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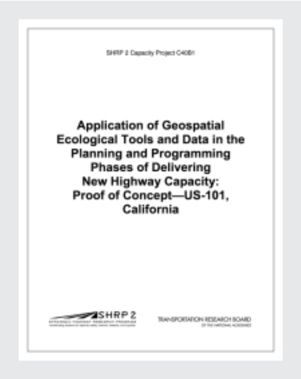
SHRP 2 Capacity Project C40B1

Application of Geospatial Ecological Tools and Data in the Planning and Programming Phases of Delivering New Highway Capacity: Proof of Concept—US-101, California

SHRP 2

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Application of Geospatial Ecological Tools and Data in the Planning and Programming Phases of Delivering New Highway Capacity: Proof of Concept—US-101, California

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TRANSPORTATION RESEARCH BOARD
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Executive Summary

The overall purpose of this project was twofold: to demonstrate the transferability of impact assessment methods from programmed transportation projects developed in California under a regional advance mitigation planning (RAMP) framework and to evaluate and help in the development of a national impact scoping tool being developed under SHRP 2 C40A called Eco-Plan.

In California a consortium of government agencies, nongovernmental organizations, and the University of California have been working on the development of a RAMP framework for the last several years. The University of California, Davis team for this SHRP 2 C40B1 project has served as the primary developer of the geospatial methods, beginning in 2005, and has collaborated with the California Transportation Agency (Caltrans) and the California Department of Water Resources. The UC Davis team has participated in a roundtable framework development group that has had active participation from the U.S. Fish and Wildlife Service, U.S. Army Corps of Engineers, U.S. Environmental Protection Agency, Caltrans, California Department of Fish and Wildlife (formerly California Department of Fish and Game), California State Parks, and California Department of Water Resources.

The general approach in California offers several benefits over conventional project-by-project mitigation that are similar to benefits from the federal Eco-Logical program: (1) projected impacts from multiple projects could permit acquisition of larger areas, which generally is biologically more effective than acquisition of “postage stamps” and has lower subsequent management costs; (2) environmental review is potentially faster because explicit geographical information system analyses permit easy assessment of the impact projections; (3) advanced acquisition of lands to satisfy mitigation demand is typically cheaper than acquisition at later dates and ensures that resources are available to meet the mitigation requirements; (4) reduction of the number of parcels needed through bundling of mitigation needs for multiple projects potentially produces savings in terms of transaction costs for infrastructure agencies; (5) regulatory agencies can have the required service areas for any given impact (e.g., within the watershed a project is conducted in) incorporated into the portfolio of potential suitable mitigation sites; (6) the identification of regions that are highly suitable for mitigation of programmed projects provides an incentive for private mitigation banks to develop assets in those regions, permitting stabilization of markets for mitigation banking; and (7) the extended planning horizon for mitigation actions permits systematic conservation planning techniques that can lead to multiple regional conservation priorities being addressed by the mitigation.

This SHRP 2 C40B project leveraged previous work, geospatial techniques, and ongoing collaborations in different parts of California. The transferability of the RAMP impact assessment methods was tested by analyzing a previously unassessed long transportation corridor: U.S. Highway 101 from Santa Barbara County north through Mendocino County, a distance of over 450 miles.

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This project permitted several areas of the RAMP approach to be addressed that have not yet been satisfactorily developed. These areas included (1) approaches for transferring RAMP methods from one region to another; (2) methods for assessing and projecting the aquatic impacts and mitigation needs from many bridge retrofits programmed for California; and (3) approaches for assessing impacts across a variety of landscapes, from rural natural landscapes to intensive agriculture to urban settings.

The impact assessments for U.S. Highway 101's programmed projects, as coordinated with Caltrans, comprised an inventory of currently funded and unmitigated projects and assessment of the projected impacts. Within the three Caltrans's districts, 68 transportation projects were analyzed for the likely occurrence of listed species. Transportation projects in District 4, representing the San Francisco Bay Area, were analyzed for urban impacts, including farmland.

A number of other national-level, web-based tools were reviewed, and their applicability for mitigation assessment was tested in the coastal region of California. These tools are the ESA WebTool, NEPAssist, and the Information Planning and Conservation System. In addition, the Eco-Plan tool developed by the C40A team was tested using the data compiled for the region. The salient features of each of these national tools were brought to bear on the proposed study area, as well as within the timeline of environmental review and assessment in California.

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CHAPTER 1
Introduction

One of the areas of research supported by the Transportation Research Board through the second Strategic Highway Research Program (SHRP 2) is the development of tools and methods that can advance the goals of the Eco-Logical program (Brown 2006), which are called for in past and current transportation bills. To that end, the SHRP 2 C40A and C40B programs are focused on developing techniques for assessing regional environmental impacts from transportation projects and a website that could function as a tool for that purpose, called Eco-Plan. This report relays the progress of one of three C40B pilot projects that were meant to develop or improve existing impact assessment methods and to provide review and testing of the national tool as it is developed by the C40A team.

This pilot project was conducted by the University of California, Davis and was located along 450 miles of US-101 in California. The project used the impact assessment methods previously developed as part of an initiative within California called regional advance mitigation planning (RAMP), which is an approach to mitigating unavoidable biological resource impacts from transportation or other infrastructure projects well in advance of the actual construction of the projects. The RAMP framework covers the advance mitigation process; the work conducted in this study targets the impact assessment component of RAMP, which lays the foundation for conducting advance mitigation. The next section provides background on the RAMP framework in California and is followed by the objectives, methods, results, and discussion of the study.

RAMP Framework and Mitigation Planning in California

RAMP is an innovative methodology that can incorporate regional planning principles and environmental impact assessments early in the development of transportation infrastructure and other construction plans and projects. It provides a way to assess impacts from multiple transportation projects and to direct funds required by those projects for environmental mitigation to fund more ecologically effective land acquisitions and restoration. If the funding associated with multiple infrastructure projects is bundled, larger parcels may possibly be acquired. In addition, it also becomes possible to coordinate the mitigation actions with regional open space and conservation plans, thereby integrating the mitigation into larger, regional-level sustainability designs. Under a RAMP, transportation infrastructure agencies work with resource agencies to consider the environmental impacts of several planned projects at once. They bundle the mitigation needs of those projects and use the recognized needs to protect habitat at a larger, more ecologically effective scale and to link mitigation actions with conservation priorities as identified by a “regional greenprint” (Figure 1.1). This approach addresses a

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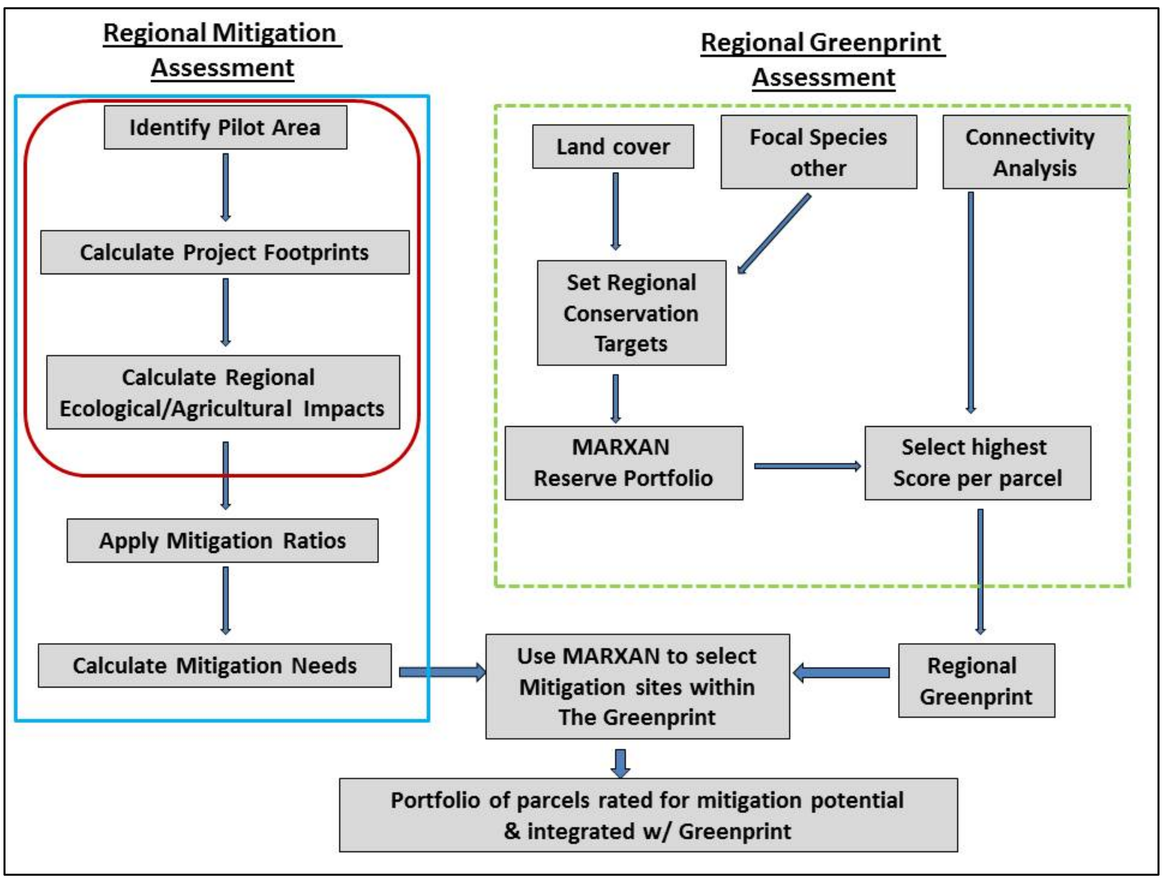
known inefficiency in the way transportation and other infrastructure projects are typically implemented. Infrastructure agencies often engage in project-by-project mitigation, usually at the end of a project's timeline, thereby losing valuable dollars to real estate appreciation and speculation and also losing potential habitat acquisition opportunities to encroaching development and speculation. In addition, project-by-project mitigation often overlooks regional- and ecosystem-scale impacts to species and critical habitats, thereby missing opportunities for efficient, reliable, and effective environmental mitigation. RAMP is a win-win for conservation and infrastructure agencies: it can expedite project delivery and yield better conservation outcomes. Under RAMP, mitigation for infrastructure projects can be more proactive; more systematic; multifunctional rather than single purpose; and better integrated with other planning efforts, resulting in more meaningful and cost-effective conservation that advances statewide and regional environmental goals.



Source: Thorne et al. 2014.

Figure 1.1. Conceptual graphic outlining the overall RAMP process. This pilot project addressed the first three boxes within the mitigation assessment (red box).

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In California, several advance mitigation programs are ongoing at the county level. These programs, in San Diego and Orange Counties, have been authorized as environmental mitigation programs through their respective transportation sales tax measures, meaning that the funding for assessments, planning, acquisition, and so forth, is derived from county-level financing. At higher levels of government, agencies such as Caltrans, the California Department of Water Resources, California Department of Fish and Wildlife, U.S. Fish and Wildlife Service, U.S. Army Corps of Engineers, and U.S. Environmental Protection Agency, as well as other state and federal agencies and organizations such as UC Davis and The Nature Conservancy, have been participating in a roundtable working group, formed in 2008, to identify a statewide approach to advance mitigation. Some of these institutions have also signed a memorandum of understanding to support the RAMP effort and "build state–federal agency partnerships to advance the RAMP process" (Appendix A). However, one of the large bottlenecks for Caltrans lies beyond the impact assessment capacity, in that no clear vehicle to enable the funding of advance mitigation implementation has been identified. This issue is mentioned in passing in this report, which is focused on the further development of impact assessment capacity and methods.

RAMP Working Group

In 2012, the RAMP working group presented a draft RAMP statewide framework (Figure 1.2), which is a document that describes the vision for RAMP and the process for implementing this approach at the regional level. The framework illustrates the basic methodology, from creating a map of planned infrastructure projects to selecting mitigation sites within a conservation greenprint.

Figure 1.2. The draft Regional Advance Mitigation Planning framework is a publicly available document.

Part of the methodology has been implemented in a pilot project of the RAMP working group for a 1,500-square-mile area in the central Sacramento Valley (Figure 1.3).

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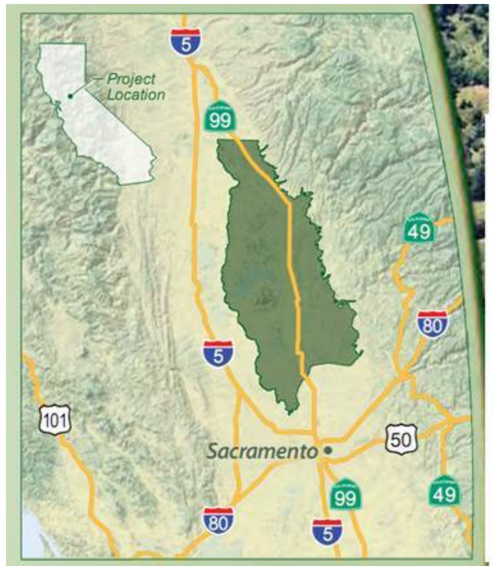

Figure 1.3. A map of the central Sacramento Valley pilot project area.

The methodology (Figure 1.4), while giving an overall structure for analyzing impacts, does not provide a detailed and systematic approach for calculating areas of impact.

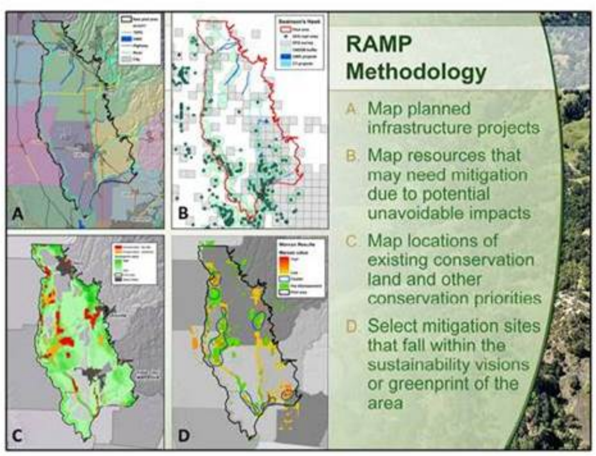

Figure 1.4. The different components of the methodology are shown with maps of the pilot area.

The basic approach for assessing the environmental impacts from planned transportation projects is the development of an inventory of projects for which compensatory mitigation has not been finalized, the digitization of those projects, and the accounting of projected mitigation needs through geographic information system (GIS) analysis of the locations of multiple projects in a region with regional natural resource data of various types. This process typically identifies projects within a 10- to 20-year planning horizon and is essential for beginning an assessment (see, for example, Figure

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1.5). These inventories need to be conducted each time a regional impacts assessment is conducted.

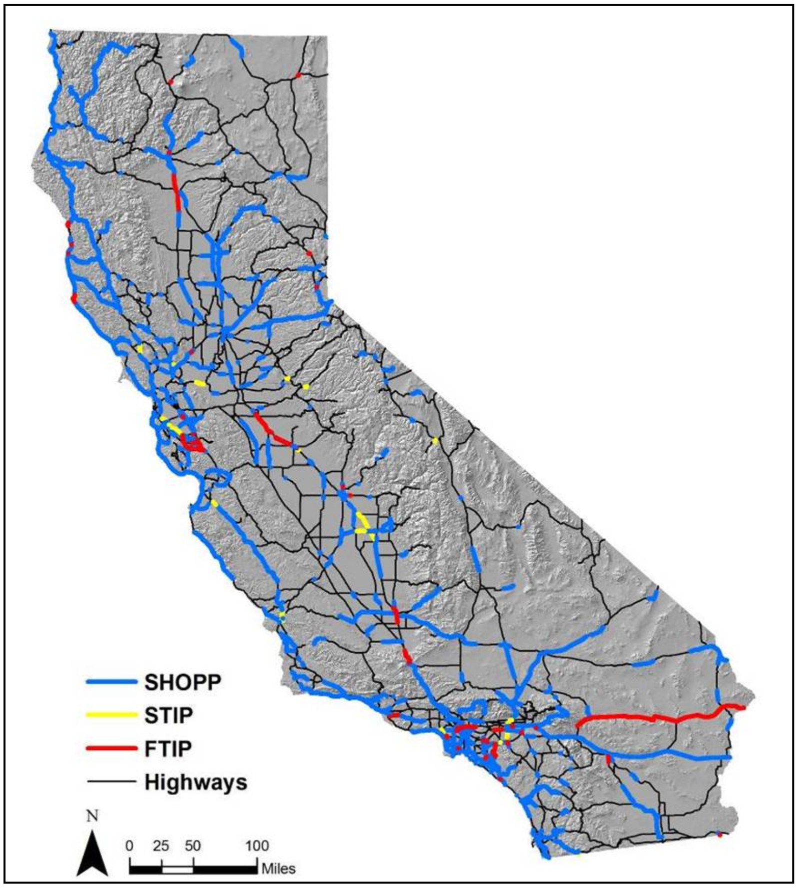

Figure 1.5. Planned transportation projects for California in 2008. SHOPP = State Highway Operation and Protection Plan; STIP = State Transportation Improvement Program; FTIP = Federal Transportation Improvement Program.

The overall process also demands the assembly of important biological and ecological information (Thorne et al. 2009b). In parallel, the best-developed conservation targets from agency plans, habitat conservation plans (county-level planning), and nongovernmental organizations (e.g., The Nature Conservancy), together with occurrence and connectivity data and models, are assembled to create a greenprint for the study area. Once the recognized conservation priorities are constructed in a map, mitigation sites only from within those areas can be selected to coordinate the compensatory, off-site mitigation. Portfolios of sites around the region can be identified that could be satisfactory in a replicable manner by using the reserve selection algorithm Marxan (Ball et al. 2009). Marxan can identify areas that meet the mitigation need and rank all parcels for their irreplaceability in meeting those needs in suitable locations so that a suite of

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areas, each comprising many parcels, is identified. These portfolios then become areas in which mitigation acquisitions could be identified that would meet multiple construction mitigation needs while contributing to regional sustainability objectives.

U.S. Highway 101: The C40B1 Study Area

A major focus of this project was to assess the impacts from planned infrastructure projects across a large section of highway to demonstrate that the methods used in a RAMP impact assessment are replicable.

The SHRP 2 C40B1 pilot project covered a 450-mile span of US-101, including Mendocino County in the north coast region down through Santa Barbara County in the central coast region. The area spans three Caltrans districts: District 1, District 4, and District 5 (Figure 1.6). The potential impacts from programmed transportation projects were assessed across the full study area, as provided by each Caltrans district.

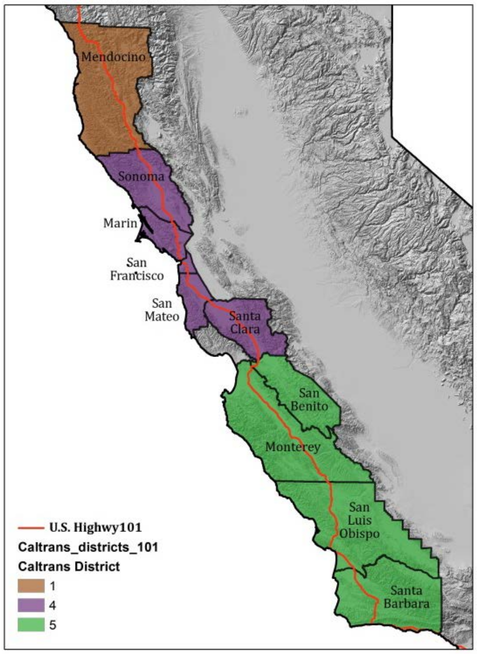

Figure 1.6. Map of pilot region for the SHRP 2 C40B project along U.S. Highway 101.

Each Caltrans district had distinct attributes that informed the study and analysis.

District 1 (Mendocino County on the north coast) is occupied by large extents of conifer and hardwood–conifer woodlands and has many streams used by anadromous fish; the latter potentially influence stream-crossing structure construction. Wetland and stream mitigation can be an especially challenging obstacle for water quality and social equity, as seen in other areas in North America and around the world (BenDor and Stewart 2011; BenDor et al. 2009; Meriano et al. 2009). Compared with the other

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Caltrans districts, there are relatively few listed species requiring mitigation in this district.

District 4, which includes the San Francisco Bay Area (Sonoma, Marin, San Francisco, San Mateo, and Santa Clara Counties), is highly urbanized, has a high number of listed species, and has a large number of anadromous fish streams. Transportation projects in urban settings can usually expect less compensatory environmental mitigation, but they often have more issues with increased congestion and air quality management, as well as potential mitigation for impacts to personal property (Thorne et al. 2006).

District 5 on the central coast (San Benito, Monterey, San Luis Obispo, and Santa Barbara Counties) includes large expanses of oak woodlands, grasslands, and agriculture. This region has a number of threatened and endangered species, as well as many habitat corridors that can be affected by transportation projects, creating additional complications (Thorne et al. 2005; Huber et al. 2010; Caliskan 2013). Various actions have been employed by Caltrans in District 5 to reduce wildlife mortality at transportation intersections (Figure 1.7). Extensive farmland in the Salinas Valley will potentially be affected by planned Caltrans projects in this district.

(a)


(b)

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(c)

(d)

Figure 1.7. Methods used by Caltrans to avoid wildlife mortality at the transportation–wildlife interface include (a) wildlife fencing, (b) escape ramps, (c) crossing passages at culverts and bridges, and (d) electric wildlife crossing deterrent mats at unfenced intersections.

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CHAPTER 2
Research Approach: Methodology

Geospatial and tabular data were collected from the three Caltrans districts for planned and programmed transportation projects over the next 10 to 20 years. The assessment methods used were similar to impacts that were accounted for in a statewide assessment for Caltrans that was loaded into a database intended for desktop use (Thorne et al. 2009a). That database did not generally make it into wide use due to the difficulty of adding updates and the overhead to remove projects from the database as they were implemented.

Some of the projects provided by Caltrans were not included in this analysis if, for example, the project was not likely to require mitigation (such as landscape projects), or if the project already had its mitigation identified or was closed out. The remaining projects were categorized using a standardized set of project types with estimated footprints from the California Transportation Investment System (CTIS), which is a spatial data viewer and database that was created with input from Caltrans and Regional Transportation Planning Agency representatives (Table 2.1). CTIS also contains a list and GIS data of programmed transportation projects in California over the next 20 years, which was also accessed to compare their list of projects with the lists received from the individual Caltrans districts.

The following steps were performed for each Caltrans district.

Data Review

The regional offices (District 1, Arcata; District 5, San Luis Obispo; and District 4, Oakland) provided information on transportation projects, which were then reviewed using a GIS. The data received portrayed each project as a general point or line. For road projects such as adding lanes or installing median barriers, line segments were used; for interchanges, a central point was used. From these generalized data, the project boundaries were transcribed to a transportation network in order to include both sides of the road. For some projects, this step was time intensive and created a bottleneck in the process. Discussions are currently underway with Caltrans to see if this step could be automated more easily in their system. However, the transformation of generalized line segments to a transportation network would normally not occur at Caltrans until a later stage in the planning and programming timeline.

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Table 2.1. CTIS Estimated Footprints

Project Type	Estimated Footprint Width (ft)
New alignment	500
Reconstruct interchange and access ramps	200
Construct expressway	200
Construct new bridge	150
Widen roadway	100
Remove rail trestle	100
Realign curve	100
Grade separation improvements	100
Construct expressway existing alignment	100
Slow-vehicles lane	50
Passing lanes	50
Construct lane	50
High-occupancy lanes	40
Stabilize slope	30
Rehabilitate roadway	30
Construct noise barrier	30
Construct left-turn lane	30
Construct retaining wall	20
Install median barrier	20
Roadside rest areas	10
Install warning devices	5
Install message signs/traffic operation systems	5
Install ramp metering	5

Transportation Project Preparation

From the list of selected transportation projects, the potential spatial extent was assessed, and a GIS footprint for each project was created to represent the total area affected. This estimate was created by combining estimates of the distance from the road centerline that different types of projects require for construction with a visual observation of each project using National Agricultural Inventory Program aerial imagery. The existing widths of roads were measured, and added lanes or new alignment widths were assessed. These measurements were made for each project. The centerline or center point of each project was then buffered by the width determined by the estimated footprint table (Table 2.1) to identify the area, or footprint, of impact associated with that project (Figure 2.1).

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This method identifies only the extent of new pavement or roadway and is perhaps conservative relative to the construction process, particularly for new alignments and interchanges.

Figure 2.1. An example of how buffers are used to estimate the extent of impact from a new project. Black dotted lines represent road centerlines, blue lines represent the edges of existing roads, and red lines are the estimated buffered impacts.

Biological Data Preparation

Because not all suitable habitats are occupied by vertebrate species, an additional analysis was added that used terrestrial vertebrate location records from the state-managed California Natural Diversity Database (CNDDB). Buffers 2 and 4 miles long were applied to the known point locations of threatened and endangered species data from the

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CNDDB records (see bullets below for the selection criteria for CNDDB records). These buffers (Figure 2.1) were then overlaid on project footprints, and suitable habitat within the buffer ring was identified. This method of identifying the suitable habitat of mitigation species that might be affected is a conservative measure because, although a transportation project might be longer, and have more suitable habitat beyond the buffer, there is no assurance that it is occupied by the listed species. Therefore, the analysis identifies the locations (and amount) of habitat that are most likely to have the species present because they are relatively near to an observed occurrence. This type of analysis has the effect of reducing the overall lands identified as potential impacts for long transportation projects, but it also recognizes that not all habitat is actually occupied, therefore providing a more realistic estimate of the lands that might require mitigation due to project impacts. The 2- and 4-mile buffers themselves also provide a range of predicted impacts that can be further refined as projects are later reviewed on the ground.

- Existing data for threatened and endangered species were compiled, along with the distribution of land cover or habitat, and the locations of important agricultural lands.
- CNDDB points were selected that occurred within and up to 5 miles beyond the US-101 corridor. The CNDDB data represent the known and available inventory of threatened and endangered species and some habitats.
- From the CNDDB points, those that were listed as “presumed extant” and from 1980 to the present were selected.
- Federally listed and/or state-listed species and other species requiring mitigation were selected.
- The subset of CNDDB points were buffered by 2 and 4 miles.
- Buffered points were overlaid on land cover maps depicting vegetation type.
- Appropriate habitat types for each mitigation species were selected using the California Wildlife Habitat Relationships model for terrestrial vertebrate species, Calflora-listed land cover types for plant species, and various online sources for invertebrate species. U.S. Fish and Wildlife Service and National Marine Fisheries Service data, along with National Hydrography data on waterways, were used for fish species.
- Only the specified habitat types for each specific species were selected from the land cover overlay to ensure a conservative estimation of species occupancy (Figure 2.2).

Figure 2.2 shows the use of CNDDB records with transportation project impacts to predict the extent of suitable habitat that could be affected by a project. Green represents suitable habitat for a species, although it is not known if the species is occupying that entire habitat. The red cross represents a known occurrence record for that species. The

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black outlines depict a transportation corridor and its estimated impact footprint. The green areas within the red circles of (a) a 2-mile and (b) a 4-mile buffer from the CNDDB point represent the suitable habitat that falls within the project footprint. Any appropriate habitat patches within the circles are summed to provide the impact estimate for that species on that project.

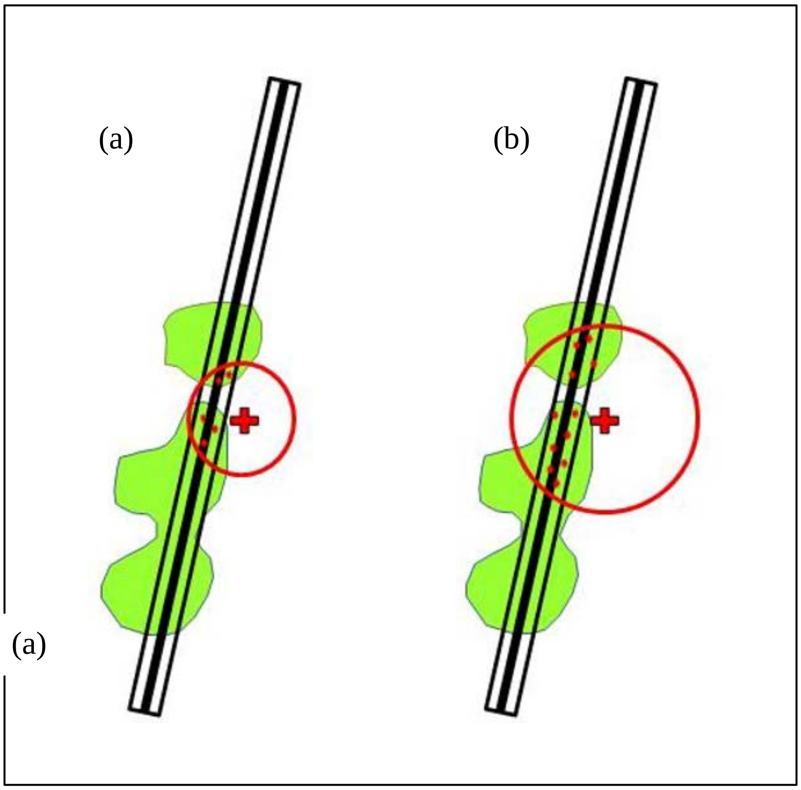

Figure 2.2. Use of California Natural Diversity Database records with transportation project data to help predict potential impacts on habitat.

Calculation of Biological Impacts

The project footprints were overlaid with the biological and agricultural data to estimate impacts. These were then summarized for each project, and can be summed across multiple projects, such as by county, by road, or by types of projects.

Calculation of Aquatic Impacts

Some projects in each district include modifications to existing bridges over streams. Examples of these projects include new alignments, repairing channel paving, bridge widening, and reconstructing interchanges. Several maps of wetlands and riverine features, including the National Wetland Inventory (NWI), the CALVEG wildlife habitat relationships (WHR) classification, and the Conservation Lands Network (CLN) in the Bay Area, were used to examine potential impacts from the portfolio of transportation

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projects. CALVEG and the CLN use the same land cover classification system; NWI has its own classification.

Impact assessments for anadromous fish with the GIS forecasting tool is a portion of the project that is still under development. Current practice within Caltrans is to assess the potential of a transportation project to directly affect fish mortality. Without a base of population numbers for different fish species to use, the research team assessed the number of projects that cross streams with a known presence of listed fish species, all in the anadromous fish category.

Calculation of Urban Impacts

Caltrans District 4 includes the San Francisco Bay Area and is unique in that many of the transportation projects occur in highly urbanized areas. Although transportation projects in urban areas generally aim at solving problems of safety and capacity, such as reducing congestion, improving walking and bicycling, and possibly reducing vehicle travel to minimize air pollution and greenhouse gas emissions, some of the impacts that can affect urban areas include community cohesion, economic development, traffic noise, visual quality, and property value (Forkenbrock and Weisbrod 2001). In addition, various population groups within the community may be affected quite differently. The impacts of transportation products to urban and farmland areas were calculated using a parcel-level land use data set (from Digital Map Products, 2013). Using parcel-level data also allows for the examination of land use types that are affected the most by projects.

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CHAPTER 3
Findings and Applications: Assessment Results

This chapter summarizes the results of the transportation project impact assessment.

Analysis of Transportation Projects

For the project study area of US-101 from Mendocino County to Santa Barbara County, 68 road projects with estimated footprints totaling over 4,200 acres (Table 3.1) were analyzed. District 5 had by far the most planned projects (38 analyzed), and District 4 had the greatest estimated footprint (1,810 acres) (Table 3.2).

Table 3.1. Transportation Projects by Project Type, Number Present in Each Caltrans District, and Estimated Total Footprint in Acres

Project Type	Number of Projects			Estimated Footprint (acres)
	District 1	District 4	District 5	
Construct expressway existing alignment	0	1	0	23.746
Construct new bridge	0	0	1	1.638
Construct retaining wall	0	0	1	21.065
High-occupancy lanes	0	2	1	253.805
Install median barrier	1	0	8	162.983
Install message signs/traffic operating systems	1	0	0	0.719
New alignment	1	1	0	1759.834
Realign curve	0	0	1	0.388
Reconstruct interchange and access ramps	6	7	13	323.617
Rehabilitate roadway	3	0	7	293.452
Roadside rest area	1	0	1	12.940
Slow-vehicles lane	0	0	3	153.091
Widen roadway	2	4	2	1228.685
Total	**15**	**15**	**38**	**4235.964**

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Table 3.2. Number of Projects and Total Estimated Footprint by District

District	Number of Projects	Total Estimated Footprint (acres)
1	15	1,094.40
4	15	1,810.30
5	38	1,331.27

The two new alignment projects, one in District 1 and one in District 4 (Figure 3.1), added the greatest amount of estimated footprint area, which accounts for the greater number of acres in those two districts despite District 5 having more projects.

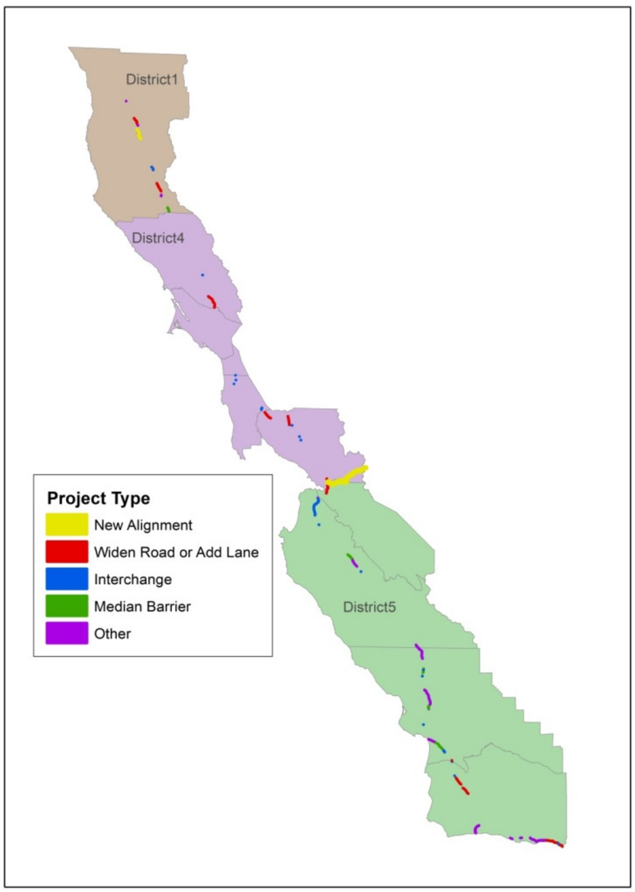

Figure 3.1. The 68 transportation projects in this study span a range of project types, each with a specified estimated footprint of impact.

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Because each project type has a specified estimated footprint (Methodology), some projects (new alignments, road widening) had large footprint estimates, and some (installing message signs) had minimal footprint estimates.

Analysis of Impacts to Species

District 4 had the largest total number of acres of species habitat affected, and District 5 had the greatest number of species affected (Table 3.3). These findings are likely due to the new alignment planned in District 4. District 5 overall had a greater number of listed species than the other two districts.

Table 3.3. Number of Species and Estimated Number of Acres of Habitat Affected for 2- and 4-Mile Buffered Areas by District

Variable	District 1	District 4	District 5
Number of species affected	3	11	14
Acres of affected habitat (2-mile buffer)	13.59	364.91	287.91
Acres of affected habitat (4-mile buffer)	47.31	876.2	483.26

The tricolored blackbird had likely habitat present in all three districts and had the highest number of acres of estimated habitat affected, 54.4 and 402.5 acres for the 2-mile and 4-mile buffered areas, respectively (Table 3.4). The San Joaquin kit fox and California tiger salamander had likely habitat present within estimated transportation project footprints in two districts and had the second- and third-highest estimated acreage.

Many of the estimated areas of impact to species are found within multiple projects and, in some cases, in multiple counties or districts (Figure 3.2). This situation again highlights an area of opportunity for bundling compensatory mitigation funds from multiple projects to purchase a more ecologically significant parcel.

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Table 3.4. Species Analyzed and Estimated Number of Acres of Habitat Affected from Project Footprints for 2- and 4-mile Buffered Areas in Caltrans Districts 1, 4, and 5

Species Common Name	2-Mile Buffer Area (acres)	4-Mile Buffer Area (acres)	District(s) Found
Burrowing owl	42.9	168.0	4, 5
California black rail	5.1	5.7	4
California clapper rail	13.4	13.6	4
California least tern	2.4	2.4	4
California red-legged frog	113.8	157.8	4, 5
California tiger salamander	287.1	337.9	4, 5
Fisher	13.3	43.9	1
Least Bell's vireo	14.6	17.5	4, 5
La Graciosa thistle	29.9	76.0	5
Lompoc yerba santa	0.0	1.0	5
Milo Baker's lupine	0.3	0.4	1
Monterey spineflower	0.0	35.5	5
Pismo Clarkia	0.0	0.1	5
Salt marsh bird’s-beak	0.0	1.0	5
Salt marsh harvest mouse	0.0	1.7	4
San Joaquin kit fox	74.3	188.5	4, 5
Showy rancheria clover	0.0	1.4	4
Townsend’s big-eared bat	5.8	16.0	5
Tricolored blackbird	54.4	402.5	1, 4, 5
Vernal pool fairy shrimp	5.2	5.2	5
Yadon’s rein orchid	3.8	8.7	5
Total	**666.4**	**1484.7**	

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(a) (b)

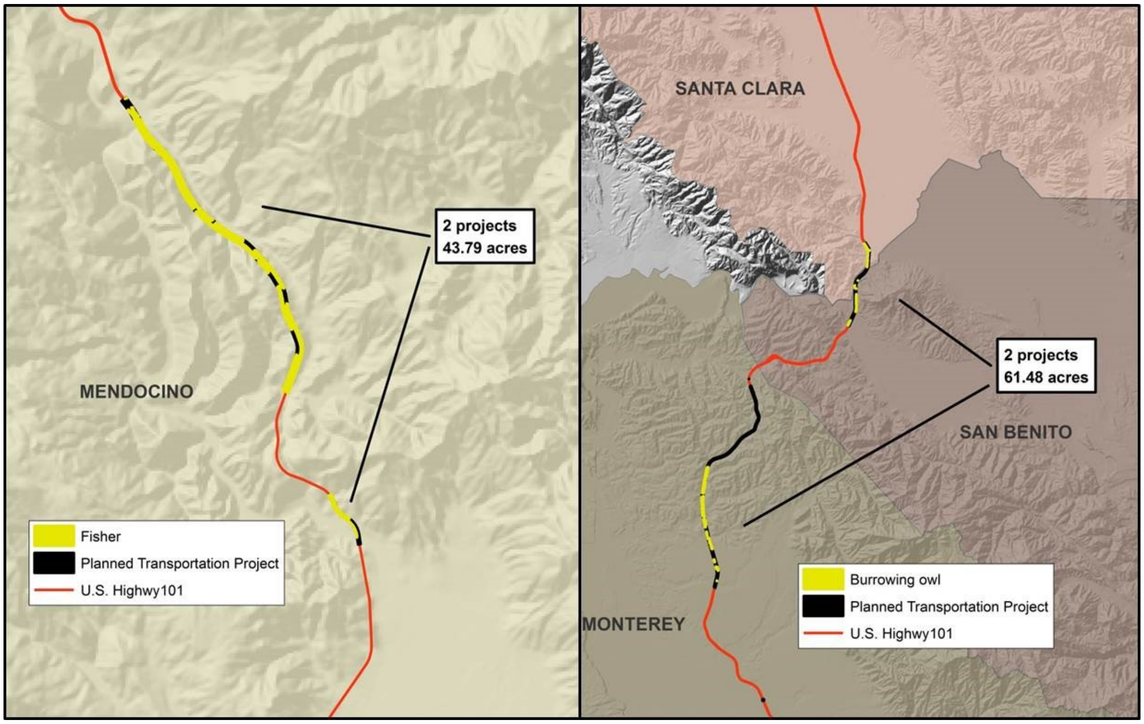

Figure 3.2. Two examples of estimated impacts to species: (a) likely fisher habitat, found in three projects in District 1 (two shown); and (b) likely burrowing owl habitat, found in seven projects in Districts 4 and 5 (two shown).

Analysis of Urban Impacts

The urban impacts analysis was performed only in District 4, the San Francisco Bay Area, which is a highly urbanized region. Using the parcel layer allowed for the comparison of land use types within the urbanized area, including agricultural lands.

The parcel map does not include rights-of-way for transportation corridors, but it does include facilities that are related to transportation activities, such as train stations and airports.

Farmland was the most heavily affected land use type in District 4, followed by commercial and industrial types (Table 3.5). Satellite imagery in Figure 3.3 shows two areas within District 4 where different land use types can be seen. Census data could be added to further explore the demographic characteristics within the distinct land use classes.

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Table 3.5. Initial Estimate of Urban Impacts in District 4 (San Francisco Bay Area), Including Farmland, from the 15 Planned Transportation Projects

Land Use Type	Number of Acres
Farmland	1,031.4
Residential	32.4
Commercial/Industrial	98.6
Vacant	36.8
Transportation	53.5
Other/Miscellaneous	77.1

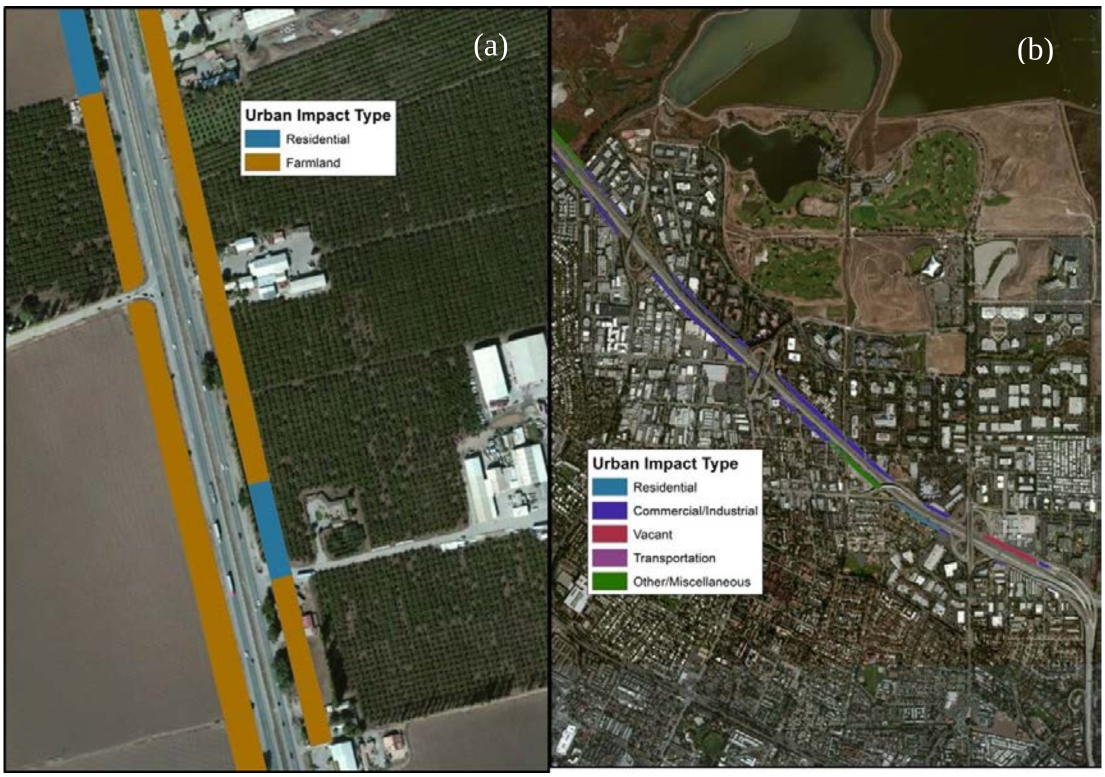

Figure 3.3. Map showing two projects in Santa Clara County: (a) road widening affecting farmland and residential areas and (b) new lane construction affecting an urbanized area.

Analysis of Aquatic Impacts

Discussions with a Caltrans fish biologist revealed that although impacts from road construction projects may go far beyond the immediate vicinity of where a road project crosses a stream, the mitigation for fish impacts is typically based on an estimate of the number of fish killed. This number can be considerable, particularly for fry. It was not possible to project such numbers; therefore, for a projection of impacts, the number of

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times road projects crossed streams was used to develop an accounting of impacts to streams. There were 44 stream crossings associated with the transportation projects in the Bay Area and central coast areas: 16 in District 4 and 28 in District 5 (Table 3.6).

Table 3.6. Assessment of Stream Crossings in Districts 4 and 5 by Transportation Project Type

District	Project Type	County	Number of Stream Crossings
4	High-occupancy lane	Santa Clara	1
4	Widen roadway	Santa Clara and San Benito	4
4	Widen roadway	Santa Clara and San Benito	11
5	Construct new bridge	San Luis Obispo	1
5	Construct retaining wall	Santa Barbara	1
5	Install median barrier	San Luis Obispo	1
5	Install median barrier	Santa Barbara	1
5	Rehabilitate roadway	San Luis Obispo	2
5	Rehabilitate roadway	Monterey and San Luis Obispo	1
5	Rehabilitate roadway	San Luis Obispo	3
5	Rehabilitate roadway	Santa Barbara	5
5	Rehabilitate roadway	Santa Barbara	1
5	Rehabilitate roadway	Santa Barbara	1
5	Roadside rest area	Santa Barbara	1
5	US-101 bridge rail replacements	Santa Barbara	7
5	Widen roadway	Santa Clara and San Benito	3
Total			44

Some wetland and aquatic habitats, including emergent marsh, floodplain riparian, freshwater marsh, riparian forest, and wetlands, were also likely to be affected by the planned transportation projects in this study (Table 3.7). The research team assessed these impacts by using a national data set (NWI), a statewide data set (CALVEG), and a localized data set for District 4 (CLN). The national data set indicated more wetland impacts consistently for the same projects, especially in Districts 1 and 4.

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Table 3.7. Comparison of Aquatic Impacts from Different Wetland and Vegetation Layers

Dataset	Wetland Type	District 1		District 4		District 5	
		Acres	Projects	Acres	Projects	Acres	Projects
CALVEG	Lacustrine	1.74	2			2.13	5
	Montane riparian	2.82	3				
	Riverine	0.33	1			0.19	1
	Saline emergent wetland					1.46	1
	Valley foothill riparian					28.37	9
CLN	Coastal salt marsh/coastal brackish marsh			1.73	1		
	Permanent freshwater marsh			0.73	1		
	Valley oak forest/woodland			5.68	1		
	Water			3.15	2		
NWI	Estuarine and marine deep water			1.14	2	0.09	1
	Estuarine and marine wetland			1.05	1	1.15	1
	Freshwater emergent wetland	4.45	1	5.50	5	8.80	9
	Freshwater forested/shrub wetland			4.22	3	28.99	13
	Freshwater pond	14.10	1	1.93	3	0.01	1
	Riverine	1.49	2	15.49	4	13.06	17
Total Aquatic Area (CALVEG and CLN)		**4.89**	**6**	**11.28**	**5**	**32.15**	**6**
Total Aquatic Area (NWI)		**20.04**	**4**	**29.33**	**18**	**52.10**	**42**

This discrepancy could be due to a difference in spatial resolution. The CLN layer is a raster format that was created using a 30-meter cell size, which creates the distinctive pattern of patchy triangles shown in Figure 3.4. CALVEG is in vector format, but it also has the jagged edges characteristic of a raster, at a 5-meter cell size, which is likely due to the remote sensing data sets from which it is derived. The NWI data set, in contrast, was originally created as a vector file by using U.S. Geological Survey topographic maps as the base maps; it generally has smoother edges, as shown in Figure 3.4. However, there are possible other reasons for the discrepancy, such as different mapping dates.

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Figure 3.4. A section of Highway 101 in District 4 showing aquatic impacts from the NWI (freshwater emergent wetland) and CLN (water, permanent freshwater marsh) layers. Nonaquatic areas in the CLN layer that overlap are classified as urban.

The different classes used by each data layer could also account for the differences in wetland area calculated in the analysis. For example, CALVEG has two riparian classes, montane riparian and valley foothill riparian, but the NWI classification has a broader category of freshwater forested/shrub wetland. It is therefore difficult to directly compare some wetland categories. From a regulatory perspective, it may be necessary to include both maps, as one helps guide state regulatory considerations and the other, federal ones.

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CHAPTER 4
Conclusions and Recommendations

Review and Enhancements of RAMP

Obstacles of RAMP

Transportation Project Data Inventories and Consistency

There were a number of obstacles to developing and maintaining an inventory of transportation projects for use in the advance impact scoping phase of advance mitigation planning.

One obstacle was the lack of consistency of transportation project data collected from the different Caltrans districts. Although each district has GIS data of transportation projects along with similar fields relating to each project (such as a project description, county, unique project number, and so forth), the geographies of the data were often in different formats, in varying degrees of accuracy to the road, or only represented along one side of the road. In addition, some projects were represented as points and others as line segments. To resolve this problem, most of the transportation project data received from the districts were overlaid with a transportation road network and satellite imagery to adjust the GIS representations of each project.

A second obstacle was the timing of transportation project implementation; that is, there was difficulty discerning which transportation projects should be included in the analysis. Some of the projects listed in the district-provided data sets are so far in the future that they are not depicted accurately in the GIS or are likely to change before construction begins. Other projects had already begun construction and were thus likely to already have mitigation impacts estimated, and should be excluded. And unfortunately, using only the data provided by the districts, it is difficult to distinguish at what stage each project is in its timeline. This problem suggests a possible need for better tracking of projects by transportation districts, which represents an investment in time and resources.

A third obstacle was a lack of standardization among project descriptions. It was difficult to estimate the footprints of transportation projects because there seemed to be few standards regarding the size of impacts by transportation project type. For example, constructing a new interchange may have a different-sized impact on the land depending on the size of the adjacent highway, the number of lanes, and other existing features on the land such as other roadways, buildings, or natural features. Often the description accompanying the transportation project was not very informative beyond the very basic nature of the project. To compensate for this lack of standardization, the estimated footprints developed as part of CTIS (Table 2.1) were used for this project as a tool for classifying the project types and standardizing the footprint areas. Caltrans staff were also consulted at times to see if more information about a specific project could be used to

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guide the footprint estimate; however, for estimating projects at a regional level, this type of discussion can be time consuming. Related to the question of whether standardized footprints for different types of projects can be developed, and how accurate those footprints might be, is the issue that the same type of project may have a different-sized footprint depending on the context of the surrounding landscape. For example, adding lanes to a highway in mountainous regions may require more cut and fill than the same-sized project on a flat surface.

A fourth obstacle has to do with the history of ongoing projects that have been subject to delay. In some cases projects that appeared to have already passed through the mitigation requirements and satisfaction phase were actually still under development or had been greatly delayed due (in some cases) to environmental concerns. Although these projects may fall outside the purview of an advance planning framework, they constitute a class of projects that need to be avoided and for which the framework under consideration here may be of some use.

Biological and Landscape Data

For biological data, one obstacle was that some areas had land cover data sets of higher resolution or more accurate data than other areas. The quality of land cover data sets was not consistent throughout the three regions along US-101, resulting in the development of a piecemeal data set that combined using the best layers available for the area. This is particularly an issue for areas with high biodiversity, such as California. Many national-scale mapping classifications, such as the National Land Cover Database (http://www.mrlc.gov/nlcd2001.php) or the U.S. Geological Survey GAP Analysis Program's maps (http://gapanalysis.usgs.gov/), lack the biological detail to identify land cover types that contain endemic species. For this reason, state-level and regional maps were assembled to portray what was thought to be the most accurate representation of general land cover and habitats. The Bay Area district has the highest number of high-resolution land cover maps, which gives the greatest confidence level in the accuracy of the data for that area. The central coast district is next in terms of land cover accuracy. The north coast district has few high-resolution land cover data sets and may have the greatest level of omissions of critical land cover types and habitats.

Species occurrence data were also variable, with some species having high-quality species distribution models or habitat ranges developed by researchers focused on those specific species. For other species, CNDDB, a statewide locality database that can be uneven with regard to the accuracy of some species or is not up to date, was the best available data source. To address this issue, species occurrence points were given 2- and 4-mile buffers to capture a range of possible impacts to a given species. In addition, the use of suitable habitat to limit the species occurrence area also created a more accurate picture of species distribution on the landscape.

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Aquatic Impacts

The methods described above for estimating impacts to anadromous fish (salmonids) have several limitations.

First, it is often difficult to discern the actual open water channel by using aerial imagery, especially if there is dense riparian vegetation. This difficulty leads to a lack of precision in estimating the actual impact area a transportation project is likely to create.

Second, it is difficult to systematize the process for estimating impacts. Each crossing of aquatic habitat by a planned project can have a unique width and hence area of impact. This bottleneck could possibly be reduced by using a regionally derived general waterway width associated with stream order. If stream order data do not exist, they can be derived using GIS techniques.

Third, this method assumes that all salmonid habitats within the project footprint will be affected. This assumption does not allow for avoidance measures and thus could lead to overestimation of project impacts.

Improvements to RAMP

Several observations and modifications were made as a result of this project's internal Task 4 report and analysis, which was the evaluation of methods used. First, the importance of selecting which transportation projects to include in the study cannot be underestimated. The inclusion of each additional project can result in a substantial change in the impact accounting. Unfortunately, there is no simple process for determining which projects to include. The best method is to be able to communicate with the Caltrans district planners and biologists, who have the local knowledge of which projects are likely to proceed and which project types will require mitigation.

One change to the existing methodology was to isolate only the new footprint area beyond the existing road. Once the initial results were calculated, it became apparent that the biological and ecological impacts were an overestimation, because the underlying biological and ecological data continue where existing roads are present (Figure 4.1). By excluding the existing roads in the analysis, only the new potential impacts from project construction are captured. This correction represented on average a 33% decrease in impacts for the 2-mile buffer area and a 23% decrease for the 4-mile buffer area (Table 4.1). However, it should be recognized that the area already paved is not suitable for wildlife, and that before paving it likely had attributes that may or may not have been mitigated.

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Table 4.1. Total Impacts for All Districts, With and Without Existing Road

	2-Mile Buffer		4-Mile Buffer	
	With Road	**Without Road**	**With Road**	**Without Road**
Total for All Districts	470.27	316.35	1046.10	803.10
Decrease (%)		32.73%		23.23%

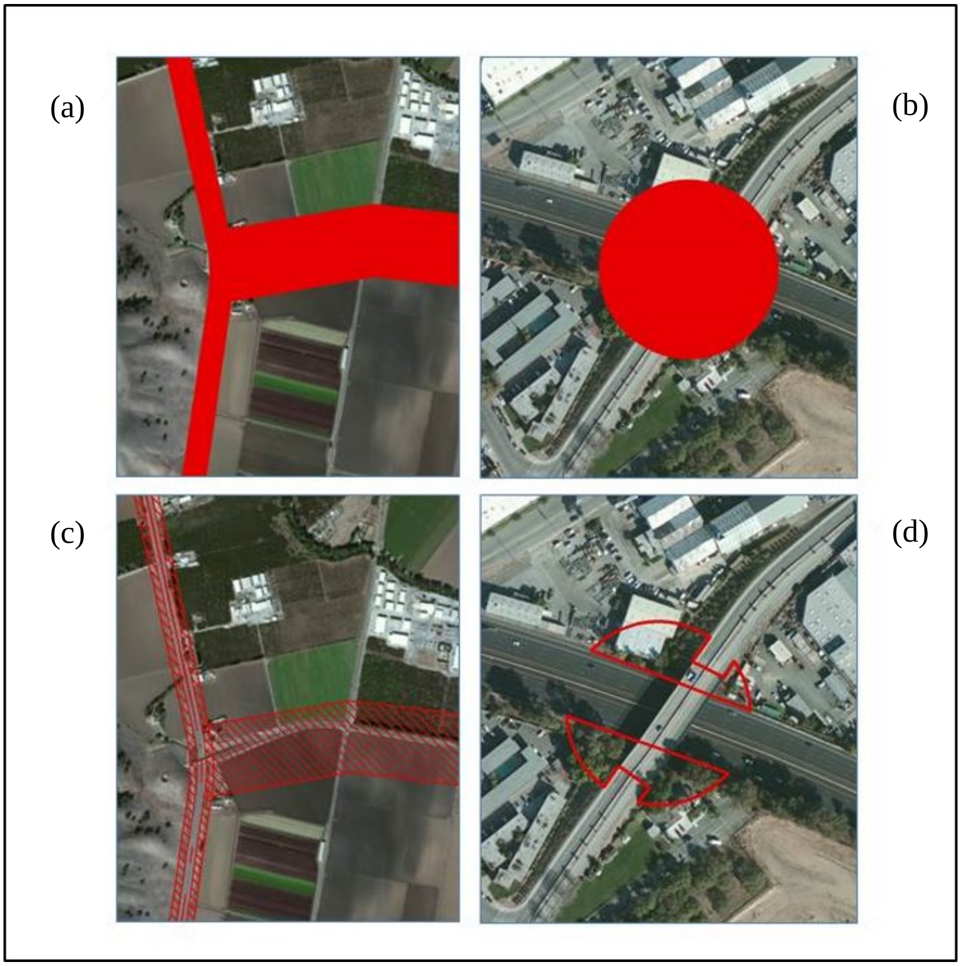

Figure 4.1. The image shows the modification in the transportation project footprints as a result of this study. The initial impact results were overestimated due to the inclusion of the existing road (a) and (b). Some projects included the construction of a new road [see (a) and (c), east–west portion]. For these projects, the footprint remained the same.

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Transferability of Methods

The RAMP approach is data driven, and thus transferability is predicated on the availability of similar data sets regardless of location. Although some of the data used in the analysis comprise standardized, national data, other data critical to the process are specific to California (although there may be analogues in other states). The CNDDB data set, maintained by the State Department of Fish and Wildlife, is an example of data specific to California. This statewide clearinghouse for known occurrences of rare species is relatively large (approximately 75,000 records and increasing) and, although not comprehensive for 160,000-square-mile California, it provides very useful information, especially in some particularly well-studied regions. The CNDDB data set is a frequently updated data layer that requires a subscription to maintain adequate funds for upkeep. Therefore, this analysis could output slightly different results each time it is performed, but with the assumption that the most-recent data are the best available. It should be noted that not only are new sightings recorded that add new points to the data, but older sightings that have not been verified within a certain time frame also change their "presence" status, which would effectively remove those points from the subset once the queries were applied.

Equivalent data sets are not necessarily readily available in other states, thereby posing potential limitations if RAMP were to be exported from California.

Even within California, differing levels of accuracy in impact assessment due to varying quality in input data can be expected. This is not only true for CNDDB data, but land cover, as well. Some regions within the state have been the subject of intensive efforts to develop fine-scale (taxonomic and spatial) land cover data sets (e.g., the VEGCAMP effort by the California Department of Fish and Wildlife), but many places have not. Therefore, even within a single transportation district, there may be qualitative differences in inputs used in the assessment process. This variation would likely be compounded when transferring the approach outside the state.

The use of CNDDB data in a full public-access national tool would therefore need to identify how the CNDDB could be maintained, given that the incentive to pay for subscriptions could be compromised by access to the same data through a national portal. This comment also applies to state agency data from other states that may require subscription.

The impact estimation for anadromous fish (salmon and steelhead) is generally transferrable within the United States. Both National Marine Fisheries Service fish distribution data and National Hydrography waterway data are available and applicable throughout the country. National Agricultural Inventory Program aerial imagery or other imagery is also available nationwide.

Transportation project data are also a vital component of the analyses; their accuracy plays a large role in the assessment outcome. For this project, each Caltrans district was contacted to explain the project and to coordinate which data would be

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attainable and how they would be used. CTIS, which is the source of the footprint estimates for transportation projects based on project type that were used in this project, also contains a list of and GIS data for programmed transportation projects in California over the next 20 years. The projects from the CTIS database were compared with the lists received from the individual Caltrans districts to see if using the CTIS database could be a viable alternative to asking individual Caltrans districts for their data. The results from this comparison showed that although there is considerable overlap between the two data sources, receiving data from the Caltrans districts directly was the preferable method due to the benefits of local knowledge. However, the CTIS database returned an exhaustive list of projects, which could prove useful for preliminary scoping of impacts if obtaining projects from Caltrans districts directly was not feasible. It should be noted that the CTIS database download requires that users obtain a password from Caltrans.

Review of National-Level Tools

Using a sample data set from the analyses, the capabilities of the existing national environmental online scoping tools were tested to see if the results were similar to the RAMP methodology.

NEPAssist

NEPAssist is an online tool created by the U.S. Environmental Protection Agency intended to facilitate environmental review project planning through visualizing multiple biological, health, and demographic data, which will promote collaboration and identify important environmental issues in the early stages of the project. The background data available in the NEPAssist map include water features, soil surveys, wetlands, and land cover, which are also included in the RAMP analyses. However, there are no threatened or endangered species included on the map. To define the project area, the user is given a detailed base map and tools to draw the boundary, but there is no place to upload existing GIS files.

Users familiar with the project area can use the tools to draw a generalized view of the project. Drawing an area could potentially give the user a set of impacts for the habitat types listed above.

ESA Webtool

ESA Webtool is an online tool developed by the U.S. Department of Transportation’s Federal Highway Administration to streamline the preparation of biological assessments (BAs) and the consultation process required under the Federal Endangered Species Act. This tool allows a user to create a profile in which different milestones can be added and saved. As documents are developed, they can be put in a single place (referred to on the website as a File Cabinet) and organized into folders. Other users can be allowed access as needed. There is also a checklist on which the progress toward BA development and

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submittal can be tracked. There is a national BA template, as well as region-specific information.

This tool is useful for tracking the progress of documents required during transportation project timelines. The website is an excellent source of information for many types of impacts, not just biological, that may require mitigation, such as historic structures and archaeological and agricultural impacts. However, there is no mapping function that allows projects to be overlaid with species occurrences or habitats that might require mitigation.

IPaC

The IPaC Initial Project Scoping tool was developed by the U.S. Fish and Wildlife Service to provide an official list of threatened and endangered species that should be considered when evaluating the potential impacts of a transportation project. Map layers that are available for overlay with transportation projects include LEAP (Landscape-scale Energy Action Plan) species, potentially restorable wetlands, U.S. Fish and Wildlife ecoregions and bird conservation areas, landscape conservation cooperatives, NWI wetlands, proposed and final critical habitat areas, land protection and land ownership status, national conservation easements, and a hydrography layer.

To define the project area, the user can either upload GIS files or draw the area on the map. This function did not seem to work properly, despite several attempts using different files and different projections and attempting to upload only the essential files of a shapefile. The online program could not detect a projection file, despite there being a .prj file included, and it was not able to correctly display the file using the program's on-the-fly feature. It also appeared that only one project or area can be uploaded at a time, and each area is analyzed separately.

However, once a transportation project was drawn on the map using the tools provided by IPaC, the output report was well-organized and informative. For Project 230531, a lane construction project in Santa Clara, IPaC reported that the area intersected with steelhead critical habitat, as well as seven types of wetlands, along with reported acres. It is unclear what area the approximate area represents, however, because the report suggested there were more acres of estuarine and marine wetland than the entire footprint of the project. The report also indicates if there are U.S. Fish and Wildlife migratory birds or Endangered Species Act species in the defined area. For the construction project in Santa Clara, the report indicated that no online information was available for migratory birds or Endangered Species Act species. However, it was suggested the user request a preliminary or official species list from the U.S. FWS Sacramento office, and the address and phone number were provided. Finally, the last step of the scoping tool, Conservation Measures, was still under development and being tested by the U.S. Fish and Wildlife Service and was unavailable for the Santa Clara project.

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This tool seemed the most promising of the online scoping tools tested. The main drawbacks were not being able to upload GIS files and only being able to look at one project at a time. For use with advance mitigation, having multiple projects examined together, with acreage amounts for each species and project, would be extremely useful. The results on impacts to wetlands seemed to be overestimates, but because the transportation project boundary was drawn instead of uploaded, it could be the result of the boundaries being different.

Eco-Plan Testing

Throughout this project, the C40B groups and ICF International, the C40A group, communicated through planned group meetings, web conferences, and individual sessions about the content, function, and appearance of the new web tool, Eco-Plan. Once the Eco-Plan website was ready for testing, the C40B teams were asked to review the website and comment on different aspects of the tool. Specific tests were provided in the form of step-by-step instructions to reviewers on the different components of the web tool. The teams' comments were incorporated into the final design.

The test scripts asked reviewers to examine two functions of the web tool: Eco-Plan and Eco-Plan Advanced.

Eco-Plan

The Eco-Plan test component was targeted toward transportation and conservation planners with limited GIS capabilities and for those who are doing preliminary scoping at a general level. A variety of theme maps had already been assembled by ICF to show different groupings of relevant data around a theme, such as critical habitat and at-risk species, or development potential in unprotected areas. There is also a mapping interface on the website that can be used to locate and zoom in on a specific area of interest and examine the different data sets preloaded by ICF.

Three members of the research team completed the tests provided by ICF to evaluate the Eco-Plan website. Overall, Eco-Plan was easy to use and allowed users with little or no GIS experience a way to explore many types of data and relevant data sets in a specific geographic area. Other capabilities, such as a function to upload or draw transportation layers, were not yet available for review on the website during the testing phase, but have since been added to the website. The ability to view the different data layers along with a visibly defined project area is a great enhancement to the tool. A further improvement would be some limited geoprocessing capabilities, such as the ability to intersect multiple layers or calculate the area of overlapping layers.

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Eco-Plan Advanced

Another part of the C40B beta testing component was to compare the RAMP method for calculating initial impact to threatened and endangered species and other habitats from proposed transportation projects with the capabilities of the Eco-Plan web tool. Specifically, the ArcGIS Online (AGO) module of Eco-Plan, called Eco-Plan Advanced, was examined for the ability to scope impact assessments.

Before this testing, UC Davis received login information and AGO training over several phone calls with ICF International. Instructions were provided on how to navigate the AGO portion of Eco-Plan, upload data, and use the data already uploaded by ICF International, as well as how to use the data available through Esri, save maps, and use geoprocessing and analysis tools.

The objectives for testing the AGO portion of Eco-Plan were to answer the following questions:

- Did the tools in AGO function so that analysis could be performed on the project study area and results could be displayed?
- Could multiple projects be added at a time?
- Would the national-level and state-level data within the AGO platform be both relevant and comprehensive to meet the needs of this project?
- How did the results obtained through the Eco-Plan website compare with the results from the UC Davis RAMP approach, which used more localized data sets?

The basic steps included (1) adding the research team’s transportation project inventory maps to AGO; (2) selecting a variety of natural resource layers, including some that the team had previously assembled portraying habitats from the study area, as well as ICF preloaded Eco-Plan and Esri data layers; (3) using the geoprocessing tools within AGO to intersect and see what possible impacts the U.S. Highway 101 transportation projects might cause; and (4) comparing results from impact assessments via the Eco-Plan AGO and from the team’s local analysis.

There were no difficulties adding transportation projects and species habitat maps to AGO for analysis. Adding shapefiles containing multiple projects at the same time was also possible. Similarly, adding preloaded layers from the Eco-Plan or Esri was easy and straightforward.

There was mixed success running the intersect tool on the different layers (Figure 4.2). For the species habitat layers from the projects added, the intersect tool worked, either successfully running or returning an error message if there were no intersecting areas. For some of the Eco-Plan or Esri layers, an error message revealed that the overlay layers failed to be used for the analysis.

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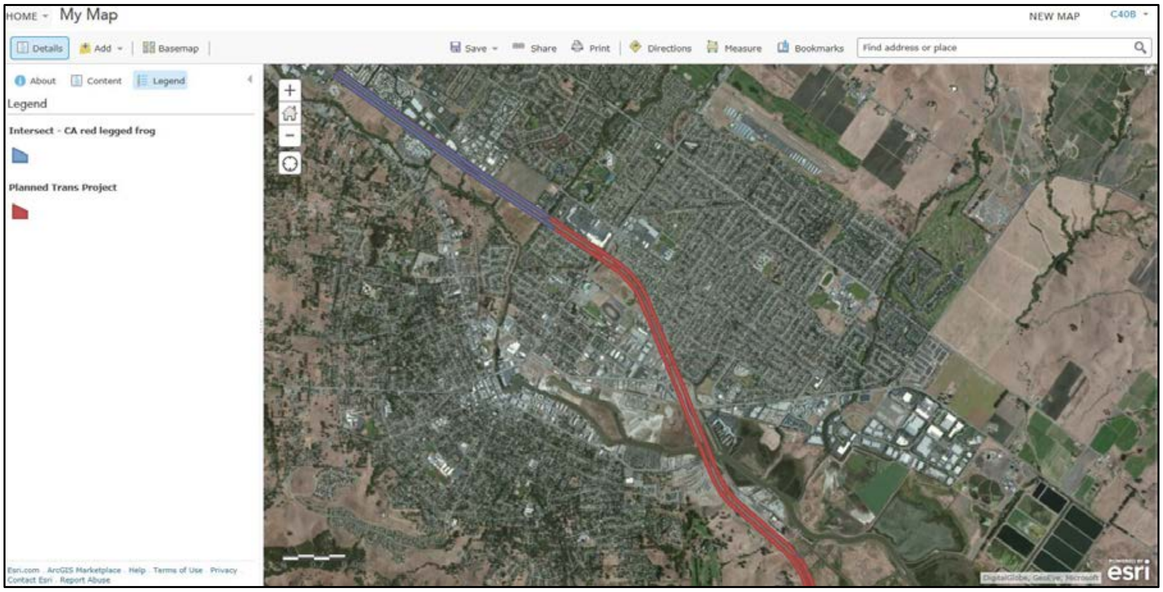

Figure 4.2. Eco-Plan map showing a successful intersection process of California red-legged frog with the uploaded District 4 planned transportation projects.

For all intersections that worked, an output table could be created to show the sum of all intersecting areas. The output tables were created and compared with the tables created using individual ArcGIS desktop tools at UC Davis (Table 4.2).

Table 4.2. Species and Habitat Impact Results Using AGO in Eco-Plan and RAMP Analysis Using ArcGIS Desktop

Species	**Area Overlap Using AGO (km^2)**	**Area Overlap Using Local ArcGIS Desktop (km^2)**	**Difference (km^2)**
Tricolored blackbird	1.731	1.616	0.115
Santa Cruz long-toed salamander	0.705	0.630	0.075
Tiburon mariposa lily	0.000	0.000	0.000
Burke's goldfields	0.000	0.000	0.000
California black rail	0.024	0.023	0.001
Salt marsh harvest mouse	0.007	0.007	0.000
California red-legged frog	0.552	0.485	0.067
Habitat			
Wetlands (U.S. Fish and Wildlife Service)	0.037	0.015	0.022
Wetlands (USA)	Error	0.015	NA
Riparian (U.S. Fish and Wildlife Service)	9.654	0.022	9.632

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Generally, the areas resulting from the intersect tool in AGO were slightly larger than the analysis using ArcGIS Desktop, especially for individual species. For scoping projects, this is a better result than underestimating impacts or not identifying them outright. For habitat impacts, the results were mixed. The wetlands impacts for the ArcGIS Desktop analysis and within AGO using the U.S. Fish and Wildlife Service data were almost identical. For the national wetlands data set (NWI), results using the AGO tool were not obtainable, and an error message was produced. For riparian habitat, the ArcGIS Desktop analysis resulted in a much lower estimate of impacts. This is most likely due to the different layers having different definitions or inclusions of certain land cover types within the riparian category.

The overall impression of the AGO function of the Eco-Plan tool was positive, especially compared with the other national-level tools reviewed (**Error! Reference source not found.**). If planners or researchers wish to assess impacts and have specific data layers or wish to do a preliminary assessment using preloaded layers from Esri or Eco-Plan, this tool can accomplish those tasks. Further observations of the tool are as follows.

- The UC Davis–uploaded habitat area layers in AGO were identical to the layers used in the ArcGIS Desktop analysis, yet the outputs of the intersect tool were not identical. For the most part, however, the areas are very close to the research team's analysis, and species not present in one are also not present in the other.
- The more general habitat layers (wetlands, riparian) were harder to compare, as they derive from different sources. Some national layers, like grasslands, showed something very different from a native grassland layer that would be expected within California, because over 90% of all California grasslands have been converted to nonnative types.
- It is difficult to discern in AGO from the Contents page which layers have features that can be used in geoprocessing analyses like intersecting and which are only for visual purposes. For other layers, like EnviroAtlas, there are features that can be used for geoprocessing, but they are difficult to display. This makes it difficult to determine whether to use the layer in an analysis.
- While using the geoprocessing tools, such as the intersect tool, the names of the layers changed from the labels given on the Contents page to a more general layer name. For example, there are two wetland layers, with names on the Contents page that differentiate them (i.e., USFWS Wetlands and USA Wetlands). However, when selecting a layer to intersect, the layers have different names, such as "Wetlands" and "Wetlands layer," making it difficult to know which layer is being selected. One possible way to distinguish the layers occurred after a successful intersect, when opening the attribute table and comparing the table with those on the Contents page.

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Table 4.3. Overview of National-Level Tools Reviewed for This Project

Capabilities Present	NEPAssist	ESA Webtool	IPaC	Eco-Plan
Import Layers			X (did not work for UC Davis testing)	X
Draw Layers	X		X	X
Provided Layers	X (but no threatened and endangered species)		X	X
Geoprocessing			X	X
Save/Export Map or Features			X (Save list of impacts only)	X (Save map and features)
Additional Features	Health and demographic data available	BA checklist	Conservation measures tool under development	ArcGIS Online

Opportunities and Next Steps

This project demonstrated the transferability of impact assessment methods developed under the RAMP framework in California from one region to another. Using the inventory from the statewide database (CTIS) and updates using the three districts' information, 68 projects were identified to be included in an analysis of impacts. Further work included assisting ICF International in the development of a national tool. During the project, a number of bottlenecks and opportunities (Table 4.4) were identified that can be broken into three categories: transportation, geospatial tools, and biological.

For transportation, a challenge is the standardization of terminology and the geospatial portrayal of projects. Caltrans has 12 districts, each of which is responsible for the development and delivery of transportation projects. How the projects are described, how the inventory of projects is kept as the projects progress from conception to planning to implementation, and how projects are portrayed in GIS are all elements of Caltrans' business that vary from region to region. Efforts to standardize have been made, with the CTIS database as a good example, but variations inevitably occur because of the specifics that arise with each project, differences among staff, and the long timelines that are involved. Therefore opportunities for making repeated advance analyses of impacts using a rotating set of pending projects include efforts to develop more standardized descriptions. Efforts could also potentially be made to further map the entire project development phase with regard to identifying the points at which regional early assessment of impacts could contribute to improving environmental practice overall.

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Geospatial issues include the practice in California of relaying much of the planning phase of projects in post miles. Transitioning these values to most GIS systems requires Caltrans staff. In addition, many early project renderings are either line segments that approximate the location of a road or points on the transportation network. For the RAMP methods to be applied, these lines must accurately reflect the centerline of single roads and the centerlines of lanes going in different directions for divided roads. This potentially represents a "low-hanging fruit," in that developing a single, highly accurate GIS of the road network that contains the capacity to directly transition between post miles and other GIS values would allow the entire agency to more efficiently transition projects in early phases to GIS for environmental scoping. It was beyond the scope of this project to determine how far this approach has already been developed at Caltrans, but there are at least some GIS centers in the agency that already have some capacity in this regard.

In addition, the assembly of geospatial data that portray biological, land cover, and ecosystem attributes and that are used by regulatory agencies in their evaluation of mitigation requirements for projects is needed. These data are publicly accessible data that have been developed by agencies at the federal and state levels of government, by university studies, or through citizen science efforts (e.g., ebird). For this California-based study, publicly available data from state and federal surveys (e.g., NWI and the CNDDB) were primarily used, but also included were some regional data (e.g., the CLN map for Bay Area land cover types) for the impact assessments. The SHRP 2 C40A project website compiled an impressive amount of data for national-level scoping, but a fully integrative tool that covers the needs of all states still requires further data sources, particularly from states' inventories, to be added. Once developed, the tool would also need to have the capacity to be updated, probably at several levels such as county, state, and federal, as new and updated information and new data types (such as LIDAR) are rendered to geospatial databases.

The geospatial considerations listed above intersect with biological and ecological opportunities in a manner similar to the considerations needed for transportation: the inventory, georeferencing, and upkeep of landscape-level information that can be used in a GIS to assess the impacts from planned and programmed projects. As recognition of additional areas of environmental health arise (such as landscape connectivity and expected levels of stress associated with climate change), they will need to be incorporated into the overall "biological backbone" of a national or statewide system.

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Table 4.4. Overview of Bottlenecks and Opportunities Encountered During This Project

Type	Data Category	Issue
Bottleneck	Transportation	Standardization of how to portray projects in a GIS for ease of regional assessment
Bottleneck	Transportation	Developing and maintaining current inventories of transportation projects
Bottleneck	Transportation	Standardizing descriptions of project types
Bottleneck	Transportation	Identifying project delays proactively
Bottleneck	Biological	Quality and accuracy of land cover maps
Bottleneck	Biological	Quality and accuracy of listed species data
Bottleneck	Biological	Assessment of risk of fish kills from stream crossings of various types
Opportunity	Geospatial tools	Ability to track mitigation requirements to better predict future requirements
Opportunity	Geospatial tools	Access to a regional greenprint
Opportunity	Geospatial tools	Using a standardized tool like Marxan to identify suitable mitigation parcels

In sum, the methods for impact assessment, which are the first part of an overall drive to achieve Eco-Logical goals of early and regional environmental mitigation, appear to function acceptably well, either via desktop analyses or through the use of a GIS-enabled web interface. The tasks of preparing the data on both the transportation and environmental sides for their accurate analysis using the tools available are areas that represent next steps in the development of a tool that can be widely used and trusted by transportation agencies, their regulatory counterpart agencies, and the public.

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APPENDIX A
Memorandum of Understanding Signatory Sheet

The RAMP working group brought together more than 14 organizations, including Caltrans, the Department of Water Resources, California Department of Fish and Wildlife, the U.S. Fish and Wildlife Service, U.S. Army Corps of Engineers, U.S. Environmental Protection Agency, University of California, Davis, and The Nature Conservancy, to convene on a regular basis and explore the potential for regional advance mitigation in California. In 2009, a memorandum of understanding (MOU) was drafted to initiate the implementation of RAMP through a pilot study and other activities to explore the benefits of advance mitigation.

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Dear Secretary Bonner and Secretary Chrisman:

On behalf of the U.S. Army Corps of Engineers (Corps) and the U.S. Environmental Protection Agency (EPA), we are writing to express our support for the advanced mitigation planning process described in the proposed "State of California Memorandum of Understanding Regarding Regional Advance Mitigation and Conservation Planning For Transportation and Flood Control Infrastructure Projects." The proposed MOU describes general goals and process steps to identify in advance compensatory mitigation needs and opportunities associated with construction projects to be completed by the California Department of Transportation and Department of Water Resources. The Corps and EPA have been participating in initial discussions of this project, referred to generally as the regional advance mitigation planning or "RAMP" process, for several months. The MOU is intended to build state-federal agency partnerships to advance the RAMP process and complete a pilot demonstration project.

We understand that several agencies have signed the MOU and that its proponents will be asking the Corps and EPA to sign the proposed MOU. As discussed below, we have decided not to sign the MOU but will continue to support and participate in the RAMP process as resources allow.

In 2008, the Corps and EPA issued final regulations to improve the quality and success of compensatory mitigation projects for activities authorized by permits issued pursuant to Clean Water Act Section 404 (73 FR 19594, April 10, 2008). The final regulations strengthen the planning, implementation, and management of compensatory mitigation projects by emphasizing

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a watershed approach in selecting mitigation project locations, encouraging development of larger scale mitigation sites to address multiple project needs, and advocating advance mitigation planning.

Consistent with the provisions of the new regulations, the Corps, EPA, and other state and federal resource agencies have implemented an interagency review team (IRT) process in each Corps District in California through which the reviewing agencies work with project proponents to streamline the review process and site and design mitigation activities to maximize environmental benefit. The IRT process enables agencies and project proponents to work together to devise mitigation approaches that address mitigation requirements under the federal Clean Water Act and Endangered Species Act along with associated State statutes. We have been and will continue to encourage the participants in the RAMP process to coordinate with the Corps and EPA through the IRT process as the proposed pilot project and associated activities are developed. We believe that by meshing the RAMP approach with the existing IRT process, our agencies will be able to most efficiently pursue our shared objectives of identifying and securing larger scale mitigation resources in advance that can be used to provide necessary compensatory mitigation for infrastructure construction activities.

We have decided not to sign the proposed MOU because its drafting is vague in several areas and some provisions appear duplicative of or potentially in conflict with existing requirements and procedures associated with the new Corps/EPA compensatory mitigation rule. Moreover, the MOU does not contain several types of standard language we need to see in MOUs we are asked to sign. As we are aware other agencies have already signed the MOU and the RAMP process can proceed without our agreement to the MOU, we have decided not to engage in a potentially lengthy MOU negotiation process that could slow progress in carrying out a pilot project. We would instead prefer to devote our limited available staff time to participate in RAMP discussions and help coordinate discussions of the RAMP initiative within the applicable IRTs in the coming months.

We look forward to our continued participation in the RAMP process and to its eventual success in targeting and securing advance mitigation sites. If you have questions, please call Michael Jewell at the Corps Sacramento District (916-557-6605) or David Smith at EPA's South Pacific Region (415-972-3464).

Sincerely,

Dr. Christine Altendorf, Director
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24 July 2009

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APPENDIX B
Data Sources

Below is a list of spatial layers that were used for this study, along with links to more information about the specific layers. Many of the geographic data sets used for this project are available to the public for download. There may be additional metadata for some of the spatial layers, as well.

- Conservation Lands Network (http://www.bayarealands.org/gis/)
- National Wetlands Inventory (http://www.fws.gov/wetlands/)
- San Francisco Estuary Institute Bay Area Aquatic Resources Inventory (BAARI_wetlands_01; http://www.sfei.org/ecoatlas/gis)
- U.S. Fish and Wildlife vernal pools (VP_2005; http://www.fws.gov/sacramento/es/Critical-Habitat/Vernal-Pool/es_critical-habitat-maps_vernal-pool.htm)
- National Hydrography data set (http://nhd.usgs.gov/)
- Important farmland as identified from the Greenbelt Alliance (ImportantSoil_2010; http://www.greenbelt.org/)
- California Natural Diversity Database (CNDDB; http://www.dfg.ca.gov/biogeodata/cnddb/)
- National Agricultural Inventory Program aerial imagery (http://www.fsa.usda.gov/FSA/apfoapp?area=home&subject=prog&topic=nai)
- Vegetation types with a "high" rating in the California Wildlife Habitat Relationships model (California Department of Fish and Wildlife; http://www.dfg.ca.gov/biogeodata/cwhr/wildlife_habitats.asp for terrestrial vertebrate species was selected).
- Calflora-listed land cover types for plant species were selected (http://www.calflora.org/).
- Various online sources for invertebrate species were used to define appropriate habitat types.
- For plants, invertebrates, and unique types identified from the literature, the habitat requirements were cross-walked to California Wildlife Habitat Relationships model types so that their potential locations on the landscape could be identified using the research team's reference maps.

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