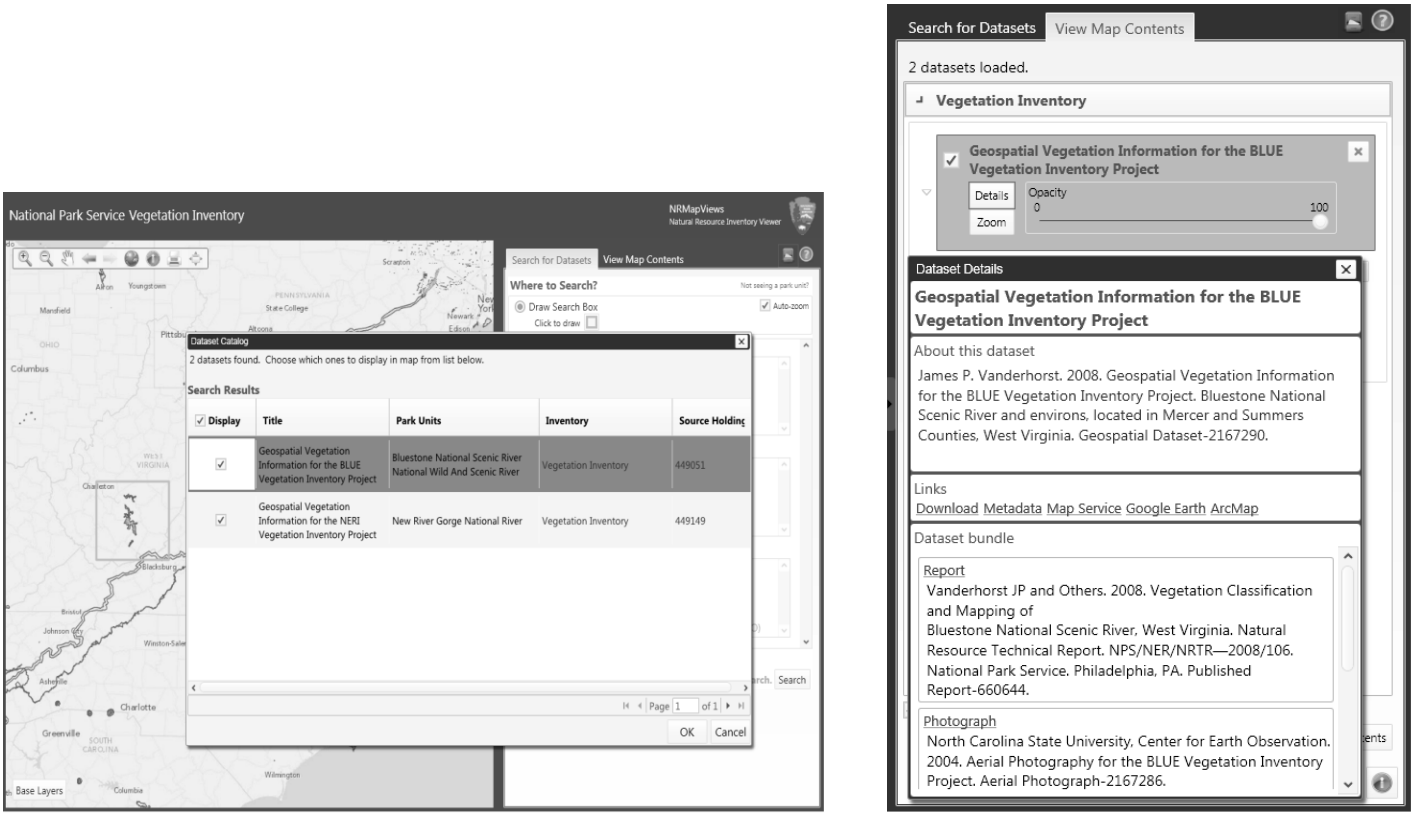
U.S. Department of Interior, National Park Service (NPS). Natural Resource Inventory Viewer. http://science.nature.nps.gov/im/inventory/veg/mapviewer/mapviewer.html. Accessed Jan. 6, 2014.

National Wetlands Inventory

http://www.fws.gov/wetlands/
U.S. Fish and Wildlife Service
Branch of Resource and Mapping Support
4401 N. Fairfax Drive, Room 830
Arlington, VA 22203

Overview

National Wetlands Inventory (NWI) discontinued production of paper maps in favor of distributing data via online "mapping

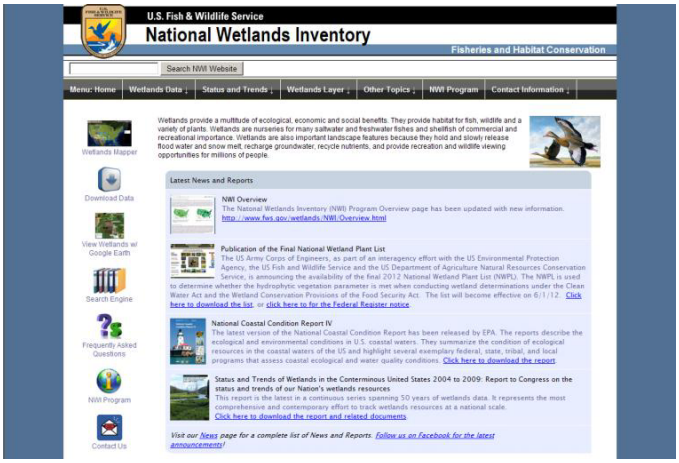


Source: http://science.nature.nps.gov/im/inventory/veg/mapviewer/mapviewer.html.

Figure C.20. Screenshots of NPS Vegetation Inventory.

tools," where information can be viewed and downloaded. Today, the Fish and Wildlife Service serves its data via an online data discovery "Wetlands Mapper." GIS users can access wetlands data through an online wetland mapping service or download data for various applications (maps, data analyses, and reports).

Figure C.21 presents a screenshot of NWI.



Source: http://www.fws.gov/wetlands/.

Figure C.21. Screenshot of NWI.

System Configuration

The updated Wetlands Mapper interface was developed with Adobe Flex.

Interoperability and Standards

Geospatial Wetlands Data are also available through an OGC WMS.

WMS service name:	**Projection:**	**OGC**
FWS_Wetlands_WMS	GCS, NAD83	**Version:** 1.3

The WMS address is http://107.20.228.18/ArcGIS/services/FWS_Wetlands_WMS/mapserver/wmsserver.

The techniques used by NWI have been adopted by the Federal Geographic Data Committee (FGDC) as the federal wetland mapping standard (FGDC Wetlands Subcommittee 2009).

Users can access the FGDC compliant metadata, as well as project-level metadata (for specific updated project areas) and "historic" metadata collected when the original mapping was completed.

The NWI site is an important component of the Department's Geospatial Blueprint, actively supporting the

E-Government (E-Gov) initiative, Geospatial One-Stop, http://gos2.geodata.gov/wps/portal/gos and The National Map, http://nationalmap.gov/.

Analytical Functions and Reports Available

The NWI website is not designed to do analysis. The Wetlands Mapper can perform a spatial query of features by extent.

The NWI has also prepared "special project reports" for work often funded by outside agencies, including local and regional wetland trend reports and local wetland status reports. Many of these reports are now online and can be searched on the NWI website using the Documents Search Engine (type in subject of interest); some may also be accessed online at the FWS Conservation Library website. In addition to data summary reports, the NWI has gone to great length to document technical procedures and data standards that are shared with partner organizations and the scientific community and available on the NWI website.

Data Loading and Downloading Tools

NWI geospatial data are available for decision makers for viewing or downloading via the cloud.

Data are distributed in a .zip file that contains the following layers:

- NWI wetland polygon data
- NWI riparian polygon data (if available at the requested location) Metadata (NWI project metadata including image dates used for delineation)

Data can be downloaded by extent using the Wetlands Mapper, or simply by state.

Wetlands data can also be downloaded or incorporated as a direct link by any organization through a WMS. Some applications incorporating NWI wetlands data include Esri's ArcGIS Resources Community; ArcGIS Online (AGO) Resources; the FWS Environmental Conservation Online System [ECOS (endangered species planning)]; the U.S. Army Corps of Engineers Operation and Maintenance Business and Information Link Regulatory Module 2 [ORM2 (online wetland permitting system)]; and the Department of Housing and Urban Developments and over 60 social media portals.

The federal government is adopting a "cloud-first" policy, in support of web-based computing as it looks to retool the way it buys information technology, and the Office of Management and Budget (OMB) has required agencies to develop an analysis of how they could use cloud computing for all major technology projects. Working with FGDC's Technology and Architecture Working Group, the NWI Wetlands Mapper became the first geospatial service application to reach a cloud-computing platform from DOI.

Data Types or Data Sets Used

The data available from NWI form the Wetlands Spatial Data Layer of the National Spatial Data Infrastructure (USFWS 2013c) as shown in Table C.2.

NWI has produced a Historic Wetlands data layer, available at http://www.fws.gov/wetlands/Data/Historic-Wetlands-Product-Summary.html. Other data products include riparian habitat classification and mapping, surface waters and wetlands mapping, and specialty mappers for the Coastal Barrier Resources System.

Technical Support

Product summary information and limitations are included in the metadata at www.fws.gov/wetlands/Data and http://www.fws.gov/wetlands/data/Metadata.html.

The Wetlands Mapper (http://www.fws.gov/wetlands/Data/Mapper.html) displays the current status of wetlands data available from the service.

More information is available by contacting the wetlands team (Wetlands_Team@fws.gov).

Answers to commonly asked questions can be found at http://www.fws.gov/wetlands/FAQs.html.

Table C.2. Wetlands Spatial Data Layer of the National Spatial Data Infrastructure

Layers	
Wetlands Data	Alaska
	Continental U.S.
	Continental U.S. Scanned Maps
	Hawaii
	Pacific Trust Islands
	Puerto Rico/Virgin Islands
Wetlands Metadata and Status	Alaska Metadata
	Alaska Status
	Continental U.S. Metadata
	Continental U.S. Status
	Hawaii Metadata and Status
	Pacific Trust Islands Metadata and Status
	Puerto Rico/Virgin Islands Metadata and Status
Riparian Status	Riparian Status
Riparian Data	Riparian

References

U.S. Fish and Wildlife Service. National Wetlands Inventory (NWI). http://www.fws.gov/wetlands/NWI/Overview.html. Accessed Jan. 6, 2014.

U.S. Fish and Wildlife Service. National Spatial Data Infrastructure Wetlands Layer. http://www.fws.gov/wetlands/Documents/National-Spatial-Data-Infrastructure-Wetlands-Layer-Fact-Sheet.pdf. Accessed Jan. 6, 2014.

U.S. Fish and Wildlife Service. Product Summary—Historic Wetlands Data Layer. http://www.fws.gov/wetlands/Data/Historic-Wetlands-Product-Summary.html. Accessed Jan. 6, 2014.

U.S. Fish and Wildlife Service. Web Map Services. http://www.fws.gov/wetlands/data/Web-Map-Services.html. Accessed Jan. 6, 2014.

U.S. Fish and Wildlife Service. Wetlands Inventory Data. http://www.fws.gov/wetlands/data/. Accessed Jan. 6, 2014.

U.S. Fish and Wildlife Service, National Wetlands Inventory (NWI). Wetlands Mapper Documentation and Instructions Manual. http://www.fws.gov/wetlands/Documents/Wetlands-Mapper-Instructions-Manual.pdf. Accessed Jan. 6, 2014.

Regulatory In-Lieu Fee and Bank Information Tracking System (RIBITS)

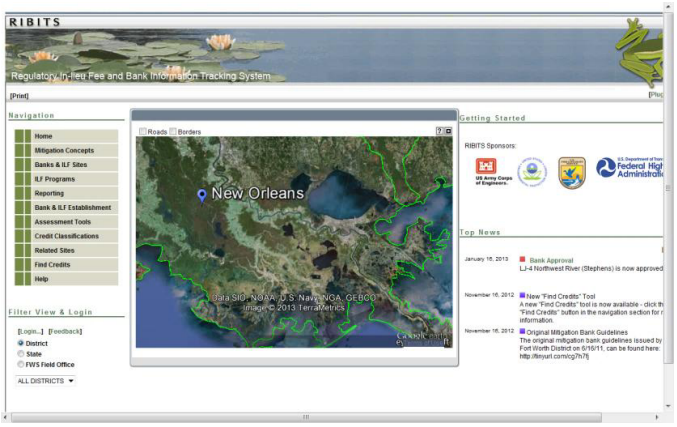
http://ribits.usace.army.mil/

Overview

RIBITS was developed by the U.S. Army Corps of Engineers to provide better information on mitigation and conservation banking and in-lieu fee programs across the country (Figure C.22). RIBITS allows users to access information on the types and numbers of mitigation and conservation bank and in-lieu fee program sites, associated documents, mitigation credit availability, and service areas, as well as information on national and local policies and procedures that affect mitigation and conservation bank and ILF program development and operation. Installation of a Department of Defense (DOD) security certificate is currently required to access RIBITS.

RIBITS can also be used early in the project development process for transportation project proponents to visualize overlaps and gaps in coverage of mitigation banks and ILF programs within a proposed project area. This can help transportation project proponents plan for mitigation earlier in the process, avoiding later delays in finding appropriate mitigation, should there not be banks or ILF programs that will likely have sufficient credits for proposed project impacts. Since the options for mitigation vary by state and/or district, RIBITS first asks the user the location of the project. RIBITS then filters all information based on that location. Mitigation banks are shown in a Google Earth interface, and all rules, regulations, and information for that area are listed for the user. To illustrate the variance between states, Georgia requires that the project's mitigation be handled through its mitigation banks. Credits can be purchased to fulfill the project's mitigation obligation. No work has to be scheduled by the project's sponsor. Other states may have an option to buy a credit or the sponsor of the project could contract to do the mitigation.

The site provides information and criteria for how the regulatory rules were adopted for the area of the project.



Source: http://ribits.usace.army.mil/.

Figure C.22. Screenshot of RIBITS. Navigation is accomplished by using the buttons on the left.

System Configuration

- Google Maps/Google Earth Plug-In
- Oracle Spatial 11G. Apex, Apache 4.2

Interoperability and Standards

None.

Analytical Functions and Reports Available

The site allows the user to find mitigation banks within a state or district. The user can spatially see the location of the banks and query the type and quantity of credits that are available. The user can filter data by geographic location or by user-defined category (e.g., permittee, credit type, agency, date range).

Data Loading and Downloading Tools

Authorized users enter new bank and ILF records, ledger transactions, bank limit and service area shapefiles, and mitigation bank files and documents.

All users can download data (ledgers, shapefiles, program files) and create user-directed queries of ledger, bank, and ILF program data.

Authorized users can create user-defined polygons for bank and ILF programs using the Google Earth Plug-In.

Data Types or Data Sets Used

Mitigation Banking and ILF Sites.

Technical Support

RIBITS User Guide and User Documents (under "Help" navigation button in Figure C.22).

Reference

U.S. Army Corps of Engineers, Regulatory In-Lieu Fee and Bank Information Tracking System (RIBITS). http://ribits.usace.army.mil/. Accessed Jan. 6, 2014.

ScienceBase

https://www.sciencebase.gov/catalog/
sciencebase@usgs.gov

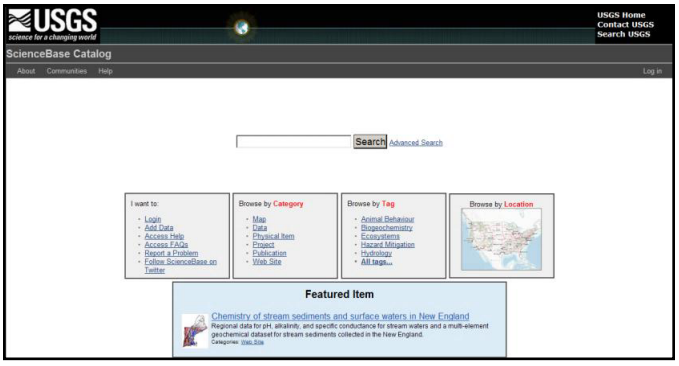
Overview

ScienceBase provides a data cataloging and collaborative data management platform for USGS scientists and partners. ScienceBase has a central search and discovery application along with web services that facilitate other applications. Research communities can set up their own "virtual catalogs" that contain items of particular import to their work.

ScienceBase is designed to do the following:

- To provide science teams a foundation of all the information needed for their work.
- To provide access to aggregated information derived from many sources.

Figure C.23 presents a screenshot of ScienceBase Catalog.



Source: https://www.sciencebase.gov/catalog/.

Figure C.23. Screenshot of ScienceBase Catalog.

System Configuration

ScienceBase is based on a REST service architecture using JSON (JavaScript Object Notation) as a data transport format for reading items and for manipulating data in ScienceBase (create, update, and delete).

ScienceBase has a web-based interactive mapping component using ArcGIS. Any item with a geospatial footprint will have simple map services in Web Mapping Services (WMS) and Keyhole Markup Language (KML) showing available parts of the footprint: point, bounding box, complex geometry.

Both original software code and the overall architecture of ScienceBase are released as an open-source project. Source code for ScienceBase will soon become available in a subversion repository at https://source.sciencebase.gov/subversion/.

The website uses Apache.

For more details about the system architecture, access https://www.sciencebase.gov/confluence/display/sciencebase/ScienceBase+Architecture.

Interoperability and Standards

ScienceBase provides an array of web services that expose ScienceBase data and metadata in a way that they can be incorporated into many other applications.

ScienceBase provides a REST web service for querying the catalog and an individual item service for retrieving a known item by its identifier. Certain types of data such as shapefiles, Geographic Tagged Image File Format (GeoTIFF) images, and a few others are able to be served from the repository using appropriate types of web service technology [e.g., OGC-WMS, OGC-Web Coverage Service (WCS)] for streaming-type uses (e.g., search for "water" returning JSON http://www.sciencebase.gov/catalog/items?s=Search&q=water). CRUD (Create, Read, Update, Delete) operations on ScienceBase items can be performed RESTfully using HTTP methods.

The ScienceBase directory (http://www.sciencebase.gov/brain/ScienceBase/#-15) provides information in ScienceBase on people and organizations. ScienceBase provides a REST web service for querying the directory and retrieving records.

Analytical Functions and Reports Available

Since the goal of ScienceBase is solely to provide and manage data, there are no analytical functions. There are the following tools for querying:

- Browse by location (spatial query—list features within the analysis boundary).
- Browse by category (map, data, physical item, project, publication).

- Browse by tag (e.g., animal behavior, biochemistry).
- Browse by date range.
- Advanced Search interface.

Data Loading and Downloading Tools

Items are added to the ScienceBase Catalog through one of several methods:

- Harvesting engines access other catalogs and integrate them into ScienceBase.
- Authorized users enter new items with or without attaching data through online forms.
- Authorized users document uploaded data by loading existing metadata or by filling out a form employing metadata standards.
- On-screen or user-defined polygons are part of the upload process to tag data items for spatial retrieval.
- CRUD operations on ScienceBase items can be performed RESTfully using HTTP methods.

Similarly, items can be downloaded from the ScienceBase Catalog. Through the interface, items can be selected and downloaded. CRUD operations on ScienceBase items can be performed RESTfully using HTTP methods.

Data Types or Data Sets Used

ScienceBase provides access to aggregated information derived from many data and information domains, including feeds from existing data systems, metadata catalogs, and scientists contributing new and original content.

Technical Support

- *Help documentation.* https://www.sciencebase.gov/confluence/display/sciencebase/ScienceBase.
- *Release notes and news.* https://my.usgs.gov/confluence/display/sciencebase/ScienceBase+Release+Notes.
- *Customer support.* http://feedback.sciencebase.gov/forums/137810-sciencebase-support.
- *Contact information provided for additional assistance.* sciencebase@usgs.gov.

Highlights

ScienceBase is a data-mining tool using open-source technology. It provides search tools to find available information by category, keyword, or location. An advanced search is also available.

Once users find a data set they are interested in, they can view the item summary page, which includes the history and source of the data as well as how to access it directly and other related items.

Figure C.24 presents screenshots of ScienceBase Catalog.

References

U.S. Geological Survey. ScienceBase Architecture. https://my.usgs.gov/confluence/display/sciencebase/ScienceBase+Architecture. Accessed Jan. 6, 2014.

U.S. Geological Survey. ScienceBase Catalog. https://www.sciencebase.gov/catalog/. Accessed Jan. 6, 2014.

U.S. Geological Survey. ScienceBase Directory. https://www.sciencebase.gov/brain/ScienceBase/#-15. Accessed Jan. 6, 2014.

U.S. Geological Survey. ScienceBase Source Code Repository. https://source.sciencebase.gov/subversion/. Accessed Jan. 6, 2014.

Southern Great Plains Crucial Habitat Assessment Tool (SGP CHAT)

http://kars.ku.edu/maps/sgpchat/

Overview

The Southern Great Plains Crucial Habitat Assessment Tool (SGP CHAT) is a dynamic online mapping application created by a coalition of states at the request of the Western Governors Association's (WGA) Wildlife Council to provide information on lesser prairie-chicken (LEPC) habitat (and other species in coming years) to help facilitate responsible development of natural resources. The SGP CHAT encompasses those portions of Colorado, Kansas, New Mexico, Oklahoma, and Texas that fall within the historic range of the LEPC. Representatives from each state worked together to acquire the best biogeophysical data available for the region to model the habitat probability and identify important movement corridors within and between meta populations.

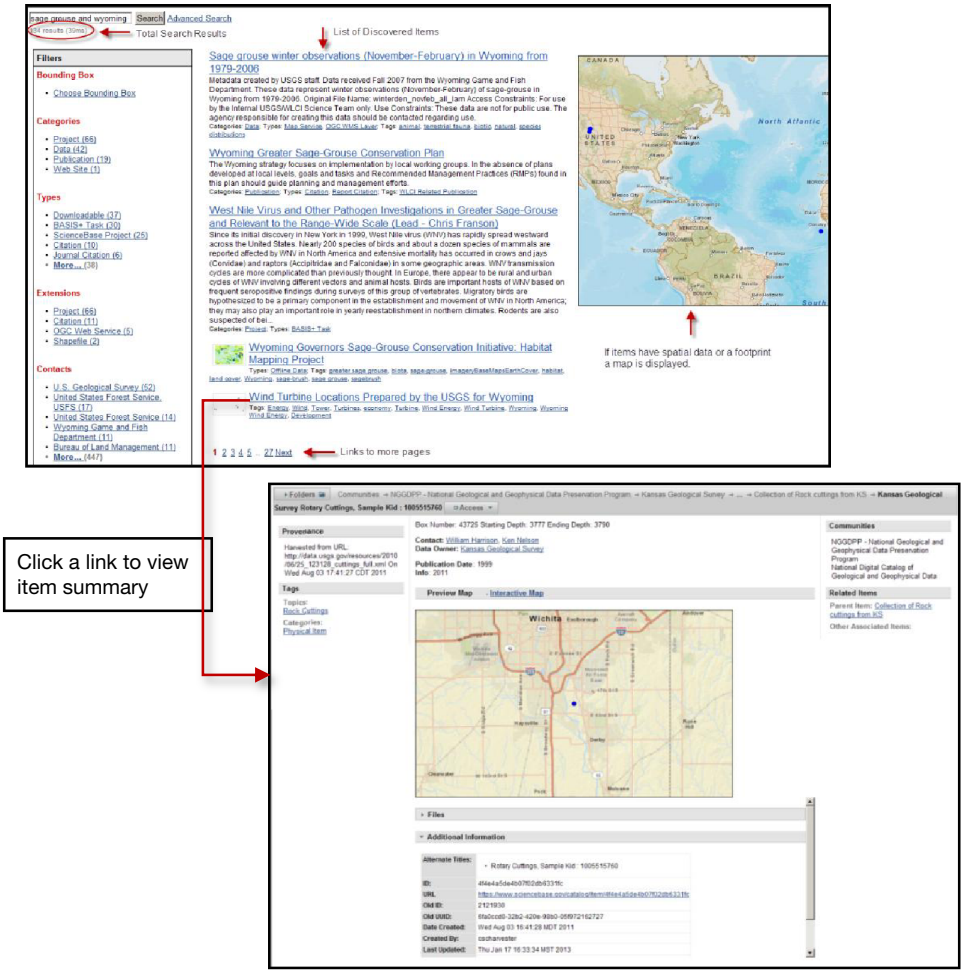
Figure C.25 presents a screenshot of SGP CHAT.

System Configuration

Interactive map viewer based on Esri software (ArcGIS Server using ArcGIS Viewer for Flex Version 3.0).

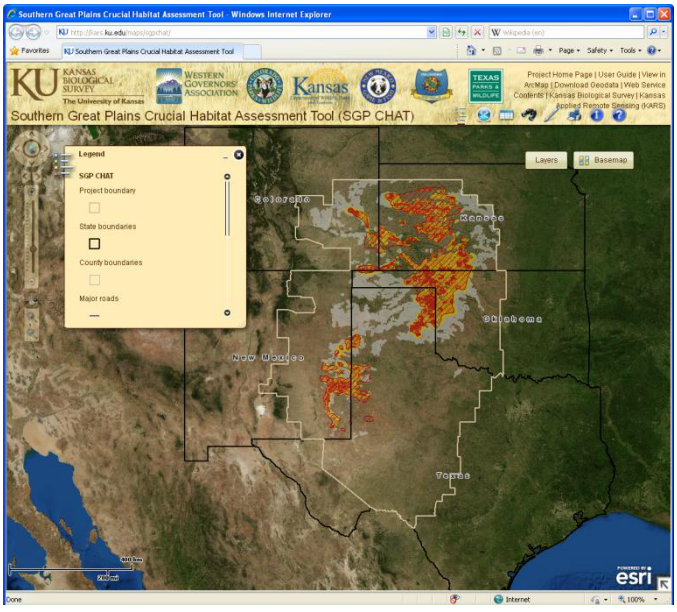
Interoperability and Standards

Data are published in an ArcGIS map service, which may be accessed by other sites.



Source: https://www.sciencebase.gov/catalog/.

Figure C.24. Screenshots of ScienceBase Catalog.



Source: http://kars.ku.edu/maps/sgpchat/.

Figure C.25. Screenshot of SGP CHAT.

Analytical Functions and Reports Available

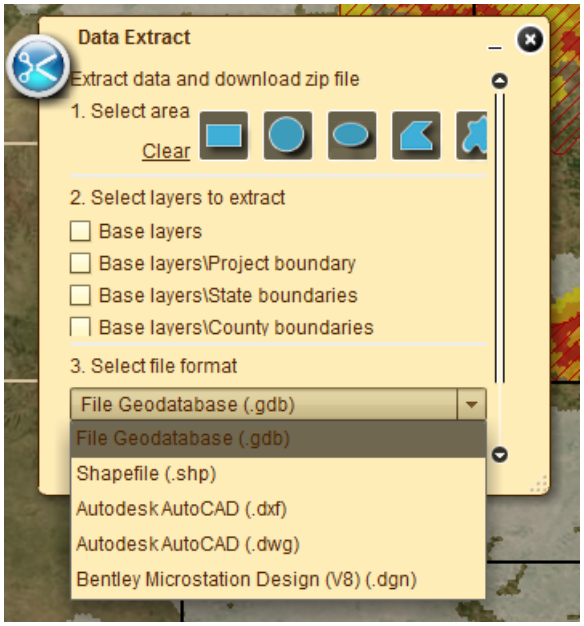
- Data extraction
- Landscape summary report

Data Loading and Downloading Tools

- "View in ArcMap" tool opens the SGP CHAT data in ArcMap.
- "Download Geodata" tool opens a page where the user can select data sets to download.
- Interactive Data Extract tool allows user to define an area and selected set of data layers to extract to shapefile, geodatabase, or computer-assisted drafting (CAD) formats.

Data Types or Data Sets Used

The crucial habitat layer displayed in SGP CHAT classifies land by its relative value as LEPC habitat, according to WGA-defined categories. In addition to the crucial habitat index, the SGP CHAT also includes current and historical LEPC range, land cover, oil/gas well density, vertical structures, and a



Source: http://kars.ku.edu/maps/sgpchat/.

Figure C.26. Screenshot of SGP CHAT Data Extract tool.

1-square-mile hexagon summary to provide users contextual information about the surrounding landscape.

More information about the data layers is available on the site.

Technical Support

- Project Home Page describes the SGP CHAT. User Guide is available via link at the top of the page.
- Metadata are available from the layers list and through information links at the top of the page.

Highlights

- Data Extract tool: Figure C.26 presents a screenshot of the SGP CHAT Data Extract tool, and Figure C.27 presents a screenshot of the SGP CHAT Landscape Summary tool.

Reference

Oklahoma Department of Wildlife Conservation Programs and Research, Kansas Department of Wildlife, Parks, and Tourism Environmental Services Section. Southern Great Plains Crucial Habitat Assessment Tool (SGP CHAT). http://kars.ku.edu/maps/sgpchat/. Accessed Jan. 6, 2014.

Utah Department of Transportation (UDOT) UPLAN

http://uplan.maps.arcgis.com/home/

Overview

UPLAN is an interactive mapping platform that supports UDOT by helping visualize data, track assets, and strengthen transportation planning with better analysis and collaborative information.

Figure C.28 presents a screenshot of UDOT UPLAN.

System Configuration

ArcGIS Online (AGO).

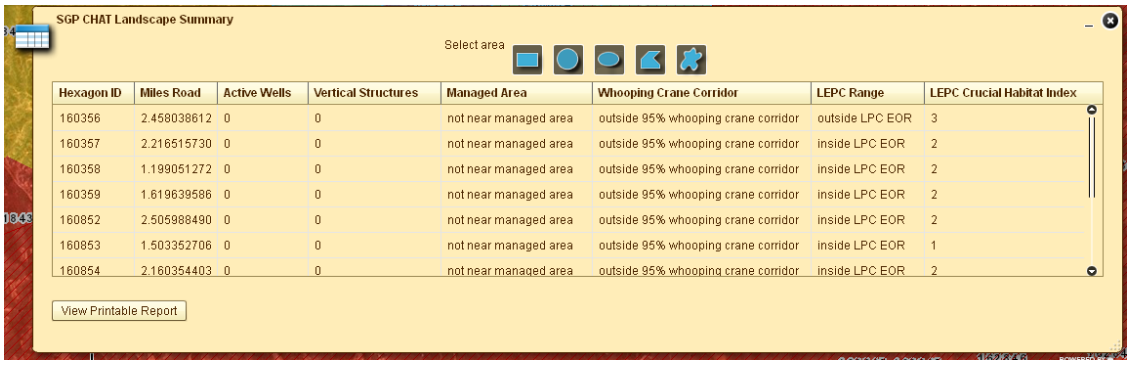
Interoperability and Standards

Includes the ability to add data from web services and various standard geographic information system (GIS) file formats.

Analytical Functions and Reports Available

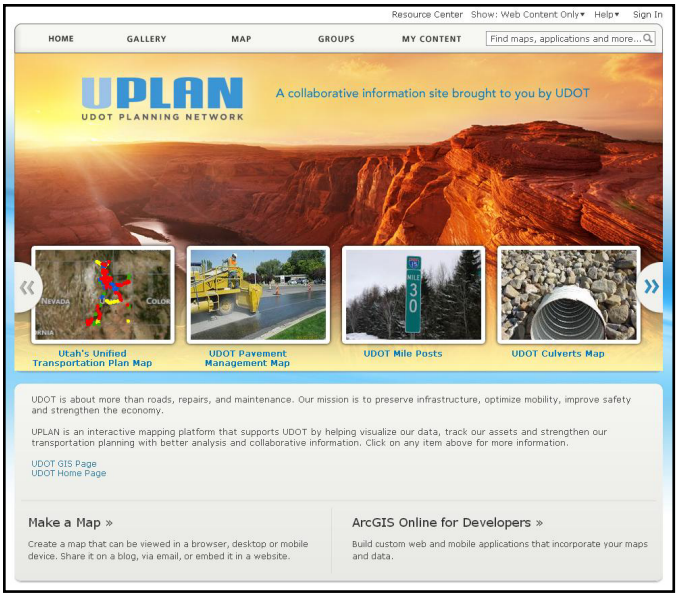
The maps allow users to click map for more information about features at that location. The Long Range Plan has a report available summarizing potential environmental impacts. This was created in ArcGIS Desktop using Python and stored in the database for access through AGO.

ArcGIS application programming interface (API) can be used to create tools and applications.



Source: http://kars.ku.edu/maps/sgpchat/.

Figure C.27. Screenshot of SGP CHAT Landscape Summary tool.



Source: http://uplan.maps.arcgis.com/home/.

Figure C.28. Screenshot of UDOT UPLAN.

Data Loading and Downloading Tools

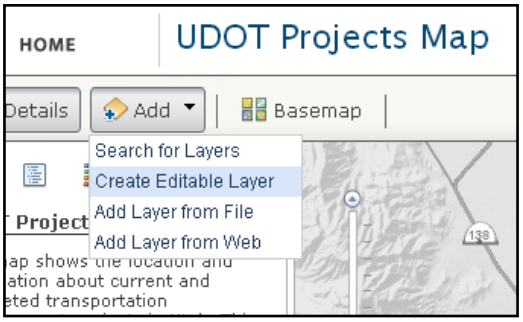
Import a zipped shapefile (ZIP), a comma, semicolon, or tab delimited text file (CSV or TXT) or a GPS data file [GPS Exchange Format (GPX)] with up to 1,000 features in it (or 250 features when geocoding addresses).

Data Types or Data Sets Used

UPLAN Map Center provides a series of online maps displaying UDOT information over basemaps available from AGO. Data from web services and user files may also be added to each map. Maps include the following:

- Utah's Unified Transportation Plan Map
- UDOT Pavement Management Map
- UDOT Mile Posts
- UDOT Culverts Map
- UDOT Functional Class Map
- Maintenance Station Information
- MAP-21 Performance Measures
- 2011 Daily Traffic Map—Annual Average Daily Traffic (AADT)
- UDOT Projects Map
- Energy Development in Uintah Basin, Utah
- Access Category Inventory 2006
- UDOT Safety and Crash Analysis

Figure C.29 presents a screenshot of UDOT Projects Map.



Source: http://uplan.maps.arcgis.com/home/.

Figure C.29. Screenshot of UDOT Projects Map.

Technical Support

- Tool tips
- ArcGIS Resource Center
- AGO Help

Highlights

The map viewer allows users to load and edit information on the map. For example, the UDOT Maintenance Division used the UPLAN platform as a tool to do culvert data collection with their smartphones and tablets. Leveraging the GPS in those devices, they were able to access the UPLAN platform and edit culvert data locations and conditions while in the field.

Reference

Utah Department of Transportation (UDOT), UDOT Map Center Unified Transportation Plan Map (UPLAN). http://uplan.maps.arcgis.com/home/. Accessed Jan. 6, 2014.

USFWS Critical Habitat Portal/ ECOS Critical Habitat Mapper

http://criticalhabitat.fws.gov/crithab/

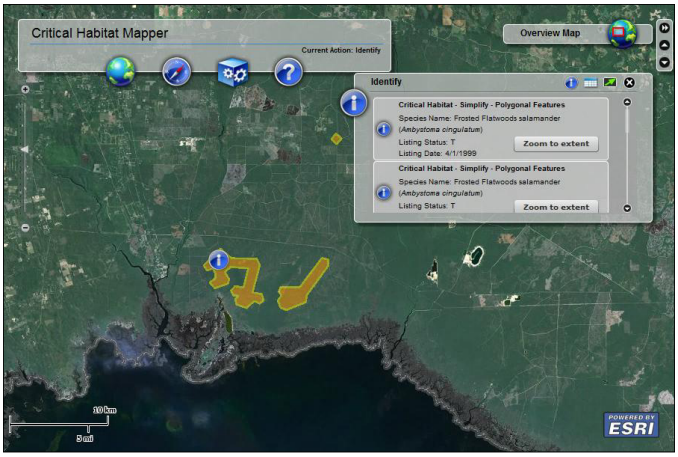
Overview

Information portal and interactive online mapping tool for information on threatened and endangered species final critical habitat designation across the United States.

Figure C.30 presents a screenshot of USFWS Critical Habitat Portal/ECOS Critical Habitat Mapper.

System Configuration

ArcGIS Server via a slightly customized out-of-the-box Flex viewer.



Source: http://criticalhabitat.fws.gov/crithab/.

Figure C.30. Screenshot of USFWS Critical Habitat Portal/ECOS Critical Habitat Mapper.

Interoperability and Standards

Critical habitat data are provided via an OGC WMS and KML. The URLs to those services are http://criticalhabitat.fws.gov/arcgis/services/crithab/usfwsCriticalHabitat/MapServer/WMSServer and http://criticalhabitat.fws.gov/arcgis/rest/services/crithab/usfwsCriticalHabitat/MapServer/kml/mapImage.kmz.

Analytical Functions and Reports Available

Identify (list features intersecting a point drawn on the map) critical habitat areas, listing species name, listing status, and listing date.

Data Loading and Downloading Tools

No data loading tools, but data can be submitted in Esri shapefile, coverage or Arc export (e00) format to add new critical habitat data.

In addition to the WMS and KML services, critical habitat data can be downloaded in shapefile format in the following packages:

- Zip file containing seamless composite layer and metadata for all species (download file: http://criticalhabitat.fws.gov/docs/crithab/crithab_all/crithab_all_layers.zip).
- Zip file containing all individual shapefiles and metadata for submitted species (download file: http://criticalhabitat.fws.gov/docs/crithab/crithab_all/crithab_all_shapefiles.zip).

Data Types or Data Sets Used

Nationwide critical habitat data. Note that not all of the critical habitat data designated by the Fish and Wildlife Service (FWS) is available from this portal. The website directs you to contact the lead FWS region for certain species for which the portal is not displaying designated critical habitat spatial information. Per the online critical habitat mapper's disclaimer: "It is important to understand that the designated critical habitat displayed in this mapper DOES NOT represent all of the critical habitat designated by the U.S. Fish & Wildlife Service. Only digitized critical habitat submitted into this system as of Sep 18, 2014 is available. This means that there is additional designated critical habitat that is not displayed in this mapper. For complete information about all species with designated critical habitat, go to the Critical Habitat Data folder on the left side of this screen."

Technical Support

Online help at URL http://criticalhabitat.fws.gov/html/map_help.html is not functioning as of this writing. Interactive help via a Help Desk web form: http://ecos.fws.gov/ecos/helpDeskPublicForm.do.

Reference

U.S. Fish and Wildlife Services, Critical Habitat Portal. http://criticalhabitat.fws.gov/crithab/. Accessed Dec. 20, 2013.

Washington Department of Fish and Wildlife Priority Habitats and Species (PHS) on the Web

http://wdfw.wa.gov/mapping/phs/
planningforwildlife@dfw.wa.gov

Overview

PHS on the Web is a Washington Department of Fish and Wildlife web-based, interactive map for citizens, landowners, cities and counties, tribal governments, other agencies, developers, conservation groups, and interested parties to find basic information about the known location of PHS in Washington State.

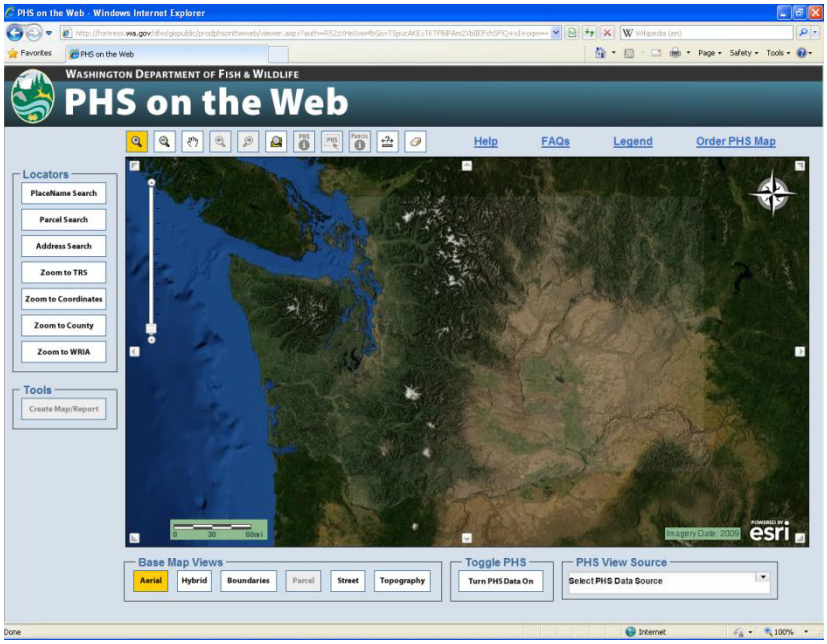
Figure C.31 presents a screenshot of PHS on the Web.

System Configuration

Web-based interactive map viewer based on Esri software, including ArcGIS Server and the ArcGIS Server JavaScript API (Version 2.2).

Interoperability and Standards

- No methods beyond direct user interaction with the interface for accessing the reporting, data delivery, or analytical functions of the tool.
- No functions to import or export data between different systems.



Source: http://wdfw.wa.gov/mapping/phs/.

Figure C.31. Screenshot of PHS on the Web.

Analytical Functions and Reports Available

- Spatial query at a point location and within the analysis boundary.
- A reporting wizard allows the user to create a map and corresponding PHS report for a selected area of interest.

Data Loading and Downloading Tools

No tools for loading or downloading data. Data are available upon request.

Data Types or Data Sets Used

The web-based maps include all species and habitats on the PHS List, as well as some additional fish and wildlife information. The PHS List is maintained by the Washington Department of Fish and Wildlife. It includes all State-listed (Endangered, Threatened, and Sensitive) and Candidate species, vulnerable aggregations of species (such as seabird concentrations, shellfish beds, and heron rookeries), and species of recreational, commercial, and/or Tribal importance that are vulnerable to habitat changes. Federally listed species are also displayed. In addition to priority species from the PHS List, priority habitats are also mapped. Priority habitats are habitat types or elements with unique or significant value to a diverse assemblage of species. A priority habitat may consist of a unique vegetation type (e.g., shrub-steppe) or dominant plant species (e.g., juniper savannah), a described successional stage (e.g., old-growth forest), or a specific habitat feature (e.g., cliffs).

In addition to species and habitats on the PHS List, the tool includes the known locations of potentially vulnerable species where their status is still being evaluated by the department ("Monitor" species). It also includes many species that have been identified as Species of Greatest Conservation Need (SGCN) in the state's Comprehensive Wildlife Conservation Strategy.

Technical Support

- Frequently Asked Questions (FAQs)
- Help page describing how to use the tool

Reference

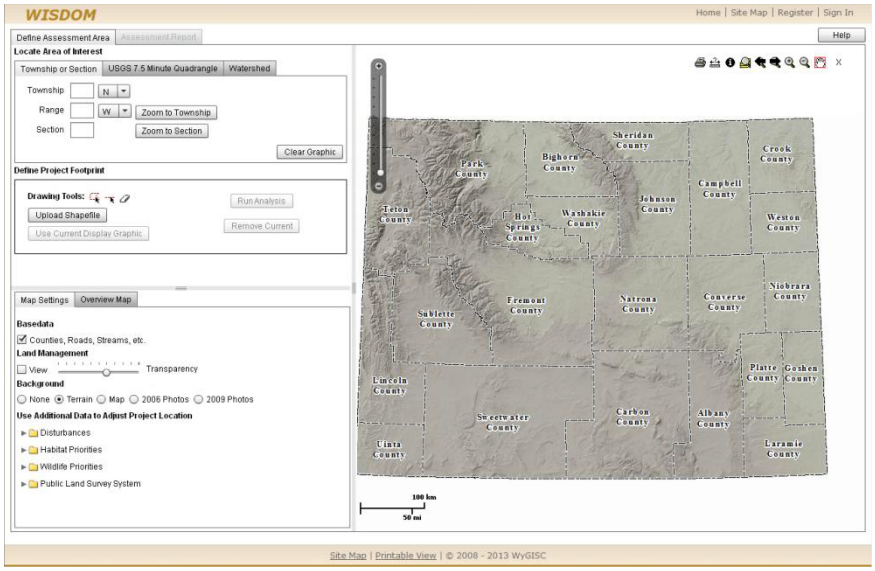
Washington Department of Fish and Wildlife, Priority Habitats and Species (PHS). PHS on Web. http://wdfw.wa.gov/mapping/phs/. Accessed Jan. 6, 2014.

Wyoming Interagency Spatial Database & Online Management (WISDOM) System

http://wisdom.wygisc.org/

Overview

The WISDOM System is a web-based delivery system for providing a set of natural resource data layers. This nonregulatory, landscape-level information allows a user to visually explore the distribution of important Wyoming wildlife habitat,



Source: http://wisdom.wygisc.org/about-wisdom.aspx.

Figure C.32. Screenshot of WISDOM System.

identify wildlife migration corridors, identify potential stressors to wildlife, and other relevant data.

Figure C.32 presents a screenshot of the Define Assessment Area feature of WISDOM System.

System Configuration: Client Software

- Browser (IE 8 or higher, Firefox, Chrome)
- Flash player 10.0 or higher

Application Development

- Flash Builder 4.5
- Esri Flex API 2.2
- Services Software
- Esri ArcServer for GIS 10.0
- Esri File Geodatabase

Server Setup (as of June 1, 2012)

- 2 load balance servers.
- Windows Server 2008 R2.
- 64-bit OS.
- 32.0 GB memory.
- AMD Opteron Processor 2.80 GHz (2 processors).

Server hardware resides in the University of Wyoming Information Center (UW ITC) Data Center providing

- Backups;
- Redundant uninterruptable power; and
- Climate control.

Interoperability and Standards

None.

Analytical Functions and Reports Available

Run Analysis tool provides dynamic results of a spatial query for a user-defined area. The results are visible on the map with information available in information tabs, or may be compiled in a report. The report may be printed or saved as a PDF.

Query Visible Layers allows the user to point and click a feature in the active topic tab and returns the attribute information (identify results).

Data Loading and Downloading Tools

The user may upload shapefiles to define the assessment area.

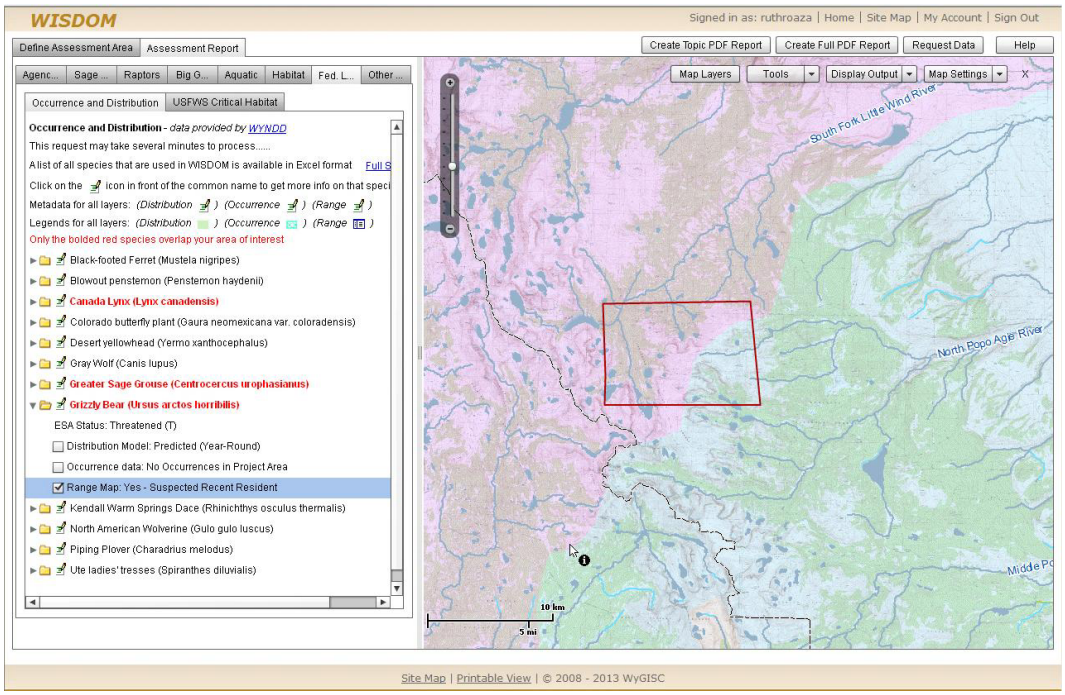
An online form is available for requesting data. If data are publicly available, these data are provided through e-mail as:

- Clip and zip files;
- Links for statewide data; and
- Links to the download pages for the data providers.

Some of the data sets are available for direct download through the Wyoming GeoLibrary (http://wygl.wygisc.org/wygeolib/).

Data Types or Data Sets Used

WISDOM includes a variety of natural resource data such as water resources, species information, and resource



Source: http://wisdom.wygisc.org/about-wisdom.aspx.

Figure C.33. Screenshot of WISDOM System.

management agency jurisdictions. Among these is a raster data layer with results of the Wyoming Species Distribution Model.

A list of the data sets used in WISDOM is available at http://wisdom.wygisc.org/Data/Sites/10/wga_documents/wisdom_technicalspecs.pdf.

Technical Support

- Video tutorials
- User Guide
- Newsletter and newsfeed (for registered users)

Highlights

Assessment areas can be defined by uploading a shapefile or drawing on the map.

After defining an area of interest, an Assessment Report is integrated into the map viewer. It is easy to see what was found within the analysis area. Categories of data are presented in tabs, or a PDF version of the report is available.

Figure C.33 presents a screenshot of the Assessment Report feature of WISDOM System.

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APPENDIX D

List of All Data Sets Provided in Eco-Plan

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APPENDIX E

Screening of Analytic Tools

Table E.1 lists several analytic tools that ICF evaluated for possible integration with Eco-Plan. For each system, ICF documented information on ownership, scope, scale, fit for Eco-Plan, and purpose.

Table E.1. Analytic Tools Evaluated for Integration with Eco-Plan

Name	Owner	Extent	GIS	Current	Web Application?	Fit	Purpose of the Tool
Primary Candidates for Integration							
Automated Geospatial Watershed Assessment (AGWA)	USDA-ARS Southwest Watershed Research Center and U.S. EPA Office of Research and Development Landscape Ecology Branch	National	GIS-based watershed management tool; AGWA is available as AGWA 2.0 for Esri's ArcGIS 9.x and 10.x and AGWA 1.5 for Esri's ArcView 3.x.	2013	Downloadable software	Yes	AGWA is designed to provide qualitative estimates of runoff and erosion relative to landscape change. GIS provides the framework within which spatially distributed data are collected and used to prepare model input files and evaluate model results. AGWA uses widely available standardized spatial data sets that can be obtained via the Internet. The data are used to develop input parameter files for two watershed runoff and erosion models: KINEROS2 and SWAT.
Better Assessment Science Integrating Point and Nonpoint Sources (BASINS)	EPA (Environmental Protection Agency)	National	Yes—includes within the open-source MapWindow GIS interface, a Data Download Tool, project builder, watershed delineation routines, and data analysis and model output visualization tools. New features include plug-in interfaces for well-known watershed and water quality models SWMM5, WASP7, and SWAT 2005.	Yes	Downloadable multipurpose environmental analysis system that integrates a GIS, national watershed data, and state-of-the-art environmental assessment and modeling tools into one convenient package.	Yes, but limited to watersheds and water quality issues.	Multipurpose environmental analysis system designed for use by regional, state, and local agencies in performing watershed and water quality-based studies.
CommunityViz	Placeways LLC	National	Yes. Operates as an extension to Esri's ArcGIS platform.	Yes	Yes—it is a website.	Yes—it is a Web Tool: CommunityViz is advanced yet easy-to-use GIS software designed to help people visualize, analyze, and communicate about important land-use decisions.	ArcGIS software extension widely used by planners; features flexible and interactive analysis tools, a rich set of presentation tools, and several options for 3-D visualization of future places.

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Table E.1. Analytic Tools Evaluated for Integration with Eco-Plan (continued)

Name	Owner	Extent	GIS	Current	Web Application?	Fit	Purpose of the Tool
Data Basin	CBI (Conservation Biology Institute)	National	Yes	Yes	Yes—it is a web-based application.	Yes	Data Basin is a science-based mapping and analysis platform that supports learning, research, and sustainable environmental stewardship.
Ecosystem Management Decision Support (EMDS)	Developed by U.S. Forest Service, and maintained by Redlands Institute	National	Yes—public domain and free; Full compatibility with ArcGIS 9.2, 9.3, and 9.3.1.	Yes	No—downloadable software	Yes	Application framework for knowledge-based decision support of ecological assessments at any scale. With the high level of public interest in natural resource management in these times, black box solutions are a political liability. The Hotlink Browser displays the evaluated state of a knowledge base. Users can navigate the networks of analysis topics to trace the logic of evaluations in an intuitive interface. More importantly, the presentation of results in this graphic format is sufficiently intuitive that users of the system can use the Hotlink Browser as a powerful communication tool that effectively explains the basis of evaluation results to broad audiences.
Envision	Oregon State University		GIS-based tool (beta version)	Yes	Downloadable software	Yes—built on an open, extensible architecture that can be adapted to a variety of location and applications.	Created to conduct research about the nature and properties of coupled human and natural environmental systems in the context of climate change. For developing alternative-futures analysis used to model the landscape impacts of various policy scenarios on land use change and accompanying biophysical impacts. Strongest applications are mapping the cumulative effects of multiple actions at multiple sites as it tracks impacts over time. Has the ability to plug in evaluative models (e.g., credit calculators).
FRAGSTATS	University of Massachusetts		Yes—accommodates ArcGIS10.	Program was completely revamped in 2002 (Version 3).	Downloadable software	Yes	Computer software program designed to compute a wide variety of landscape metrics for categorical map patterns.

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Table E.1. Analytic Tools Evaluated for Integration with Eco-Plan (continued)

Name	Owner	Extent	GIS	Current	Web Application?	Fit	Purpose of the Tool
Habitat Priority Planner (HPP)	NOAA Coastal Services Center	National	Yes—is a geospatial tool. Just one person with intermediate skills in ArcGIS is needed to operate the planner for an entire group.	Yes	Not a web app—downloadable software	Yes	Habitat Priority Planner is a spatial decision support tool designed to assist users in prioritizing important areas in the landscape or seascape for conservation or restoration action. Creates maps, reports, and data. Teams of people working on habitat decisions use this tool to share information and find answers to questions. The Habitat Priority Planner packages spatial analysis and stakeholder engagement in one geospatial tool. This Esri-based toolbar has been used for strategic conservation planning, to create species monitoring plans, and to plan for climate change adaptation. Users can customize base data, select a series of spatial analyses, and work with stakeholders to prioritize areas for management action.
Land Change Modeler (LCM)	Clark University, Worcester, MA	National	Available as a software extension for use with Esri's ArcGIS product. It is compatible with ArcGIS 9.2 SP2 and ArcGIS 9.3, but ArcGIS 10 is not supported.	Yes	Not a web app—commercial software	Yes—but a commercial product	The Land Change Modeler (LCM) for Ecological Sustainability is an integrated software environment for analyzing land cover change, projecting its course into the future, and assessing its implications for habitat and biodiversity change. Commissioned by the Andes Conservation Biology Center of Conservation International, LCM is vertical application developed by Clark Labs and integrated within the IDRISI GIS and Image Processing software package. The Land Change Modeler for Ecological Sustainability is oriented to the pressing problem of accelerated land conversion and the very specific analytical needs of biodiversity conservation.

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Table E.1. Analytic Tools Evaluated for Integration with Eco-Plan (continued)

Name	Owner	Extent	GIS	Current	Web Application?	Fit	Purpose of the Tool
Land Transformation Model (LTM)	Purdue University	Has been used in Great Lakes region and internationally.	Yes. The LTM combines GIS, artificial neural networks, geostatistical, and remote sensing technologies to forecast land use change. Standard inputs are: roads, rivers, elevation, soils, population and two land use maps. These are processed using Esri's ArcGIS or ArcView software.	Development of LTM began in 1995 and is ongoing.	Not a web app—downloadable software	Yes	The model uses landscape ecology principles, patterns of interactions to simulate land use change process, to forecast land use change. Though the model can be used in any definable region, precedence is given to watersheds. Useful for simulating land use/cover changes across large regions. It can be used to simulate land change in areas that contain several million to even a few hundred million cells. It is thus a useful tool to couple to regional climate, hydrologic, and carbon sequestration models.
Landuse Evolution and Impact Assessment Model (LEAM)	University of Illinois at Urbana-Champaign	National	Scenario results and impact assessments can be displayed in a number of ways: as simulation movies, through a built-in mapping tool, in graph or chart displays, or simply as raw data.	Yes	Unknown	Yes	Environmental, economic, and social system impacts of alternative scenarios such as different land-use policies, growth trends, and unexpected events can be tested out in the LEAM modeling environment.
Marxan	University of Queensland, Australia	National	Yes	Yes	Downloadable software	Yes—seems to be well regarded and widely used.	Marxan is freely available conservation planning software that provides decision support to a range of conservation planning problems, including the design of new reserve systems, reporting on the performance of existing reserve systems, and developing multiple-use zoning plans for natural resource management. It provides many good solutions to complex problems, offering a number of options and encouraging stakeholder participation. These features provide users with decision support to achieve an efficient allocation of resources across a range of different uses.

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Table E.1. Analytic Tools Evaluated for Integration with Eco-Plan (continued)

Name	Owner	Extent	GIS	Current	Web Application?	Fit	Purpose of the Tool
NatureServe Vista	NatureServe	National	Compatible with ArcMap 10; fully compatible with Marxan 2.1.1.	Yes	Not a web app (downloadable software program)	Yes—supports quantitative and defensible planning approaches that incorporate science, expert opinion, community values, and GIS. It works with a number of other useful software tools to incorporate land use, economics, and ecological and geophysical modeling. The flexible approach and structure of Vista is suitable for planning and GIS experts as well as non-experts with a minimum of training and support.	Free decision-support system that helps users integrate conservation with land use and resource planning of all types. Planners, resource managers, scientists, and conservationists can use NatureServe Vista to conduct conservation planning and assessments; integrate conservation values with other planning and assessment activities, such as land use, transportation, energy, natural resource, and ecosystem-based management; evaluate, create, implement, and monitor land use and resource management scenarios designed to achieve conservation goals within existing economic, social, and political contexts.
NEPAssist	EPA (Environmental Protection Agency)	National	Yes—a GIS application that automates and web-enables the collection and coordination of information inherent in the environmental review process mandated by NEPA.	Yes	Yes, it is a web application—automates and web-enables the collection and coordination of information.	Yes. The web-based application draws environmental data dynamically from EPA's GIS databases and web services and provides immediate screening of environmental assessment indicators for a user-defined area of interest.	NEPAssist is a tool that facilitates the environmental review process and project planning in relation to environmental considerations. These features contribute to a streamlined review process that potentially raises important environmental issues at the earliest stages of project development.

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Table E.1. Analytic Tools Evaluated for Integration with Eco-Plan (continued)

Name	Owner	Extent	GIS	Current	Web Application?	Fit	Purpose of the Tool
Nonpoint Source Pollution and Erosion Comparison Tool (N-SPECT)	NOAA	N-SPECT was developed as a decision-support tool for the Waianae area of Oahu, Hawaii, but other coastal communities can use the tool if they have the information needed for the base data layer.	Yes—requires MapWindow GIS v.4.8.6 (open source).	Yes	Not a web app—downloadable software	Yes	Use OpenNSPECT, the open-source version of the Nonpoint Source Pollution and Erosion Comparison Tool to investigate potential water quality impacts from development, other land uses, and climate change. OpenNSPECT was designed to be broadly applicable. When applied to coastal and noncoastal areas alike, the tool simulates erosion, pollution, and their accumulation from overland flow. N-SPECT is complex yet user-friendly GIS extension that helps coastal managers and local decision makers predict potential water quality impacts from nonpoint source pollution and erosion. See http://ebmtoolsdatabase.org/tool/n-spect-nonpoint-source-pollution-and-erosion-comparison-tool.
TransCAD	Caliper Corporation	National	Stand-alone GIS system	Yes	No—commercial software	Yes—a commercial product	TransCAD is a GIS system designed specifically for use by transportation professionals to store, display, manage, and analyze transportation data. 2-D and 3-D visualizations, cartography, buffering, region/cluster grouping, spatial statistics, and grid generation. Its strengths lie in the ability to create and model transportation networks and matrices, providing functions to develop an integrated UTPS.

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Table E.1. Analytic Tools Evaluated for Integration with Eco-Plan (continued)

Name	Owner	Extent	GIS	Current	Web Application?	Fit	Purpose of the Tool
Watershed Analysis Risk Management Framework (WARMF)	Developed by Systech Water Resources under sponsorship from Electric Power Research Institute.	National	Yes—built-in GIS system to access model coefficients and data by point-and-click on a watershed map.	Yes	WARMF is now available in the public domain through the EPA Ecosystem Research Division TMDL Modeling Toolbox.	Yes	WARMF is a physically based watershed modeling framework and decision support system for watershed management. It is suitable for applications including watershed stewardship, land use planning, climate change impact, mercury transport, and TMDLs. It also includes a consensus module designed to bring scientific information to a stakeholder group and facilitate decision making on a watershed scale. WARMF is now compatible with the U.S. EPA's BASINS software (e.g., the data extraction and watershed delineation tools of BASINS can be used to set up a WARMF application).
Possible Candidates for Integration							
Artificial Intelligence for Ecosystem Services (ARIES)	The ARIES Consortium, which includes many sponsors (e.g., NSF and Conservation International)	National and international	Unsure	Yes	Yes—it is a web-based application.	Possibly—focus is on ecosystem services.	ARIES is a web-based technology offered to users worldwide to assist rapid ecosystem service assessment and valuation (ESAV). Its purpose is to make environmental decision making easier and more effective. ARIES helps discover, understand, and quantify environmental assets and what factors influence their values, for a geographical area and based on its users' needs and priorities.

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Table E.1. Analytic Tools Evaluated for Integration with Eco-Plan (continued)

Name	Owner	Extent	GIS	Current	Web Application?	Fit	Purpose of the Tool
C-Plan Conservation Planning System	New South Wales Office of Environment and Heritage	Developed in Australia—but may be more widely applicable.	Yes—conservation decision-support software that links with GIS to map options for achieving explicit conservation targets. Interfaces with either Esri ArcView 3 GIS or Zonae Cogito to act as the GIS GUI.	Yes	Not a web app—free downloadable software	Possibly—but may need more investigation.	The Environmental Decisions Group is a network of conservation researchers working on the science of effective decision making to better conserve biodiversity. The EDG includes a variety of Australian and International research centres, hubs, and teams. C-Plan maps options for achieving an explicit conservation goal in a region, allows users to decide which sites (areas of land or water) should be placed under some form of conservation management, accepts and displays these decisions, and then lays out the new pattern of options that results. The system displays information in tables, maps, or diagrams that can be used to guide decisions.
Circuitscape	UC Santa Barbara and The Nature Conservancy staffers	National	Yes—ArcGIS export to Circuitscape	Yes	Not a web app	Possibly—limited to questions about wildlife connectivity	Free open-source program; developed for Mac, Linux, and Windows; applies algorithms from electronic circuit theory to predict patterns in gene flow and connectivity.
City Green	American Forests	National	Yes—Esri ArcGIS extension	Yes	Not a web app—commercial software	Possibly	An ArcGIS package of models that calculates ecosystem services and economic value for stormwater, carbon storage and sequestration, air pollution removal, and water quality. Does analysis on user-defined land cover layer.
Florida DOT-Efficient Transportation Decision Making (ETDM)	Florida Department of Transportation	Florida	Yes	Yes	Online database	Possibly—may be only for Florida.	(ETDM) program, which collaboratively works with Florida Water Management Districts (WMDs) to prioritize resource mitigation needs at the watershed or basin level. Early identification of potential impacts is promoted through the program's Environmental Screening Tool (EST), an online database that overlays transportation project and resource data from various sources, allowing planners to share data and foresee potential ecological impacts of infrastructure investments.

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Table E.1. Analytic Tools Evaluated for Integration with Eco-Plan (continued)

Name	Owner	Extent	GIS	Current	Web Application?	Fit	Purpose of the Tool
Habitat Evaluation Procedure (HEP)	USGS Fort Collins	National	Yes—links to GIS data are provided.	Unknown	No	Possibly, but may be outdated—says it uses DOS system—may need more investigation.	Quantitatively compare two or more alternative management practices of an area with regard to those practices affecting species in that area; the HEP accounting program uses the area of available habitat and Habitat Suitability Index (HSI) to compute the values needed for HEP as described in the Ecological Services Manual (ESM 102) and the HEP training course Habitat Evaluation Procedures. This is an important tool for land use managers, as they can quantify the effects of alternative management plans over time, and provide for mitigation and compensation that can allow fair use of the land and maintain healthy habitats for affected species.
Impervious Surface Analysis Tool	NOAA Coastal Services Center		Yes—available as a geographic information system extension.		Not a web app—downloadable software	Maybe	Used to calculate the percentage of impervious surface area within user-selected geographic areas (e.g., watersheds, municipalities, subdivisions). In small watersheds, the correlation between an increase in impervious surfaces and a decrease in water quality has been well established. People use the information derived from ISAT to predict how different management scenarios might impact local water quality.
Index of Biological Integrity—Birds, Fish, Invertebrates, and Plants	James R. Karr, University of Washington	Nationwide in most habitat types	No	1981 but still used.	No	Maybe—the IBI is a widely used approach to determining ecological health of an aquatic system, using fish or benthic invertebrates.	To assess biological integrity of a habitat utilizing one of the four (birds, fish, invertebrates, and plants) as indicators of relative condition of a selected habitat.

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Table E.1. Analytic Tools Evaluated for Integration with Eco-Plan (continued)

Name	Owner	Extent	GIS	Current	Web Application?	Fit	Purpose of the Tool
Information System of Plans (ISoP)	Department of Urban and Regional Planning University of Illinois at Urbana-Champaign	National	Unsure—may be a database.		Unsure—needs more investigation of original source.	Possibly—link goes to an example ISoP for one county and illustrates a database that local, county, and regional decision makers can use to find, view, and examine existing comprehensive, environmental/natural resource, land use, transportation, and facilities/infrastructure plans in the county.	The ability to access and compare multiple plans yields more information pertinent to making a decision than can be found in any one plan, which of necessity suppresses disagreement and multiple perspectives. The result is an ISoP that is a persistent, interactive, and continually changing set of information that puts plans to work rather than on a shelf.
Integrated Valuation of Ecosystem Services and Tradeoffs (InVEST)	Natural Capital Project	National	Yes. InVEST models run as script tools in the ArcGIS ArcToolBox environment.	Yes	Not a web app—downloadable software	Possibly	A package of models in an ArcGIS extension that calculates ecosystem services based on land use/land cover and packaged assumptions about service provision by land cover type.
Maryland Watershed Resources Registry	Maryland, multiple partners	Maryland	Yes—provides downloadable GIS layers.	Yes	It is a web-based application.	Possibly—but specific to Maryland.	An interactive mapping tool to characterize and prioritize natural resource management opportunities using a Watershed Approach. Areas across Maryland have been scored on a scale of one to five stars based on their potential benefits for restoration or preservation. Users can either access the interactive mapping tool or download the data directly http://watershedresourcesregistry.com/.

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Table E.1. Analytic Tools Evaluated for Integration with Eco-Plan (continued)

Name	Owner	Extent	GIS	Current	Web Application?	Fit	Purpose of the Tool
Michigan DOT Wetland Mitigation Site Selection Tool (WMSST)	Michigan DOT	Michigan	Yes	Yes	Not a web app	Possibly—but may be specific to Michigan.	A geospatial site selection tool for strategic identification of ideal compensation areas. See http://tarut.org/. MTRI has developed a WMSST that uses satellite imagery, GIS data analysis, and customized geospatial software to create a user-friendly method of rapidly assessing large watersheds for suitable locations of wetlands mitigation projects needed due to transportation projects.
Miradi	CMP (Conservation Measures Partnership)	National	Not yet but planned	Yes	Desktop software program resides on client's machine, but data can be sent via Internet collection to central servers.	Maybe—but software is evolving so may become more GIS based in future.	Miradi uses conceptual models and results in chain diagrams to support project planning, threats assessments, work planning, budgeting, and tools for measuring and reporting on the status of conservation targets and the impact of conservation strategies. Miradi is desktop software that helps conservation practitioners implement the Conservation Measures Partnership's (CMP: www.conservationmeasures.org) Open Standards for the Practice of Conservation.
Physical Habitat Simulation System (PHABSIM)	USGS Fort Collins	National	No	2012	Not a web app	Possibly—downloadable software but doesn't appear to involve GIS.	The purpose of PHABSIM is to simulate a relationship between streamflow and physical habitat for various life stages of a species of fish or a recreational activity. The basic objective of physical habitat simulation is to obtain a representation of the physical stream so that the stream may be linked, through biological considerations, to the social, political, and economic world.

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Table E.1. Analytic Tools Evaluated for Integration with Eco-Plan (continued)

Name	Owner	Extent	GIS	Current	Web Application?	Fit	Purpose of the Tool
RESTORE	Oregon State University	Unknown	Yes	Unknown	No	Possibly—sounds promising, but the link is broken and more investigation will be needed to find this product online.	RESTORE integrates models of watershed function and economic characterizations of restoration options with stakeholder-determined constraints and priorities to provide a tool for stakeholders to identify feasible restoration strategies and evaluate the ecological and economic effectiveness of these strategies at addressing watershed-level function. The approach involves integrating (1) models of hydrology, water quality, biodiversity, and habitat quality at the watershed scale, (2) socioeconomic analyses of stakeholder constraints on feasible restoration options, and (3) economic analysis of restoration options to develop a GIS-based decision tool for generating and evaluating restoration strategies consistent with stakeholder goals.
Spatial Wetland Assessment for Management and Planning (SWAMP)	NOAA	Website says Intended Use: Ashepoo-Combahee-Edisto River Basin, South Carolina tidal and riverine wetlands but could be more broadly applicable.	Yes	Yes	Not a web app	Possibly	A conceptual GIS-based model to help managers prioritize wetland habitats within a watershed. Called the SWAMP, this model consists of two modules, tidal and riverine, that examine a wetland's contribution to water quality, hydrology, and habitat. The model considers site-specific characteristics obtained from soil and vegetative data. See http://gcmd.nasa.gov/KeywordSearch/Metadata.do?Portal=GCMD_Services&KeywordPath=ServiceParameters%7CREFERENCE+AND+INFORMATION+SERVICES%7CKNOWLEDGE%2FDECISION+SYSTEMS&EntryId=NOAA-SWAMP&MetadataView=Full&MetadataType=1&lbnode=mdlb2.

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Table E.1. Analytic Tools Evaluated for Integration with Eco-Plan (continued)

Name	Owner	Extent	GIS	Current	Web Application?	Fit	Purpose of the Tool
Watershed Vulnerability Analysis	Center for Watershed Protection (MD)	Northeast, Upper Midwest, and Southeast	No—but GIS may be able to be used as part of the process.	Yes	Not a web app—it's a report.	Possibly—not GIS or web based but outlines an 8-step process for developing effective watershed plans.	Intended Use: Streams within subwatersheds. The model was based on research in the Pacific Northwest and Mid-Atlantic regions. Supporting data exist for the Northeast, Upper Midwest, and Southeast. Outlines a basic eight-step process for creating a rapid watershed plan and provides guidance on delineating subwatersheds, estimating current and future impervious cover, and identifying factors that would alter the initial classification of individual subwatersheds.
Not Appropriate for Integration							
Applied River Morphology Method		Nationwide	No	No—1996	No	No—it is a stream classification system.	Provides a detailed explanation of the Rosgen stream classification system (Rosgen 1994[a]). Link goes to a short course by author.
Arkansas Wetland Information Management System	Arkansas Multi-Agency Wetland Planning Team	Arkansas	Yes. Arkansas Wetland Information Management System provides GIS capability to non-GIS users over the Internet.	Unknown—see comment.	Yes—Arkansas Wetland Information Management System provides GIS capability to non-GIS users over the Internet.	Probably not—limited geography and more detail would be needed.	Only linked to a 2003 newsletter article about the program
Basinwide Visual Estimation Technique	USDA Forest Service, Southern Research Station	Mostly western United States	No	1993	No	Probably not—it's a PDF of a 1993 paper.	Basinwide visual estimation techniques (BVET) are statistically reliable and cost effective for estimating habitat and fish populations across entire watersheds. Survey teams visit habitats in every reach of the study area to record visual observations. At preselected intervals, teams also record actual measurements. These observations and measurements are used to compute calibration ratios that correct for observer bias. This publication introduces modifications of the original BVET protocols and provides examples and practical instructions for use by resource managers.

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Table E.1. Analytic Tools Evaluated for Integration with Eco-Plan (continued)

Name	Owner	Extent	GIS	Current	Web Application?	Fit	Purpose of the Tool
Beneficial Use Reconnaissance Method Field Manual for Streams	Idaho Department of Environmental Quality	Idaho	No	2004	Not a web app	Probably not—limited to Idaho	Initiated to help determine the existing uses and beneficial use support status of Idaho's water bodies. Beneficial Use Reconnaissance Program (BURP) monitoring emphasizes sampling, analysis, and assessment of biological assemblages and physical habitat structure of streams to ultimately support characterization of stream integrity and overall quality. This BURP Field Manual provides information needed for consistency and comparability of monitoring efforts among Idaho Department of Environmental Quality personnel as well as other entities interested in following these methods.
BushBroker	Victoria Department of Sustainability and Environment	Australia		2006		Not a good fit	A trading scheme for registering and trading native vegetation offset credits. Native vegetation credits are listed on the BushBroker register, and these can be bought by another party and subsequently used as an offset for the approved clearing of native vegetation.
Bushtender	Victoria Department of Sustainability and Environment	Australia	No		No	Not a good fit	This survey protocol develops habitat scores based on field site studies that can be conducted on large tracts of land. The resulting score has been used in trials for auction-based conservation financing.
Business and Biodiversity Offset Program (BBOP)	International collaborative					Not a good fit	An international partnership between companies, governments, and conservation experts to explore biodiversity offsets and develop the principles and methodologies required to support best practice in voluntary biodiversity offsets. BBOP has published a set of 10 principles on biodiversity supported unanimously by the 40 member organizations of the BBOP Advisory Committee, together with supporting material in the form of interim guidance on the design and implementation of offsets.

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Table E.1. Analytic Tools Evaluated for Integration with Eco-Plan (continued)

Name	Owner	Extent	GIS	Current	Web Application?	Fit	Purpose of the Tool
California Carbon Project Protocols	California Climate Action Reserve					Not a good fit	Carbon credit calculator
California Rapid Assessment Method (CRAM)	California Wetlands Monitoring Workgroup (CWMW)	California	Unsure	Yes	CRAM is generally done in the field with the eCRAM software installed on a tablet computer or laptop. An online version of the eCRAM software is also available.	Yes—a widely used tool in California	A wetland functional assessment. Provides rapid, scientifically defensible, standardized, cost-effective assessments of the status and trends in the condition of wetlands and related policies, programs, and projects throughout California.
Casco Bay Watershed Wetlands Characterization Method		Maine					Outdated link
CoastRanger MS	Discovery Software Ltd. and Halcrow Group Ltd.	United Kingdom	Unclear—it is a commercial software program.	Yes	No	Probably not—an educational tool for coastal management simulation	CoastRanger MS presents a virtual coastline within a PC-gaming type environment. CoastRanger MS incorporates a legacy of past developments and defenses and uses a coastal process simulator to predict the impacts of climate change under different management scenarios chosen by the user. Users are able to make various decisions about the management of the virtual shoreline and then see the consequences on screen.
Combined Assessment Procedure/ Habitat Evaluation Procedures (CHAP)	Bonneville Power Administration/ NW Habitat Institute	Washington and California				Probably not—too limited	Used to quantify the impact of hydroelectric projects and benefits of mitigation in the Pacific Northwest. CHAP is an evolution that allows for crediting out-of-kind habitats. Based on species-habitat associations.

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Table E.1. Analytic Tools Evaluated for Integration with Eco-Plan (continued)

Name	Owner	Extent	GIS	Current	Web Application?	Fit	Purpose of the Tool
Connecticut Method	Connecticut DEP and some federal cooperators	Connecticut non-tidal wetlands; to be used for noting relative value of all wetlands within a town or selected watersheds in Connecticut (and was revised for New Hampshire)	No—revision may be under way.	Based on a 1986 report.	Most likely not	Probably not	Primary purpose: To evaluate wetlands in planning, education, and wetland inventory; but not for detailed impact analysis on individual wetlands. Based on Ammann, A.P., R.W. Frazen, and J.L. Johnson. 1986. Method for the Evaluation of Inland Wetlands in Connecticut. DEP Bulletin No. 9. Connecticut Department of Environmental Protection, Hartford, CT.
Conservation Assessment and Prioritization System (CAPS)	University of Massachusetts	Massachusetts	Probably, but no info provided on website to explain what CAPS is or how it works.	Yes—website cites 2011 reports.	Unsure	Not a good fit	Not available
Conservation Plan for the Southern Watershed Area	Virginia Natural Heritage Program	Virginia	No	Date unknown	Not a web app	This is a conservation plan, not a tool.	Not available
Descriptive Approach (Highway Methodology)	Army Corps New England Regulatory Program 1999	New England	Unknown	1999	Protocol downloaded from website.	Not a good fit	Not available
Developing Rapid Methods for Analyzing Upland Riparian Functions and Values	WA State	To implement upland riparian Laws in Washington.		2009	No	Not a good fit	A rapid assessment method for non-wetland riparian habitat in Washington State. Indicators are used to identify the potential of a site to provide a function, the potential of the landscape to support the function, and the value the function provides to society.
Development of a Floristic Quality Assessment Methodology for Wisconsin	Wisconsin Department of Natural Resources; Report to USEPA	Wisconsin	It is an Index—does not seem to be GIS based.	2003	Not a web app	Probably not—Method for calculating an Index for evaluating the quality of natural areas.	Not available
Eastern Kentucky Stream Assessment Protocol (EKY)	Army Corps	Eastern Kentucky aquatic systems (but RBP can be applied elsewhere—see comments).	Modern versions could potentially use GIS, but these appear to reference reports.	2002	Not a web app	No—refer to original RBP (see comment).	Version of the 1999 USEPA RBP (Rapid Bioassessment Protocols) calibrated to local condition in Kentucky. Methodology for assessing streams and wadeable rivers.

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Table E.1. Analytic Tools Evaluated for Integration with Eco-Plan (continued)

Name	Owner	Extent	GIS	Current	Web Application?	Fit	Purpose of the Tool
Ecological Site Inventory	Natural Resources Conservation Service (NRCS)	National—forest and rangelands soils.	Unclear—may be a data repository and not a visualization tool.		Not a web app	Probably not—too specific to certain NRCS data sheets	The ESI application provides the capability to enter, edit, and retrieve rangeland, forestry, and agroforestry plot data. ESI stores plot data collected via the Soil-Woodland Correlation Field Data Sheet (ECS-005), the Windbreak-Soil-Species Evaluation Data Sheet (ECS-004), and the Production and Composition Record (RANGE-417).
Ecometrix	Parametrix					No	An integrated function-based ecosystem services accounting methodology that integrates resources and methodologies allowing for decision-making analysis, crediting and trading, and environmental performance measurement monitoring.
Ecosystem Diagnosis and Treatment Model	Jones & Stokes					No	Ecosystem Diagnosis and Treatment (EDT) is a conceptual framework system for rating the quality, quantity, and diversity of habitat along a stream, relative to the needs of a focal species such as coho or Chinook salmon.
Ecosystem Valuation Methods	Virginia Department of Forestry					Not a good fit	A package of models on a website that allows landowners to calculate potential ecosystem credits from their lands. Best available models are approved by agencies for use but are still early in development.
Environmental Monitoring and Assessment Protocols (EMAP)	U.S. EPA			No—outdated.		No—outdated.	Monitoring of the nation's aquatic resources is now being routinely conducted by the National Aquatic Resource Surveys, run by EPA's Office of Water.
EPA Oregon Stream Methodology	Oregon Department of State Lands	Oregon perennial and ephemeral streams	Unclear—appears to be a manual and data forms available online.	Yes	Not a web app	Not a good fit	Doesn't appear to be an EPA tool although it may have been tested by EPA. This tool has been developed for use in Oregon to provide technical guidance when identifying waters that may be subject to the regulatory jurisdiction under Oregon's Removal-Fill Law and Section 404 of the Clean Water Act.

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Table E.1. Analytic Tools Evaluated for Integration with Eco-Plan (continued)

Name	Owner	Extent	GIS	Current	Web Application?	Fit	Purpose of the Tool
EPA Region 10 In-Stream Biological Monitoring Handbook	U.S. EPA					No—outdated; a protocol available for download.	
Evaluation for Planned Wetlands	Comtact Environmental Concern Inc.			1994		No	Functional assessment of planned wetlands.
Fairfax County Stream Physical Assessment Protocols	Fairfax County	Virginia (Fairfax County)	No—appears to be a report.	1998	Not a web app	Not a good fit	The focus was on biological indicators of the ecological health of streams and entailed the sampling of all the major streams and tributaries throughout the county to assess stream water quality.
Field Manual for Ohio's Headwater Habitat Streams	Ohio Environmental Protection Agency	Ohio headwater streams	A manual for stream sampling and analysis—GIS could potentially be used.	2009 revision of 1999 document	No	No—this is a field manual.	
Fire Regime Condition Class		National		2005		No—broken link	To provide tools for fire, vegetation, and fuels assessment and management at both the landscape and the stand levels. Methods are used to describe general landscape fire regime and vegetation-fuel characteristics.
Florida Wetland Quality Index							
Florida Wetland Rapid Assessment Procedure	South Florida Water Management District			1999		Not a good fit	A rapid assessment protocol available online.
Floristic Quality Assessment Index	National		No	1979	No	No—this refers to a 1979 paper.	See above for FQA for Wisconsin—this was the original research on which that effort was based.
Freshwater Wetland Mitigation Quality Assessment Procedure	New Jersey DEQ			2005		Not a good fit	A wetland functional assessment that evaluates the relative probability that a constructed freshwater wetland will develop to approximate the functioning of natural wetlands over time.

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Table E.1. Analytic Tools Evaluated for Integration with Eco-Plan (continued)

Name	Owner	Extent	GIS	Current	Web Application?	Fit	Purpose of the Tool
Georgia Potential Wetland Restoration Areas (PWRA) GIS Model		Georgia	Yes	2009		Not a good fit	The purpose of this GIS model is to provide state, federal, and non-governmental natural resource managers with a Georgia-specific GIS database of potential areas for wetland mitigation banks and conservation and restoration projects using a GIS model to prioritize wetland functions and values. This model prioritizes wetland areas based upon ecosystem functions as well as threats to these functions.
Grant Anticipation Revenue Vehicles (GARVEEs)	FHWA	National	No	Yes	No	Probably not	It is a financial tool—specific to highways, a GARVEE is used as a term for a debt instrument that has a pledge of future Title 23 federal-aid funding.
Gravel Bed In-Stream Flows	USDA Forest Service, Rocky Mountain					No	A methodology for estimating essential water flow regimes needed for the self-maintenance of gravel-bed stream channels.
Green Infrastructure	The Conservation Fund	National	No		No	No	
Guidance for Rating the Values of Wetlands in North Carolina	North Carolina DENR		No	1995	No	No	
Habitat Assessment Model	Colorado Division of Wildlife	Colorado	No	2005	No	It is a PDF report.	
Hawaii Stream Bioassessment	Hawaii DOH	Hawaii streams	Unknown		Unknown	No	

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Table E.1. Analytic Tools Evaluated for Integration with Eco-Plan (continued)

Name	Owner	Extent	GIS	Current	Web Application?	Fit	Purpose of the Tool
Interim Guidelines to Avoid and Minimize Wildlife Impacts from Wind Turbines—Potential Impact Index	USFWS	National	No—it's a guidance checklist.	2003	Not a web app—it's a report.	Probably not—very specific to wind projects	PII is a protocol that allows the user to evaluate potential development sites using checklists and rank them against a reference site. Objectives are to: (1) assist developers in deciding whether to proceed with development; (2) provide a procedure to determine pre-construction study needs to verify use of potential sites by wildlife; and (3) provide recommendations for monitoring potential sites post construction to identify, quantify, or verify actual impacts (or lack thereof).
King County Functional Equivalency Evaluation System	King County Department of Natural Resources and Parks and Department of Development and Environmental Resources	King County		2008		Not a good fit	A methodology to provide a standardized procedure for assessing the functions provided by wetlands and aquatic areas; the amount those functions are reduced by impacts and the amount of mitigation required to offset the loss.
Maryland Green Infrastructure Assessment	Maryland DNR	Maryland	Used GIS to produce the document.	2003	Not a web app	No—it is a PDF report.	
Methods for Assessing Wetland Functions. Volume I: Riverine and Depressional Wetlands in the Lowlands of Western Washington	Washington State Department of Ecology	Restricted to depressional and riverine class wetlands located in Washington's western lowlands.	No	1999	Not a web app	No—it is a PDF report with methods, procedure, and spreadsheets.	A hydrogeomorphic (HGM) reference-based assessment.
MetroQuest	Envision Sustainability Tools Inc.	National	Yes	Yes	Commercial desktop software program	No—meant for stakeholders	Public engagement software for kiosks, iPads, online, or for workshops; allows stakeholders to instantly see the connections between choices and consequences as they explore alternative future scenarios. Its user-friendly, visually engaging interface allows stakeholders and citizens to make sense of the complex interrelationships and the trade-offs required to create a clean, prosperous, and livable future.

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Table E.1. Analytic Tools Evaluated for Integration with Eco-Plan (continued)

Name	Owner	Extent	GIS	Current	Web Application?	Fit	Purpose of the Tool
Michigan Valley Segment Ecological Classification—Inventory	Michigan Department of Natural Resources	Michigan River valley segments	GIS was used to produce report.	1997 report	Not a web app	No—but a good reference document to guide a holistic and landscape-level approach to ecological classification.	An approach to create a landscape-based ecological classification system for river valley segments in Michigan is described in this report. Intended Use: Lower Michigan. Currently being revised for application for states of Michigan, Illinois, and Wisconsin.
Minnesota Habitat and Water Chemistry Protocol	Minnesota Pollution Control Agency	Minnesota		2002		Not a good fit	To support assessment of water quality and development of biological criteria for Minnesota streams. These procedures are also applicable for U.S. EPA EMAP stations and sites suspected of being impacted by a source of pollution.
Minnesota Routine Assessment Method Updated Version	Minnesota Board of Soil and Water Resources	Intended Use: Northern Great Plains Prairie Pothole Region wetlands within watershed context, including open water bodies and streams	Doesn't look like it has a GIS component. It appears to be a downloadable program using Microsoft Access that stores and organizes field data to be used for assessing, classifying, and ranking wetlands.	Yes—was updated in 2010.	Not a web app	No—too limited—but this program could receive data on wetlands, or organize data before outputting into another tool (it is a Microsoft Access database).	Developed to provide a practical assessment tool that would help local authorities make sound wetland management decisions as they assumed responsibility for regulating wetland impacts. The current version represents a more refined procedure that provides numeric, rather than the original descriptive, ratings. It may be applied to existing wetlands or potential restoration sites. Descriptive and ordinal scale output. Sorts wetlands into Categories of higher or lower protection.
Mitigation Ratio Calculator	King Economics					Not a good fit	An analytical tool that can be used to develop wetland mitigation ratios that are technically and legally defensible and are based on achieving "full" replacement of lost wetland services. The tool can be used to establish appropriate ratios for specific wetland permitting decisions, to "score" wetland mitigation trades, or to assign "credits" to wetland mitigation banks.

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Table E.1. Analytic Tools Evaluated for Integration with Eco-Plan (continued)

Name	Owner	Extent	GIS	Current	Web Application?	Fit	Purpose of the Tool
Montana Stream Mitigation Process	U.S. Army Corps of Engineers—Omaha	Montana				Not a good fit	Uses indicators of riparian functions to assign a broader range of trading ratios.
Montana Wetland Assessment Method	Montana Department of Transportation	Montana wetlands		1999		Not a good fit	To evaluate wetland function and values. Designed to address highway and other linear projects, but can be applied to other types of projects including mitigation.
Montana Wetland Rapid Assessment Method	Montana DEQ	Montana	GIS could possibly be used when using this method.	2005	No	Probably not—more of a field guide	The purpose of this guidebook is to assist the field technician in accurately completing a rapid field assessment of wetland condition and to document the rapid assessment method.
Multi-Scale Assessment of Watershed Integrity		Riverside, CA					
New Hampshire Method	New Hampshire DES	New Hampshire	No	1991	No—it's a PDF report.	Probably not	See Connecticut Method above—this was adapted from that.
New Jersey Watershed Method	New Jersey	Watersheds and wetlands in NJ pinelands	GIS-based method for assessing watershed and wetland integrity and the potential impact.	1994	No	Probably not	
New York State DOT Environmental Initiative	NY State DOT	NY State	No	1999	No	Probably not	
North Carolina Coastal Region Evaluation of Wetland Significance	NC DENR	North Carolina (may be more broadly applicable)	A watershed-based wetlands functional assessment model that uses GIS software and data to assess the level of water quality, wildlife habitat, and hydrologic functions of individual wetlands.	1999	Not a web app	Probably not—does not appear to be a tool that is available online, and may be only applicable to North Carolina.	Technical documents, GIS data, and guidance are provided online.

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Table E.1. Analytic Tools Evaluated for Integration with Eco-Plan (continued)

Name	Owner	Extent	GIS	Current	Web Application?	Fit	Purpose of the Tool
Ohio Rapid Assessment Method for Wetlands V 5.0	Ohio EPA	Ohio only	No	2001	Not a web app	Probably not—too narrow in scope; this is a user manual and forms.	Intended Use: The method is designed to identify the appropriate level of regulatory protection a particular wetland should receive. It is not designed or intended to be used to determine a particular wetland's ecologic or human value.
Oregon Rapid Wetlands Assessment Protocol	Oregon Department of State Lands	Oregon specific	No	Yes	Not a web app	Probably not—used for assessing wetlands for purposes of the state Removal-Fill Law, and is also recommended by the Portland District Corps of Engineers.	ORWAP consists of several downloadable components including the Users Manual; two Excel spreadsheets; PDF versions of the data forms that users fill out; PDF versions of several of the supplemental information worksheets; and a separate guidance document for using ORWAP for state and federal permitting.
Oregon Vernal Pool Method	Agate Desert vernal pools	Oregon	No	2007	No—it's a PDF report.	Probably not—too narrow in scope	Purpose was to identify functions and values specifically relevant to vernal pool wetlands, and appropriate indicators for these.
Qualitative Habitat Evaluation Index (QHEI)	Midwest Biodiversity Institute for Ohio Environmental Protection Agency	Ohio, but probably more widely applicable	No	2006 report	No—it's a PDF report	Probably not—it's instructions for field crews.	Guidance to tabulate data and information for calculating the QHEI. See http://tycho.knowlton.ohio-state.edu/qhei.html. QHEI gives scientists a quantitative assessment of physical characteristics of a sampled stream similar to IBI and ICI biological data.
Rapid Bioassessment Protocols for use in Streams and Wadeable Rivers: Periphyton, Benthic Macroinvertebrates, and Fish. Second Edition	U.S. EPA		No	1999	Not a web app—it's a report.	No—it is published guidance.	Developed to provide "a practical technical reference for conducting cost-effective biological assessments of lotic systems."

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Table E.1. Analytic Tools Evaluated for Integration with Eco-Plan (continued)

Name	Owner	Extent	GIS	Current	Web Application?	Fit	Purpose of the Tool
Remote Functional Wetland Assessment Model	U.S. EPA and Baldwin Co. Commission	Baldwin County, Alabama	No	2005 report	No—it's a PDF report.	Not a good fit	Assess wetlands in the project area in order to categorize them as suitable for conservation, enhancement, or restoration. Nominal and ordinal scale output.
Rouge River Project Rapid Assessment Method		Wayne County, Michigan	No	1997 report	No—it's a PDF report.	Not a good fit	Provides a regional evaluation of the condition of wetland (river and lake) resources in order to aid in development of a watershed management plan. Nominal scale output.
Soil Management Assessment Framework	USDA-NRCS	Intended as a national framework to be modified as necessary for more local use.	No	It's a 2004 paper.	No—it's a journal article.	No—it's a journal article outlining a method for assessing soil quality.	To enhance and extend current soil assessment efforts by presenting a framework for assessing the impact of soil management practices on soil function.
Spatial Wetland Assessment for Management and Planning	NOAA	Ashepoo-Combahee-Edisto River Basin, South Carolina tidal and riverine wetlands	Yes			No	To assess the level of water quality, wildlife habitat, and hydrologic functions of individual wetlands using a watershed-based model in GIS software.
Technique for the Functional Assessment of Non-tidal Wetlands in the Coastal Plain of VA	Virginia Institute of Marine Science	Coastal plains of VA	No	1991—no, it has been largely phased out.	No	Not a good fit	A wetland functional assessment based on WET that assesses functions of non-tidal wetlands in the coastal plain of Virginia. Output is a rating system of high, medium, and low relative probability that a wetland has the opportunity to perform and/or be effective at performing a function.
Unified Classification of Direct Threats and Conservation Actions	International Union for the Conservation of Nature (IUCN) and the Conservation Measures Partnership (CMP)					Not a good fit	

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Table E.1. Analytic Tools Evaluated for Integration with Eco-Plan (continued)

Name	Owner	Extent	GIS	Current	Web Application?	Fit	Purpose of the Tool
Unified Stream Assessment—Urban Subwatershed Restoration Manual No. 10	Center for Watershed Protection (MD)	Urban corridors of Maryland	No	2005	No—link is to a manual.	Probably not—limited to urban stream corridors of Maryland.	A rapid technique to locate and evaluate problems and restoration opportunities within an urban stream corridor in Maryland.
Uniform Mitigation Assessment Method	Florida DEP	Florida	No	Yes	Not a web app	Probably not—due to limited focus on Florida and mitigation banking.	New link is at http://www.dep.state.fl.us/water/wetlands/mitigation/umam/index.htm. A functional assessment for wetlands and surface waters, but also applicable to several terrestrial habitat types. Determines the amount of mitigation needed to offset adverse impacts to wetlands and other surface waters and to award and deduct mitigation bank credits. Quantifies gains and losses by developing a multiplier applied to area. Considers landscape support, water environment, and community structure. Also applies factors for time lag for recovery and risk of project failure.
Variables for Assessing Reasonable Mitigation in New Transportation	Vermont Agency of Natural Resources	Vermont	Unknown	2004	Unknown	Not a good fit	
Vermont Stream Geomorphic Assessment Protocol Handbooks	Vermont DEC	Vermont	No	2003	No—it's a handbook.	Not a good fit	The Handbooks have a focus on those watershed processes and features critical to its riparian corridor management objectives.
Virginia Aquatic Resources Trust Fund	The Nature Conservancy	Virginia	No	Yes	No	No—it's a fund.	

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Table E.1. Analytic Tools Evaluated for Integration with Eco-Plan (continued)

Name	Owner	Extent	GIS	Current	Web Application?	Fit	Purpose of the Tool
Virginia Pilot Wetland Restoration, Mitigation, and Conservation Catalog	Virginia Department of Conservation and Recreation	Virginia	GIS was used to build this database.	Yes	No	Could be of limited value—it's a database for Virginia wetlands.	
Watershed Treatment Model	Center for Watershed Protection		No	Yes	No	Not a good fit	A simple spreadsheet-based approach that evaluates loads from a wide range of pollutant sources, and incorporates the full suite of watershed treatment options.
Watershed-Based Preliminary Assessment of Wetland Functions	USFWS	Wetlands and deepwater habitats of U.S.; emphasis on wetlands including shallow open waterbodies; focus on Northeastern United States.	No	2003 report	Not a web app—it's a report.	Not a good fit	
Wetland Evaluation Technique				No	No	No—WET has been superseded by more rigorous reference-based, regionally specific methods recently developed.	WET is an initial, rapid assessment of wetland functions, designed to assess the qualitative probability that a wetland function will occur. WET has been superseded by more rigorous reference-based, regionally specific methods recently developed.
Wetland Value Assessment Methodology	Environmental Work Group	LA coast marshlands		2002	Not a web app—it's a report.	Not a good fit	
Wildlife Habitat Appraisal Procedure		Texas uplands/wetlands	No	1995	Not a web app—it's a report.	Not a good fit	
Wisconsin Wetland Assessment Methodology	Wisconsin Department of Natural Resources			2001	Not a web app	Not a good fit	Provides a standardized process to evaluate the extent to which a specific wetland performs a given function.

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Table E.1. Analytic Tools Evaluated for Integration with Eco-Plan (continued)

Name	Owner	Extent	GIS	Current	Web Application?	Fit	Purpose of the Tool
Habitat Equivalency Analysis							
Guidelines for Evaluating Fish Habitat in Wisconsin		Wisconsin		1993		No	To establish a standardized general protocol "that can be used when conducting any stream habitat survey, evaluation, monitoring program, appraisal, or special project. When precise, defensible methods are needed to substantiate management objectives, priorities, or effectiveness [of management treatments]."
Heat Source Model	Oregon Department of Environmental Quality	Willamette				No	Currently, the Shade-a-Lator tool within the Heat Source model is being used to calculate temperature credits in the Willamette. Requires data from GIS and field collection.
Hydrogeomorphic Method	U.S. Army Corps of Engineers/EPA/FHWA	National		1993		No—a 1993 technical report	National methodology for wetland impacts and mitigation
Idaho Small Stream Assessment	Idaho Department of Environmental Quality	Medium and large rivers in mountainous settings		2002		No	To assess aquatic life use support for small streams using biological indicators, habitat data, and numeric water quality criteria. The document provides detailed technical information concerning the development and integration of the Stream Macroinvertebrate Index (SMI), Stream Fish Index (SFI), and Stream Habitat Index (SHI) used in the aquatic life use support determination.
Index of Marsh Bird Community Integrity	Smithsonian Environmental Research Center			2004		No	To evaluate the biological integrity of marsh bird communities and assess estuarine wetland condition. Modification of Karr method, above.

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Table E.1. Analytic Tools Evaluated for Integration with Eco-Plan (continued)

Name	Owner	Extent	GIS	Current	Web Application?	Fit	Purpose of the Tool
Instream Flow Incremental Methodology	USGS	National		2004		No—it is a technical report.	IFIM is a tool to assess in-stream flow problems, ranging from simple diversions to complex storage and release schemes. It provides resources managers with a decision-support system for determining the benefits or consequences of different water management alternatives.
LandServer	Pinchot Institute for Conservation	Chesapeake region				No—under development—limited geography	LandServer is a tool for landowners, managers, and governments to identify ecosystem service production opportunities on their lands. The tool is under development with a current pilot test running in the Chesapeake region. It is a secondary data GIS-based tool that works to identify payment for ecosystem services options for landowners.
Methods for Assessing Wetland Functions. Volume II: Depressional Wetlands in the Columbia Basin of Eastern Washington	Washington State Department of Ecology	Columbia Basin		2000	Not a web app—protocols and spreadsheets	No	A hydrogeomorphic (HGH) reference-based assessment restricted to depressional class wetlands located in Washington's Columbia Basin.
Methods for Characterizing Stream Habitat	USGS	Nationwide streams	No	1998		No	To assess status and trends in water quality nationwide and to develop an understanding of the major factors influencing observed conditions and trends.
Methods for Evaluating Stream Conditions	Forest Service			1983		No	
Methods for Stream Habitat Surveys Aquatic Inventories Project	Oregon Department of Natural Resources					No	Protocol and survey forms; developed to monitor habitat conditions for Oregon streams.

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Table E.1. Analytic Tools Evaluated for Integration with Eco-Plan (continued)

Name	Owner	Extent	GIS	Current	Web Application?	Fit	Purpose of the Tool
Numerical Method for Evaluation of Maine Peatlands						No	
Nutrient Trading Tool						No	
NutrientNet (powered by EPIC)	World Resources Institute				Yes	No	Web-based platform customized for each watershed to support nutrient trading. It has a credit calculator, registry, and exchange function. Very similar to Nutrient Trading Tool.
Pfankuch Channel Stability				1975		No—has been replaced.	
Proper Functioning Condition	BLM					No	
Rapid Assessment Method for Oregon Tidal Fringe Wetlands						No	
Rapid Stream Assessment Technique Field Methods						No	
Remotely Sensed Indicators for Monitoring Condition of Natural Habitat in Watersheds						No	
Riparian Community Type Classification of Utah and Southeastern Idaho—Inventory		Utah, Idaho		1989		No	
Rogue River Project Rapid Assessment Method		Wayne County, Michigan	No	1997 report	No—it's a PDF report.	No	Provides a regional evaluation of the condition of wetland (river and lake) resources in order to aid in development of a watershed management plan. Nominal scale output.

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Table E.1. Analytic Tools Evaluated for Integration with Eco-Plan (continued)

Name	Owner	Extent	GIS	Current	Web Application?	Fit	Purpose of the Tool
South Australian Biodiversity Assessment Tool	Government of South Australia, Department of Water, Land and Biodiversity Conservation	Southern Australia (but approach may be more widely applicable).	Maybe, but info about it on the web is hard to find—needs more research.			No	The South Australian Department for Water, Land and Biodiversity Conservation (DWLBC) has developed the South Australian Biodiversity Assessment Tool around the NCSSA method. SABAT was originally developed to allow assessment of the biodiversity value of native vegetation. At an individual site level, the tool provides site-based reports on current vegetation condition within a site and provides reports on change of vegetation condition within a site. At a regional/state scale, the tool provides a central repository for Bushland Condition Monitoring data and collates and reports regional data on a number of attributes related to vegetation condition.
Southern California Riparian Ecosystem Assessment	SCCWRP	Southern California riparian	Yes	1997	No	No	To assess hydrology, sediment processes, habitat support, and biogeochemistry components of riparian habitat using a watershed-based model in GIS software.
Stream and Riparian Habitats Rapid Assessment Protocol	USFWS	Chesapeake Bay	Unknown	2001	Unknown	No	Provides a comprehensive stream and riparian corridor assessment and inventory protocol for use by trained practitioners to rapidly identify, assess, and prioritize physical stream corridor conditions.
Stream Assessment in the VA Coastal Zone: Development of a Significant New Database and Interactive Assessment Application	Virginia Commonwealth University	Virginia		2004	No	No	Development of a multivariate model of reference stream conditions for the Virginia Coastal Zone using biological, ecological, and geomorphological variables.

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Table E.1. Analytic Tools Evaluated for Integration with Eco-Plan (continued)

Name	Owner	Extent	GIS	Current	Web Application?	Fit	Purpose of the Tool
Stream Channel Reference Sites	U.S. Forest Service			1994	No	No	Provides techniques from numerous published sources for collecting a minimum set of high-quality data necessary to quantify the physical character of streams for monitoring, impact assessment, inventory, response to management actions, etc.
Stream Corridor Assessment Survey Protocols	Maryland Department of Natural Resources			2001	No	No	To rapidly assess the general physical condition of a stream system and identify the location of a variety of common environmental problems within the stream's corridor. Not intended to be a detailed scientific survey, it provides a rapid method of examining an entire drainage network to target future monitoring, management, or conservation efforts.
Stream Impact Assessment Manual for the Northern Virginia Stream Bank	Wetland Studies and Solutions, Inc.	VA		2006		No	
Subjective Evaluation of Aquatic Habitats		Kansas				No	To provide a rapid holistic evaluation based on subjective assessments of physical, biological, and chemical parameters of the aquatic system.
Temperature Trading Platform	Oregon State University					No	Tool that allows landowners to draw a reach for riparian shade and estimate the temperature credits created. The tool is powered by a derivative of the Heat Source model rather than the Shade-a-Lator. Wetted width and some data still need to be collected in the field, but most run on spatial GIS layers.

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Table E.1. Analytic Tools Evaluated for Integration with Eco-Plan (continued)

Name	Owner	Extent	GIS	Current	Web Application?	Fit	Purpose of the Tool
Visual Stream Assessment Protocol	USDA-NRCS					No	NRCS has a number of protocols used by field staff to identify baseline farm conditions and to design conservation plans. Most are visual assessments that provide general scores of conditions.
Wadeable Stream Assessment Field Operations	U.S. EPA					No	Contains the field operations and bioassessment methods for evaluating the health and biological integrity of wadeable freshwater streams throughout the U.S. These methods can be used to determine stream condition assessment and/or to monitor the effects of impacts on aquatic 155 organisms, particularly benthic macroinvertebrates.
Washington Aquatic Habitat Design Guidelines	Washington State Department of Natural Resources	Washington State aquatic habitats		2004		No	To characterize the present (and/or historic) state of habitat and the processes that create and maintain it so that problems and appropriate restoration options and obstacles can be identified and prioritized.
Washington State Wetlands Function Assessment Program	Washington State Department of Ecology					No	The Wetlands Function Assessment Project was a statewide effort to develop relatively rapid, scientifically acceptable methods of assessing how well wetlands perform functions such as improving water quality, reducing floods, and providing wildlife habitat. The methods were developed for different wetland types in Washington State.

[a] Rosgen, D.L. 1994. A classification of natural rivers. *Catena* 22(3): 169–199.

Note: Blank cells = information not available.

APPENDIX F

Draft Wireframes

Figures F.1 through F.5 are examples of draft wireframes.

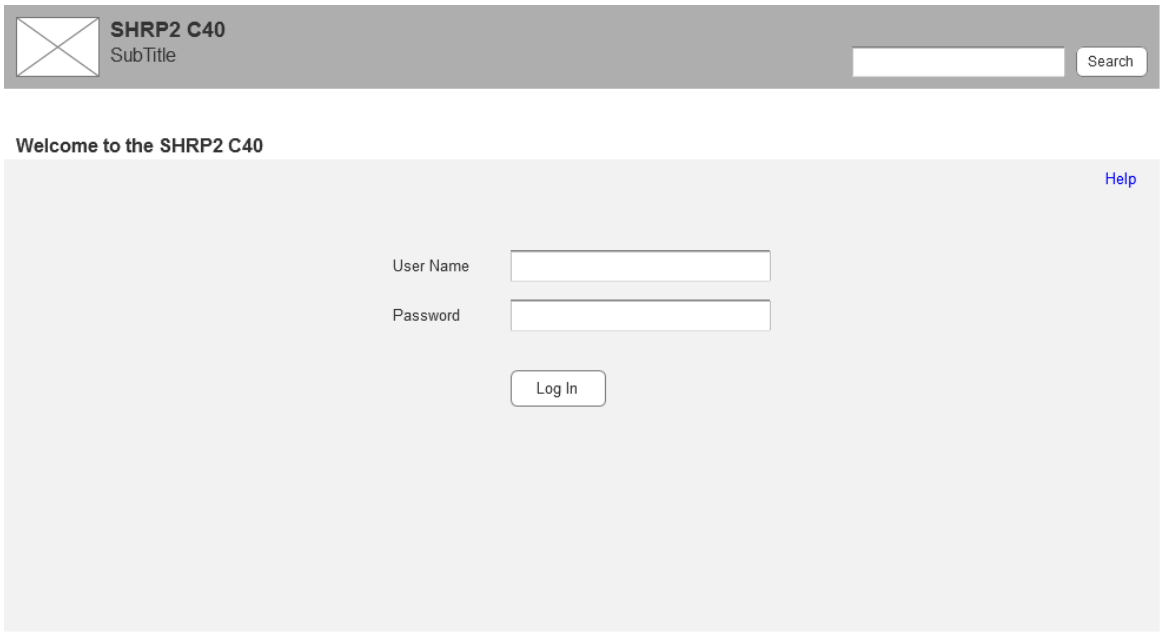

Figure F.1. Login wireframe.

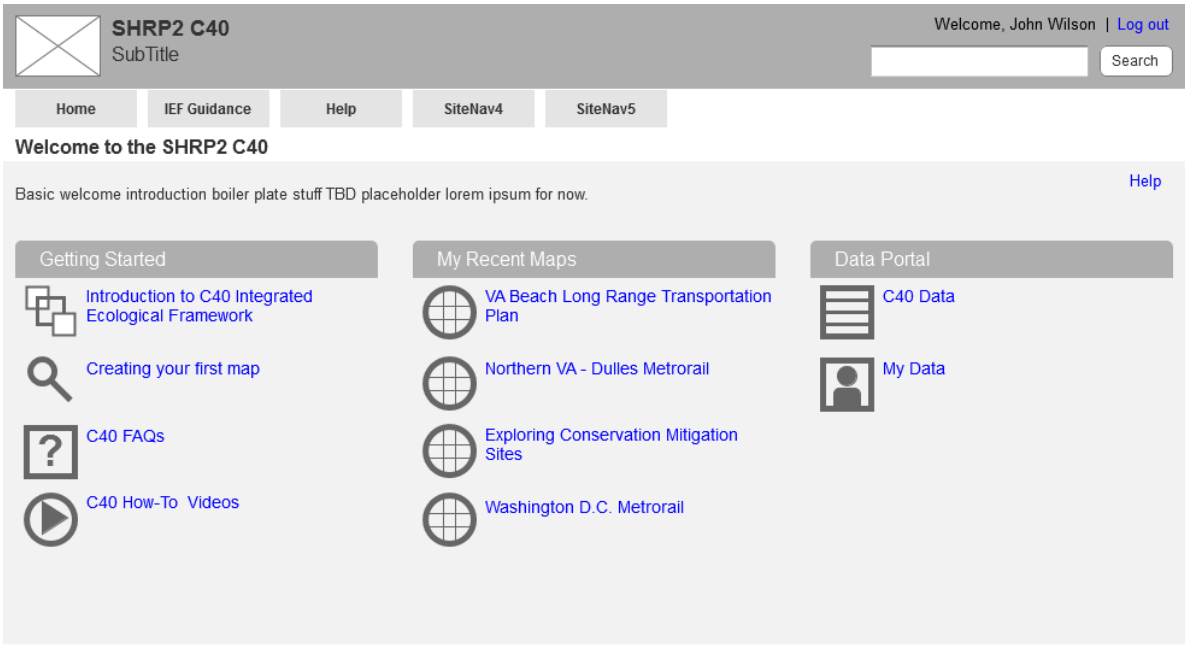

Figure F.2. Landing wireframe.

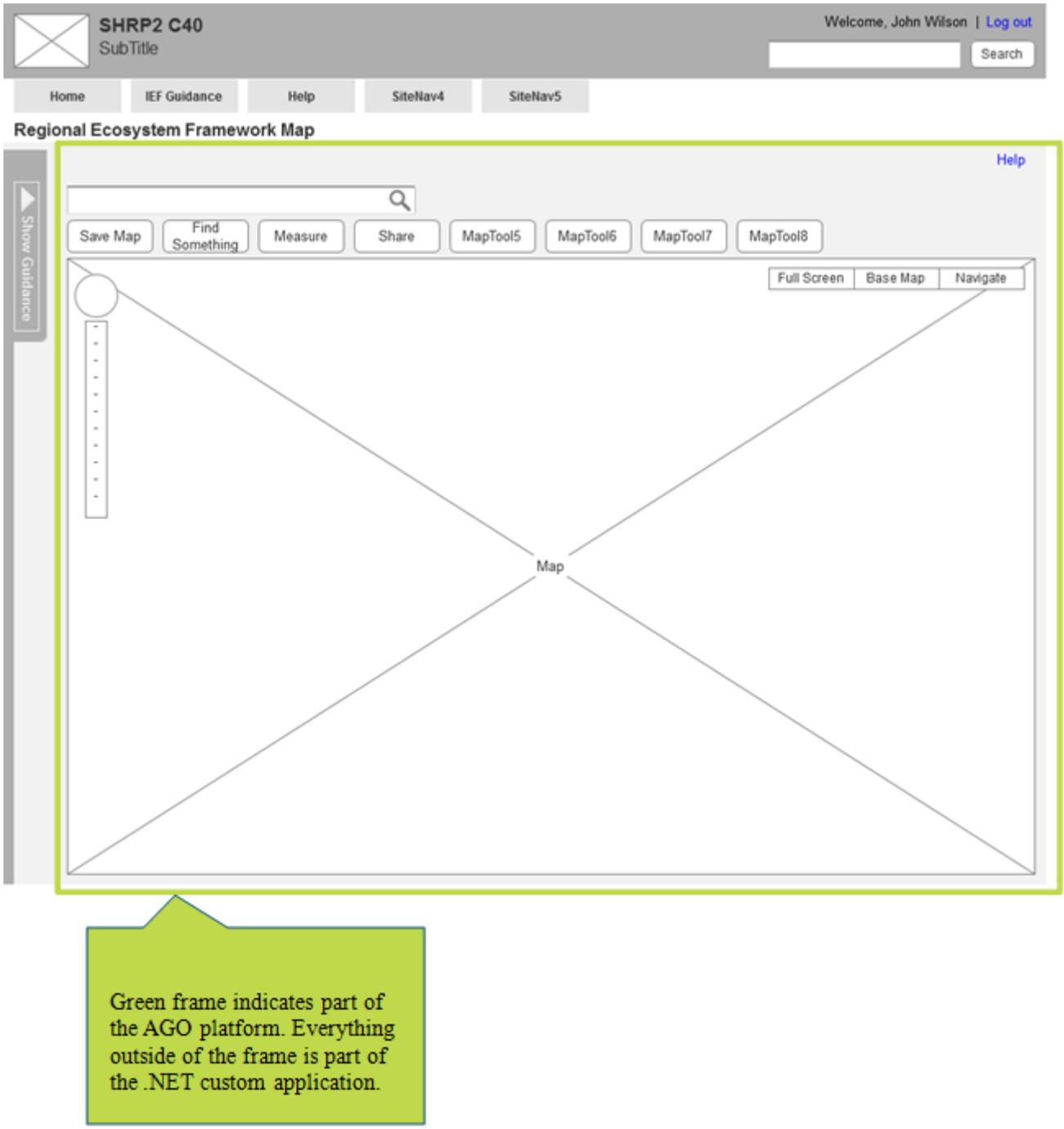

Figure F.3. Map wireframe.

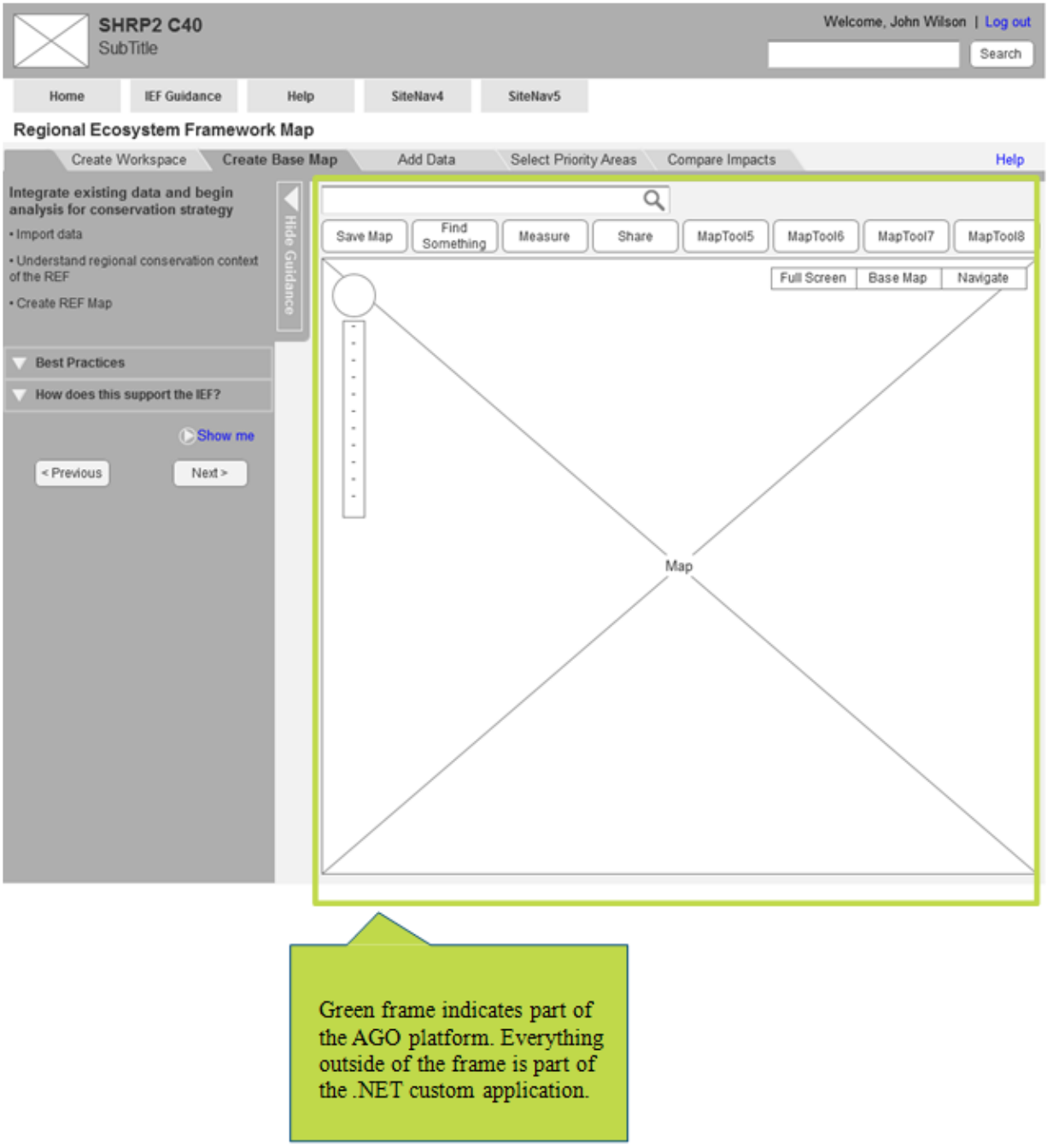

Figure F.4. Map with guidance wireframe.

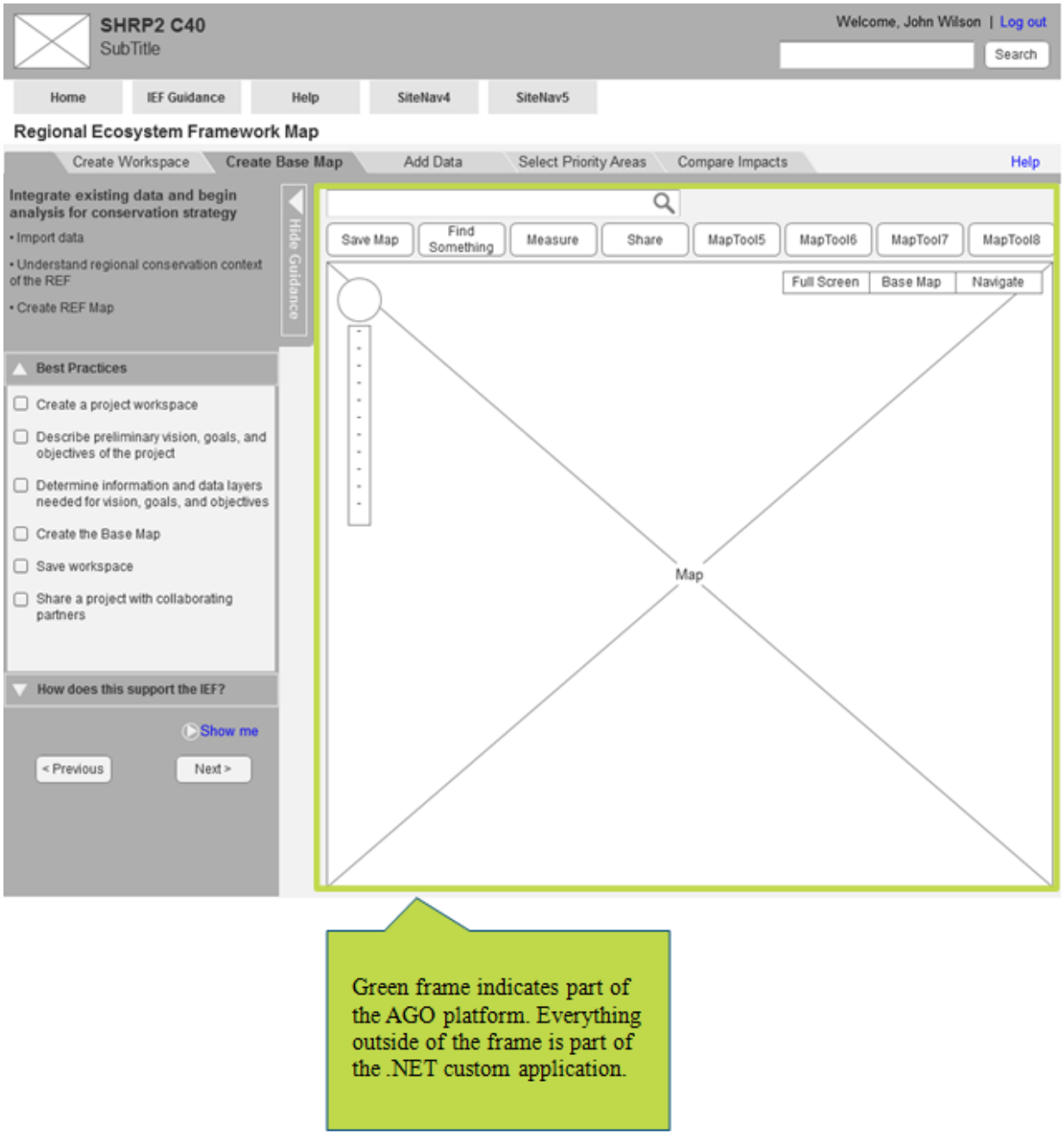

Figure F.5. Map with guidance expanded wireframe.

APPENDIX G

Testing Plan

Introduction

The primary objective of the SHRP 2 C40A project is to develop an integrated, geospatial ecological screening tool for early transportation planning that can produce results that can carry through and inform the environmental review process. This tool will advance both *Eco-Logical* and the IEF by providing the transportation community with the means to identify and analyze environmental impacts at a regional scale.

The tool consists of two major components, shown in Figures G.1 and G.2.

Testing Objectives

As part of our ongoing efforts to create a useful and usable GIS tool for state and MPO transportation planners, we plan to conduct two testing studies and investigate the functionality and user experience of this tool in supporting the target audience's information needs. The feedback from users in your organization will help us to uncover issues on this tool and guide us to enhance the design, content, and functionality.

This is a beta version of the website. The project team is in the middle of development and plans this testing task to receive comments on the website so far and get feedback on the usefulness of future functionality. The team is considering the following possible tasks for the second half of development, if validated by user feedback:

- Build search capabilities so website content can be found by keywords.
- Incorporate ways for the user to draw or upload a project on the Eco-Plan site.
- Provide an intersection tool to allow Eco-Plan users to see what important data layers intersect with their project.
- Build the About and Help pages.

Methods

Functionality Testing

Functionality testing acts as a verification of the proper functioning of the system.

In this test, participants will receive a Word document that contains test scripts and a questionnaire. The test scripts list the steps that they need to take in order to successfully complete the tasks. Each step also describes the expected result. Participants will be asked to follow the scripts to perform a few tasks, mark whether the actual result matched the expected result, and record any difficulties, comments, or questions encountered during the process. A short questionnaire is included in the end for participants to assess the overall experience and indicate how useful the content and functionality are. No moderation is needed for this test. Participants will be asked to fill out and return the test document in two weeks.

Usability Testing

The goal of usability testing is to determine how well people can use this GIS tool on their own, uncover any usability issues, evaluate the participant's satisfaction, and identify opportunities for enhancements.

The test will consist of a series of 1-hour sessions. Each participant is invited to join an online meeting with one test moderator and one or more silent observers who are taking notes or just watching and listening. Participants will be asked to perform a few realistic task scenarios as they normally would in a neutral environment without any instruction and verbalize their thoughts as they are performing. The moderator will initiate tasks and probe questions to understand participants' perspective and needs, but will not provide assistance on the task. Data will be

Figure G.1. Eco-Plan. Portal of theme maps, data layers, and resources to help novice users explore relevant environmental and ecological data during planning.

collected via the direct observation of, and conversation with, the participants.

Feedback Link

You may also send us your comments through the feedback link at the bottom of the Eco-Plan website at any time, shown in Figure G.3.

Participants

Each organization will identify **one person** to participate in the usability testing and a few others to participate in the functionality testing. Each person can only attend one test.

Please do not share with the usability testing participants any information about the Eco-Plan website and the tasks we are going to test. The goal is to find out how a user will naturally interact with the system without any prior background. We don't want them to look at the Eco-Plan website in advance of the testing session.

The only information they would need to know before usability testing includes:

- The objective of the usability testing is to improve a GIS tool we are developing.

Figure G.2. Eco-Plan Advanced. Interactive ArcGIS Online portal with preloaded theme maps and data layers to help experienced users integrate state and local data and perform geoprocessing.

- Their participation is highly appreciated, and their feedback will be kept confidential.
- Participants will need access to a phone and a computer with Internet access to participate.
- Their scheduled data and time.
- The conference number to call in (1-877-423-6338, 910391#).
- Our contact information in case they have to reschedule (jasper.liu@icfi.com, 734-972-2728).

Schedule and Logistics

Functionality Testing

The test will take 1 or 2 hours. The test scripts will be sent out to participants on January 31. Participants will be asked to perform the tasks; fill out the results, comments, and questionnaire; and e-mail the document back to ICF (Beverly.Bowen@icfi.com) on or before February 17.

Usability Testing

The test will be conducted remotely. ICF will use and provide the following equipment:

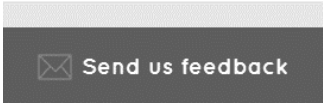

Figure G.3. Eco-Plan feedback link.

- Online meeting software (join.me, backup tools: Lync, Skype);
- Conference call number (1-877-423-6338, 910391#); and
- Video capture software (Morae) for recording the sessions.

We aim to schedule the testing sessions on February 11 and 12, 2014. Here are the time slots available in **eastern standard time**. Please contact us if the participant in your organization prefers to attend the test at a different date and time. We will try to schedule additional sessions if necessary.

Testing Documents

- *Functionality Testing:* A Word document with Test Scripts and A Questionnaire.
- *Usability Testing:* Usability Testing Moderator Guide.

Tue., Feb. 11	Time	Participant Name	Job Title	Organization	E-mail and Phone
Session 1	10:00–11:00				
Session 2	11:30–12:30				
Lunch	12:30–1:30				
Session 3	1:30–2:30				
Session 4	3:00–4:00				
Session 5	4:30–5:30				

Wed., Feb. 12	Time	Participant Name	Job Title	Organization	E-mail and Phone
Session 1	10:00–11:00				
Session 2	11:30–12:30				
Lunch	12:30–1:30				
Session 3	1:30–2:30				
Session 4	3:00–4:00				
Session 5	4:30–5:30				

APPENDIX H

Testing Scripts

Usability Testing Moderator Guide

Objectives

The purpose of this research is to conduct usability testing on the Eco-Plan website, in order to assess the perceptions and needs of target audiences, identify any potential usability issues and unmet needs, and understand how the site might be improved to increase overall user satisfaction.

Topic Areas and Questions

The primary scope of this study is the user experience of the Eco-Plan website. Although the connections between Eco-Plan website and Eco-Plan Advanced web application will be tested, the functionality on Eco-Plan Advanced is not the focus of this study.

The following topic areas will be used to facilitate conversations:

- *Overall Impression.* Understand users' overall impression of the purpose, content, look, and feel of this site.
- *Content and Navigation.* Evaluate how effectively users can locate the content they need, and whether the content is helpful and intuitive.
- *Map Data and Functions.* Verify if the map data are clearly presented and have the right level of details, and identify any potential issues with the map functionality on the Eco-Plan site.
- *Eco-Plan Site and Eco-Plan Advanced.* Assess the extent to which users understand the connections and differences of these two systems.

Introduction Script

Thank you for agreeing to help us today. Before we begin, I'd like to give you an overview of the process so you'll know exactly what to expect.

- In a few minutes, I'll ask you to use your computer to complete a few tasks.
- While you are working, please think out loud. It is very helpful for us to hear you describe what you are seeing, what you are trying to do, and what you are thinking. It's important for you to know that we are interested in your honest feedback and opinion.
- This test is about how well the website performs. This is not a test of your knowledge or computer skills. There are no right or wrong answers.
- Through this session, I want to understand how people will actually use this website on their own. So, I may not be able to answer your questions right away. But we will work through the tasks together and discuss any questions in the end.
- I have a colleague here with me to take notes, and there may be a couple of people in our team quietly observing. We will collect a video recording of this session. The recordings will only be used for this study and will not be released to any third parties.
- Do you have any questions before we start?

Participant Background

- To start, please tell me a little bit about your work and role.
- Would it be more appropriate to categorize your role as transportation planning, environmental analysis, GIS professional, or some combination?
- Do you use any GIS systems for work?
- Do you rely on others to provide maps or GIS analysis to you?
- What kinds of environmental data do you use in your work? Where does that data come from?
- Could you give me a couple of specific examples of how you might use environmental data in your job?

Usability Scenarios

Scenario 1 (Overall Impression)

Assume you are looking for information to help with transportation planning and come across the following website: http://c40-stage.icfwebservices.com/. Take a few minutes to look at the home page, and tell me what this site is about and if there's anything of interest to you.

Probing Questions

- What do you think this site is for? Is the content easy to understand? Is there anything that confuses you?
- Is there any other information you want to see here?
- Where are you inclined to go next?

Scenario 2 (Content and Navigation)

Now click around, and find information that is relevant to your transportation planning work.

Probing Questions

- Is the content easy to understand? Is it helpful to you? Are there any terms that you find confusing?
- What information is most useful on this (data details, map details) page?
- What information is the least useful on this (data details, map details) page?
- What is the additional information you would like to see here?
- (If users focus on the map content and overlook the Data page) We will take a closer look at the map later. Is there any other useful information on the site besides the maps?

Scenario 3 (Map Data and Functions)

Pick a specific planning area, transportation network, or corridor that you are interested in, and determine if there is any protected land in that area and who manages the land.

Probing Questions

- Is it clear which map you need to use? Do you understand the purpose of each map?
- What does this map tell you? Is the information clearly presented on the map?
- What do you think of the level of details of the data on the map?
- What is the source of the map data?
- Do you normally look at protected land for your planning?

Scenario 4 (Map Data and Functions)

What other environmental issues are you concerned about? Use this website to find information about these issues in an area that you are interested in.

Scenario 5 (Upload Data)

Think of one of the transportation planning projects you worked on recently, add your planning area to the map, and determine if it causes any potential environmental issues.

Probing Questions

- How do you document the geospatial information of your planning area? What format do you use?
- Is it clear what kind of file you can upload?
- What do you expect to see after uploading the data?
- What could you do with the information you found?

Scenario 6 (Eco-Plan Advanced)

Assume you find not all information on the map is directly relevant to you. Hide some data from the map, and send the simplified view to your colleagues.

Probing Questions

- (When a participant navigates to Eco-Plan Advanced) Do you know where you are now and why you come here?
- Do you usually share map information with others? How do you share?
- Have you used ArcGIS before?
- Now that you have seen both Eco-Plan website and Eco-Plan Advanced, could you describe when you are likely to use Eco-Plan website and when you are likely to use Eco-Plan Advanced?

Closing

We are almost done.

- Think back on what you have seen on the site today. How would you describe your overall experience?
- Thinking about the content you saw, how useful was the content to you? What content seemed the most helpful? Which seemed the least helpful?
- Which is the most helpful function on the map? Which is the least helpful function on the map? What additional function you would like to add to the map?
- What was the hardest part? The easiest?
- Do you have any additional comments or suggestions?
- Questions from observers. (Moderator will check with observers to see if they have any questions before releasing participant).

That's all the questions we have for you. Thank you so much! Your feedback is very important, and we appreciate you sharing your experiences and thoughts with us.

Functionality Test Scripts

Eco-Plan is a collaborative geospatial tool whose goal is to provide current environmental data to be used in transportation planning. Eco-Plan provides transportation planners with easy-to-use geospatial data that define areas of critical habitats, endangered species, watersheds and wetlands, as well as built environments. The Eco-Plan tool provides the ability to easily visualize—and avoid—conflicts between ecological assets and transportation plans.

The tool consists of two major components:

- *Eco-Plan:* Portal of theme maps, data layers, and resources to help novice users explore relevant environmental and ecological data during planning.
- *Eco-Plan Advanced:* Interactive ArcGIS Online portal with preloaded theme maps and data layers to help experienced users integrate state and local data and perform geoprocessing.

The purpose of this study is to investigate the functionality of the Eco-Plan website (Tasks 1–5) and Eco-Plan Advanced web application (Tasks 6–13). Your feedback will help us to uncover issues on this tool and guide us to enhance the content and functionality.

Each test script below lists the steps you need to carry out in order to successfully complete the task. Each step also describes the expected result. Please mark whether the actual result matched the expected result, and record any difficulties, comments, or questions you may have in the space provided. A short questionnaire is included at the end for you to assess the overall experience and indicate how useful the content and functionality are.

Task 1: Review the Eco-Plan Website

Purpose: Become familiar with the Eco-Plan website				
			Actual Result	
Step #	**Procedure**	**Expected Result**	**As expected?**	**Other/Comments**
1	Go to http://c40-stage.icfwebservices.com/	The Eco-Plan home page appears.	Y N	
2	Review the home page.	Look for a coherent general structure, a clear layout, a pleasing color scheme, and easy-to-understand navigation.	Y N	

Task 2: Get Started

Purpose: Start using Eco-Plan				
			Actual Result	
Step #	**Procedure**	**Expected Result**	**As expected?**	**Other/Comments**
1	In the top navigation, click "Get Started".	You are prompted to the Get Started page; the first item in the "accordion"—find your area or load your project—is expanded.	Y N	
2	Click "Find your area or load your project".	A content box pops up, describing this upcoming feature and asking users to send an e-mail message to indicate if this feature would be useful.	Y N	
3	Click "Review protected areas".	The map of your area/project displays protected areas and ownership.	Y N	
4	Click "Explore land cover".	The map of your area/project displays the types of land cover.	Y N	
5	Click "Identify critical habitat and species at risk".	The map of your area/project displays the critical habitats and at-risk species.	Y N	
6	Click "View Watershed and wetlands maps".	The map of your area/project displays wetlands, watershed boundaries, water monitoring locations, and shorelines.	Y N	
7	Click "Review the potential for development in unprotected areas".	The map of your area/project displays areas with high ecological values and development pressures affecting these resources.	Y N	
8	Click "Next steps".	The links and short descriptions are presented for you to navigate to Map Details page and Eco-Plan Advanced, respectively.	Y N	

Task 3: Review the Map Gallery

Purpose: Review precompiled maps				
			Actual Result	
Step #	Procedure	Expected Result	As expected?	Other/Comments
1	In the top navigation, click "Maps". OR Under Next steps of the Get Started page, click "Map Details".	You are prompted to the Map Gallery page.	Y N	
2	Review the map gallery.	One precompiled map gallery with four maps is presented.	Y N	
3	Review the maps in the map gallery.	Maps present a useful grouping of federal data sets.	Y N	
4	Click a map of your choice.	You are prompted to a Map page, displaying your selected map and other information (e.g., description, user tips, data services).	Y N	
5	Click the Details link at the top left-hand corner of the map.	Description of this map is displayed on the left side of the map.	Y N	
6	Click Legend link next to Details link.	The legend of this map is displayed on the left side of the map.	Y N	
7	Click the "+" or "–" icons at the top left-hand corner of the map.	The map zooms in or out as selected.	Y N	
8	Click the "Basemap" drop-down menu at the top right-hand corner of the map; select a basemap.	The map redraws to reflect the selected basemap.	Y N	

Task 4: Explore Additional Map Functionality

Purpose: Explore additional features of precompiled maps				
			Actual Result	
Step #	Procedure	Expected Result	As expected?	Other/Comments
1	From the map page (after a map has been selected from a map gallery), enter an address in the "Find address or place" window at the top right-hand of the map; click "Enter".	You are prompted to the desired address or place on the map.	Y N	
2	Click a color-coded area on the map.	A content box presents on the map and displays detailed information of the selected area.	Y N	
3	Click "Upload your transportation plan" at the bottom left-hand of the map.	A content box pops up, describing the acceptable data format.	Y N	
4	Click "Cancel" or the "X" icon.	The context box is closed.	Y N	
5	Click "Open Eco-Plan Advanced for more functions" at the bottom of the map.	A new browser tab opens in your browser, prompting you to the larger map on ArcGIS Online.	Y N	
6	Go back to the previous browser tab.	Open the map page on the Eco-Plan website again.	Y N	

Task 5: Review Eco-Plan Data

Purpose: Learn how to search for data and open data sets				
			Actual Result	
Step #	Procedure	Expected Result	As expected?	Other/Comments
1	In the top navigation, click "Data". OR In the main area of the home page, click "View Current Data".	You are prompted to the Data Gallery page, which is a compilation of data sets divided into 3 categories: Natural Environment, Cultural/Social, and Built Environment.	Y N	
2	Click a data set of your choice.	You are prompted to a "Data" page, which contains various information on the selected data set: Source, URL, Status, Description, User tip, etc.	Y N	

You have now completed Tasks 1–5, which are the tasks involved in the **Eco-Plan website** functionality testing. Thank you!

Please help us improve users' experience with **Eco-Plan** by filling out the following questionnaire, based on your experience testing the Eco-Plan website.

Eco-Plan Questionnaire

1. Which browser were you using while performing the tasks?
   ☐Chrome ☐Firefox ☐Safari ☐IE10 ☐IE9 ☐IE8 ☐IE7 or older ☐Other (Please specify)
2. How satisfied are you with the following aspects of the Eco-Plan website?

	Very Dissatisfied	Dissatisfied	Neither	Satisfied	Very Satisfied
2.1 Ease of use					
2.2 Usefulness of content					
2.3 Navigation					

3. How relevant are the theme maps on the Eco-Plan website to your transportation planning?
4. Is there any content or terms you find confusing?
5. What content or function do you like most?
6. What content or function do you NOT like?
7. What additional content or function would you like to have on the Eco-Plan website?
8. How would you use the Eco-Plan website in your planning efforts?
9. Do you have any additional comments or suggestions?

Please continue to Tasks 6–13, which test the functionality of the **Eco-Plan Advanced** web application.

Eco-Plan Advanced is an interactive ArcGIS Online portal with preloaded theme maps and data layers to help experienced users integrate state and local data and perform geoprocessing. Completing the Eco-Plan Advanced web application functionality testing tasks should take about 2 hours. Your feedback will help us to uncover issues with this tool and guide us to enhance the content and functionality.

Task 6: Create a Free ArcGIS Account

Purpose: Create an account in order to be able to create maps and manipulate geographical data				
			Actual Result	
Step #	Procedure	Expected Result	As expected?	Other/Comments
1	Go to https://www.arcgis.com/home/signin.html.	You are prompted to the ArcGIS Sign-In page.	Y N	
2	Click "Create a Public Account".	You are prompted to the "Create Your Account" page.	Y N	
3	Enter your details in all 9 fields (all are required).	Fields are filled in.	Y N	
4	Select "Identify Question" from the drop-down and enter the answer.	Answer field is filled in.	Y N	
5	Click "Terms of Use," read, click "I ACCEPT".	Pop-up clears.	Y N	
6	Click "CREATE MY ACCOUNT".	You are prompted to the "My Profile" page.	Y N	
7	Optional: Click "Edit My Profile" to make changes to the profile.	Edits to the profile are saved.	Y N	

Task 7: Create and Save a Map

Purpose: Create a map that will allow you to experiment with web-based geographical data				
			Actual Result	
Step #	Procedure	Expected Result	As expected?	Other/Comments
1	In your ArcGIS account, click "MAP" (top navigation).	You are prompted to the "My Map" page.	Y N	
2	Zoom in to find the area of your choice, or enter an address in the search bar (top right); be patient—it may take a few moments for the server to respond.	The map is showing the requested area.	Y N	
3	Click "Save," then "Save as"; enter a title, tags, and summary; click "SAVE MAP".	The pop-up clears; the name of your new map appears in the left-hand list of maps.	Y N	

Task 8: Select a BaseMap

Purpose: View a variety of geographical data available for your newly created map				
			Actual Result	
Step #	Procedure	Expected Result	As expected?	Other/Comments
1	From the top navigation, select "Basemap".	A pop-up window appears with several basemap options.	Y N	
2	Select one of the basemaps (and be patient—it may take some moments for the basemap to load).	If you see the following message: "Data is not available here at this scale. Try zooming out or mapping a new location," use the zoom-out tool (the minus sign) to zoom out; repeat until the basemap for your selected map is visible.	Y N	
3	Click "Save" (top navigation), select "Save" to save your map with the selected basemap; click "Save As" to specify a new name for this map.	Map is saved with the basemap data.	Y N	

Task 9: Find and Add Data

Purpose: Add data to your map or basemap				
			Actual Result	
Step #	Procedure	Expected Result	As expected?	Other/Comments
1	From the top navigation, select “Add”.	A pop-up window appears with four options.	Y N	
2	Select “Add Layers from the Web”.	A pop-up window appears.	Y N	
3	(3a) Select “an ArcGIS Server Web Service”; enter the following url: http://maps1.arcgisonline.com/arcGIS/rest/services/USFS_Ecological_Subregion/MapServer		Y N	
	(3b) Click “ADD LAYER”. Note: This particular layer displays the various ecological subregions within the U.S.	A layer of color (or several colors) appears on top of your basemap; the left-hand panel now displays a checked check box named “USFS Ecological Subregion”.		
4	In the left-hand panel, uncheck the “USFS Ecological Subregion”.	The colorful layer depicting the ecological subregion is removed from the basemap.	Y N	
5	Click “Save” (top navigation), select “Save” to save your map with the newly added layer; click “Save As” to specify a new name.	Map is saved with the layer data.	Y N	

Task 10: Change Basemap

Purpose: Change the basemap of your map				
			Actual Result	
Step #	Procedure	Expected Result	As expected?	Other/Comments
1	From the top navigation, select “Basemap”.	A pop-up window appears with several basemap options.	Y N	
2	Select one of the basemaps—different from the one you selected under Task 3 (and be patient—it may take some moments for the basemap to load).	The new basemap is now visible.	Y N	
3	Click “Save” (top navigation), select “Save As,” and specify a new name for this map.	The new map is saved with the basemap data.	Y N	
4	Check to verify that any previously added layers are still functional on the new basemap. You may need to add them again (see Task 9).	Previously added layers are functional with the new basemap.	Y N	

Task 11: Change Transparency

Purpose: Change the transparency of your basemap or a layer				
			Actual Result	
Step #	Procedure	Expected Result	As expected?	Other/Comments
1	In the left-hand panel, make sure your USFS Ecological Subregion layer is checked.	USFS Ecological Subregion layer is active.	Y N	
2	Click the down arrow to the right of the map name (or layer name).	A menu pops up.	Y N	
3	Select “Transparency”.	A small slide menu pops up, where “Opaque” is 0% and “Transparent” is 100%.	Y N	
4	Slide the slider to 50%; click the map.	The slider pop-up clears and the basemap (or the selected layer) is more transparent.	Y N	
		Note: You may need to zoom in or out in order for the new transparency setting to appear.		
5	Optional: save your map with the new transparency setting.	The map is saved with the new transparency setting.	Y N	

Task 12: Change Visibility Range

Purpose: Change the visibility range of your map				
			Actual Result	
Step #	Procedure	Expected Result	As expected?	Other/Comments
1	In the left-hand panel, make sure your USFS Ecological Subregion layer is checked.	USFS Ecological Subregion layer is active.	Y N	
2	Click the down arrow to the right of the layer name.	A menu pops up.	Y N	
3	Select “Set Visibility Range”.	A small window pops up, displaying “Only show this layer when zoomed” and two entry fields.	Y N	
4	From the top drop-down, “In closer than,” select “1:12,000,000 (Country)”; from the bottom drop-down, “Out further than,” select “1:20,000 (Neighborhood)”; click the map.	The pop-up window clears.	Y N	
5	Zoom out until the entire U.S. is visible.	The USFS Ecological Subregion is not visible, since it is outside the range you indicated in step.	Y N	
6	Zoom in closer to your region.	The USFS Ecological Subregion is visible again.	Y N	

Task 13: Find an Existing Eco-Plan Theme Map and Save It Locally

Purpose: Find an existing Eco-Plan theme map and save it locally				
			Actual Result	
Step #	Procedure	Expected Result	As expected?	Other/Comments
1	In your URL window, enter one of the following URLs (and be patient—it may take a few moments for the server to respond): ■ http://bit.ly/1em8jjM (Critical Habitat and At-Risk Species) ■ http://bit.ly/1em6Yt0 (Protected Areas and Boundaries) ■ http://bit.ly/1em7J5n (Watersheds and Wetlands)	The existing Eco-Plan map is visible on your screen.	Y N	
2	Click "Save" and select "Save As"; specify a new name for this map.	The Eco-Plan theme map is saved in your local account.	Y N	

You have now completed Tasks 6–13, which are the tasks involved in the **Eco-Plan Advanced** web application functionality testing. Thank you!

Please help us improve users' experience with **Eco-Plan Advanced** by filling out the following questionnaire, based on your experience testing the application.

Eco-Plan Advanced Questionnaire

1. What functions of Eco-Plan Advanced do you like most?
2. What additional functions would you like to have on Eco-Plan Advanced?
3. How would you use Eco-Plan Advanced web application in your planning efforts?
4. Are the differences between **Eco-Plan** and **Eco-Plan Advanced** clear to you?
5. Do you have any additional comments or suggestions?

APPENDIX I

Test Results

1. Usability Testing

- Nine sessions scheduled.
- Six sessions conducted with participants from Colorado, Texas, Washington State, California, and Missouri.

Table I.1 lists participant numbers, testing dates, and organizations involved in the usability testing.

The findings from the usability testing are listed below. The more significant issues are bolded.

Home Page

- Participants liked the visual appearance and simplicity of the home page.
- It was not clear to some participants how to get started from the home page. There was a Get Started link at top, and also three compelling calls to action in the center area.
- After reading the description of Eco-Plan and Eco-Plan Advanced at the bottom of the home page, **many participants had the impression that Eco-Plan was free and Eco-Plan Advanced was paid.** Therefore, they hesitated to learn anything more about Eco-Plan Advanced.

Get Started

- Compared with the theme maps, participants liked the ability to quickly flip through different maps on the Get Started page.
- Several participants suggested the capability to overlay multiple theme maps on one view. For example, users can see both protected areas and endangered species on the same map.
- The seven accordion panels were not always successfully loaded. Some participants saw only the first four panels.
- A couple of participants did not realize that the first panel was already opened by default, and wondered why the first panel was not clickable.
- Several participants complained that the legend, when expanded, blocked a large area of the map.
- There were too many colors in the legend. It was difficult for participants to distinguish the different shades of green or blue.
- One participant pointed out that the colors could not be recognized by color-blind users, like someone in her organization. She suggested showing the data type not only in the legend, but also in the pop-up box.
- It was not apparent to participants that the colored areas on the map were clickable.
- Most participants did not notice the left and right arrows in the pop-up box at the beginning. Some found the arrows after seeing "(1 of 5)" at the top bar.
- It was confusing to participants that clicking on an area did not always pop up a content box with information in that area. Sometimes it showed information about the county that this area belonged to.
- Participants pointed out that not all the data in the pop-up box were useful, such as IDs and distribution policy. One user suggested distinguishing the data for its owners and public users.
- Population was mentioned as a helpful addition to the pop-up content box.

Maps

- Most participants didn't understand the differences between the maps on the Get Started page and the maps on the gallery page. Their impression was that the gallery-page maps must be somehow different from the maps on Get Started.
- The title "Map Gallery" made many participants feel that this section had just static map images or examples.
- Participants did not understand how the maps were grouped together and suggested gallery titles that would be more descriptive than "Gallery 1," "Gallery 2."
- It was easy for all participants to locate options at the top of the image, such as Details, Legend, Basemap, and Search box. In the meantime, **most participants paid little attention to the three links below the map.**

Table I.1. Participant Data from the Usability Testing (2013)

Participant Number	Testing Date	Organization
Participant 1	February 11	North Front Range Metropolitan Planning Organization
Participant 2	February 11	North Central Texas Council of Governments
Participant 3	February 12	North Central Texas Council of Governments
Participant 4	February 17	ICF International
Participant 5	February 18	California Department of Transportation
Participant 6	February 18	East-West Gateway Council of Governments

- Most participants wondered if they could filter the data through the legend.
- The map did not indicate which basemap was currently presented.
- Several participants mentioned the text below the map was helpful. Some suggested making it more accessible, like moving it above the map.
- Most participants were able to locate the link of "upload your transportation plan" on Map Details or Get Started page. **Some would like to upload multiple Shape Files or project data in different formats.**
- The level of detail of the map data seemed all right for novice users but not sufficient for expert users. One participant particularly mentioned that he would usually look at high-resolution maps at less than 10-ft scale.
- Expert GIS users found that the theme maps did not offer additional data that they didn't have in their organization or could not be found elsewhere.
- Many participants would like to have more theme maps.

Data

- The first paragraph introduction test on the Data Gallery page was confusing to most participants who read it. They didn't know what "the Integrated Ecological Framework" was, and the last sentence in the paragraph was not straightforward.
- Some participants expressed that they expected to view data and maybe images of the data/map on the details page, but found only metadata on the Eco-Plan site.
- The metadata on the details was helpful. Participants were particularly interested in the publication date and how often the data set was updated.
- Presenting the connections between the data sets and the theme maps on the Eco-Plan website would be helpful for many users.

Eco-Plan Advanced

- Most participants saw the descriptions about Eco-Plan and Eco-Plan Advanced on the home page but didn't clearly understand the connections and differences.
- Several participants thought Eco-Plan Advanced was the paid version of Eco-Plan, so additional functions were available there.
- The page title of the Eco-Plan Advanced home page was "Eco-Plan." Most participants who navigated to this page thought they were still on Eco-Plan.
- When they were on the map details page of Eco-Plan and were looking for additional functions like filter and share, they could not find these functions. Neither did they intend to click "Open Eco-Plan Advanced" link, because the page didn't indicate what was available there and users didn't recall what they read on the home page at this moment.
- Participants who were familiar with ArcGIS wondered what the differences were between Eco-Plan Advanced and ArcGIS.
- Participants found that the filter, share, print, and search function and being able to view a larger map were all very useful.
- The function to export or download data from a map was suggested by a few participants. Some would export/download the data and customize the format of presentation with their desktop tools.

2. Functionality Test Feedback

Figures I.1 through I.3 summarize the functionality test feedback. Tables I.2 through I.6 summarize the responses to the test questionnaire and comments on the scripts for the Eco-Plan Test and the Eco-Plan Advanced Test.

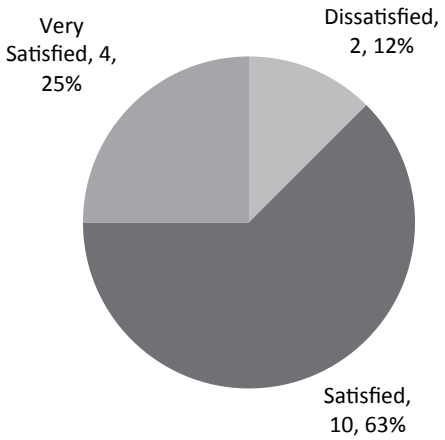

Figure I.1. Ease of Use question results.

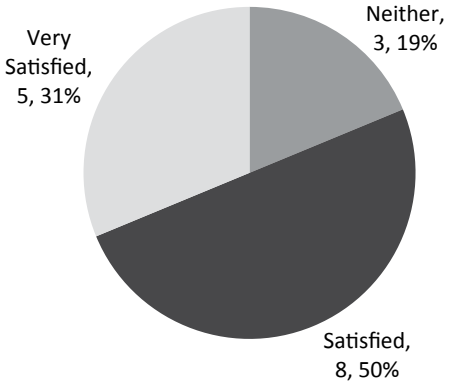

Figure I.2. Usefulness of Content question results.

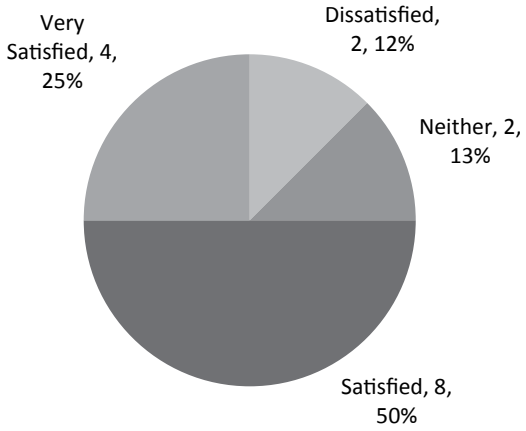

Figure I.3. Navigation question results.

Table I.2. Summary of Responses to Test Questionnaire

Eco-Plan	Count
Relevancy of the theme maps to your transportation planning	
Relevant	11
Already use the data	1
Too coarse	1
Relevant but some issues	1
Confusing content or terms	
Yes	5
No	6
Initially confusing	1
What do you like most?	
Information and Data	6
Ease/Simplicity	4
Getting Started	3
Maps	2
Speed	1
Design	1
What do you NOT like?	
Theme maps	2
Map legend	1
Map search not working	1
Map gallery	1
Navigation	1
Additional content or function you want	
Different data	4
Add maps to ArcDesktop	1
More layers	1
Keep location across pages	1
Geoprocessing tools	1
Dynamic legend	1
Full-screen maps	1
How would you use this site?	
Preliminary scoping	6
Data	2
Overview for nontechnical audience	2
Won't use	1
Eco-Plan Advanced	1

Eco-Plan Advanced	Count
What functions do you like most?	
Interact with maps and add data	7
Save own maps	3
Add own data	3
Data	3
Speed	2
Basemaps	1
Ease of analysis	1
What additional functions would you like to have?	
Link accounts	1
Sketch or draw	1
Export layers	1
Additional symbology	1
Attribute tables	1
Default to my location	1
Create communities	1
How would you use Eco-Plan Advanced web application in your planning efforts?	
Share maps	3
Create maps	2
Upload data	2
Develop LRTP	2
Find areas of concern	1
Basic corridor planning	1
Browse layers	1
Are the differences between Eco-Plan and Eco-Plan Advanced clear to you?	
Yes	14
No	0
Maybe	1

Table I.3. Comments on Eco-Plan Test Scripts

Tester #	Task 1: Review the Eco-Plan Website	Task 2: Get Started	Task 3: Review the Map Gallery	Task 4: Explore Additional Map Functionality	Task 5: Review Eco-Plan Data
Tester 1		Would recommend removing Alaska/Hawaii specific legend info or putting it after that of the lower 48.		Location search not working. Map defaults to Surry County, NC.	
Tester 2	Yes, page is well organized.	The content box did not pop up. It appears this row is not active. When I hovered the mouse above this selection, it did not highlight like the other cells in the column. Can you put some information here to define "linear features" and "polygon features"?		Did not see "Find address or place." A window appears, but no content was in the window and does not respond when clicked.	There is no "data" option in the top navigation window.
Tester 3	Appears okay. Not great but not bad.	This was confusing because the "accordion" does not always show.	Yes, but maps don't correlate with each other. Each one starts off somewhere else.	Not immediately. Does not say if it is still processing. Appeared dead.	
Tester 4	Looks nice; logical categories.	Maybe not "upcoming" anymore. Can scroll around map and zoom in and out.	The Details and Legend links are a bit hard to find.	Zoom worked, but the map lost the landcover display—GAP displays up to the 2 mi. scale. The address function did not work for the watershed map, critical habitat map, or protected areas map. Worked on one map that I tried (Protected Areas), but then the cursor was stuck on identify and I couldn't move around the map or zoom. The identify function did not work on the GAP map. "Upcoming feature" pop box will allow user to upload a shapefile.	

(continued on next page)

Table I.3. Comments on Eco-Plan Test Scripts (continued)

Tester #	Task 1: Review the Eco-Plan Website	Task 2: Get Started	Task 3: Review the Map Gallery	Task 4: Explore Additional Map Functionality	Task 5: Review Eco-Plan Data
Tester 5	The banners at top are too big; can't get whole page on one screen without scrolling past them. Should at least be able to keep the drop-down menus on screen and look at map. Maybe put the EcoPlan banner on the left side? Suggest drop-down menus from the top level click-ables. Then a user can more easily map the site.	No content box pops up. Can scroll the map to my area. Note that the protected areas color (reddish) is the same as the letters used to name the protected areas. So, hard to read because on top of each other. The legend should state what vegetation map is used. It's just called USGS landcover. But, is that the NLCD? Is it National GAP? Is it NatureServe? The species for critical habitat are not defined. I like the clickable data! There was no housing + jobs layer, at least for the southern Bay Area section I was looking for. You have the road density, which is good. I would remove reference to the activity density unless you can include it. I would put the road density above the protected area status in your web description. The text names "Map Details," but the drop-down menu at top says "Maps." I'd use the same term in both places.	Need a sentence at top of Map Gallery telling people how to use the page, similar to the home and get started pages. Gallery 1 maps seem good. Gallery 2—I think you already found the bug. A couple days ago, you could only see some of the layers that were in there. Generally it was difficult to look at road density and activity density at the same time, and activity density seemed to not be working. You could leave it with road density, for a transportation planning. Now road density seems to be missing. I like the clickable format to get info, but somewhere near the top there needs to be instructions that some layers need to be zoomed in before they can be seen/used. In the current (2/14) version, I see that the road density is still in the "details" section, but no longer in the legend.	Yes, but see notes above on mouse functionality and on having more than one land-cover or colored set of data (grids or polygons). No current upload capacity The UCD team has particular interest in working with this function because it will allow comparison of what we found vs. what's in national data sets. It might be a lot of work, but it might be nice to provide a thumbnail image of each data set—both for the zoomed out view and the detail view.	

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Table I.3. Comments on Eco-Plan Test Scripts (continued)

Tester #	Task 1: Review the Eco-Plan Website	Task 2: Get Started	Task 3: Review the Map Gallery	Task 4: Explore Additional Map Functionality	Task 5: Review Eco-Plan Data
			I like that you removed the labels for the critical habitats; they were previously in red, and unreadable on top of a red background. Suggest you determine the 3 to 4 things people can do on the web version of map crawling, and have a short written instruction for those, maybe as another button next to "details and Legend." This would be different from the "how to use" that is buried in the text. I think that section should include (as it does) things about how to add data, to go to ArcGIS online, types of analyses that can be done, etc. The button on the banner would tell people, "zoom in to see some data layers," "click on locations to get data," "scroll by . . ." things like that. Gallery 3—suggest you rank the protected areas by area protected, or at least put the big 3 federal at top—NPS, BLM, USFS . . . possibly followed by other federal, then by state, and then by other. Same for National Map Gov Units. Gallery 4—it's neat that the HUC units vary with the level zoomed in or out, but this is not clear in the legend. Needs to add wording like "varies with scale" or something.		

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Table I.3. Comments on Eco-Plan Test Scripts (continued)

Tester #	Task 1: Review the Eco-Plan Website	Task 2: Get Started	Task 3: Review the Map Gallery	Task 4: Explore Additional Map Functionality	Task 5: Review Eco-Plan Data
			When scrolled out, the mouse stayed on "click," calling up the Huc level and also scrolling the map. This is a glitch. Suggest that you use right mouse click to get info, and the left mouse click to navigate the maps. Doesn't seem to work to have them both on the same command. Or, have an "info" button in the banner that switches the mouse from navigate to data retrieval mode. Generally, there is work to clean up this legend as well. Right now the watermonitoring icons jump out more than anything else. It this the thing that should be at the top of the Legend? What does "High Resolution" mean? How do you toggle between the USFWS categories and the many other, non-identified categories? That mouse glitch is really annoying! See above. Ok, but why two sets of streets? What does "oceans" mean? Generally I think more attention to the text communication would improve user utility.		
Tester 6	Looks good.	There were no links to click that I could see. I don't know if this is possible, but it would be nice to be able to turn off and on the gov. units. The land cover overwhelms everything else on the map. How are the classifications done in the legend? The splits seem kind of random. I don't see this (View Watershed and wetlands maps). I don't see this (Review the potential for development in unprotected areas). I don't see this (Next steps).	Are there supposed to be maps in galleries 3 and 4? And why are there multiple galleries? Is there a significance to them? Maybe bold the data set names or something here to make them stand out more.	Despite all the addresses/places here, the map only seems to take you to selected places. Is there a place to go to view the metadata? If not, it is hard to decipher what the field names mean. "Cancel" was not found, just "X." Error message when trying to draw one of the layers.	I don't see "View Current Data."

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Table I.3. Comments on Eco-Plan Test Scripts (continued)

Tester #	Task 1: Review the Eco-Plan Website	Task 2: Get Started	Task 3: Review the Map Gallery	Task 4: Explore Additional Map Functionality	Task 5: Review Eco-Plan Data
Tester 7			User tips, things to be aware of, and source links are extremely helpful for users. Good job adding those! This is a helpful feature and will make the data and site more usable.	I searched for "Saint Louis, Missouri," and an option for that location was available. I selected it, but it did not zoom me to selected area. Not sure if it's supposed to zoom me to queried location, but I would expect it to.	
Tester 8		Link is broken or option is not completed. I also had difficulty scrolling down past #4 once I went out and came back to the page. I'm not sure if this is a problem with the program or an internal error with our server/Internet. The layer works fine, but the data are coarse. It was hard to see anything at the default scale. It was also difficult to distinguish some of the colors (e.g., shades of green). However, the ability to zoom in and data provided by the pop-up tables when you click on the individual features (e.g., wetlands) was very helpful and provided the information I was looking for.	"Maps" loads, but it takes a while. The delay was long enough to make me think that the link was broken.	I'm not sure if this is working properly. The content box comes up, but only says that the feature is coming. It does not mention the acceptable data format. Slow in opening on my computer, but there were Internet issues earlier in the day. In addition, I had an error message in trying to load the Layer STORET Water Quality Monitoring Locations. The message said at first, the layer was not responding and then that the layer could not be added to the map.	
Tester 9		No need to click on this. When starting on the "Get Started" page, it's already open. Maybe this is a limitation of the data, but this is not showing the types of species. At the original extent, the legend suggests that I should see a lot more; it's not the case until I zoom close in.	My only issue is that the maps are very narrow.	A drop-down box with suggested addresses shows up, but I am not taken to the place I inputted. Pop-up comes up with "Upcoming Feature." In IE8, a new browser opens up.	
Tester 10	I think that Eco-Plan and Eco-Plan + should be more visible, so the information on the page should be vertical and not horizontal.	The map should be the U.S. so that the user does not have to do so much manipulation. I did not see the question or request for an email I do not find this information very useful.	The layer came up, but because there are two layers of information "at-risk species"—and critical habitat—one of the layers needs to be more transparent. Also, it would be great if there was a way to enlarge the map.	The map does not go to the address. The text box sits over the area so that changes that come up as different information is presented on the map; it is obscured by the text box. Not yet. It is really step 7, and then I would have to know to open it and look for Eco-Plan Advanced.	

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Table I.3. Comments on Eco-Plan Test Scripts (continued)

Tester #	Task 1: Review the Eco-Plan Website	Task 2: Get Started	Task 3: Review the Map Gallery	Task 4: Explore Additional Map Functionality	Task 5: Review Eco-Plan Data
		The critical habitat mapping is variable—sometimes it comes up—sometimes it does not and often it is not correct—at-risk species is not helpful. It blends those with legal protection and those that do not, which does not provide very good data to an environmental planner. There were no wetlands shown on the map. The critical habitat layer is too variable and inaccurate—it works fine on ECOS and IPaC so not sure that issue is here.	Yes—helpful because after I read this description, I realized that NatureServe layer is not helpful because too generic and G1/G2 mean nothing to me. The results of the analysis by NatureServe of species that are Imperiled (G1/G2) or listed under the U.S. Endangered Species Act (ESA). The At-Risk layer does not identify which species are endangered, only the number of at-risk species within each 12-digit Hydrologic Unit (HUC).		
Tester 11		Doesn't work. This is really ownership. How is "city land" protected? It isn't owned by the city. Is it possible to have the legend sensitive to what is visible in the map? There is a lot on "land cover" that doesn't retain. Geography search—i.e., Colorado, rather than zoom in/out on map.	An indicator telling you which basemap is depicted would be helpful. And a ✓next to the selected map in the drop-down so you know where you are.	Doesn't work. Stayed at default location.	
Tester 12	I think the home page looks very nice and not too much information for the user to sift through and decide where to go next. The content at the top and options are self-explanatory and correlate to what a user might be looking for. Right off the bat without clicking on it, I wasn't sure what "Systems" means though.	No, if you click on the "Coming Soon: Upload your Transportation Plan" in the upper right corner, a pop-up box is displayed that describes the upcoming feature and asks for an e-mail message. Yes, this works, but when you click on a polygon of at-risk species, the attribute table that pops up is hard to understand what each abbreviated attribute is. Example: AQ_TOT, WT_TOT, etc . . . . not sure what these mean?		I put in an address in the search box and could not get anything to come up on the map. It finds the address when I type it in but does not display on the map.	

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Table I.3. Comments on Eco-Plan Test Scripts (continued)

Tester #	Task 1: Review the Eco-Plan Website	Task 2: Get Started	Task 3: Review the Map Gallery	Task 4: Explore Additional Map Functionality	Task 5: Review Eco-Plan Data
		Yes, this works, but when you click on a polygon of housing + jobs, the attribute table that pops up is hard to understand what each abbreviated attribute is. Also—why is the Critical Habitat in Step 4 not displayed in addition to the US Protected Areas, and USFWS Critical Habitat? It seems all of those would be important to determine risk of development.			
Tester 13		No e-mail prompt. Legend link could be bolder. Pop-up often blocks part of watershed, or blocks part of Legend. Hard to discern whether USGS Protected areas, NPScape Road Density, or SmartLocationDatabase is displayed. Perhaps use different "families" of colors for 3 data sets.	Legends should be accessed the same way on all maps. Once left-clicked, the map moves with pointer until you right click. If you then move the pointer off the map and back again, pointer still moves the map. Link Upload your transportation plan misspelled. Number of terrestrial animal species: Obed River HUC_12 060102080305 For example, obscures entire watershed until zoomed out. I would recommend "light gray canvas" as default.		
Tester 14	Good color. I like the layout, as it is clear, concise, and easy to navigate. It draws the eye to the various parts of the home page.	I didn't see an e-mail message about the usefulness of this feature.	Will you be renaming the galleries? Are you separating the maps into categories? Happy with the speed of the map showing the details in the current extent as you zoom in and out.	Limited address/place finding ability. I was unable to find places/addresses in Alaska and Oregon. I was able to find places in Kansas and Missouri. The first three details in the box are a little confusing, and I would suggest maybe not showing them or renaming them. The next two—Source_DataDesc and Source_Originator—should be renamed as well. I am excited for this feature to be enabled. I like that you are using the ArcGIS Online.	
Tester 15	Nothing happens when you click on "Access GIS Systems."	Not able to click on "Find your area or load your project." Nothing happened. No content box popped up. No message about sending an e-mail.	Recommend adding a description of what users can do with this page (i.e., look at map details).	Search function does not work. You can enter a location, but the map doesn't change. I tried several locations in the U.S., and the map never changed.	

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Table I.3. Comments on Eco-Plan Test Scripts (continued)

Tester #	Task 1: Review the Eco-Plan Website	Task 2: Get Started	Task 3: Review the Map Gallery	Task 4: Explore Additional Map Functionality	Task 5: Review Eco-Plan Data
		The "Map Details" link takes you to the Map Gallery—is this where it should take you? Map details vs. map gallery could be confusing. Recommend making more consistent. Or at the top of Map Gallery, state that people can click on a gallery to see map details. "Eco Planned Advanced" takes you to an ArcGIS online webpage and shows the same layers that the getting started map does. Is this meant to direct you somewhere else?		Link to "Upload" works, but there is not a pop-up that describes the data formats. I think this is an upcoming feature?	
Tester 16	Page displayed as expected. Testers need clarification of what the third major icon refers to. Is it the AGO? Is it the limited number of data sets available via ICF/host server?	Typo first sentence, delete "or." Panning is only search option. Search field would be nice. We did not see this feature/ did not work. Panning refresh is slow. No scroll bar on legend. Labeling obscures protected areas. Labels do not align when scaling. Cannot determine protected areas. St. Louis County mislabeled. (St. Louis City is not in St. Louis County.) Include in the legend only values displayed in the project area. Too clunky to be used by some to get an overview. Why just terrestrial fauna? Why not plant and aquatic? We clicked on HUC label and got info. More icons to choose from. Tried clicking on dot. Got info. Hand does not appear when hovering over an icon we want to click on, i.e., water quality monitoring sites. Or automatic label pop-up would be good. Green blobs are protected—poorly explained in legend. Identify tool needed. Would be nice to select just one color in the legend. Display box often cut off by window. "Map Details" takes you to "Map Gallery." Titles should be the same.	User knows what you are starting to look at, when you click on the map. The Get Started section doesn't have enough information as to what you are looking at. Had to go to the legend. Legend wasn't well defined. Very focused and direct for low end users. More advanced users will go to AGO. Not as jumbled. Framing, navigation good. Drawing a box option to select project area would be good selection tool. Works; provides the explanation. Need legend narrowed to data that is present. The scroll bar nice. The legend for Critical areas does not include what the red lines indicate. Seems more responsive than previous. Basemaps not loading. Now it did, just took a while. Typo transportation plan. Testers like the text below map. Description of data is good. This is more logical and user friendly.	On protected areas and boundary theme. Can you make map full screen? No. Box doesn't work—could not find Belleville, did not find St. Louis. Site locked up. Hand over clickable feature would be good. Navigated to St. Louis region. Would be more helpful if protected area was first record that popped up rather than state, etc.; rearrange layers. Falling spring. Good explanation of data. Edit to read "Upload your transportation plan shapefile." Nothing being displayed. Directory of web service links is useful. Testers feel we would be more likely to use this feature, but we know what we are looking for. Users could look through the data to see the general area a project is in and to see impacts. Or someone without a lot of GIS support could use this. Small RPCs in Missouri would benefit from this feature; they currently use MSDIS for GIS support.	

Table I.4. Responses to Eco-Plan Questionnaire

Tester #	Browser	Ease of use	Usefulness of content	Navigation	Relevancy of the theme maps to your transportation planning	Confusing content or terms	What do you like most	What do you NOT like	Additional content or function you want	How would you use this site	Additional comments or suggestions
Tester 1	Firefox	Satisfied	Very Satisfied	Satisfied	The maps are relevant to those looking for information on the environment and habitats.	No	The ease of use and the speed at which the map widget works	I would like to be able to move the legend on the getting started map widget. The button and the legend are large enough that they obscure a large portion of the map frame.	It would be nice to be able to search and add the pre-made map galleries maps via Arc Map Desktop.		
Tester 2	IE10	Very Satisfied	Very Satisfied	Very Satisfied	I noted the need to define "linear" and "polygon" features on the critical habitat layer map.	Noted above	They are all very good. The ability to zoom into an area is probably my favorite.	na	More layers	As a source of existing data to alert us to areas of concern	No, I would need to use the tool more.
Tester 3	IE8	Dissatisfied	Neither	Neither	They are relevant. How do you get to others? Will they be preloaded or do you have to go load?	"Accordion" initially	Maps	Search. Does not go where you ask it to go.	Maps should track so when you switch from one map to another you are in the same location.	Not at this stage	
Tester 4	IE10	Satisfied	Satisfied	Neither	The Critical Habitat map seems the most relevant. The other maps all show layers I already access in my GIS at work.	The pop-up content boxes that appear when you click on an area in the map are confusing—they appear to be taken directly from the attribute table with no changes made to the field names. Ex. Number of Terrestrial Animal Species 4-23 (legend) when you click on an area on the map, it is unclear which field is being used to populate that area. Is it TR_TOT_A? Hard to discern. Also, can we see which species are included in that? Or at least which category the species is in (ex. federally listed as threatened? endangered?)	The "Get Started" function is nice and easy to follow, especially for novice GIS users. Once you can upload your transportation plan, it would be even more useful for experienced users. Also, the data portal is well organized and pretty comprehensive.	The Map Gallery is not something I would likely use. The zoom wasn't working well and the information is not as useful for the analysis I would be doing.	Some geoprocessing tools would be great.	I would recommend the website to people who want preliminary scoping for projects who do not have access to GIS. I would check the data portal for possibly tracking down useful data I don't already have.	
Tester 5	IE10	Satisfied	Satisfied	Dissatisfied	I'm a university user. They seem relevant.	See comments in table.	I like the scalability, the info from the clicking; colors are pretty good.	The linking of data retrieval and navigation to the mouse caused the site to hang in some cases.		Remains to be seen with the data upload capacity	See above. Some further work on legends would make them more informative.
Tester 6	IE11	Satisfied	Satisfied	Satisfied	They seem pretty relevant.	See comments above.	The collection of data sets assembled to date				
Tester 7	Chrome	Satisfied	Satisfied	Satisfied	na	No	I like the explanatory information and metadata provided so that users know what they are looking at and the limitations of the data. Simplicity of use is helpful to the novice or non-GIS user.			na	

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Table I.4. Responses to Eco-Plan Questionnaire (continued)

Tester #	Browser	Ease of use	Usefulness of content	Navigation	Relevancy of the theme maps to your transportation planning	Confusing content or terms	What do you like most	What do you NOT like	Additional content or function you want	How would you use this site	Additional comments or suggestions
Tester 8	IE10	Satisfied	Satisfied	Satisfied	They are relevant for showing some general information and concepts. However, the data are very broad and coarse and would be of limited use if we couldn't add local data and/or themes from the advanced version.				The ability to add your own data and maps. It'd be fine to work from the advanced platform and save to the basic platform.	The website would be helpful for providing an overview of resources on a broad level for nontechnical personnel. The data provide a decent overview, but would be of limited use given the wealth of information/data we have in Southern Oregon. However, if we could upload our local data to the Eco-Plan Advanced, that would be incredibly useful. We would use this platform to share the database we created for the pilot project, maps, results, and other relevant information. In addition, there are other applications that we are likely to test our process on and envision using this as the end user interface.	
Tester 9	IE8	Very Satisfied	Satisfied	Satisfied	Maps are relevant. However, there may be the need for additional themes.	No	I like the availability of online data, and the mixture of background data is helpful to help clear up some of the data.	Opening a map file that I saved took a little work and was not readily evident on where it was saved. The data is not consistently in the correct location and moves as the image is changed.	The legend is too long to be useful. Having the legend reflect only what is shown on the screen would be helpful.	I would use Eco-Plan for presentations, some research, and sharing maps with other people on the project.	I would like to see a zoom window so that one can select an area and zoom in.
Tester 10	IE8	Dissatisfied	Neither	Dissatisfied	For early planning, the most important maps to me are ones that could slow down or force a change in the alignment—critical habitat needs to be a map on its own and specifically identify the species. Wetlands are important, and they did not show, and they are key as well.	None	I like the simplicity of Eco-Plan, but the two key features are not available for testing so not sure how it will ultimately work.	I do not like combining critical habitat with "species at risk"—I do not think that species at risk is helpful at all because some are protected and some are not, so it does not really inform the planning process.	A wetland map and a map of threatened and endangered species. The critical habitat could be combined with T and E species; however, since critical habitat only applies to federally funded projects, it may be good to be separate.	To determine whether a proposed alignment may need to be shifted. To anticipate potential resource agency concerns. To plan ahead for potential mitigation.	
Tester 11	Chrome	Satisfied	Satisfied	Satisfied	They cover the main themes within our transportation plan.	How do you know what the initial Basemap is?	Eco-Plan Advanced	Basemaps create shading that alters other data.	Export a map to jpg or pdf.	To identify environmental items in the planning process	Can you export a map?
Tester 12	IE9	Very Satisfied	Very Satisfied	Very Satisfied	I think they are relevant, but I think they will be even more relevant if this website was fully functional and allowed users to upload shapefiles, etc.	I think some of the layers that have very large attribute tables with a lot of abbreviations are hard to understand what they mean without going to the "Maps" and learning what they are.	Easy access to all data sets that are important in one location and knowing they are the most recent version. Also, I like the idea that all users will have access to the same data from the most recent update and transportation planners would be looking at the same data that resource agencies/regulatory agencies would be looking at. This is great from a consistency standpoint. I also like the functionality and descriptions of the Get Started map and the gallery maps.		Has the NEPAssist tool offered through EPA been considered to be added to this site somehow? That tool provides a lot of data; some similar or the same data but some additional data like soils, nonattainment areas, EPA facilities, demographics, etc.	We would use the website during creation of our Metropolitan Transportation Plan, individual project and corridor studies, and other transportation planning efforts such as bike/pedestrian planning. I think we would be interested in the Advanced version where we can load lots of local data such as our Regional Ecosystem Framework, parks, conservation areas, etc. I also think that local partners such as cities/counties would be interested in this tool in addition to resource agencies and conservation NGO partners.	I would suggest having a few resource agencies/regulatory agencies test this tool also. I think the benefit of a tool like this is that it is easily accessible by many people and could be added to very easily by users who know of other helpful data and information and improve functionality for agencies that don't have the expertise or money to have their own GIS staff or resources.

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Table I.4. Responses to Eco-Plan Questionnaire (continued)

Tester #	Browser	Ease of use	Usefulness of content	Navigation	Relevancy of the theme maps to your transportation planning	Confusing content or terms	What do you like most	What do you NOT like	Additional content or function you want	How would you use this site	Additional comments or suggestions
						Under the "Data" tab there is Natural Environment, Cultural/Social, and Built Environment, but I don't see the Social and Built Environment data sets available through the "Get Started" or "Maps" tab. Is this just listing out data but not really to be integrated into the "Get Started" Map? It looks like the Get Started map is for very basic ecological/natural environment data, whereas the Data site will link you to other types of data that can be accessed through the Eco-Plan Advanced. Is that correct?			What about the National Conservation Easement Database data being added? It's important to know what conservation areas are already protected, and this is a national database that could be accessible by all and then locals could load their own data (parks, etc.) in the Advanced tool for a more holistic protected lands map. Also—What about data from RIBITS, the USACE new GIS tool for mitigation banks? This gets to the mitigation side of projects and planning, but these are also protected lands that are important to know when doing planning.		
Tester 13	IE10	Satisfied	Very Satisfied	Satisfied	Very relevant	Colors indicated in legends sometimes difficult to differentiate.	Ecosystem layers	Watersheds	Population density	Yes	Only to rethink the color palettes of individual data sets, so that they are not too similar. Easier to see data initially on the light grey background.
Tester 14	Chrome	Very Satisfied	Very Satisfied	Very Satisfied	Very relevant. As a Planner, our job is to help communities identify projects in their area or planning for the future projects and when they will be necessary. These maps will help us to identify if there are any potential impact areas at the start of the process.	No, and if there was I would look it up online.	The interactive parts of the maps. I also like being able to add in our own transportation plan or project for impacts.	So far, nothing.	Well, if you can get everything up and running; as you have it laid out now I am not sure what else we would need.	As explained above, I would use it at the start of projects or during transportation plan updates/ starts.	I really enjoy the massive amount of information you have on the various pages, such as the information provided under the interactive maps. I wonder if this would be confusing to normal users? Is there a way to put some of the titles and information into a collapsible format, so you have to expand to see more? I am looking at the Data Services section specifically.
Tester 15	Chrome	Satisfied	Neither	Satisfied	The wetlands, critical habitat, and protected areas are useful.				Hazardous/contaminated sites, invasive species, anadromous streams, air quality non-attainment areas, mileposts	As an environmental analyst for Alaska DOT, I analyze various resources, land uses, species, etc., when preparing an environmental document. Though I still go out and ground truth resources, it is helpful to have a mapping program that can give me an idea of what I should be looking for or what is in the vicinity of the project area.	

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Table I.4. Responses to Eco-Plan Questionnaire (continued)

Tester #	Browser	Ease of use	Usefulness of content	Navigation	Relevancy of the theme maps to your transportation planning	Confusing content or terms	What do you like most	What do you NOT like	Additional content or function you want	How would you use this site	Additional comments or suggestions
Tester 16		Satisfied	Satisfied	Satisfied	The theme maps were good. However, testers noted some of the data were not up to date. That could be a result of state agencies not reporting updates in a timely manner. While testers benefit from a work place with a dedicated GIS staff, other smaller planning organizations would benefit from real-time access to the data.	The "Get Started" page was very clunky with limited map functionality. The difficulty of use led the testers to confusion as to need of the tool. If "Get Started" is the first thing a new user encounters, it could turn them off. The testers had trouble understanding the need for the Get Started page. If the intent is to walk people through the steps of overlaying data, then be clear about that in the description on the home page. On the home page, there seem to be a lot of options to choose from and difficult to determine what is most relevant to the user's needs. Perhaps "Get Started" needs a longer explanation or rephrased title. It seems to refer to getting started with the IEF, when a user might assume it means get started with the web tool. On the home page, there needs to be better narrative as to the content of the page. There should be a heading or explanation about the three icons. The "Learn more" link should not be in that location. Taking a new user to that link so early would lead to a great deal of confusion. Perhaps locate the AGO links off to the side with specific description of what it is. If we are trying to engage low-level GIS users, make the main page as easy to move through as possible. The Eco-Plan explanation at the bottom should be at the top of the page as part of the introduction to the site. Moving all AGO related links and text to one location, perhaps bottom of page, would be good.	The Map Gallery and the associated functionality of the theme maps and the narrative accompanying the theme maps. These maps are much more intuitive than maps under "Get Started." The users can be sure they are getting federal data layer feeds straight from the source.	The limited navigation features on the Get Started map. No scroll bar on Legend. The legend lists all fields, not just ones identified in the map. Severely limits legend usefulness.	Option to make the maps full screen. Improved map navigation.	The website could be a resource to staff without ARC GIS installed on their computers (the agency has limited licenses) who wish to take a cursory look at national-level data sets and protected areas in the region.	

Note: na = not applicable.

Table I.5. Comments on Eco-Plan Advanced Test Scripts

Tester #	Task 6: Create a free ArcGIS Account	Task 7: Create and save a map	Task 8: Select a basemap	Task 9: Find and add data	Task 10: Change basemap	Task 11: Change transparency	Task 12: Change visibility range	Task 13: Find an existing Eco-Plan theme map and save it locally
Tester 1	Not applicable—have ArcGIS online account							No save option on ribbon
Tester 2				Received error message "the layer, USFS_ Ecological_ Subregion" cannot be added to the map. Tried twice at different scales and it did not work either time.			See above comment about this layer not being added to the map. "Set Visibility Range" does not appear on the menu choices.	
Tester 3	(ArcGIS Sign In box) Not at top. Not an easy find.							
Tester 4		Some hiccups with the "tags" but ok otherwise						
Tester 5								Links as written did not sink to the ESRI site, but took me to Bing. Then, ARCGIS online signaled that the roads layer I was adding could not be accessed. Note that these could at least be found when using the "Add" button in ArcOnline, but the ARC site still then produced an error message. But, the instructions to the left are apparently not complete.
Tester 6								

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Table I.5. Comments on Eco-Plan Advanced Test Scripts (continued)

Tester #	Task 6: Create a free ArcGIS Account	Task 7: Create and save a map	Task 8: Select a basemap	Task 9: Find and add data	Task 10: Change basemap	Task 11: Change transparency	Task 12: Change visibility range	Task 13: Find an existing Eco-Plan theme map and save it locally
Tester 7								
Tester 8	Skipped and signed in with an existing user account.			There are 5 options.				Opened second link using hyperlink in this table.
Tester 9								
Tester 10								
Tester 11	Put “public” in the create your “public” account							
Tester 12								
Tester 13	No dropdowns for Language, Region, or Units							
Tester 14					The base-map loads much faster than expected.	Zoom in or out was not required.		All three worked.
Tester 15	I already have an account so I did not create a new one.							
Tester 16	Testers logged into existing free AGO account.		Limited navigation similar to .net AGO Stores saved content, your maps you created on their server	Case sensitive	Selected Natural Geographic Functional	Did not change transparently until we zoomed in/out	No zoom extent When zoom into neighborhood level layer is not visible.	Selected Critical habitat

Table I.6. Responses to Eco-Plan Advanced Questionnaire

Tester #	What functions do you like most?	What additional functions would you like to have?	How would you use Eco-Plan Advanced web application in your planning efforts?	Are the differences between Eco-Plan and Eco-Plan Advanced clear to you?	Do you have any additional comments or suggestions?
Tester 1	Ability to interact with the mapping data.	Ability to link from an existing ArcGIS online account to the Eco Plan advanced ArcGIS online content	I see Eco-Plan as a useful tool for planning level exercises and a useful tool for conducting initial project reviews.	Yes	The site looks like it's a really useful tool for transportation planners. I would like to know more about the ability to print or save a map once you have made one for a project.
Tester 2	Because of the inability to add a layer to the basemap, I am not sure what functions I like most.	Cannot tell from this test.	As a method to look for areas of concern or areas of opportunity.	I think so, even though some of the features do not appear to work in my test.	No, I look forward to seeing and using this tool in the future.
Tester 3	Layering	Sketch or draw on the maps so that you can put projects on the map. Cross-sectional analysis	Basic corridor planning.	Yes. EcoPlan has very little use besides tutorial.	Would be helpful to clarify the differences though between the two. How would upload regional data? Is this MAC compatible? What difference will a paid account do? Not sure if there is additional capability.
Tester 4	The ability to save maps to a personal account and the ability to add layers available through ArcGIS Online.	Would like to be able to export layers to a GIS shapefile or raster	I would use to browse layers in ArcGIS Online, share an existing map with outside clients/ stakeholders or view premade maps in a presentation.	Yes	
Tester 5	I like the idea of adding our own info, wonder what the projections and datum issues will be, if any.		Not sure until we test with our own data.	Yes	
Tester 6	Adding other local data sets will be very important			Yes	
Tester 7	Access to more basemap layers and a more robust, customizable user experience as well as the ability to save what your "project" with the data you want.		na	Yes, Eco-plan is a more premade approach for the novice users, and Eco-Plan Advanced is a tool suited to someone more comfortable with GIS and one who wants to tailor a project to their specific needs.	I feel that the tools do what they are supposed to do and do it fairly well. I understand that the best available data is being used, but it is important for users to understand that many of these data sets are out of date and mapped at a fairly coarse resolution. Nothing can be done about this, but users must be aware of this and use the data appropriately.

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Table I.6. Responses to Eco-Plan Advanced Questionnaire (continued)

Tester #	What functions do you like most?	What additional functions would you like to have?	How would you use Eco-Plan Advanced web application in your planning efforts?	Are the differences between Eco-Plan and Eco-Plan Advanced clear to you?	Do you have any additional comments or suggestions?
Tester 8	Since I signed in with my user account, I am not sure of what features are Eco Plan Advanced versus ArcGIS. I do like the feel of the platform as it's fairly user friendly and has more utility than Google Earth.	I like being able to upload my own data (a function of ArcGIS). We were able to upload our data from our pilot project successfully. I liked the base map features.	We had envisioned creating a user interface for our TRB/SHRP 2 pilot project to share our project data and results, and are likely to use ARCGIS to share our data and create maps. It would be helpful to be able to link or upload materials to the Eco-Plan portion of the program for planners and non-technical users.	Yes. Based on my experience and needs, I would use Eco-Plan advanced. However, for sharing information to steering committees and other groups, I would use Eco-Plan.	
Tester 9	I like being able to have some control over what's available on the map.	I would like to see additional symbology options (e.g., making railroad tracks not on the background look like railroad tracks). Being to add layer files from ArcGIS would solve this problem and be very useful. Also, being able to upload files that allow more features than currently allowed would be beneficial. This would allow me to be able to post parcel maps or even a species map that allow me to identify specific occurrences of critical species.	I would use it to create basic maps that I could share with clients and other people that don't use ArcGIS.	Yes, I believe it's clear. In a nutshell, Eco-Plan just shows the maps in a controlled environment while Eco-Plan Advanced allows the user to turn on/off layers (other than the transportation plan), add layers, label features, etc.	I feel that when I use Eco-Plan Advanced that I'm just in ArcGIS Online. When I found a portal to Eco-Plan Advanced, I couldn't sign in. Is there some actual difference between Eco-Plan Advanced and ArcGIS Online?
Tester 10	I am a little confused—is this Eco-plan advanced or ArcGIS. It is great to be able to impact and save maps.	I am guessing it just depends on how much I want to pay for Arc-GIS—am I wrong?	It would greatly depend on the cost. The available maps are very limited and not very useful. So, the main reason to use it is to upload my own maps and share—so it would depend.	Yes	I know we were not testing the bottom of the page, but I am assuming that the icons will be activated and the login for Eco-Plan advance will work.

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Table I.6. Responses to Eco-Plan Advanced Questionnaire (continued)

Tester #	What functions do you like most?	What additional functions would you like to have?	How would you use Eco-Plan Advanced web application in your planning efforts?	Are the differences between Eco-Plan and Eco-Plan Advanced clear to you?	Do you have any additional comments or suggestions?
Tester 11	Ease of making maps. Very quick response	Link between map layer and data -> like attribute tables in ArcGIS	I would use it in the development of long range plans	Yes	This will be a great resource for planning
Tester 12	The functionality—it is very easy to use. I do have moderate GIS skills and the site is way faster than using GIS. I think it provides the most critical information and looks to be fairly simple to add our own regional data to it.	Well, it appears that there are fees to be able to load your own data. I really see this tool being most beneficial to use the information already available in it and then being able to add our own regional data. There is a limit on the free account of 1000 features in each Shapefile, but for parks and other layers (roadway system) for a region our size, that limit is too small. We would need to be able to load our regional data without huge fees associated with the use of the tool. The only comment I would have on function is having some sort of reference built in for the web sites URLs that you have to load in to use them in the system such as the Critical Habitat. If I didn't have the URL handy to add it in then I wouldn't have known how to get that data layer. How do you know from the list of other data sets and maps available in the Gallery on the regular Eco-Plan what the URL is so that it can be added to the Advanced version?	We would use it during development of the Metropolitan Transportation plan if we were able to load in our own shapefiles. We could load alternative alignments for corridor studies and many other planning efforts such as bike/pedestrian, etc. to ensure we are capturing all of the ecological data during the different phases and types of transportation plans.	Yes, to me they are.	

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Table I.6. Responses to Eco-Plan Advanced Questionnaire (continued)

Tester #	What functions do you like most?	What additional functions would you like to have?	How would you use Eco-Plan Advanced web application in your planning efforts?	Are the differences between Eco-Plan and Eco-Plan Advanced clear to you?	Do you have any additional comments or suggestions?
Tester 13	High number of data sets	Select colors in legends	Add selected data sets to compare with "related" content on Eco-Plan data sets	I understand the ability to add layers from other sources; don't know what else can be done, i.e., look at attribute tables, other GIS operations	Other than the legend color scheme comments above, I feel this is a very useful tool for portraying the relationships of data sets graphically.
Tester 14	Adding in your own data and pulling in from other sources. Allows you to make a unique custom map for any situation.	Nothing at this time. As I use it more in the future I might have more suggestions. Without being able to use it in conjunction with a project. I am unable to put something else here.		Yes and I think they will be clear to other users who have not used ArcGIS Online.	
Tester 15	I like that I can add layers from many different sources. Seems much more useful for the type of work we do in the Environmental section of the Alaska DOT. Useful to be able to add layers from local agencies and our own agency when doing analysis.	I would like maps to automatically default to my location.	As an environmental analyst for Alaska DOT, I analyze various resources, land uses, species, etc. when preparing an environmental document. Though I still go out and ground truth resources, it is helpful to have a mapping program that can give me an idea of what I should be looking for or what is in the vicinity of the project area.	Yes. I prefer the Eco-Plan Advanced.	

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Table I.6. Responses to Eco-Plan Advanced Questionnaire (continued)

Tester #	What functions do you like most?	What additional functions would you like to have?	How would you use Eco-Plan Advanced web application in your planning efforts?	Are the differences between Eco-Plan and Eco-Plan Advanced clear to you?	Do you have any additional comments or suggestions?
Tester 16	Speed of data upload and display (could be time of day). Preloaded a good selection of basemaps and overlays. Testers tried the share links option. The link takes people directly to the user interface, cannot modify, just view, can change base map.	This might be a function of AGO, but testers would have liked to see an exercise in how to create communities. Ideally the testers would like the ability to store local data on the tool with a clip and ship option for users.	In theory, we could see creating maps that display critical areas and our ecological data in the region and making those accessible to fellow AGO users at regulatory and resource agencies. However the limitations associated with AGO costs and crediting system would hinder the execution of the idea. At this time, EWG is not planning to acquire a paid AGO account and take on the cost associated with storing data on the ESRI servers and covering costs for related downloads and report generation. EWG currently uses the free version offered by ESRI as a contractual ARC GIS user. To get the full functionality of the data, one would need to be able to download the data directly to a PC, but the size constraints and real time access to data updates quickly become an issue, which leads back to the initial need for the national data tool.	Yes. Able to highlight areas of concern. Add map notes, mark up the maps, change color of markups, but clunky; an option only for people with AGO accounts.	Smaller MPOs who do not have the technical capacity and do not have money to spend on ARC GIS would use it if it was at no cost. County level staffs in transportation and planning departments are potential users.

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Related SHRP 2 Research

- Framework for Collaborative Decision Making on Additions to Highway Capacity (C01)
- An Ecological Approach to Integrating Conservation and Highway Planning (C06)
- Incorporating Greenhouse Gas Emissions into the Collaborative Decision-Making Process (C09)
- Expedited Planning and Environmental Review of Highway Projects (C19)
- Application of Geospatial Ecological Tools and Data in the Planning and Programming Phases of Delivering New Highway Capacity: Proof of Concept—California US-101 (C40B1)
- Application of Geospatial Ecological Tools and Data in the Planning and Programming Phases of Delivering New Highway Capacity: Proof of Concept—East-West Gateway Council of Governments (C40B2)
- Application of Geospatial Ecological Tools and Data in the Planning and Programming Phases of Delivering New Highway Capacity: Proof of Concept—Contra Costa County Transportation Authority (C40B3)
- TCAPP and Integrated Ecological Framework Pilot Projects: Synthesis of Lessons Learned (C41)