TWO CALTRANS FORUMS ON WILDLIFE CONNECTIVITY

by

Rob Ament, Road Ecology Program Manager
Marcel Huijser, Wildlife Ecologist

Western Transportation Institute
College of Engineering
Montana State University

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Planning Department
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Sacramento, CA 94273

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GLOSSARY OF ACRONYMS

BIOS	Biogeographic Information and Observation System
Caltrans	California Department of Transportation
DSMP	District System Management Plan
EIR	Environmental Impact Report
FHWA	Federal Highway Administration
GIS	Geographic Information System
LD/IGR	Local Development/Intergovernmental Review
MSCP	Multiple Species Conservation Program
PDT	Project Development Team
PEAR	Preliminary Environmental Analysis Spatial Report
PEL	Planning Environmental Linkages Program
PEMS	Caltrans' Performance Measurement System
PID	Project Initiation Document
RTIPS	Regional Transportation Improvement Plan
SEP	Standard Environmental Preference
SHOPP	State Highway Operation and Protection Program
TCR	Transportation Concept Report
WVC	Wildlife-Vehicle Collision

EXECUTIVE SUMMARY

The California Department of Transportation (Caltrans) hosted two forums to increase the consideration of aquatic and terrestrial habitat connectivity, wildlife movement and wildlife-vehicle collisions (WVCs) for its planning and project development. One forum was hosted in San Diego for the southern districts and the other forum was held in Marysville for employees of the state office and the northern districts, over 90 employees participated. The forums sought to help Caltrans employees better understand where existing information resides, how to use it, and the current state of knowledge regarding the efficacy of fish and wildlife mitigation measures.

Each forum agenda was developed into several sub-sections: an overview of the policies and science on connectivity, a section on the tools and data sources available to Caltrans employees, two different breakout sessions and several geographically relevant case studies of Caltrans aquatic and terrestrial connectivity projects, as well as one on partnerships.

The core activity at each forum was to engage attendees to share their information, experiences, challenges and needs to improve their ability to engage in connectivity conservation. Two different moderated breakout sessions using small groups at each forum were dedicated to exploring the knowledge and the needs of Caltrans employees. At the end of each forum an exit questionnaire was used to generate additional feedback from those in attendance.

A few highlights of the results of the first moderated breakout session, based on a hypothetical scenario for State Highway 23, were based on employees' understanding of the information needed to make connectivity decisions and what aquatic and terrestrial connectivity issues should be addressed for highway construction or reconstruction projects were:

1. Include the need to protect wildlife connectivity into a project's purpose and need section. This will then require connectivity issues to be investigated, including a field assessment of any existing structures (i.e., culverts, bridges).
2. Avoidance, mitigation or compensation (or-off-site mitigation) may be needed if important habitat or wildlife corridors are disrupted by the highway. Action may also be required if important habitat is nearby, especially on both sides of the highway, with or without it being a designated wildlife corridor.

The second moderated session engaged forum participants in assessing their needs to better incorporate the concerns for wildlife connectivity into their daily work. Some of the most frequent responses were:

- Many stakeholders/partners usually involved, thus projects/plans need coordination.
- Preliminary Environmental Analysis Spatial Report (PEAR) GIS Data Base important, need training, host on a single web platform, and provide guidelines on its use.
- Cost-benefit analyses are beneficial, need to expand models (e.g. non-safety parameters)
- Consult with Transportation Concept Reports (TCRs), Caltrans is updating TCR guidelines, training needed for project managers.
- Better internal Caltrans coordination and communication across various functions.

Attendees of the forums were asked to fill out an evaluation form at the end of each forum. Most participants agreed that their understanding greatly increased with regard to terrestrial connectivity, fish passage connectivity, and the costs and benefits of terrestrial and aquatic connectivity. Their understanding with regard to available tools and data also increased.

The most numerous responses to the evaluation form question, "[w]hat part of the forum was most valuable", were:

- Cost-benefit analyses
- Terrestrial passages and wildlife-vehicle collisions information
- Fish passages presentations
- What fish and wildlife and habitat connectivity data was available and the references

The top two responses to the evaluation form question, "[h]ow do you see wildlife connectivity being included in your functional work products?", were:

- Project Initiation Document (PID)
- System planning

The top five responses to the evaluation form question, "[w]hich if any, tools and datasets would be helpful to your functional units?", were:

- Preliminary Environmental Analysis Spatial Report (PEAR) GIS Data Base
- Geographic Information System (GIS), including wildlife habitat
- Database with connectivity data (terrestrial and fish)
- Cost-benefit analyses for California fish and wildlife species
- Database with wildlife crash and carcass data

As a result of the two forums, it is apparent many Caltrans employees are willing to be more engaged in reducing wildlife-vehicle collisions and addressing impacts of state highways to terrestrial and aquatic connectivity. The various functional groups within the agency request additional support and training to help them more fully consider ecological connectivity in their daily activities. It will be critical to provide this additional strategic support and training regarding wildlife connectivity for staff and managers in various functional units. This support and training will improve Caltrans' ability to address species movement and habitat connectivity resulting from ongoing changes to the environment from climate change and infrastructure development.

These changes highlight the need for Caltrans to consider terrestrial and aquatic connectivity as early as possible in the planning phase, in order to efficiently and effectively include their consideration through all the planning, programming, and project delivery processes. This objective is aligned with Caltrans' strategic plan's mission, vision, and goals.

1. INTRODUCTION

Transportation projects are being built with little to no consideration of aquatic and wildlife movement from early planning through project development phases. This is leading to missed opportunities to reduce the incidence of wildlife-vehicle collisions and decrease the disruption of wildlife's natural movement patterns, which can isolate species, thus leading to a greater possibility of extirpation or even extinction. Although Caltrans has developed some exemplary projects that address both terrestrial and aquatic connectivity, a more systematic approach is needed.

To begin a broader discussion on ecological connectivity by the Department, and among its various divisions, two one-day forums were envisioned to engage a diversity of employees on the issues, challenges and existing successful implementation efforts regarding both aquatic and terrestrial connectivity. The Caltrans organizing committee also sought to explore suggestions from forum attendees for better collaboration among Caltrans functional units that would lead to enhanced wildlife crossings or other mitigation measures.

Invitations to the forums were extended to all Caltrans employees in the hope that representatives of both Caltrans Headquarters and various District staff would attend. Thus, one forum was held in the south, San Diego and the other in the north, Marysville. Similarly, it was hoped that there would be diverse functional representation in attendance from environment, design, operations, project management, construction, and maintenance. The forums were designed to increase the understanding of transportation planning, environmental review, design needs and requirements that lead to transportation projects that provide fish and wildlife a greater ability to move in their natural patterns.

In addition, the forums sought to help in the development of a Planning Environmental Linkages (PEL) Program, as Caltrans explores PEL with the Federal Highway Administration (FHWA). PEL is a methodology to examine potential environmental issues during the planning stage in order to lead to more effective mitigation of environmental issues and streamlined project delivery. The forums targeted methods that improve the way that Caltrans is integrating wildlife data and connectivity issues into early project scoping and long-range transportation plan development in accordance with FHWA's Eco-Logical framework. This work also would support Caltrans' effort to create a modernized and sustainable transportation system in accordance with its new Strategic Management Plan and its Goal 3 on Sustainability, Livability, and Economy.

2. FORUM GOAL AND OBJECTIVES

As the forums were developed Caltrans Division of Transportation Planning (DOTP) and Division of Environmental Analysis (DEA) staff were intent on setting up a clear goal and achieving several objectives for the two meetings. These were included in the agenda so that all attendees were aware of the purpose of each of the day-long workshops.

The forum for the southern half of California was hosted by District 11 of Caltrans at their Garcia Auditorium in San Diego on 26 January 2016 and the northern California forum was hosted by District 3 at their Sierra Nevada Room in Marysville on 28 January, 2016 (Figure 1).

GOAL: Increase the consideration of aquatic and terrestrial wildlife movement and habitat connectivity for Caltrans planning and project development.

OBJECTIVES:

1. Increase the awareness for the need to evaluate wildlife connectivity across different planning and design stages (i.e., planning, environmental review, design).
2. Assess the need for wildlife connectivity in the development of Planning Environmental Linkages (PEL), a potential joint Caltrans and FHWA effort.
3. Target methods to improve Caltrans integration of wildlife habitat and connectivity data into early project scoping and long-range transportation plan development.

Figure 1: Wildlife Connectivity Forum held at District 3 of Caltrans in Marysville, CA, on 28 January 2016.

3. FORUM ATTENDANCE

A diverse mix of Caltrans employees from various functions attended the forums, 24 employees were in attendance in San Diego (Figure 2) and 61 attended in Marysville (Figure 3), respectively. In addition to the Caltrans forums' organizing committee and forum speakers this totaled over 90 Caltrans employees who participated in the two events. Combined, the two forums had the following functional representation (number in parentheses) recorded on the sign-up sheets at each forum location: maintenance (3), transportation planning (29), environmental planning (24), design (27), right-of-way (1) and landscape (1).

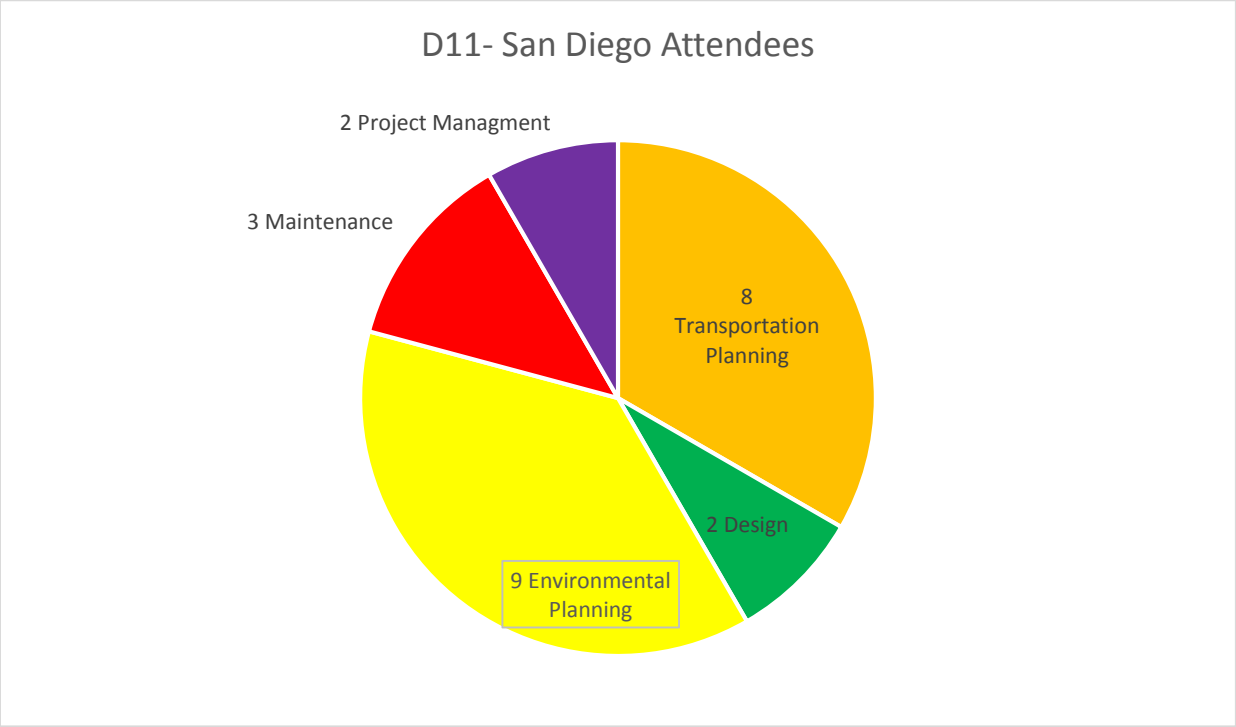

Figure 2: Functional representation of Caltrans employees attending the San Diego, CA, forum on wildlife connectivity.

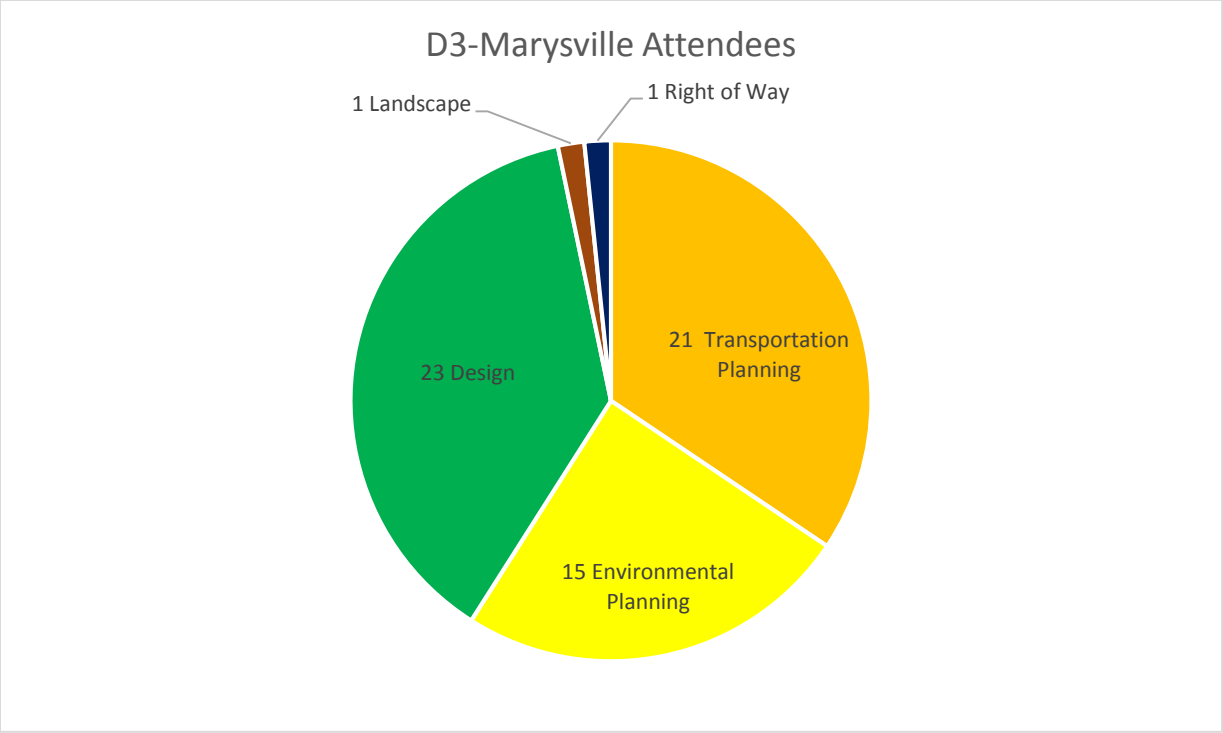

Figure 3: Representation of Caltrans employees attending the Marysville, CA, forum on wildlife connectivity.

4. FORUM PRESENTATIONS

4.1. Introduction

Each forum was developed to increase the awareness of the consideration for, and the needs of, aquatic and wildlife connectivity within and between the different functional units of Caltrans. To do so would help align the identification and protection of aquatic and terrestrial connectivity with Caltrans' Strategic Management Plan, 2015-2020, of which sustainability is a central element (http://www.dot.ca.gov/perf/library/pdf/Caltrans_Strategic_Mgmt_Plan_033015.pdf) under Goal 3: Sustainability, Livability and Economy.

The forums had several key elements, these different portions of each forum were spent on 1) policy and scientific information that is available, 2) case studies of Caltrans projects or programs that already have successfully addressed connectivity, and, 3) breakout sessions. The breakout sessions were designed for attendees to share information on their experiences and needs and provide suggestions that would help improve the incorporation of ecological connectivity into their daily work.

Each forum agenda was developed into several sub-sections for its different presentations: an overview of the policies and science on connectivity, a section on the tools and data sources available to Caltrans employees, two different breakout sessions and several case studies of Caltrans aquatic and terrestrial connectivity projects, as well as one on partnerships. Some of the case studies were different, depending on whether the forum was held for southern Caltrans districts or northern ones. Many of the presentations were developed in Powerpoint™ software and are available on the Caltrans intranet (Figure 4) at: transplanning.onramp.dot.ca.gov.

Figure 4: Screenshot of Caltrans intranet site where the presentations given at the Wildlife Connectivity Forums are located for viewing - see bottom link on "What's New" page. [accessed 4 March 2016].

4.2. The Big Picture

The first portion of each forum was formulated to inform attendees, regardless of their experience or the Caltrans functional group they were from, with the best available information on wildlife connectivity. This information was split across three presentations: 1) the Caltrans Division Chief for Transportation Planning discussed the agency's policies and strategic direction that encourage sustainability and efforts to address connectivity, 2) the next talk detailed the latest science and solutions to maintain terrestrial connectivity, including addressing wildlife-vehicle collisions (WVCs), and 3) the last speaker described the status of fish passage efforts for the California state highway system.

4.2.1. Planning for sustainability and connectivity

Caltrans Division Chief, Katie Benouar, described some key policy direction that has been given to Caltrans employees that supports their efforts to address connectivity. She also emphasized the need to integrate wildlife connectivity within and across Caltrans planning and design phases: planning, environmental review, design and construction, and maintenance.

Ms. Benouar suggested Caltrans' organizational goals can be met by paying attention to habitat connectivity, as well as by implementing projects that reduce WVCs. Specifically, the following two of the agency's five goals:

- Safety and Health
  Provide a safe transportation system for workers and users, and promote health through active transportation and reduced pollution in communities.
- Sustainability, Livability and Economy
  Make long-lasting, smart mobility decisions that improve the environment, support a vibrant economy, and build communities, not sprawl.

Other policies that protecting wildlife connectivity would help meet are:

- Caltrans' Strategic Management Plan, which, in part, seeks to preserve and restore environmental and ecological systems under its Sustainability, Livability and Economy goal.

- California Assembly Bill 857 and its provisions for fish passage.

- Caltrans' Transportation Corridor Report (TCR) Guidelines. The new TCR Guidelines will begin to be updated in June 2016. The new TCR Guidelines will likely include a more in-depth environmental scan that will include the identification of wildlife connectivity needs.

Another key factor that was described by the Planning Chief for Caltrans employees to consider is to help streamline project delivery by incorporating wildlife connectivity concerns and needs early in planning and project development. This will help comport with:

- The streamlining provisions in *Fixing America's Surface Transportation Act* (FAST Act), Pub. L. 114-94, which seeks to improve project delivery times.

- The potential for Caltrans to develop a Planning and Environmental Linkages Program (PEL) with the Federal Highway Administration (FHWA) to introduce environmental considerations early into the planning process.

4.2.2. Terrestrial connectivity and wildlife-vehicle collisions

Dr. Marcel Huijser, a wildlife ecologist with the Western Transportation Institute at Montana State University (WTI-MSU), presented the latest information on:

1. the impacts of roads and traffic on wildlife,
2. human safety issues associated with wildlife-vehicle collisions,
3. characteristics of crash and carcass data,
4. ineffective mitigation measures to reduce collisions with large mammals,
5. effective measures to reduce collisions with large mammals and those that also provide safe crossing opportunities for wildlife (see Figure 5 as an example), and
6. practical recommendations for the implementation of wildlife fencing in combination with safe crossing opportunities for wildlife, including the importance of fence end treatments for relatively short fenced road sections (see articles Huijser et al. 2015 and Huijser et al. 2016)

Figure 5: Multifunctional overpass (wildlife and farm road), about 100 meters wide, across A4 motorway, Parndorf, Austria. The overpass is designed for farmers, agricultural machinery, hunters and wildlife including

roe deer (*Capreolus capreolus*) and European hare (*Lepus europaeus*). Note the wildlife fencing on the other side of the motorway. Photo credit: © Marcel Huijser.

4.2.3. Aquatic connectivity and fish passage

Caltrans Senior Fish Biologist, Melinda Molnar, described the efforts that are being made by her agency to address the intersection of streams with roads. Some of the attention to these road crossings are that State Bill 857, Article 3.5, prohibits any activity that extends the life of a culvert that has been identified as a barrier to fish passage and requires Caltrans to construct projects that are not fish barriers and the project plans must be approved by the California Department of Fish and Wildlife and the National Marine Fisheries Service. The focus of this work is primarily state and/or federally listed threatened or endangered species such as Chinook and Coho Salmon or Steelhead which are all anadromous species (spawn in freshwater river systems and mature in the ocean).

Caltrans has funded the assessment of approximately 4,000 potential fish barriers since 2006. The California State Highway System has around 520 known barriers – temporal, partial or totally impassable. Caltrans has repaired, reconstructed or removed 31 barriers since 2006 with 27 more actively slated to be fixed (Figure 66). This is challenging work and at the current rate of barrier restoration it will take 173 years. So Caltrans is seeking to work with the California Legislature to increase funding for fish passage remediation and develop nearly 50 priority restoration projects.

Figure 6: Fish passage structure. Photo courtesy of Caltrans.

Caltrans employees interested in attaining more information on California fish passage can go to the CalFish website where the California Fish Passage Assessment Database (PAD) is stored, online at: http://www.calfish.org/ProgramsData/HabitatandBarriers/CaliforniaFishPassageAssessmentDatabase.aspx [accessed 15 March 2016]. The PAD website has information on data access, maps, priorities and other resources.

4.2.4. Cost Benefit Analyses of Terrestrial and Aquatic Connectivity

Dr. Marcel Huijser of WTI-MSU discussed the costs and benefits of mitigation measures aimed at reducing large mammal-vehicle collisions and providing safe crossing opportunities for wildlife. While these mitigation measures are known to benefit human safety as well as biological conservation, some organizations and individuals resist implementation of these mitigation measures because the measures are experienced as a costly add-on to a road project. Marcel argued these measures should not be seen as an add-on but as an integral component of how roads are now built or reconstructed. In addition, Marcel showed that, along many road sections,

implementing effective mitigation measures should be considered as a cost-saving rather than a cost. See Huijser et al. 2009, article online at: http://www.ecologyandsociety.org/vol14/iss2/art15/ [accessed 23 March 2016].

Table 1: Summary of average direct costs per collision with large wildlife in North America in 2007 US dollars. While mitigation measures can be considered expensive, collisions with large mammals are also costly. There are many road sections where it is less expensive to implement effective mitigation measures than to let the collisions with large mammals continue to occur. Source: Huijser et al. 2009.

Description	Deer	Elk	Moose
Vehicle repair costs per collision	$2,622	$4,550	$5,600
Human injuries per collision	$2,702	$5,403	$10,807
Human fatalities per collision	$1,002	$6,683	$13,366
Towing, accident attendance and investigation	$125	$375	$500
Hunting value animal per collision	$116	$397	$387
Carcass removal and disposal per collision	$50	$75	$100
Total	$6,617	$17,483	$30,760

Similar concepts can hold for stream crossings and making them (also) suitable for large aquatic mammals (e.g. capybara in Brazil, see Huijser et al. 2013). In general, for stream crossings, it is considered good practice to have one large structure rather than multiple (or divided) structures, to have the structure cover the full bank, to include habitat for semi-aquatic and terrestrial species, to have no bottom but natural substrate instead to allow for natural stream dynamics. While building larger stream crossings than strictly needed for hydraulics alone, these calculations may not include more concentrated precipitation events associated with climate change. Such events have resulted in culvert and road failures. In this context it can be a wise economic investment to build larger structures than what we think is needed based on historic information that may not be consistent with future precipitation patterns.

4.3. Caltrans Tools and and Data Sources

During the late morning of each forum, the presentations focused on providing attendees with the variety of data and related information that is available to Caltrans employees. It included some early progress that Caltrans has been making with its partners to improve the synthesis of connectivity and habitat information, access to this data and the use of the data. This portion of the forum included case studies (exemplifying projects from the northern region for the Marysville meeting and the southern region for the San Diego forum).

4.3.1. California Essential Habitat Connectivity (CEHC) Project

Kristeen Penrod from Southern California Wildlands gave a presentation on the results of CHEC and the resulting network of natural habitats it evaluated and describes for the state of California. Using CHEC information, she outlined the steps it takes to complete regional and local connectivity analyses between natural landscape blocks (Figure 7) and how to interpret such results.

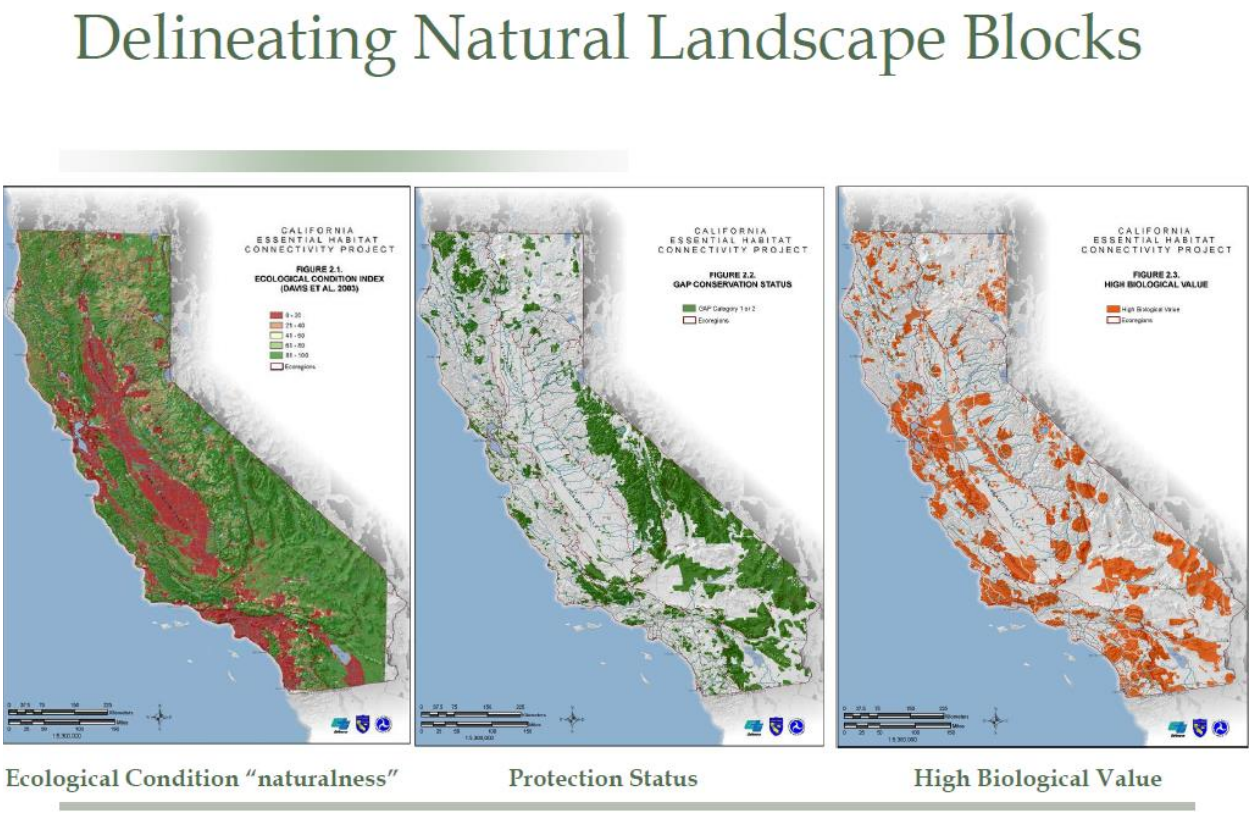

Figure 7: Slide explaining the development of the natural landscape blocks delineated by the California Essential Habitat Connectivity Project (CHEC). Image courtesy of Kristeen Penrod.

Once its natural landscape blocks were delineated, CHEC evaluated and described Essential Connectivity Connectivity Areas (ECAs) throughout the state of California based on a cumulative cost to ecological flows (

ecological flows (

Figure 89). ECAs combined with natural landscape blocks identify a state-wide conservation network. This information can be used by Caltrans planners and project managers to evaluate highway system impacts to connectivity and core areas of high quality naturalness. She described how it can also be used with more regional or local information at a finer scale to inform projects.

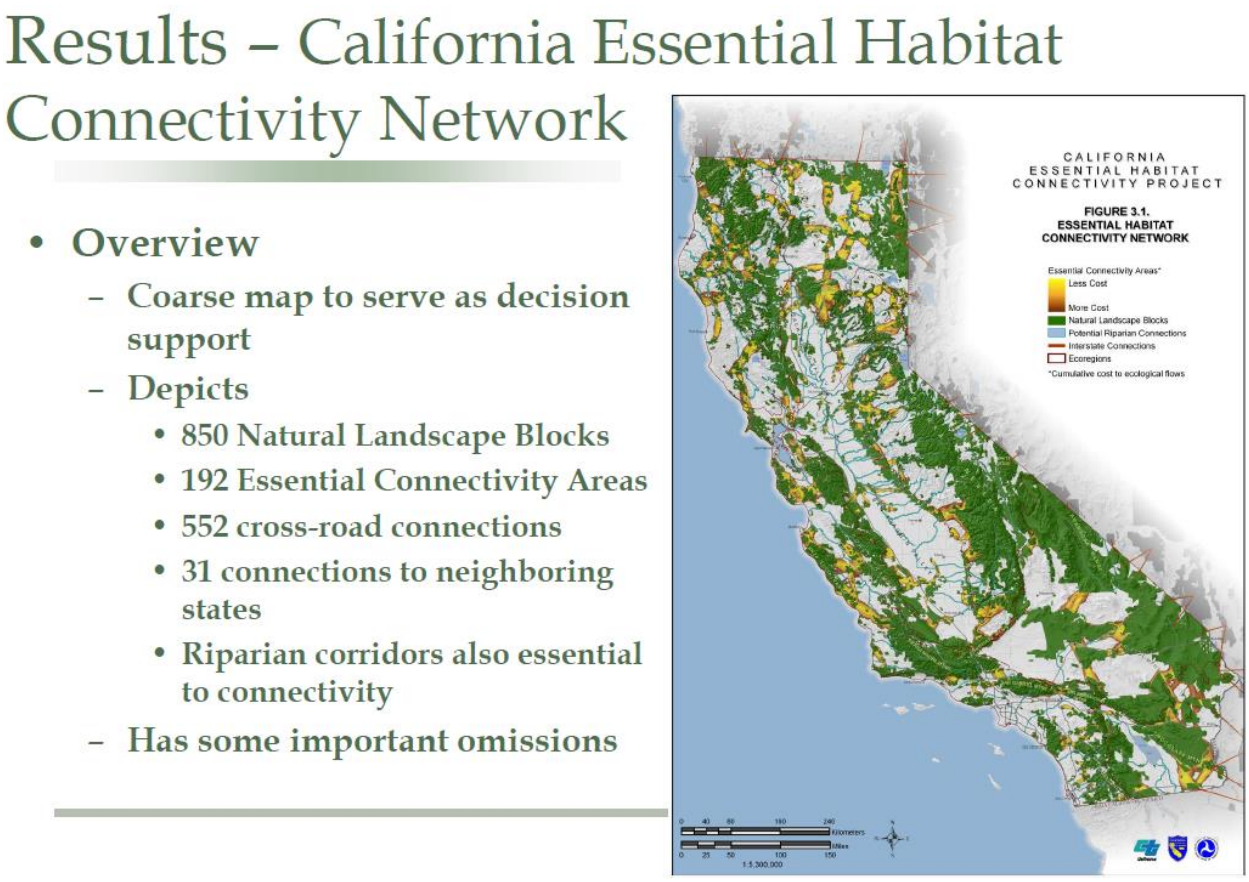

Figure 8: California's essential habitat connectivity network. Image courtesy of Kristeen Penrod.

4.3.2. Preliminary Environmental Analysis Spatial Report (PEAR) GIS Data Base

Amy Bailey, Office Chief of Caltrans' Biological Studies, provided an overview of the Preliminary Environmental Assessment Geographic Information System (GIS) data base and the types and quality of the natural resources information that was available at the site. She also reviewed the map viewer capabilities of PEAR and how users could extract the information for use in their project or reports (Figure 910). This PEAR information is being used by Caltrans environmental planners to help transportation decision-makers better understand the effects of projects on fish and wildlife resources.

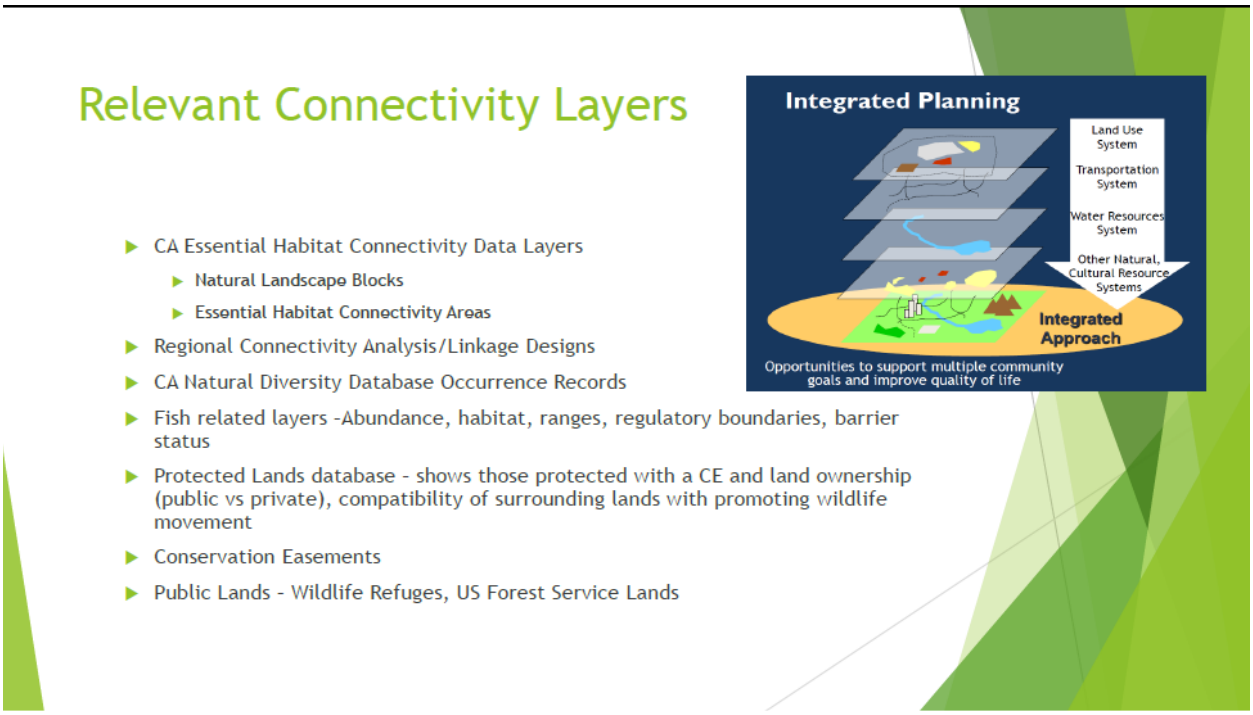

Figure 9: Information, including connectivity data available by using the Preliminary Environmental Analysis Spatial Report (PEAR) GIS Data Base. Slide courtesy of Amy Golden, Caltrans.

4.3.3. Regional Habitat Connectivity Planning and Implementation

Nancy Siepel of Caltrans' Environmental Stewardship Branch gave a presentation on some plans and projects in District 5 plus Santa Clara County in District 4. She explained how habitat and wildlife linkage information (Figure 10) could be used in highway Transportation Concept Reports (TCRs) or other environmental documents (i.e., Project Initiation Document (PID), Project Approval & Environmental Document (PAED)) and by using this information help locate the best areas for wildlife mitigation for a highway project.

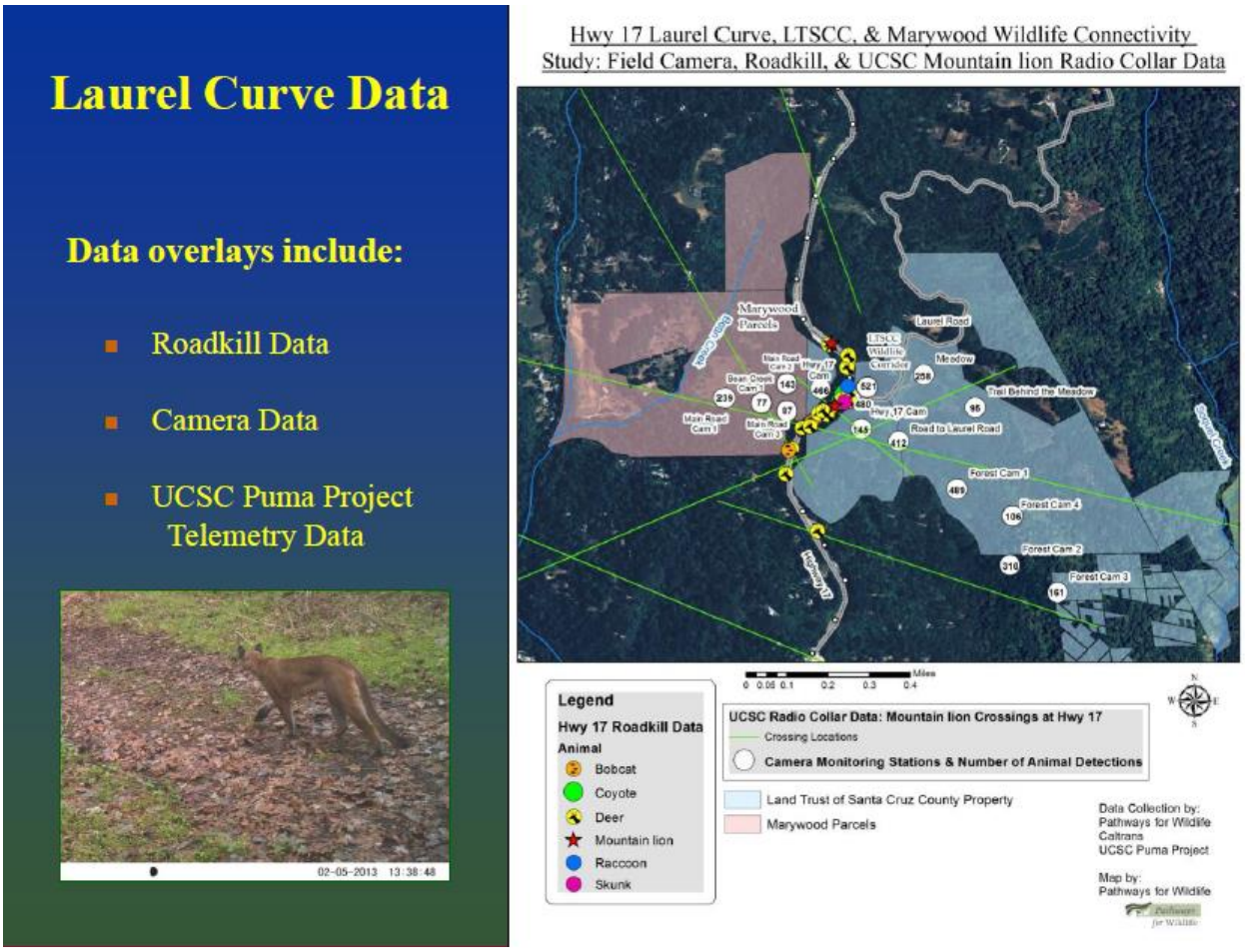

Figure 10: Wildlife information used to locate a wildlife crossing on Highway 17. Slide image courtesy of Nancy Siepel, Caltrans.

4.4. Mitigation in Practice

4.4.1. Aquatic Case Studies

The Caltrans Senior Fish Biologist gave a presentation on a variety of fish passage restoration projects; these were examples from the 31 completed since 2006 on the California State Highway System. It was pointed out that a good solution for a majority of Caltrans' barriers that were caused by under-sized structures (i.e., culverts or small bridges) was to properly size the replacement structures (Figure 112).

Figure 11: A properly sized bridge for fish passage that does not constrict water flow or channel migration. Image courtesy of Caltrans.

The presentation had case studies of many different Caltrans remediation projects, some included pictures from before project initiation with those from after the project was completed (Figure 123). Overall, seven different remediation projects were highlighted in the presentation.

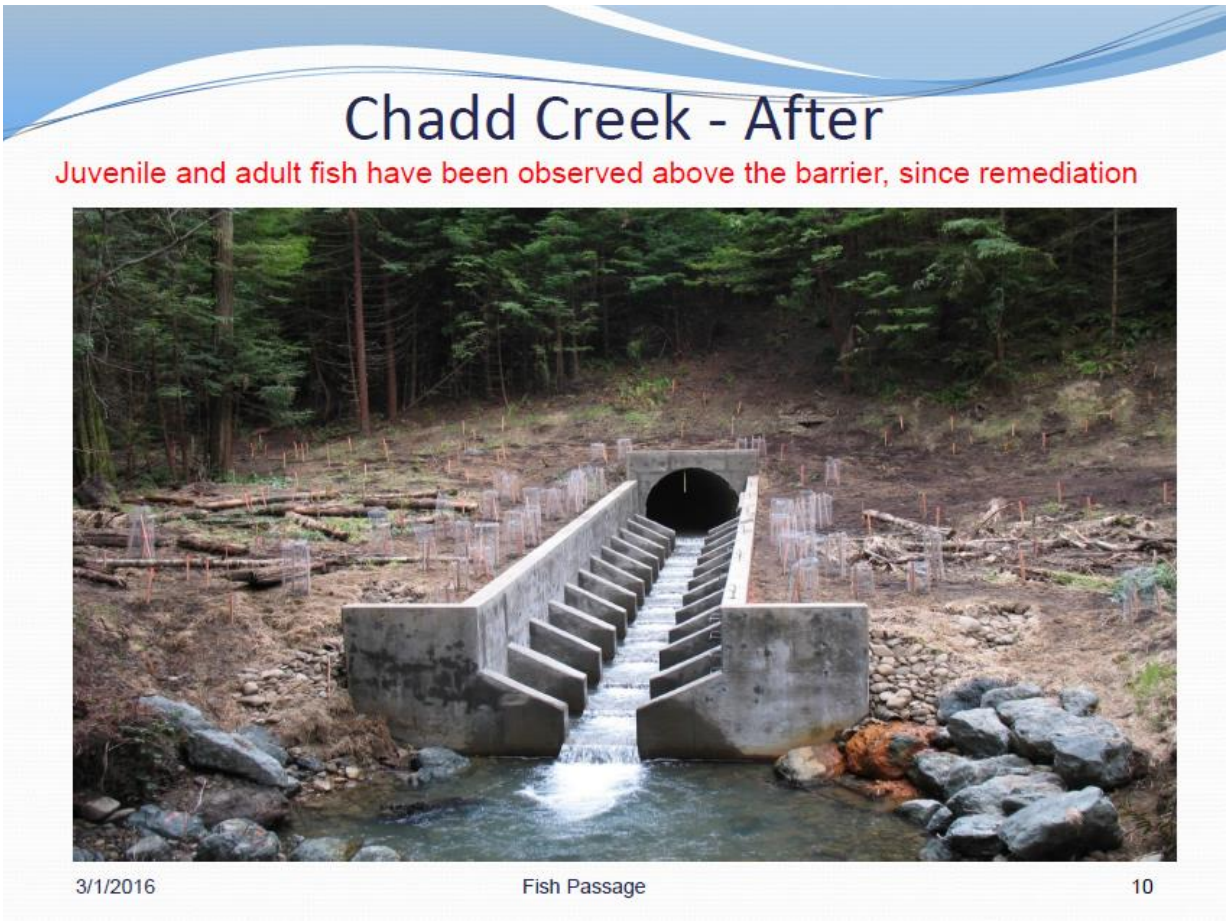

Figure 12: An engineered solution for fish passage at Chadd Creek. Slide image courtesy of Caltrans.

4.4.2. Case Study: SR-67 Connectivity Study (San Diego Forum)

The results of the SR-68 connectivity study were presented by Megan Jennings from San Diego State University's (SDSU's) Institute for Ecological Monitoring and Management. Her colleague for this project was Rebecca Lewison, also of SDSU. Their project area was a 15.8 mile segment of SR-67 for which they assessed the impacts of a proposed median barrier project, and the impacts of its various alternative designs on wildlife movement. They also gathered wildlife data for use in long-term planning for future SR-67 projects. They completed surveys of existing structures, gathered photos from deployed motion sensitive cameras to capture wildlife movement, and used roadkill data. They now have identified areas of connectivity concern for this highway segment (Figure 134). With some additional study, they seek to define areas within these areas of concern for potential future crossing sites or other wildlife friendly mitigation measures.

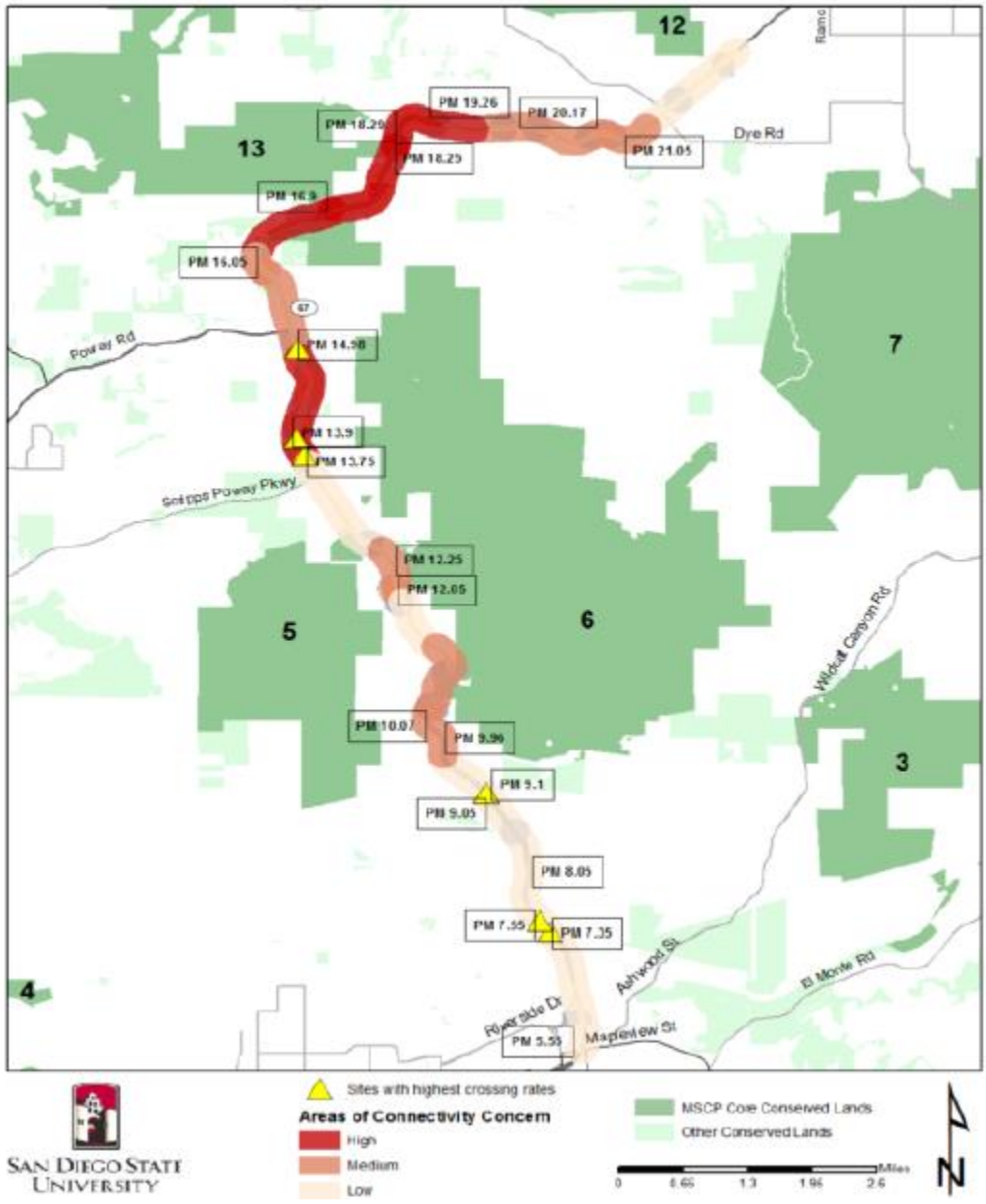

Figure 13: Slide from presentation on connectivity evaluation for SR-67 in southern California. Slide image courtesy of Megan Jennings, San Diego State University.

4.4.3. Case Study: Northern Sierra Nevada Foothill Wildlife Connectivity Project (Marysville Forum)

Suzanne Melim, Environmental Branch Chief, District 3, Caltrans, explained how her District successfully constructed over 10 large wildlife crossing structures in the past 15 years. She explained how these mitigation measures have been primarily reactionary and recommended that in the future it would be wiser to engage with planners and project managers earlier in the process. One project that was used as an example, one where wildlife concerns and habitat connectivity were raised early, resulted in two wildlife underpasses being successfully deployed on U.S. Highway 89 in the foothills of the Sierra Nevada Mountains (Figure 145). Ms. Melim also described some new steps the District is taking in its development of a Linkage Action Plan for a suite of state highways along the western slope of the Sierra Nevada Mountains. When completed, this Plan will map habitat, road development and select focal species to analyze wildlife movement in the planning area and determine the most important highway mitigation sites for wildlife. The Plan will also consider climate change.

Figure 14: Wildlife underpass on US Highway 89 in the Sierra foothills. Photo courtesy of Suzanne Melim, Caltrans.

5. RESULTS OF MODERATED BREAKOUT SESSIONS I AND II

The core activity at each forum was to engage attendees to share their information, experiences, challenges and needs to improve their ability to engage in connectivity conservation. This engagement was sought via small groups so that everyone's voice could be heard. There were two breakout sessions in the afternoon of each forum with each session comprised of small group discussions (7-10 individuals) guided by a moderator to address a series of questions. Then the small groups would reconvene as a whole and report out their findings to all attendees. The questions and other information shared at Breakout Session I is in Appendix B and Breakout Session II is in Appendix C.

5.1. Findings from Moderated Breakout Session I

The purpose of Breakout Session I was to engage forum attendees in a hypothetical scenario for State Highway 23 to determine their understanding of what information is needed to make connectivity decisions and what aquatic and terrestrial connectivity issues should be addressed by any of the following proposed highway expansion or reconstruction projects in the scenario area: lane widening, pavement rehabilitation, culvert repair and rehabilitation, and a bridge replacement (see Appendix B for questions and background information provided to the participants).

The following information was recorded by the group moderators from comments made by the various groups at the breakout sessions. Participants understood that:

3. If highway construction or reconstruction is initiated, it is important to investigate how the project can also meet concerns regarding wildlife-vehicle collisions and terrestrial and aquatic connectivity. In some cases it can be a stand-alone wildlife or fish passage project.
4. It is important to document the location, type, and dimensions of the existing culverts and bridges and assess their state, including potential use by wildlife or aquatic species. Assess if the structures may need to be modified or replaced, not only based on hydraulics, but also based on terrestrial and aquatic connectivity needs.
5. It is important to analyze wildlife-vehicle crash data and carcass removal data.
6. It is important to look at existing maps or other spatial resources related to important wildlife habitat and corridors, including for threatened and endangered species.
7. It is important to consult with local and regional experts on important wildlife habitat and corridors, as well as threatened and endangered species.
8. It is important to coordinate with other land owners and land managers, including state and federal agencies.
9. Include the need to protect wildlife connectivity into a project's purpose and need section. This will then require connectivity issues to be investigated, including a field assessment of any existing structures (i.e., culverts, bridges).
10. Avoidance, mitigation or compensation (or-off-site mitigation) may be needed if important habitat or wildlife corridors are disrupted by a highway. Action may also be required if important habitat is nearby, especially on both sides of the highway, with or without a designated wildlife corridor.

5.2. Findings from Moderated Breakout Session II

The purpose of Breakout Session II was to engage forum participants in assessing their needs to better incorporate the concerns for wildlife connectivity into their daily work. Three questions were put forward by the moderators to their groups:

1) What are some of the key ideas, issues or processes that you learned today that you can take with you to your work place?

2) What capacity, training or other support will you need to help you incorporate terrestrial and aquatic connectivity information into your work.

3) Please identify any "Next Steps" to facilitate moving this information into your work place, where appropriate.

Table 2 summarizes responses to the three questions, collectively. Since discussions were wide-ranging among all the groups, only the most frequently occurring themes were captured in the table. The participants most frequently noted that there are many stakeholders involved for wildlife and fish connectivity issues. Having centralized information on wildlife and fish connectivity was considered very important, especially information with a spatial component such as the PEAR tool. The participants also found the cost-benefit analyses and tools presented during the forum important. The participants are of the opinion that wildlife and fish connectivity should be discussed in the TCRs and that guidelines should be updated. The participants also think that the wildlife and fish connectivity training of the forum would be beneficial to project managers as better internal Caltrans communication across functional groups is needed. Wildlife connectivity needs to be considered early on in the planning process, and biologists should be consulted. Finally other Caltrans employees should be encouraged to learn about wildlife connectivity and how they should incorporate these issues in their work. For a full list of all responses see Table 8, Appendix E.

Table 2: Summary of top nine responses to Breakout Session II questions regarding what is needed by Caltrans employees to help them address ecological connectivity.

Answer	n
Many stakeholders/partners involved, projects/plans need coordination	15
Preliminary Environmental Analysis Spatial Report (PEAR) GIS Data Base, including need for training, need for 1 platform, guidelines on use	11
Cost-benefit analyses beneficial, need to expand model (e.g. non-safety parameters)	8
Consult with Transportation Concept Reports (TCRs), updating guidelines	8
Training needed for project managers	8
Better internal Caltrans coordination, communication, cross functional	7
Wildlife connectivity needs to be considered early in the planning process	5
Need to coordinate with biologists, need wildlife passage person in each district	5
Engage influential people who are not attending the forums	5

5.3. Summary of the Evaluation Forms

Attendees of the forums were asked to fill out an evaluation form at the end of each forum. Most participants agreed that their understanding greatly increased with regard to terrestrial connectivity, fish passage connectivity, and the costs and benefits of terrestrial and aquatic connectivity (Figure 14). Their understanding with regard to available tools and data also increased, but slightly less than for the other three topics.

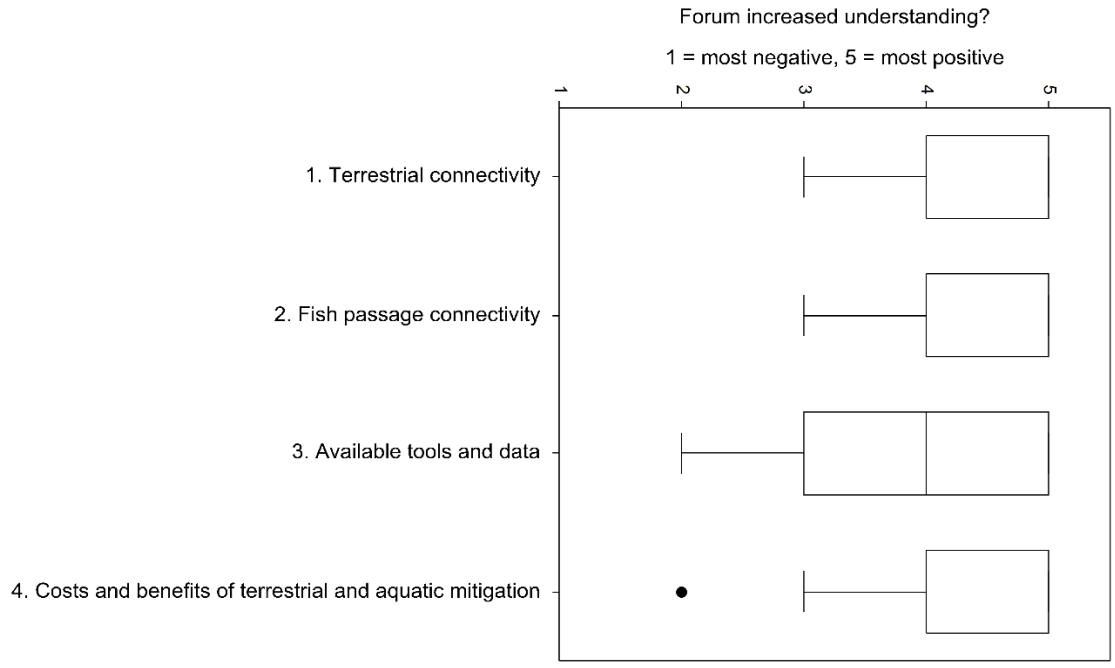

Figure 15: A box plot of the increase in understanding (1=most negative, 5=most positivie) by forum participants (n=54) regarding the different topics. Box: middle 50% of the data (25-75 quartiles); horizontal line is the median. Whisker boundaries are 1.5 times the inter-quartile range. Note that the median coincides with the upper end of the box (value is 5) for three of the four topics.

The presentations at the forums that were considered most valuable by the participants were the cost-benefit analyses, passages for terrestrial species which included information on wildlife-vehicle collisions and fish passages (Table 3). For a full list of all the responses, go to Appendix F, Table 9.

Table 3: Top responses to the question, "What part of the forum was most valuable?". A respondent was allowed to name more than one topic. The number of times a topic was named was counted (n).

Topic	n
Cost-benefit analyses	23
Terrestrial passages (and wildlife-vehicle collisions)	14
Fish passages (e.g. before & after images)	10
Available data and references	8
Learning about other agencies, departments, functional units	5

The forum participants see wildlife connectivity as something they would include in their work in the PID stage and system planning (Table 4). Project Development Team (PDT) and culvert projects were also named relatively frequently. A full list of those items named once or twice is in Table 10, Appendix G.

Table 4: Top four responses from forum participants regarding the question, "How do you see wildlife connectivity being included in your functional work products?" A respondent was allowed to have multiple answers. The number of times a topic was named was counted (n).

Answer	n
Project Initiation Document (PID)	6
System planning	5
Project Development Team (PDT)	3
Culvert projects	3

The tools deemed most helpful to the functional units of the forum participants were PEAR, GIS (including wildlife habitat), a database with wildlife connectivity data, cost-benefit analyses modified for species in California, and a database with wildlife crash and carcass removal data (Table 5). A full list of responses is in Table 11, Appendix H.

Table 5: Top five responses to the question, "Which if any, tools and datasets would be helpful to your functional units?" A respondent was allowed to have multiple answers. The number of times a topic was named was counted (n).

Answer	n
Preliminary Environmental Analysis Spatial Report (PEAR) GIS Data Base	16
Geographic Information System (GIS), including wildlife habitat	12
Database with connectivity data (terrestrial and fish)	8
Cost-benefit analyses for CA (species specific)	6
Database with wildlife crash and carcass data	6

The participants thought additional training on the placement and design of terrestrial crossing and aquatic structures would be most useful (Table 6). For a full list of all the responses are in Appendix I, Table 12.

Table 6: All responses greater than n=1, by forum participants to the question, "Now that you have completed the course, what additional training (if any) would be helpful on this topic?" A respondent was allowed to have multiple answers. The number of times a topic was named was counted (n).

Topic	n
Placement and design of terrestrial and aquatic crossing structures (including manual, specs, costs)	8
Project initiation and process	2
Training for specific functional units	2
How to obtain grants	2

When asked for other comments or suggestions, the participants thought the forum was useful (Table 7). However, they were concerned that the people who participated were probably already interested in the topic and that influential people that may not (yet) be open to wildlife connectivity were underrepresented. For a full list of responses go to Appendix J, Table 13.

Table 7: All responses greater than n=1 to the questionnaire asking for other comments, observations, and suggestions. A respondent was allowed to have multiple answers. The number of times a topic was named was counted (n).

Answer	**n**
Useful forum	8
Forum may have been self-selecting, what about the people who are in influential positions but who may not be open to this and were not here?	5
Liked short presentation format	2
Increased awareness for need for connectivity	2
Sometimes PowerPoints had too small of fonts	2
Need design specifications for crossings	2
Online resources needed (e.g. wildlife crash and carcass data)	2

6. RECOMMENDATIONS FOR NEXT STEPS

Over the course of the forums many actionable recommendations were made by participants. Following are the ones that had the largest level of support:

Develop a training module and guidelines for the use of Caltrans' Preliminary Environmental Analysis Spatial Report (PEAR) GIS Data Base. Create PEAR for a single software platform.

Develop cost-benefit analyses for highway mitigation measures that provide for both terrestrial (and reduce wildlife-vehicle collisions) and aquatic connectivity. Make these cost-benefit analyses specific to California species.

Assure connectivity provisions are added to updated guidelines for the Transportation Concept Reports (TCRs).

Develop a training module on connectivity for Caltrans project managers.

Improve internal Caltrans cross-functional coordination and communication to better provide for, and protect terrestrial and aquatic connectivity.

The following processes are where forum participants were most enthusiastic for including the consideration of mitigating for connectivity: system plans, Project Initiation Documents, PDTs and culvert projects.

Develop a seminar or workshop to train Caltrans employees on the placement and design of terrestrial and aquatic crossing structures. This should include a manual, specifications and costs.

Improve Caltrans employee access to the following information: GIS wildlife and habitat information, terrestrial and aquatic connectivity data, species specific cost-benefit analyses of highway mitigation measures, and wildlife-vehicle crash and carcass data.

Share the information presented at the forums to higher level Caltrans managers and decision-makers.

Review the draft Habitat Connectivity Best Practices (Appendix D) and coordinate the various Caltrans functional units in the development of future guidance on this topic.

Coordinate with regional Federal Highway Administration staff in the development of the Planning Environmental Linkages Program (PEL) to seek opportunities for the incorporation of PEL information into Caltrans' planning processes, National Environmental Policy Act requirements and other phases of environmental review.

7. REFERENCES

Huijser, M.P., Duffield, J.W., Clevenger, A.P., Ament, R.J. and P. T. McGowen. 2009. Cost-benefit analyses of mitigation measures aimed at reducing collisions with large ungulates in North America; a decision support tool. Ecology and Society 14 (2):15. [online] URL:

http://www.ecologyandsociety.org/vol14/iss2/art15/

Huijser,M.P. F.D. Abra & J.W. Duffield. 2013. Mammal road mortality and cost-benefit analyses of mitigation measures aimed at reducing collisions with capybara (*Hydrochoerus hydrochaeris*) in São Paulo State, Brazil. Oecologia Australis 17(1): 129-146.

Huijser, M.P., C. Mosler-Berger, M. Olsson & M. Strein. 2015. Wildlife warning signs and animal detection systems aimed at reducing wildlife-vehicle collisions. pp 198-2012. In: R. Van der Ree, C. Grilo & D. Smith. Ecology of roads: A practitioner's guide to impacts and mitigation. John Wiley & Sons Ltd. Chichester, United Kingdom.

Huijser, M.P., E.R. Fairbank, W. Camel-Means, J. Graham, V. Watson, P. Basting & D. Becker. 2016. Effectiveness of short sections of wildlife fencing and crossing structures along highways in reducing wildlife-vehicle collisions and providing safe crossing opportunities for large mammals. Biological Conservation 197: 61-68.

8. APPENDIX A – AGENDAS FOR NORTH AND SOUTH FORUMS

FORUM ON CONNECTIVITY

Garcia Auditorium
District 11
4050 Taylor Street
San Diego, CA 92210
January 26, 2016

AGENDA

GOAL: Increasing the consideration of aquatic and terrestrial wildlife movement and habitat connectivity for Caltrans planning and project development.

OBJECTIVES:

1. Increase the awareness for the need to evaluate wildlife connectivity across different planning and design stages (i.e., planning, environmental review, design).
2. Assess the need for wildlife connectivity in the development of Planning Environmental Linkages (PEL), a joint Caltrans and FHWA effort.
3. Target methods to improve Caltrans integration of wildlife habitat and connectivity data into early project scoping and long-range transportation plan development.

8:00 – 8:30 **Registration**

INTRODUCTIONS

8:30 - 8:45 **Welcome**
Presenter: Bill Figge, Deputy District Director for Planning

8:45 - 9:00 **Review of Forum Agenda, Goals and Objectives**
Presenter: Rob Ament, Road Ecology Program Manager, WTI-MSU

THE BIG PICTURE

9:00 – 9:30 **Planning for Sustainability and Connectivity at Caltrans**
20 minute presentation followed by 10 minutes of Q and A
Presenter: Katie Benouar, Division Chief, Transportation Planning, Caltrans

9:30 - 10:00 **Terrestrial Connectivity and Wildlife-Vehicle Collisions: Science and Solutions**
20 minute presentation followed by 10 minutes of Q and A
Presenter: Dr. Marcel Huijser, Research Ecologist, WTI-MSU

10:00-10:30 **Aquatic Connectivity: Fish Passage Status on the State Highway System**
20 minute presentation followed by 10 minutes of Q and A
Presenter: Melinda Molnar, Senior Fish Biologist, Caltrans

10:30-10:45 **BREAK**

CALTRANS TOOLS AND DATA RESOURCES

10:45 – 11:05 **California Essential Habitat Connectivity Project and Regional Wildlife Assessments**
Presenter: Kristeen Penrod, Director, Science & Collaboration for Connected Wildlands

11:05 – 11:25 **Preliminary Environmental Analysis Report (PEAR) GIS Data Base Map Viewer** –
Presenter: Amy Bailey, Chief, Office of Biological Studies, Caltrans

11:25-11:45 **Caltrans District 11 Case Study**: **State Route 67 Connectivity Study**
Presenter: Megan Jennings, Institute for Ecological Monitoring and Management, San Diego State University.

11:45-12:15 **The Costs and Benefits of Terrestrial and Aquatic Mitigation**
Presenter: Dr. Marcel Huijser, Research Ecologist, WTI-MSU

12:15 – 1:15 **LUNCH – on your own**

1:15 - 1:35 **Partnering for Successful Implementation**
Presenter: Kristeen Penrod, Director, Science & Collaboration for Connected Wildlands

PLANNING ENVIRONMENTAL LINKAGES

1:35 - 2:05 **Moderated Breakout Session I**
Hypothetical Scenario to Consider Connectivity: State Route 23 in Ventura County

2:05 - 2:30 **Breakout Session I Reporting**

MITIGATION IN PRACTICE

2:30 – 2:50 **Fish Passage Case Study: Incorporating aquatic values into Caltrans plans or projects**
Presenter: Melinda Molnar, Senior Fish Biologist, Caltrans

2:50 – 3:10 **Terrestrial Case Study: District 7 Wildlife Connectivity Efforts**
Presenter: Megan Jennings, Institute of Ecological Monitoring and Management, San Diego State University.

3:10 - 3:30 **BREAK**

PLANNING ENVIRONMENTAL LINKAGES

3:30 – 4:00 **Moderated Breakout Session II**
What have you learned, what is needed to move forward?

4:00 – 4:30 **Breakout Session II Reporting**

4:30 -4:45 **Wrap Up and Next Steps**

4:45- 4:50 **Complete Evaluation Form**

FORUM ON CONNECTIVITY

Sierra Nevada Room
District 3
703 B Street
Marysville, CA 95901
January 28, 2016

AGENDA

GOAL: Increasing the consideration of aquatic and terrestrial wildlife movement and habitat connectivity for Caltrans planning and project development.

OBJECTIVES:

1. Increase the awareness for the need to evaluate wildlife connectivity across different planning and design stages (i.e., planning, environmental review, design).
2. Assess the need for wildlife connectivity in the development of Planning Environmental Linkages (PEL), a joint Caltrans and FHWA effort.
3. Target methods to improve Caltrans integration of wildlife habitat and connectivity data into early project scoping and long-range transportation plan development.

8:00 – 8:30 **Registration**

INTRODUCTIONS

8:30 - 8:45 **Welcome**
Presenter: Marlon Flournoy, Deputy District Director, Planning and Local Assistance

8:45 - 9:00 **Review of Forum Agenda, Goals and Objectives**
Presenter: Rob Ament, Road Ecology Program Manager, WTI-MSU

THE BIG PICTURE

9:00 – 9:30 **Planning for Sustainability and Connectivity at Caltrans**
20 minute presentation followed by 10 minutes of Q and A
Presenter: Katie Benouar, Division Chief, Transportation Planning, Caltrans

9:30 - 10:00 **Terrestrial Connectivity and Wildlife-Vehicle Collisions: Science and Solutions**
20 minute presentation followed by 10 minutes of Q and A
Presenter: Dr. Marcel Huijser, Research Ecologist, WTI-MSU

10:00-10:30 **Aquatic Connectivity: Fish Passage Status on the State Highway System**
20 minute presentation followed by 10 minutes of Q and A
Presenter: Melinda Molnar, Senior Fish Biologist, Caltrans

10:30-10:45 **BREAK**

CALTRANS TOOLS AND DATA RESOURCES

10:45 – 11:05 **California Essential Habitat Connectivity Project and Regional Wildlife Assessments**
Presenter: Kristeen Penrod, Director, Science & Collaboration for Connected Wildlands

11:05 – 11:25 **Preliminary Environmental Analysis Report (PEAR) GIS Data Base Map Viewer** –
Presenter: Amy Bailey, Chief, Office of Biological Studies, Caltrans

11:25-11:45 **Regional Wildlife Assessment: Northern Sierra Nevada Foothill Wildlife Connectivity Project**
Presenter: Melanie Gogol-Prokurat, Ph.D., Spatial Ecologist, CA Dept. Fish & Wildlife

11:45-12:15 **The Costs and Benefits of Terrestrial and Aquatic Mitigation**
Presenter: Dr. Marcel Huijser, Research Ecologist, WTI-MSU

12:15 – 1:15 **LUNCH – on your own**

1:15 - 1:35 **Partnering for Successful Implementation**
Presenter: Kristeen Penrod, Director, Science & Collaboration for Connected Wildlands

PLANNING ENVIRONMENTAL LINKAGES

1:35 - 2:05 **Moderated Breakout Session I**
Hypothetical Scenario to Consider Connectivity: State Route 23 in Ventura County

2:05 - 2:30 **Breakout Session I Reporting**

MITIGATION IN PRACTICE

2:30 – 2:50 **Fish Passage Case Study: Incorporating aquatic values into Caltrans plans or projects**
Presenter: Melinda Molnar, Senior Fish Biologist, Caltrans

2:50 – 3:10 **Terrestrial Case Study: North Region Wildlife Connectivity Efforts**
Presenter: Suzanne Melim, Acting Chief, Planning and Modal Programs, D3, Caltrans

3:10 - 3:30 **BREAK**

PLANNING ENVIRONMENTAL LINKAGES

3:30 – 4:00 **Moderated Breakout Session II**
What have you learned, what is needed to move forward

4:00 – 4:30 **Breakout Session II Reporting**

4:30 -4:45 **Wrap Up and Next Steps**

4:45- 4:50 **Complete Evaluation Form**

9. APPENDIX B – INFORMATION FOR MODERATED SESSION I

Breakout Session #1 – Planning and Environmental Linkages

State Route 23 in Ventura County

Setting/land use:

- Agricultural, rural residential
- Public lands – State and County Park lands, Ventura County Open Space District, Happy Camp Regional Park correspond with many Natural Landscape Blocks
- Several Fish Passage barriers and unassessed barriers
- South Coast Missing Linkage (Santa Monica Sierra Madre Connection linkage area) and Statewide Essential Connectivity Area
- High roadkill and Animal Vehicle Collision accidents - high carcass counts and animal vehicle collisions north of Moorpark (District IMMS data from Division of Maintenance and District TASAS data from Traffic Ops)

Roads/facilities:

- Planned projects (not programmed)– lane widening (safety), pavement rehabilitation, culvert repair and rehab, and bridge replacement identified on 2017 SHOPP needs assessment
- Many undersized culverts along route, at least three (3) concrete or metal pipe culvert/underpass; width varies 5 to 10 feet

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Directions:

1) Take 30 minutes to discuss the three questions below with your group.
2) Organize responses by functional group and be ready to report back to the larger group.

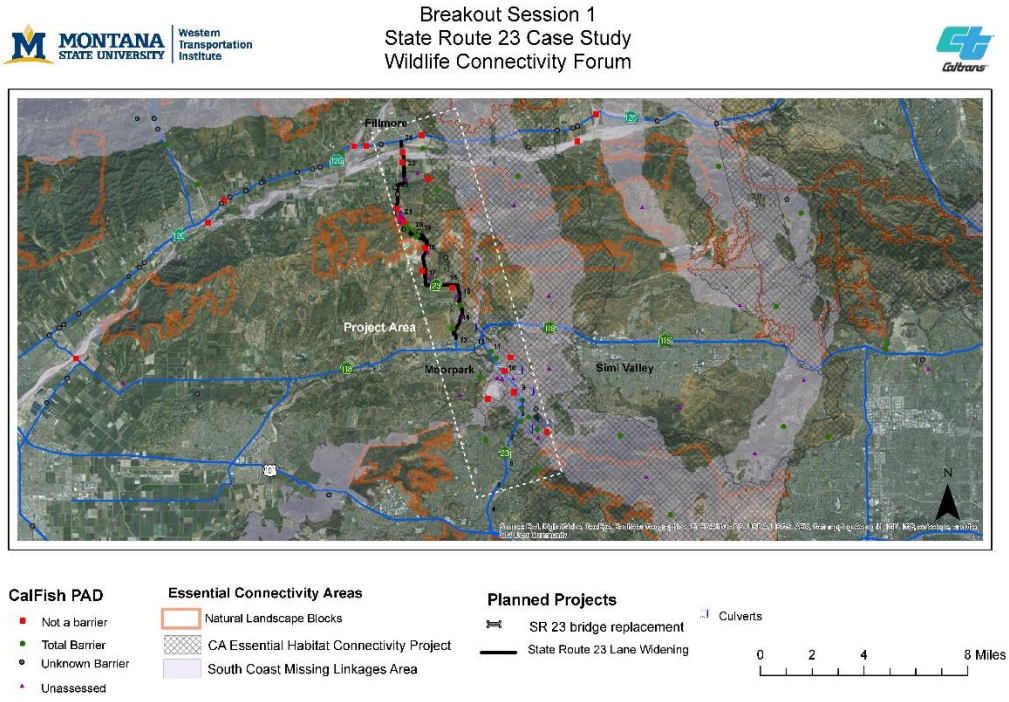

Figure 16: Coarse-scale image of hypothetical project area along State Route 23 and environs used for Breakout Session I. Image courtesy of Caltrans.

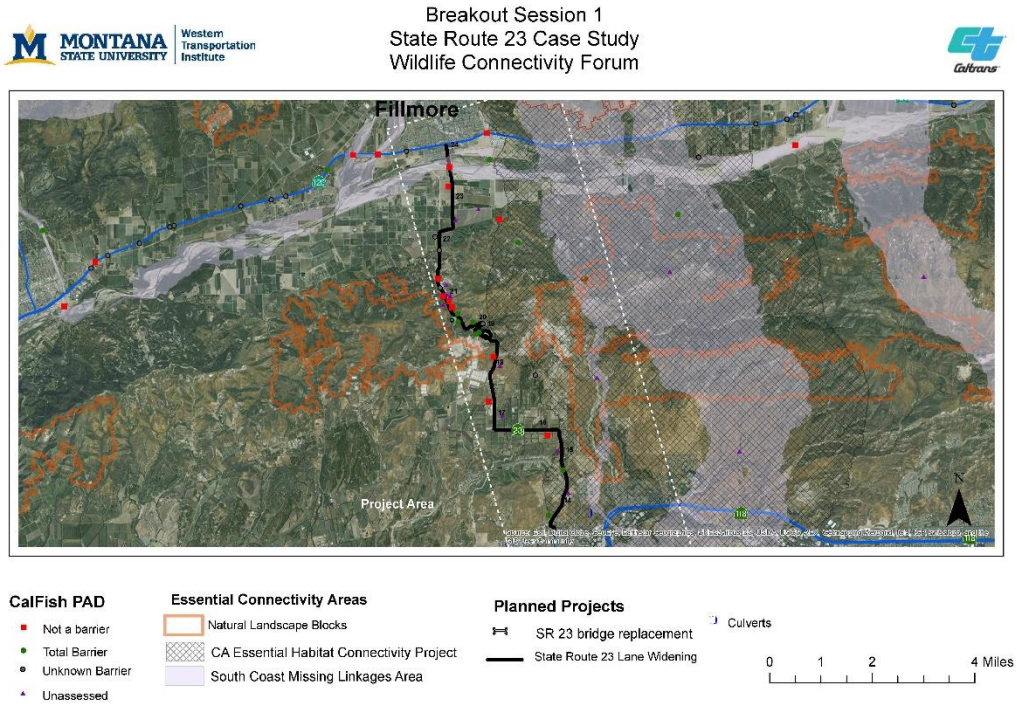

Figure 17: Finer-scale image of hypothetical project area along State Route 23 and environs used for Breakout Session I. Image courtesy of Caltrans.

Breakout Session I Questions

1) Given this image, where do you think the issue of connectivity should be addressed by your functional group? Terrestrial connectivity? Aquatic connectivity?

2) Would you address connectivity differently, depending on whether the highway is within an Essential Connectivity Areas (ECAs) or Natural Landscape Blocks (NLBs) or between these special areas?

3) Assuming this image raises concerns on connectivity, would you know where to go to get more information? What additional information would you seek?

10.APPENDIX C – INFORMATION FOR MODERATED SESSION II

Breakout Session II Questions

1) What are some of the key ideas, issues or processes that you learned today that you can take with you to your work place?

2) What capacity, training or other support will you need to help you incorporate terrestrial and aquatic connectivity information into your work.

3) Please identify any "Next Steps" to facilitate moving this information into your work place, where appropriate.

11. APPENDIX D - GUIDANCE FOR MAINTAINING CONNECTIVITY ACROSS HIGHWAYS* -

Draft Best Practices

*Developed from Draft Nov 2014 District 5' Environmental Stewardship Branch work product

Transportation Planning

- ✓ Incorporate habitat connectivity for wildlife into the environmental scan included in transportation planning documents.

- ✓ In collaboration with Environmental Stewardship Branch, create a checklist for staff to use to ensure the following key points are considered in transportation planning.

1. Identify regionally important wildlife movement corridors necessary for maintaining habitat connectivity in system planning documents including Transportation Concept Reports and Access Management Plans.

2. Incorporate the wildlife and habitat connectivity GIS scoping tool developed by U.C. Davis into existing GIS scoping tools used by transportation planners where applicable.

3. Use the U.C. Davis GIS tool and other available GIS connectivity data sets to develop "greenprints" for highway corridors in the District. Use in close collaboration with regional transportation planning agencies, county planning departments, and other entities to avoid duplication of effort and ensure compatibility with other regional plans.

4. As Regional Transportation Plans (RTPs) are updated, work with the local transportation agencies to ensure the RTPs and associated Environmental Impact Reports address the importance of maintaining essential habitat connectivity for wildlife.

5. Coordinate with the District Mitigation Coordinator and Environmental Planning to ensure that the most up-to-date information is reflected in transportation planning documents. Identify wildlife corridors that are essential for maintaining habitat connectivity for multiple species.

Environmental Planning and Project Development

- ✓ Consider whether a proposed roadway or landscape architecture project will enhance or impede wildlife connectivity.

- ✓ Incorporate an impacts analysis for habitat connectivity for wildlife into all biological reports.
- ✓ Look for opportunities to incorporate features to maintain and improve habitat connectivity for wildlife during all phases of project development.
- ✓ Look for opportunities to implement advanced mitigation strategies which may benefit multiple projects and/or partners within a geographic area.

Environmental Scoping/Project Initiation Document (PID) phase:

1. Incorporate data from the wildlife habitat connectivity U.C. Davis GIS scoping tool into the PEAR tool used by the district biologist.

2. Utilize the wildlife crossing checklist developed by the Division of Environmental Analysis (DEA) to identify potential wildlife crossing issues early in the environmental process.

3. Utilize the Wildlife Crossing Guidance Manual developed by DEA, internal expertise and external expertise to scope the types of crossing improvements that may be applicable.

4. Include wildlife habitat connectivity and fish passage as a checkbox on the Environmental Scoping Checklist used for the Preliminary Environmental Analysis Report (PEAR). Specify impacted species and the potential project features such as animal crossings, culvert enlargements, fish passages or other similar features that can enhance crossing opportunities.

5. Include potential project costs related to preserving and improving habitat connectivity for wildlife and fish including project connectivity features, mitigation parcels or banking credits (if any), long term monitoring, and reporting in the Mitigation Cost Compliance Estimate (MCCE).

6. Coordinate with staff working on other PIDs at the same time to ensure that connectivity is considered at the landscape/ecosystem scale.

Project Approval and Environmental Document (PAED) phase:

1. All functional units on the Project Development Team (PDT) should collaborate early and continually in the project development and approval process to ensure habitat connectivity for wildlife and fish passage is included as part of the project.

2. Utilize the wildlife crossing checklist developed by the Division of Environmental Analysis to identify potential wildlife crossing issues early in project development.

3. Utilize the Wildlife Crossing Guidance Manual developed by DEA, statewide internal and external expertise, and nationwide expertise to scope the types of crossings that maybe applicable.

4. Consult the PEAR tool, which includes the U.C. Davis connectivity data and the Integrated Maintenance Management System (IMMS) data on roadkill. This data is useful for determining more precise locations for improving or constructing wildlife crossings.

5. Consult with the District Mitigation Coordinator and project biologist to assess connectivity needs and to develop appropriate mitigation strategies, and element details.

6. Coordinate with staff biologists, engineering design, hydrology, landscape architecture, right-of-way, project management and other units in Caltrans as well as outside wildlife experts, resource agency experts (not to be confused with resource agency staff who issue permits) and local non-profits engaged in land conservation.

    - If a project is considering concrete median or concrete shoulder barrier, this will create a barrier effect and the project will need to consider design features such as openings in the barrier for animal passage, wildlife undercrossings or overcrossings, and fencing to guide animals to new or existing crossings.

      Note: Wildlife fencing alone can create a barrier effect and this will need to be considered in the analysis for the environmental document.

    - If a project is considering wildlife fencing as a component of the project, work closely with landscape architecture to ensure visual impacts are considered and that aesthetic design is incorporated into wildlife passages or fencing or other connectivity related elements.

7. To ensure that connectivity can be achieved at the landscape/ecosystem level, coordinate with staff assigned to other transportation projects in the same watershed or ecological region, including maintenance.

Plans, Specifications and Estimate (PS&E) phase:

1. Consider how the following will impact habitat connectivity and the ability of wildlife to cross roadways: types of traffic barriers, culverts, types of right of way or wildlife fencing, erosion control measures and seed mixes, landscape planting palette, habitat establishment, irrigation as an intended or unintended water source, pedestrian paths or trails, lighting (especially new sources of lighting), and public information such as information signs and interpretive displays.

2. Ensure that project details and specifications adequately address connectivity needs including physical dimensions and materials of connectivity features, and other aspects of construction such as defining Environmentally Sensitive Areas (ESAs) and coordinating seasonal construction staging limitations (if any).

3. Consult with the District Mitigation and Wildlife Connectivity Coordinator and project biologist to develop appropriate plans and specifications.

4. Ensure the project biologist and environmental construction liaison review the plans at all stages of constructability review.

5. Ensure adequate funds are included in the project estimate, including any required monitoring.

Construction phase:

1. The biologist and environmental construction liaison should coordinate with construction to ensure that wildlife connectivity features are built into the project at the appropriate times (seasons).

2. Provide all support needed for pre-construction surveys or other required environmental activities in a timely manner.

3. Ensure monitoring reports that are required during all phases of construction are complete and submitted on time.

Post-construction Monitoring phase:

1. Fulfill all regulatory permit requirements for timely mitigation monitoring and reporting.
2. Enter information required for long-term tracking into STEVE.

Maintenance

- ✓ Improve worker safety by sustaining habitat connectivity for wildlife through routine maintenance of existing culverts and fences.

- ✓ Environmental Stewardship Branch will periodically meet with Maintenance forces to relay the importance of maintaining existing wildlife undercrossings and fencing for wildlife passage and how maintenance activities can enhance their effectiveness.

1. Keep culverts clear of sediment and prune vegetation at culverts as directed by the District Biologist to encourage wildlife to use culverts as undercrossings. Maintaining animal movement under the highway will reduce the potential for animal-vehicle collisions, and worker exposure related to removing dead animals from the highway.

2. When clearing vegetation coordinate with the District Biologist. The amount of vegetation required at a culvert and in the adjacent habitat will vary by species. For example some animals prefer little or no vegetation to improve visibility while other animals prefer vegetation for cover. Fish also require vegetation for shade; vegetation helps regulate water temperature and provides a source of food.

3. Record roadkill data in the Integrated Maintenance Management System (IMMS).This data is useful for determining more precise locations for improving or constructing wildlife crossings.

4. Control trash to avoid attracting wildlife to unsafe locations and to prevent ingestion of plastic or other hazardous materials.

12. APPENDIX E: RESPONSES TO BREAKOUT SESSION II QUESTION

Following is a list of all the responses to Breakout Session II questions regarding what is needed by Caltrans employees to help them address ecological connectivity.

Table 8: All responses to Breakout Session II questions regarding what is needed by Caltrans employees to help them address ecological connectivity. A respondent was allowed to have multiple answers. The number of times a topic was named was counted (n).

Answer	n
Many stakeholders/partners involved, projects/plans need coordination	15
Preliminary Environmental Analysis Spatial Report (PEAR) GIS Data Base, including need for training, need for 1 platform, guidelines on use	11
Cost-benefit analyses beneficial, need to expand model (e.g. non-safety parameters)	8
Consult with Transportation Concept Reports (TCRs), updating guidelines	8
Training needed for project managers	8
Better internal Caltrans coordination, communication, cross functional	7
Wildlife connectivity needs to be considered early in the planning process	5
Need to coordinate with biologists, need wildlife passage person in each district	5
Engage influential people who are not attending the class	5
The extent of the fish barrier problem and solutions	4
Allow billing for this work to time sheets	4
Legislation to make this possible (e.g. modify SHOPP spending)	4
Policy changes and directives needed	4
Asset management important for maintenance	3
Need online resources, real time, one place for everything	3
Need to be included in PID or earlier documents, include specialists	3
Statewide data on hotspots needed, including goals, priorities	3
Better awareness laws and regulations	2
Include class in Planning Academy or other Caltrans Academy	2
Need for coordination between construction and planning; change orders may affect project goals	2
Need fish passage design standards	2
There are existing data, available to use	2
Mission vision, goals are moving forward to include wildlife connectivity	2
Develop handbooks for mitigation measures pros and cons, specs	2
System planning	2
Need contact list stakeholders	2
More training needed	2
Not just about large mammals, also small species, ecosystem	1
Carcass removal data are important	1
Wildlife connectivity is somewhat similar to bike/pedestrian inclusion	1
Expand forum to 2 days	1

Training needed for fish passage	1
Add information to planning section Standard Environmental Preference (SEP)	1
Local Development/Intergovernmental Review (LD/IGR) considered in planning?	1
Planning Horizon's web based video	1
Develop Planning Environmental Linkages Program (PEL) handbooks	1
Better cost estimates crossing structures	1
Monitoring contractor, verify specs	1
Make it possible to accept $$ from partners	1
Outreach to others on wildlife connectivity	1
Integrate with land use planning	1
Few reliable funding sources	1
Project evaluation needed, monitoring	1
Environmental issues represented in Project Development Teams (PDTs)	1
Make State Highway Operation and Protection Program (SHOPP) program for connectivity similar to SHOPP 240 (advanced mitigation)	1
Coordinate information technologies (e.g. mapping software)	1
Package this information into DSMPs	1
PE forums quarterly	1
Mark funds for wildlifee connectivity	1
Need materials focused on Right-Of-Way or other functions	1
Compendium lessons learned	1
More flexible and transparent use of funds	1
Need programmatic agreements for this work	1
Increase accountability resource agencies	1

13. APPENDIX F: RESPONSES TO THE QUESTION, "WHAT PART OF THE FORUM WAS MOST VALUABLE?"

All responses are listed in the following table to the question, "What part of the forum was most valuable?"

Table 9: All responses to the question asked at the end of each forum, "What part of the forum was most valuable?" A respondent was allowed to have multiple answers. The number of times a topic was named was counted (n).

Topic	n
Cost-benefit analyses	23
Terrestrial passages (and wildlife-vehicle collisions)	14
Fish passages (e.g. before & after images)	10
Available data and references	8
Learning about other agencies, departments, functional units	5
Preliminary Environmental Analysis Spatial Report (PEAR) GIS data base	3
Essential connectivity areas/corridors	3
Break-out sessions	3
Case studies	2
Incorporating connectivity in system planning	2
Reminder federal and state laws wildlife conservation	1
Discussion of role of Caltrans	1
Early involvement of wildlife connectivity in planning process	1
Honest conversations, real life challenges	1
Examples, lessons learned	1

14. APPENDIX G: RESPONSES TO THE QUESTION, "WHICH IF ANY, TOOLS AND DATASETS WOULD BE HELPFUL TO YOUR FUNCTIONAL UNITS?"

All of the responses to the question, "Which if any, tools and datasets would be helpful to your functional units?" are enumerated in Table 10.

Table 10: All responses to the question, "Which if any, tools and datasets would be helpful to your functional units?" A respondent was allowed to have multiple answers. The number of times a topic was named was counted (n).

Answer	n
Preliminary Environmental Analysis Spatial Report (PEAR) GIS Data Base	16
Geographic Information System (GIS), including wildlife habitat	12
Database with connectivity data (terrestrial and fish)	8
Cost-benefit analyses for CA (species specific)	6
Database with wildlife crash and carcass data	6
Guide on mitigation measures, including cost estimates, standard specifications	3
The websites	2
Biogeographic Information and Observation System (BIOS)	2
Laws at state and federal level	1
Handbooks and guides	1
Close relationship with district biologist	1
Multiple Species Conservation Program (MSCP) conservation areas	1
Confirmation from district chief/environmental that fish and wildlife concerns have been addressed	1
Caltrans' Performance Measurement System (PEMS)	1

15. APPENDIX H: RESPONSES TO THE QUESTION, "HOW DO YOU SEE WILDLIFE CONNECTIVITY BEING INCLUDED IN YOUR FUNCTIONAL WORK PRODUCTS?"

Table 11: All responses to the question, "How do you see wildlife connectivity being included in your functional work products?" A respondent was allowed to have multiple answers. The number of times a topic was named was counted (n).

Answer	n
Project Initiation Document (PID)	6
System planning	5
Project Development Team (PDT)	3
Culvert projects	3
Transportation Concept Report (TCR)	2
Connectivity included in project goals	2
Communicating with local agencies	2
Design (especially coordination with environmental)	2
State Highway Operation and Protection Program (SHOPP)	2
Regional Transportation Improvement Plan (RTIPS)	1
Local Development/Intergovernmental Review (LD/IGR)	1
Multiple Species Conservation Program (MSCP)	1
Incorporate wildlife crash and carcass data	1
EIR review	1
Preliminary Environmental Analysis Spatial Report (PEAR) GIS Data Base	1
Environmental analysis	1
Pull in Geographic Information System (GIS) data	1
Transportation Concept Reports (TCRs)	1
Bridge projects	1
Roadside projects	1

16. APPENDIX I: RESPONSES TO THE QUESTION,"NOW THAT YOU HAVE COMPLETED THE COURSE, WHAT ADDITIONAL TRAINING (IF ANY) WOULD BE HELPFUL ON THIS TOPIC?"

A list of all the responses to the question "Now that you have completed the course, what additional training (if any) would be helpful on this topic?" are listed in Table 12.

Table 12: All responses to the question, "Now that you have completed the course, what additional training (if any) would be helpful on this topic?" A respondent was allowed to have multiple answers. The number of times a topic was named was counted (n).

Topic	n
Placement and design of terrestrial and aquatic crossing structures (including manual, specs, costs)	8
Project initiation and process	2
Training for specific functional units	2
How to obtain grants	2
Repeat the training for others	1
More quantitative analyses	1
GIS tools	1
Online GIS and other data, including presentations	1
Wildlife and how it links to sustainability	1
Self-training	1
More on BIOS	1
More on Preliminary Environmental Analysis Spatial Report (PEAR) GIS Data Base	1
How to obtain data from non-governmental organizations	1
Training for upper management and project managers	1
State Highway Operation and Protection Program (SHOPP)	1

17.APPENDIX J: RESPONSES TO THE QUESTIONNAIRE ASKING FOR OTHER COMMENTS, OBSERVATIONS, AND SUGGESTIONS.

A full list of responses of forum attendees asked to share their observations after attending the workshop is in Table 13.

Table 13: All the responses of forum attendees asked to share their insights after attending the forums. A respondent was allowed to have multiple answers. The number of times a topic was named was counted (n).

Answer	n
Useful forum	8
Forum may have been self-selecting, what about the people who are in influential positions but who may not be open to this and were not here?	5
Liked short presentation format	2
Increased awareness for need for connectivity	2
Sometimes PowerPoints had too small of fonts	2
Need design specifications for crossings	2
Online resources needed (e.g. wildlife crash and carcass data)	2
Good facilitation, not tedious	1
Need for evaluation on quality of projects rather than only quantity	1
Recommend Marcel Huijser to speak at Planning Horizon or other planning forum	1
More guidance on how to incorporate wildlife connectivity in planning process	1
Expand on cost-benefit analyses	1
Explain technical terms better	1
In break-outs, spread functional groups over different tables	1
Need specialized connectivity staff in each district	1
Liked break-outs	1
Instructors were very knowledgeable	1
Discuss potential wildlife foraging in right-of-ways (including on garbage)	1
Better technical audio-visual support needed	1
Some information was too theoretical/specific	1
Marcel Huijser's presentations were very informative	1
Keep people from talking in the back	1
Invite more environmental staff, archeologists, etc.	1