



H. T. HARVEY & ASSOCIATES
ECOLOGICAL CONSULTANTS

5 April 2012

Meryka Blumer
Associate Project Manager
David J. Powers & Associates, Inc.
1871 The Alameda, Suite 200
San Jose, CA 95126

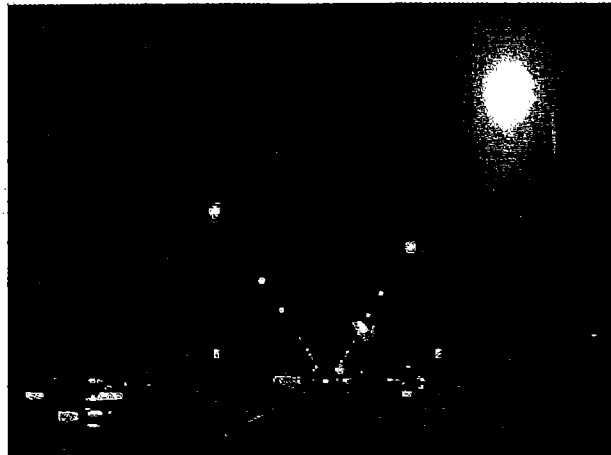
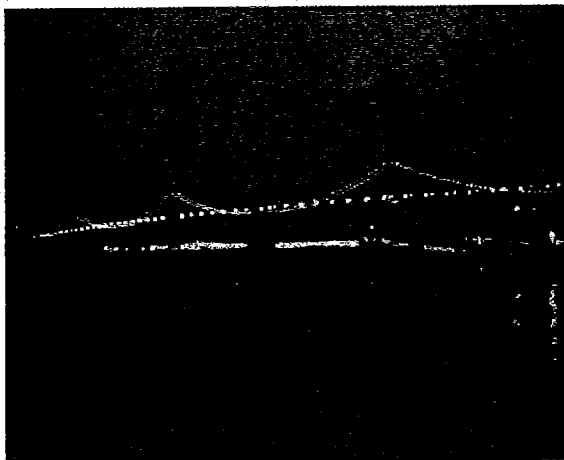
Subject: Final Assessment of the Potential Impacts of the Bay Bridge Lighting Project on Birds and Fish (HTH #3305-01)

Per your request, H. T. Harvey & Associates is providing an assessment of the potential impact of the Bay Bridge Lighting Project on birds and fish. Drs. Scott Terrill and Sharon Kramer have reviewed the project description and are providing their assessments of potential project impacts on birds and fish.

Scott Terrill conducted research on avian migration for both his Masters of Science and his PhD and has published approximately 30 scientific publications. He has conducted research on bird migration in the United States, Mexico, Germany and Austria. Sharon Kramer has conducted research on fish ecology in Hawaii, Australia, and California/Oregon/Washington for her Masters of Science and PhD, with numerous publications. Both resumes are attached.

Overview of the Project

The Project proposes to temporarily install light-emitting diode (LED) white lights on the Bay Bridge, in honor of the Bay Bridge's 75th Diamond Anniversary. Up to thirty thousand (30,000) energy-efficient LED lights, approximately two (2) inches in diameter each, will be installed on the vertical suspender cables of the north facing side of the upper deck level of the Bay Bridge's West span. The Bay Bridge is already well-lit by static bright lights, as shown below.



The LED lights will be secured to the vertical suspender bridge cables in strings of 75 fixtures per string at one foot spacing, and the LED nodes will be placed on the cables' outside-facing direction. The lights will be attached to the outer part of the bridge suspender cables with two (2) plastic coated stainless steel zip ties (one on top and one at the bottom of each fixture), so no paint disturbances will occur to the bridge structure. There will be a main fiber line installed through the system for control of the lighting system and power will be taken from existing facilities on the bridge. Electrical boxes (approximately 8x8x3 inches in size) will be required for the power of the lights (80 power/data boxes total) and communication of the lights control system (80 FO/Ethernet media converter boxes total). All electrical boxes will be bolted to a longer steel channel that will be attached to the existing bridge cable as one unit. The electrical boxes will be evenly spaced along the lower railing and on top of the bridge at the highest point, with a maximum spacing of 100 feet. Installation of the lights will not require any permanent disturbance to the bridge structure or ground disturbance off the bridge.

The bridge lights will face away from bridge vehicular traffic and will be lit from dusk to early morning (between 12:00am and 2:00am) in commemoration of the Bay Bridge's 75th Diamond Anniversary. The light display will be controlled by the artist and will appear to be moving in a wave like and alternating flickering pattern, with the option of a static pattern as well. The light installation will begin in August 2012 and it is anticipated that the lights will be first illuminated in late 2012.

The LED lights will be installed over a period of six months during the evening/overnight hours (8:00pm to 5:00am weekdays and 9:00pm to 8:00am weekends), which will require nightly lane closures. The lights will be permanently removed from the West Span after two years, with light removal expected to begin in January 2015. Removal of the lights will also be done during the evening/overnight hours, requiring nightly lane closures, and will take approximately three months.

Each energy-efficient LED node when fully powered uses about one watt per hour. The Project will install 30,000 nodes, but each node will be on less than half the time, so this will equate to 15,000 watts per hour.

Avian Assessment

Direct Effects of Installation and Removal

In general, the installation of the lights should not disturb breeding birds to the point of abandonment, unless the work is to occur in such a way as to directly impact the nests of breeding individuals. If the lights are installed in late fall – early winter, the installation will fall outside the primary breeding season and not be a potential issue. If the activity of installing the lights occurs during the breeding season, it should not significantly increase human activity levels relative to existing conditions with respect to local birds, which are obviously habituated to the traffic and other anthropogenic activities normally associated with the bridge. If installation is to occur during the breeding season (February-September), it is recommended that a biological monitor be present during the installation of the lights. If an active nest that might be directly impacted (including disturbing adults to the point of nest abandonment) is detected, the Regulatory Resource Agencies (California Department of Fish and Game / United States Fish

and Wildlife Service) should be contacted to consult on avoidance. Potentially breeding birds include cormorants and peregrine falcon, however these birds breed primarily below the traffic bearing portions of bridge structures which lie below the project activity.

The removal of the lights should involve the same considerations as the installation. If the lights are removed after the avian breeding season (i.e., “late in 2013”), there would be no impacts to breeding birds.

Indirect Effects of Installed Lighting

The lighting should not have a significant impact on birds. Nocturnal migrants collide with towers and other structures that are lit with constant white light. These birds also collide with lit windows on buildings during migration. This phenomenon is most pronounced in eastern and central North America and, with respect to towers, typically occurs when guy wires are used to secure the towers. Strobe lights and colored lights (especially green) substantially reduce the collision rates on migrants with lit structures (Gauthreaux and Belser 2006). Collision rates increase with decreased visibility due to fog, drizzle etc. In this case, the lights are not single-source, nor are they static. The movement patterns associated with the lighting scheme should not lead to the attraction and disorientation (and collision) of migrants associated with single-source, constant white lighting. The addition of constant white lighting sources to the existing lighting on the bridge could slightly increase likelihood of collision, especially during foggy or stormy nights, for nocturnally migrating birds.

In a general sense, nocturnal migrants (especially passerines or songbirds), may be attracted to the horizon glow and overall lighting of populated areas. However, no negative effects of such attraction have been demonstrated. Under current conditions, given the amount of artificial light associated with development in the San Francisco Bay Area (including the current lighting on the Bay Bridge itself), the installation of the LED lights would not add significantly to the overall lighting in the region.

Similarly, the lighting should not affect waterbirds or shorebirds associated with the Bay, including birds breeding on the bridge. In general, these birds are well below the portions of the bridge to be lit by this project and are associated with water. Migrant shorebirds flying at bridge height should be able to easily detect and avoid the bridge in most conditions. Under foggy conditions, the lighting may even increase the probability of detection and avoidance by these birds.

Fish Assessment

Fish have only been exposed to artificial lighting at night for a relatively short time (in the last 100 years or so), until then the aquatic environment at night was only affected by the moon, stars, cloud cover, and biological luminescence (Nightingale et al. 2006). Fish can be potentially affected by artificial lighting at night in the following ways: changes to essential behaviors such as feeding, schooling, and migration, changes to predation risk, and affects on reproduction (Nightingale et al. 2006). The effects of the proposed Bay Bridge Lights project on federal Endangered Species Act listed steelhead (*Oncorhynchus mykiss*) and green sturgeon (*Acipenser medirostris*), and state-listed longfin smelt (*Spirinchus thaleichthys*) are described below. We

anticipate that the only affects to fish would be associated with operation of the lights and not installation and removal: we estimated that approximately $<0.005 \text{ lux}^1$ of additional indirect light would reach the water surface from the Bay Bridge Lights project (note the Bay Bridge is already lit at night).

Indirect Effects of Installed Lighting

Steelhead

Both adult and juvenile steelhead swim past the Bay Bridge. Adult steelhead usually migrate from the ocean to tributaries in the South Bay where they spawn from late December through early April, with the greatest activity in January through March, when flows are sufficient to allow them to reach suitable habitat in far upstream areas. After hatching, juvenile steelhead remain in fresh water for one to four years before migrating to the ocean. The downstream juvenile migration occurs between February and May.

There is no specific literature on effects of artificial night lighting for steelhead, especially for the marine environment of the San Francisco Bay. The West Span of the Bay Bridge spans the deepest part of the channel leading into South San Francisco Bay, which likely will convey much of the water moving from the ocean into South San Francisco Bay. If this is the route taken by steelhead moving in as adults and out as juveniles from South San Francisco Bay to the sea, then adults and juveniles would be exposed in 2011/2012, and juveniles exposed in 2013. A potential effect of the Bay Bridge lights is to delay or alter the migration of juveniles out to sea past the bridge, or movement of adults into the south bay.

Movement of adults is unlikely to be affected by the Bay Bridge Light project. Adults are likely to be using water quality cues to move quickly into tributaries used for spawning. There is information indicating that changes in light levels (e.g., shading or lighting from docks) and strobe lights can disrupt juvenile steelhead movement (Johnson et al. 2005, Rondorf et al. 2010). Juvenile salmon swimming past docks encounter a dramatic change in light levels during the day, from bright light to shading, which seems to be the greatest impact affecting their movement and potential susceptibility to predation. Strobes deter fish from swimming into portions of dams or navigational locks where they may suffer increased risk of injury or mortality: these strobes are powerful, synchronously flashing (300 flashes per minute) lights, which are not equivalent to the light levels likely to reach the water from the Bay Bridge Lights project. Results of studies conducted on juvenile sockeye salmon in urban settings suggest that keeping direct lighting levels at $<0.1 \text{ lx}$ minimizes effects to outmigrating fish, and that shielding or redirecting lights can mitigate for effects (Tabor et al. 2004). In addition, ambient light conditions are already very bright in the bay area, and fish in urban settings may already be habituated to relatively bright night conditions.

Green Sturgeon

In the Sacramento River, green sturgeon spawn in late spring and early summer (Adams et al. 2002). Adults typically migrate into fresh water beginning in late February; spawning occurs

¹ Calculated using 12.3 lumens per node, for 5 strings on one suspension cable. Assumes light reaching the surface from each cable is not additive, using 250 ft as the approximate distance above the water.

March-July, with peak activity in April-June (Moyle et al. 1995). Juveniles spend 1-4 years in fresh and estuarine waters before migrating to the ocean (Beamesderfer and Webb 2002).

Green sturgeon are believed to spend the majority of their lives in nearshore oceanic waters, bays, and estuaries. Little information exists on green sturgeon, much of what exists is based on telemetry. Green sturgeon have been found to be more active at night than during the day when at sea (Erickson and Hightower 2007). However, in San Francisco Bay activity appeared to be independent of light level with no discernable peaks in activity at any particular time of day or light level (Kelly et al. 2007). It is unlikely that the Bay Bridge Lights project will have any effects on green sturgeon.

Longfin Smelt

Longfin smelt are a coastal/estuarine fish that moves into freshwater or slightly brackish waters of the delta and Sacramento/San Joaquin rivers to spawn in winter/spring (Baxter 1999). Longfin smelt are found throughout the San Francisco Bay (Baxter 1999). Long-term sampling in the San Francisco Bay has shown a consistent pattern of bathymetric distribution for longfin smelt, where juvenile longfin smelt tend to occur in greater abundance in deep-water habitats as they migrate into marine environments during summer months (Rosenfield and Baxter 2007).

Even less is known about effects of light on longfin smelt. The Bay Bridge Lights project would not affect spawning as spawning is not likely to occur in the project area. Lighting could potentially affect susceptibility of juvenile longfin smelt to predation (Kahler et al. 2000). However, lighting from the project is not anticipated to affect susceptibility of longfin smelt to predation as the light levels expected to reach the water are low (see above), and the bay already has high ambient light conditions.

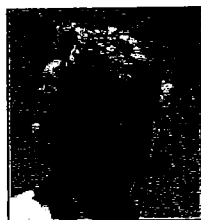
Overall Summary

Effects of the Bay Bridge Lights project are not likely to affect avian species directly during installation unless nests are impacted during the breeding season. Indirect effects of lighting are also not expected to affect avian species or listed fish in the project area. The Bay Bridge in its current condition already has a relatively significant amount of lighting. The additional lighting from this project is not anticipated to have any additional effects to listed avian or fish species.

References

- Adams PB, CB Grimes, ST Lindley, ML Moser. 2002. Status review for North American green sturgeon, *Acipenser medirostris*. National Marine Fisheries Service.
- Baxter B. 1999. Osmeridae. In: Orsi J, editors. Report on the 1980-1995 fish, shrimp, and crab sampling in the San Francisco Estuary, California. Stockton (CA): California Department of Fish and Game. Technical Report 63; p. 179-216.
- Beamesderfer RCP, MAH Webb. 2002. Green sturgeon status review information. Sacramento (CA): State Water Contractors.

- Erickson DL, JE Hightower. 2007. Oceanic distribution and behavior of green sturgeon (*Acipenser medirostris*). In: Munro J, Hatin D, Hightower JE, McKown K, Sulak KJ, Kahnle AW, Caron F, editors. Anadromous sturgeons: Habitats, threats, and management. Bethesda (MD): American Fisheries Society Symposium; p. 197-211.
- Gauthreaux SA, Jr., G Belser. 2006. Effects of artificial night lighting on migrating birds. In: Rich C, Longcore T, editors. Ecological consequences of artificial night lighting. Washington (DC): Island Press; p. 67-93.
- Johnson PN, K Bouchard, FA Goetz. 2005. Effectiveness of strobe lights for reducing juvenile salmonid entrainment into a navigation lock. North American Journal of Fisheries Management 25(2):491-501.
- Kahler T, M Grassley, D Beauchamp. 2000. A summary of the effects of bulkheads, piers, and other artificial structures and shorezone development on ESA-listed salmonids in lakes. Bellevue (WA): City of Bellevue.
- Kelly JT, AP Klimley, CE Crocker. 2007. Movements of green sturgeon, *Acipenser medirostris*, in the San Francisco Bay estuary, California. Environmental Biology of Fishes 79:281-295.
- Moyle PB, RM Yoshiyama, JE Williams, ED Wikramanayake. 1995. Fish species of special concern in California. 2nd ed. Rancho Cordova (CA): California Department of Fish and Game. Final Report for Contract No. 21281F.
- Nightingale B, T Longcore, CA Simenstad. 2006. Artificial night lighting and fishes. In: Rich C, Longcore T, editors. Ecological consequences of artificial night lighting. Washington (DC): Island Press; p. 257-276.
- Rondorf DW, GL Rutz, JC Charrier. 2010. Minimizing effects of over-water docks on federally listed fish stocks in McNary Reservoir: A literature review for criteria. Walla Walla (WA): U.S. Army Corps of Engineers. Report No. 2010-W68SBV91602084.
- Rosenfield JA, RD Baxter. 2007. Population dynamics and distribution patterns of longfin smelt in the San Francisco estuary. Transactions of the American Fisheries Society 136:1577-1592.
- Tabor RA, GS Brown, VT Luiting. 2004. The effect of light intensity on sockeye salmon fry migratory behavior and predation by cottids in the Cedar River, Washington. North American Journal of Fisheries Management 24:128-145.



Scott B. Terrill, Ph.D.

VP & Principal, Wildlife Ecology

sterrill@harveyecology.com
408-458-3203

AREAS OF EXPERTISE

- Bird ecology
- Endangered Species Act consultation/compliance
- Environmental impact assessment (NEPA/CEQA)
- Regulatory permitting/compliance

EDUCATION

- Ph.D. Biology/Ecology, State Univ. of New York, 1986
- M.S. Zoology, Arizona State Univ., 1981
- B.S. Zoology, Arizona State Univ., 1978

PRIOR PROFESSIONAL EXPERIENCE

- Associate Adjunct Professor, San Jose State University 1995-Present
- Research Director, Coyote Creek Riparian Station 1991-1995
- Adjunct Professor, State University of New York 1988-1990
- Assistant Professor, Siena College, New York 1988-1990
- Alexander von Humboldt Research Fellow, Max-Planck-Institut, Germany, Present
- Chair, Scientific Advisory Committee, San Francisco Bay Bird Observatory, Present

KEY PROJECTS

- Bear River Ridge Wind Farm Habitat Conservation Plan
- San Jose WPCP opportunities and constraints analysis
- Yolo County HCP
- NOAA marine sanctuaries management plan
- San Joaquin River improvement project biotic study

KEY PUBLICATIONS

- Berthold, P. & S. B. Terrill. 1991. Recent advances in studies of bird migration. *Annual Review of Ecology and Systematics* 22:357-78.
- Terrill, S. B. 1991. Evolutionary aspects of orientation and migration in birds. In: Berthold, P., editor. *Orientation in Birds*. Birkhauser Verlag, Basel. pp. 180-201.

Complete list of publications available upon request

PROFESSIONAL PROFILE

Scott is a Vice President and Principal, and oversees operations in our North Coast office, based in Arcata. Scott also directs our firm's research activities.

Scott is an internationally recognized ornithologist with extensive experience in avian ecology and behavior; he has made major contributions to the study of bird migration and movements. His field expertise ranges from the Antarctic to far northern Alaska, including three oceans, and he is an acknowledged expert in avian ecology. He also has a strong background in vertebrate community ecology and population biology. He leads our ornithologists on numerous special-status species investigations, and their work history includes over 500 burrowing owl and raptor projects.

Scott directs the company's full range of wildlife division projects, which can begin with identifying and investigating special-status species, creating effective and innovative mitigation measures, and ending with writing the biological sections of environmental impact reports and statements (EIR/EISs). Scott has lent his expertise to numerous large-scale EIRs, natural environment studies, constraints analyses, environmental risk assessments, hazardous-waste clean ups, and Endangered Species Act consultations. In his 18 years with the company, he has successfully managed more than 1000 projects, and his expertise spreads across all major habitats in western North America, including marine and estuarine habitats.

Examples of Scott's projects include: assessing and mitigating cumulative impacts of selenium in agricultural drain water on wildlife; more than seven years monitoring of bird use and risk at agricultural drain water basins and associated mitigation habitats in California's San Joaquin Valley; monitoring potential effects of oceanic dumping of dredge spoils on marine birds and mammals; restoring over 2000 acres of wetlands in the San Joaquin Valley; overseeing biological characterization, risk assessment, and long-term monitoring of endangered species in remediated wetlands at Concord Naval Weapons Station; conducting biotic characterizations of Fallon and Lemoore naval air stations; and completing the wildlife components of the Measure A+B transportation upgrades under the Santa Clara Valley Transportation Authority in Santa Clara County, which included successfully implementing measures to avoid take of protected species during construction on the multibillion dollar projects. Currently, he is Principal-in-Charge of a Caltrans on-call environmental services contract of over 15 transportation projects. He is also Project Manager on the Yolo County Habitat Conservation Plan.

Scott's expertise is most recently extending to renewable energy. He is Principal-in-Charge of many projects, including: the Bear River Ridge Wind Farm Habitat Conservation Plan; a bird and bat movement and mortality assessment at the Collinsville Montezuma Hills Wind Resource Area for the California Energy Commission; the King City Wind Farm site assessment and resource agency consultation; the Pacific Gas & Electric WaveConnect wave-energy project off Eureka, California; an environmental assessment framework for marine renewable energy projects for the Department of Energy; preparation of a "white paper" on developing wave energy in Coastal California; and other renewable projects in California, Oregon, Washington, and Hawaii.



Sharon H. Kramer, Ph.D.

Senior Associate Fish Ecologist

skramer@harveyecology.com
707-822-4141 x101

AREAS OF EXPERTISE

- Ecology of fishes
- Riverine, coastal and estuarine ecosystems
- Habitat conservation planning
- Endangered Species Act consultation/compliance

EDUCATION

- Ph.D. Marine Biology, UC San Diego, Scripps Institution of Oceanography, 1990
- M.S. Zoology, Univ. of Hawaii, Manoa, 1983
- B.A. Aquatic Biology, UC Santa Barbara, 1979

PRIOR PROFESSIONAL EXPERIENCE

- Senior Aquatic Ecologist & Principal, Stillwater Sciences, 2000-2007
- Regional Science Coordinator, National Marine Fisheries Service, 1997-2000
- Resource Specialist, Metropolitan Water District of Southern California, 1996
- Fish/Wildlife Biologist, U.S. Fish and Wildlife Service, Pacific HCP, 1994-1995
- Science Associate, California Sea Grant College Research Program, 1993-1994
- Postdoctoral Researcher, Australian Institute of Marine Science, 1991-1993

KEY PUBLICATIONS

Golightly, R. T., S. H. Kramer, and C. D. Hamilton. 2011. Assessment of natural resource and watershed condition: Redwood National and State Parks, Whiskeytown National Recreation Area, and Oregon Caves National Monument. Natural Resource Report NPS/NRPC/WRD/NRR—2011/335. National Park Service, Fort Collins, Colorado

Bell, E., S. H. Kramer, J. L. Aspittle, D. Zajanc. (2008). Salmonid Fry Stranding Mortality Associated with Daily Water Level Fluctuations in Trail Bridge Reservoir, Oregon. North America Journal of Fisheries Management 28:1515-1528.

Complete list of publications available upon request

PROFESSIONAL PROFILE

Sharon is an experienced fish ecologist heading up our fish ecology division and North Coast office, operating out of Arcata, California. Sharon's expertise spans over 25 years and focuses on aquatic ecology and fisheries biology in the Pacific Northwest, California, Australia, and Hawaii. Her academic research included studies of larval and juvenile fish energetics, distribution patterns, survival and growth of fishes in shallow water marine and estuarine habitats, use of shallow-water eelgrass, mud, and sand flat habitat as nursery habitat for juvenile fishes on the Great Barrier Reef, and juvenile salmonid habitat utilization. Sharon's recent professional research and work has focused on integrating watershed and coastal processes and the freshwater, estuarine, and coastal ecology of fishes, including listed salmonids and tidewater goby.

Since joining H. T. Harvey & Associates in 2007, Sharon has been involved in a variety of projects, with a focus on environmental effects of renewable energy projects. She developed study plans and provided strategic input for the Federal Energy Regulatory Commission (FERC) licensing process for Ocean Power Technology's Reedsport Wave Energy Park. She recently completed a Department of Energy market acceleration project with RE-Vision to develop an environmental assessment framework for wave and tidal renewable energy projects. She was also involved in developing the marine biological baseline, effects assessment and monitoring and adaptive management for PG&E's Humboldt WaveConnect Project FERC Pilot License Application. Most recently, she was part of a larger team developing a monitoring protocol framework for the Bureau of Ocean Energy Management for marine hydrokinetic projects including offshore wind. In addition, she has been integral in developing the Habitat Conservation Plan (HCP) for the Bear River Wind Project, focusing on minimizing and mitigating project effects on marbled murrelets.

She recently completed 3-years of fish monitoring of levee repair projects on the Sacramento River and Delta focusing on Chinook salmon and steelhead habitat utilization, watershed condition assessments of three national park units, and monitoring and restoration permitting associated restoration of the Salt River in the Eel River Estuary. She has also developed an alternative assessment and conceptual design for the removal of San Clemente Dam on the Carmel River addressing impacts to steelhead passage, and is involved in fish aspects of the South Bay Salt Pond Restoration Program, from development of fish monitoring plans to biological assessments.

Before joining HTH, Sharon opened and managed the Arcata office of a North Coast consulting firm: as a Principal, she managed over 20 scientists mostly involved in the FERC hydro-relicensing process. She has extensive experience with salmonids and habitat, including work on instream flows in the McKenzie River, OR and work on the San Joaquin River Restoration Objectives and Strategies conducted during the pre-settlement process for the San Joaquin River Restoration Program. She was the principal investigator for the Napa River Estuary Fisheries Monitoring Program for the U.S. Army Corps of Engineers. Sharon previously worked for the National Marine Fisheries Service (NMFS) as a regional science coordinator and fisheries biologist, managing and developing aquatic conservation strategies for salmonids in multi-species HCPs including the Pacific Lumber Company Headwaters HCP. Additionally, she provided scientific guidance to NMFS on regional planning strategies for salmonid recovery, including the development of guidelines for forest practices.

