

**Identifying critical habitat for Endangered species in
San Diego Bay**

**A Proposal for the:
Environmental Projects Benefiting San Diego Bay Program**

**Submitted by:
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Dr. Jeffrey Seminoff, NMFS, Southwest Fisheries Science Center
Dr. Tomo Eguchi, NMFS, Southwest Fisheries Science Center
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5/4/09

Dear Eileen,

Please find enclosed a proposal for the 2009 cycle of Environmental Projects Benefitting San Diego Bay. The focus of this project, **Identifying critical habitat for Endangered species in San Diego Bay**, is a multi-species effort to map and characterize critical habitat for the Endangered green turtle (*Chelonia mydas*) and the California Least Tern (*Sterna antillarum brownii*) in San Diego Bay. This proposal builds on current Port-funded projects evaluating resource distribution and habitat quality for these species. By integrating the findings from our current studies and collecting novel behavioral and environmental data, our goal is to identify key habitat areas in the Bay for both species. To do this, we will map fish abundances and fish species composition immediately before and during tern breeding season, manually track green turtles in the Bay, deploy temperature loggers on turtles, and record environmental characteristics at focal areas throughout the Bay. Our aim is to map and characterize specific areas that are essential for these two Endangered species, considering annual and seasonal variability. This is a collaborative research project between SDSU and NOAA-Southwest Fisheries Science Center.

The project is a 2 year project, starting in November 2009. The total cost of the project for the two years is **\$200,924**. The total funding requested from the Port is **\$156,044**. San Diego State University (SDSU) is providing 28.8% costs matched through in-kind contributions and matching funds.

This project builds on our existing research of resource distribution and quality throughout San Diego Bay (Lewison et al. *in prep*, presentation from Navy-sponsored Bay symposium is included on CD). Here, we take the next step, combining existing and new data to identify specific high use areas and characterize critical habitat for green turtles and Least Terns in the Bay. The goals of the project move beyond compliance and mitigation by focusing on research that has direct relevance for Endangered species management and protection in San Diego Bay; identifying high use areas and critical habitat for these two species of conservation concern. San Diego Bay provides a unique opportunity to investigate the interface between endangered/threatened species and human activities. The proposed research project provides a case study for identifying critical habitats for endangered and threatened species in highly urbanized environment. This study will provide information that will provide an essential foundation for all future conservation and management actions for these Endangered species in San Diego Bay.

Should you have any questions or require additional information for this proposal, please don't hesitate to call. Sincerely,

A handwritten signature in black ink, appearing to read "Rebecca Lewison".

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**SAN DIEGO STATE
UNIVERSITY**
Research Foundation

May 1, 2009

Eileen Maher
Environmental Services Department
Port of San Diego
3165 Pacific Highway
San Diego, CA 92101

Re: RFP - Environmental Projects Benefiting San Diego Bay
Rebecca Lewison, PI
Identifying Critical Habitat for Endangered Species in San Diego Bay

Enclosed please find the original application plus two copies and (1) CD ROM for the above referenced proposal.

This proposal is being submitted by the San Diego State University Research Foundation (SDSURF) on behalf of Dr. Rebecca Lewison. SDSURF is a non-profit corporation under the laws of California, whose officers and members are administrators and faculty of San Diego State University. The Foundation handles the administration of grants and contracts for research and educational projects and will serve as the fiscal agent for this project. If awarded, funds should be drawn in favor of SDSURF.

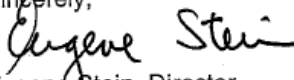
SDSU Research Foundation takes exception to Item 16 (Ownership of Records) in the agreement template. As a state agency, SDSU is not allowed to give away ownership of the intellectual property its faculty develops while working on funded projects. Item 16 should be deleted from the agreement if Dr. Lewison's project is awarded.

Please direct communications regarding this application to:

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Attachment(s)

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FURTHERING THE EDUCATIONAL,
RESEARCH AND COMMUNITY-SERVICE
MISSION OF SAN DIEGO STATE UNIVERSITY

Table of Contents

Cover Letters.....	2
Table of Contents.....	4
Proposal.....	5
I. Introduction	4
II. Project Narrative	4
III. Qualifying Experience	6
IV. Objectives	7
V. Cost proposal.....	8
VI. Personnel.....	8
VII. Subconsultants.....	8
VIII. Non-Profit Status.....	9
IX. Applicant Disclosure	9
X. Agreement.....	9
XI. Conflict of Interest.....	9
Appendix A: Itemized Budget	10
Appendix B: References	11
Appendix C: Resume_Lewison	13
Appendix D: Resume_Seminoff.....	14
Appendix E: Resume_Eguchi.....	15
Appendix F: Resume_Lai	16
Appendix G: Proof of Non-profit Status.....	17
Appendix H: Attachment A: Proposer’s Equal Opportunity Program	18

Title Identifying critical habitat for Endangered species in San Diego Bay

Primary Investigators

Dr. Rebecca Lewison, Assistant Professor, San Diego State University, Biology Department

Dr. Jeffrey Seminoff, Senior Scientist, NMFS, Southwest Fisheries Science Center

Dr. Tomo Eguchi, Ecologist, NMFS, Southwest Fisheries Science Center

Dr. Chun-Ta Lai, Assistant Professor, San Diego State University, Biology Department

Project Summary

The goal of this project is to identify critical habitat in San Diego Bay for the Endangered green turtle (*Chelonia mydas*) and the California Least Tern (*Sterna antillarum brownii*). This proposal builds on current Port-funded projects evaluating resource distribution and habitat quality for these species. Integrating the findings from these studies, our goal is to identify key habitat areas in the Bay at relevant spatial scales. To do this, we will map fish abundances immediately before and during tern breeding season, manually track green turtles in the Bay, deploy temperature loggers on turtles, and recording environmental characteristics at focal areas throughout the Bay. Our aim is to map and characterize specific areas that are essential for these two Endangered species, considering annual and seasonal variability. This is a collaborative research project between SDSU and NOAA-Southwest Fisheries Science Center.

I. Introduction

A key component to recovering populations of Threatened and Endangered species is identifying and protecting critical habitat. However, for many species, the information required to identify or characterize critical habitat is not available. This project builds on current research on the chemical composition and quality of food resources in the Bay. Integrating existing and novel data, our objective is to map specific areas of critical habitat for the Endangered green turtle (*Chelonia mydas*) and the Endangered California Least Tern (*Sterna antillarum brownii*).

As important as the Bay is for these species, these species also play an important role in maintaining ecosystem functions in the Bay. Green turtles are key consumers within eelgrass systems that, through consumption and defecation of eelgrass and invertebrate prey species, modify the cycling of nitrogen and other macronutrients within coastal ecosystems (Bjorndal 1980, Thayer et al. 1982). Further, green turtle grazing of coastal seagrass is integral for maintaining eelgrass beds with low detritus layers, which in turn allows for a healthier and more productive seagrass community (Thayer 1984, Williams et al. 1998). Likewise, seabird colonies are known to contribute valuable nutrients to shoreline areas (Anderson & Polis 1999), providing marine subsidies to coastal habitat. This project takes advantage of existing monitoring programs for Least Terns and green turtles and addresses a critical knowledge gap identified by the recent Bay report (pg. 61, State of the Bay, 2007) by designing a multi-species approach to understand how Endangered species use Bay habitat. The project also will provide an important educational opportunity for two SDSU graduate students.

II. Project narrative

Project description:

The goal of this project is to integrate existing information on resource distribution with spatially-explicit behavioral data to identify high-use areas for green turtles and California Least Terns in the Bay. To do this, we will map fish abundances immediately before and during tern breeding season, manually track green turtles in the Bay, deploy temperature loggers on turtles, and recording habitat characteristics at focal areas throughout the Bay. Our aim is to map and characterize specific areas that are essential for these two Endangered species, considering annual and seasonal variability.

Project activities: Methods and Analyses

Green turtles

An array of sonic receivers and tags were deployed in 2007 to acoustically monitor green turtles in SD Bay. These receivers have proven to be useful in detecting presence of turtles in certain areas and have provided a general understanding of the scale of movements by green turtles on a seasonal basis. These receivers provide a user-friendly means to monitor coarse scale movements of green turtles equipped with acoustic tags as receivers can be retrieved and data downloaded every 2-3 months. However, despite these advantages, remote ultrasonic receiving stations provide insufficient resolution to identify high-use or key habitat areas, and they are unable to provide necessary data to determine the directionality of movements as the tagged turtles enter and exit the receiving range of a receiver. Remote receiving stations maintained by NOAA biologists have provided vital information that has enhanced our understanding of green turtle movements in the Bay. In this study, we propose to further develop this approach by enlisting logistic support from two SDSU graduate students to conduct intensive manual tracking. The purpose of direct tracking is to identify the specific microsites visited by green turtles, determine time spent and behaviors undertaken in these areas, and identify the most important movement corridors within the Bay. Using omni and unidirectional hydrophones, we will engage in focal individual follows, monitoring turtle behavior and recording environmental conditions (e.g. depth, temperature, turbidity). These tracking data will be integrated with the distribution of sea grass beds, resource availability and quality (Lewison et al. *in prep*, current Port project) to characterize habitats used. We will also monitor water temperature at various locations throughout the Bay to characterize thermal environment. These data will be used for modeling green turtle habitat in the Bay. Overlays of these data will be used to quantify and map habitat ranges and to identify high-use areas of turtles in the Bay. Comparison between the 2010 and 2011 season will provide an estimate of annual variability in these areas.

Least terns

Work to date has used stable isotope signatures from salvaged eggs from 2002-2007 to infer food availability and the effect food availability has had on reproductive output in previous (Fournier et al. *in prep*, current Port project). This is an established and powerful approach to explore the relationship between prey composition, quality and reproductive output (Becker & Beissinger 2006). However, having concurrent measures of prey availability and composition to complement the current year's egg analyses provides an opportunity to validate the approach and to identify fine-scale changes within a season. This year, the Navy has initiated a Least Tern foraging study (P. Baird as PI). To complement this project, we propose to compare stable isotope data from current-season eggs with real-time fish monitoring. Once Baird's team identifies a foraging ground, we will work with the Baird team to conduct intensive seine surveys to record fish abundance and fish species composition in that area. Seines will be conducted biweekly at each identified foraging area and will record abundance and species composition (to genus) throughout the breeding period. Salvaged eggs from Bay colonies will continue to be collected to monitor changes in the stable isotope signatures adjacent to the seined areas for the duration of the project. This information can be directly compared to the coincident seine data and will serve to validate the relevance of the stable isotope signature. The findings from this work will be used to generate a geo-referenced fish abundance and composition map as context for the tern foraging distribution and preferences identified by the Baird research team. Comparison between the 2010 and 2011 season will provide an estimate of annual variability in prey composition.

Significance & Benefits to San Diego Bay

This project builds on our existing research of resource distribution and quality throughout San Diego Bay (Lewison et al. *in prep*, current Port funded project). Here, we take the next step, combining existing and new data to identify specific high use areas and characterize critical habitat for green turtles and Least Terns in the Bay. The goals of the project move beyond compliance and mitigation by focusing on research that has direct relevance for Endangered species management and protection in San Diego Bay; identifying high use areas and critical habitat for these two species of conservation concern.

The research proposed here relies on the expertise and experience of scientists from San Diego State University and NMFS, Southwest Fisheries Science Center. The research team represents an important partnership between the academic community and resource managers. The project also works to collaborate with other related projects ongoing in the Bay (Baird's tern foraging study) to maximize the relevance and applications of these research efforts.

At a broader scale, this study will provide necessary information for conservation and management of endangered and threatened species in San Diego Bay and elsewhere. The proposed characterization of the thermal environment of San Diego Bay will provide necessary information on habitat of green turtles in the Bay. During winter, it has been shown that green turtles are active regardless of the ambient water temperature because of their access to the warm effluent of the power plant (Lyon et al. 2006). Further, distributions of other species in the Bay, such as eelgrass and invertebrates, also are likely to be influenced by the thermal environment. By characterizing the thermal environment of the bay in a finer scale, we will have better understanding of the ecosystem of the Bay.

The proposed characterization of the thermal environment of the Bay also will provide necessary information on the potential effects of the proposed closure of the power plant. The spatial effects of the effluent can be used to determine effects of the power plant on the critical habitat of green turtles. By characterizing the thermal environment before the termination of the power plant operation, we will have necessary baseline information as comparison for future data.

Finally, San Diego Bay provides a unique opportunity to investigate the interface between endangered/threatened species and human activities. The proposed research project provides a case study for identifying critical habitats for endangered and threatened species in highly urbanized environment. Future development of management and conservation plans based on the results of our study will provide an example for other species and urban habitats.

III. Qualifying Experience

Dr. Lewison started work in the SD Bay in 2006. Her research evaluates the impact of human activities on vulnerable wildlife populations, with an emphasis on sea turtles and seabirds (Lewison et al. 2003, Lewison & Crowder 2003, Lewison et al. 2004, Lewison & Crowder 2007). Dr. Lewison combines field-based and analytical approaches to understand the ecological footprint of human activities on threatened and endangered species. Lewison currently serves as PI and advisor on three productive Port-funded projects and recently presented findings from those studies at the Navy-sponsored Bay symposium (a copy of the presentation is included on CD). Additional information and references for her recent work can be obtained from Dr. Larry Crowder, (252) 504 7536, lcrowder@duke.edu

Dr. Seminoff is a Senior Scientist and Program Leader for the Marine Turtle Ecology & Assessment Program at SWFSC. He has been involved in green turtle research in the Bay since 2000 (Seminoff et al. 2006, Seminoff et al. in press, Seminoff et al. in prep) in addition to conducting innovative sea turtle research worldwide (Seminoff & Zarate 2008). Additional information and references for his work can be obtained from Dr. Lisa Ballance, (858) 546-7173, lisa.ballance@noaa.gov.

Dr. Eguchi is an Ecologist for the Marine Turtle Ecology and Assessment Program at SWFSC. He has been involved in green turtle research in the bay since 2004. He has been involved in research projects on behavior and movements of marine organisms (Eguchi and Harvey 2005, Eguchi et al. 2006), as well as developing analytical methods (Eguchi 2002, Eguchi and Gerrodette, in press). Additional information and references for his recent work can be obtained from Dr. Lisa Ballance, (858)546-7173 or lisa.ballance@noaa.gov.

Dr. Lai has been using stable isotope ratio technique to study carbon and water cycling in terrestrial ecosystems (Lai et al. 2006a, Lai et al. 2006b, Lai et al. 2006c, Lai et al. 2005, Lai et al. 2004). He leads two projects sponsored by the Department of Energy to study carbon and water exchange between the atmosphere and major biomes in the contiguous USA. Additional information and references for his work can be obtained from Dr. James R. Ehleringer, 801-581-7623.

IV. Objectives

There are 2 primary objectives of this proposed research

- 1) To identify critical habitat for green turtles using acoustic tracking, behavioral monitoring (diving profiles, time at depth), environmental measurements (e.g. temperature, thermal gradients, turbidity) and existing information on food resource distribution.
- 2) To identify key foraging areas for California least terns that incorporates information on foraging behaviors (to be collected by Baird et al., Navy contract) with real-time data on fish species composition and abundance. We will also continue to analyze the isotopic signatures from salvaged shells to validate the stable isotope method.

Year 1	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct
Acoustic turtle tracking												
Focal individual follows												
Behavioral observations												
Environ. measurements												
Real-time fish monitoring												
Stable isotope analysis (eggs)												

Year 2	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov
Acoustic turtle tracking													
Focal individual follows													
Behavioral observations													
Environ. measurements													
Real-time fish monitoring													
Stable isotope analysis (eggs)													
Data analysis													
Report & manuscript prep													

Project Deliverables

As required by the Port, project deliverables will include quarterly progress reports detailing the work completed to date, how effective the project is at benefiting the Bay and costs incurred to date, a final report for review and comments by Port, and five copies plus an electronic copy of the final report. A presentation on the final report will also be given to the BPC, EC and/or the Environmental Services Department staff. Additional products from the project will include:

- 3-5 peer-reviewed manuscripts on habitat use and critical habitat characteristics for green turtles and least terns in SD Bay
- A GIS map of high use/critical habitat areas for green turtles
- A GIS map that overlays high use/key foraging areas for Least Terns identified by Baird et al. with fish species composition and abundance data

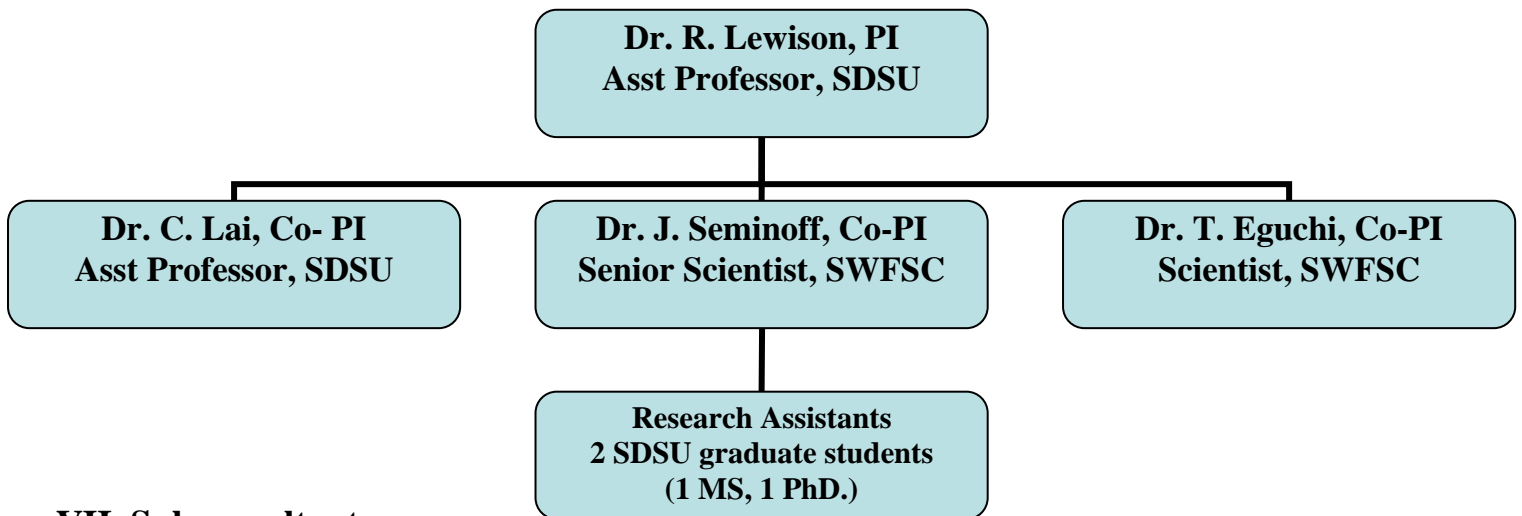
V. Cost Proposal

Total funding requested from the Port is **\$156,044**. The total funding for the project is **200,924**. San Diego State University (SDSU) is providing 28.8% costs matched through in-kind contributions and matching funds, indicated on the Budget (Appendix A).

VI. Personnel & Organizational Chart

This project draws on expertise from four scientists from two established San Diego research institutions. The project also relies on field support from two graduate student assistants. Dr. Rebecca Lewison is a conservation ecologist whose research explores the impact of resource and landuse on vulnerable populations. Her area of expertise is human activities that affect the population dynamics of sea turtle and seabird populations. Dr. Jeffrey Seminoff is a senior scientist at SWFSC and a leading expert in sea turtle ecological research and conservation. He has worked extensively with green turtles, is a member of the IUCN Marine Turtle Specialist Group and the green turtle assessor for both the IUCN Red List and US Endangered Species Act. Dr. Tomo Eguchi is an ecologist at SWFSC and has extensive background in population modeling, statistical analyses, and wildlife research. He has worked with marine mammals and marine turtles in a wide range of ecological questions, including diving behavior, movements, abundance estimates, development of analytical tools, and population modeling. Dr. Chun-Ta Lai is an ecosystem ecologist who specializes in ecosystem response and feedback to human impacts. He has been working on developing new techniques for detecting stable isotopic variation at multiple scales, and the use of isotopic signals in studies of ecosystem-atmosphere interaction.

In addition to the PIs on the project, there will also be 2 SDSU graduate students who will serve as field and research assistants for the duration of the project (1 MS and 1 PhD. student). All assistants will be required to have current CPR certification and the SDSU boat operator certification. Any personnel required to use SCUBA gear will be required to have SDSU diver certification. Only permitted individuals will be allowed to collect samples from California Least Terns and green turtles.



VII. Subconsultants

There are no subconsultants included in this proposal

VIII. Non-Profit Status

San Diego State Research Foundation has been granted tax-exempt status under section 501(c)(3) under the Internal Revenue Code. A letter with relevant information regarding this status is attached (Appendix G).

IX. Applicant Disclosure

All applicants and parties involved in this project have received no environmental violations from any regulatory agency within the last five years.

X. Agreement

The insurance clause as written in the attached sample agreement is acceptable.

XI. Conflict of Interest

There are no conflicts of interests from project participants.

Appendix A
Itemized Budget

Percentage of costs matched on proposal is 28.8%. Salaries include an annual escalation of 1.03

A. Personnel

	Total person months	Year 1		Year 2	
		Port requested	Matching costs	Port requested	Matching costs
Salaries (includes 39.9% benefits)					
R. Lewison, PI	2	19,292			
C. Lai, co-PI	0.5	5,072			
PhD Student, Asst	10mos (Y1), 9mos(Y2)	20,807		16,073	
MS Student, Asst	10mos (Y1), 9mos(Y2)	16,838		13,008	

B. Supplies

	Rate/Item	Quantity	Port requested	Matching costs	Port requested	Matching costs
Transportable omni & unidirectional hydrophone array	2500	1		2,500		
Hand-held sonic receivers and backup	2000	2		4,000		
Other Telemetry Equipment	300	1		300		
HOBO fixed Temperature Loggers	200	20	4,000			
Hardware for 10 stations (2 loggers each)	100	10	1,000			
Submersible Ultrasonic Receiver	5000	1	5,000			
Field laptop computer	3000	1	3,000			

C. Other Direct Costs

	Rate/Item	Quantity	Port requested	Matching costs	Port requested	Matching costs
Boat Hours	14/hr	300	-	4,200	-	4,200
Boat Fuel (gal.)	2.20	4000	2,200	2,200	2,200	2,200
Boat Maintenance	2000	1	-	2,000	-	2,000
Isotope Analyses	3	100	-	300	-	300

		Year 1		Year 2	
		Port requested	Matching costs	Port requested	Matching costs
TOTAL DIRECT COSTS		77,209	15,500	31,281	8,700
F&A @ TDCO (15%)		11,581		4,692	
F&A @ MTDC (49.5%)		-	7,673	-	4,307
TOTAL PROJECT COSTS		88,790	23,173	67,254	21,707

Appendix B

References

- Anderson, W.B & Polis, G.A. 1999. Nutrient fluxes from water to land: seabirds affect plant nutrient status on Gulf of California islands. *Oecologia*, 118(3): 324-332.
- Becker, H.B., and Beissinger, S.R. 2006. Centennial decline in the trophic level of an endangered seabird after fisheries decline. *Conservation Biology* 20 (2): 470-479.
- Bjorndal, K.A. 1980. Nutrition and grazing behavior of the green turtle, *Chelonia mydas*. *Marine Biology* 56:147-154.
- Eguchi, T. 2002. A method for calculating the effect of a die-off from stranding data. *Marine Mammal Science* 18:698-709.
- Eguchi, T. and Harvey, J.T. 2005. Diving behavior of the Pacific harbor seal (*Phoca vitulina richardii*) in Monterey Bay, California. *Marine Mammal Science* 21:283-295.
- Eguchi, T., Seminoff, J.A., Garner, S.A., Alexander-Garner, J. and Dutton, P.H. 2006. Flipper tagging with archival data recorders for short-term assessment of diving in nesting female turtles. *Endangered Species Research* 1:7-13.
- Eguchi, T. and Gerrodette, T. In Press. A Bayesian approach to line-transect analysis for estimating abundance. *Ecological Modelling*.
- Johnson, B.V., Fogel, M.L., and Miller, G.H. 1998. Stable isotopes in modern ostrich eggshell: A calibration for paleoenvironmental applications in semi-arid regions of southern Africa. *Geochimica et Cosmochimica Acta* 62 (14): 2451-2461.a
- Lai, C.-T., A. Schauer, C. Owensby, J.M. Ham, B.R. Helliker, P.P. Tans, and J.R. Ehleringer (2006a) Regional CO₂ fluxes inferred from mixing ratio measurements: estimates from flask air samples in central Kansas, USA, *Tellus*, 58B, 523-536.
- Lai, C.-T., W. Riley, C. Owensby, J. Ham, A. Schauer, and J. Ehleringer (2006b), Seasonal and interannual variations of carbon and oxygen isotopes of respired CO₂ in a tallgrass prairie: Measurements and modeling results from three years with contrasting water availability, *Journal of Geophysical Research-atmosphere*, 111.
- Lai, C.-T., J. Ehleringer, B. Bond, and K.T. Paw U (2006c), Contributions of evaporation, isotopic non-steady state transpiration, and atmospheric mixing on the δ¹⁸O of water vapor in Pacific Northwest coniferous forests, *Plant, Cell and Environment*, 29(1), 77-94.
- Lai, C.-T., J. Ehleringer, A. Schauer, P. Tans., D. Hollinger, K.T. Paw U, J. Munger, and S. Wofsy (2005), Canopy-scale δ¹³C of photosynthetic and respiratory CO₂ fluxes: observations in forest biomes across the United States, *Global Change Biology*, 11, 633-643.
- Lai, C.-T., J. Ehleringer, P. Tans, S. Wofsy, S. Urbanski, and D. Hollinger (2004), Estimating photosynthetic ¹³C discrimination in terrestrial CO₂ exchange from canopy to regional scales, *Global Biogeochemical Cycles*, 18.
- Muir D, Braune B, DeMarch B, et al. 1999. Spatial and temporal trends and effects of contaminants in the Canadian Arctic marine ecosystem: a review. *Science of the Total Environment*. 230 (1-3): 83-144.
- Lewison, R. L., L.B. Crowder, and D.J. Shaver. 2003. The impact of Turtle Excluder Devices and fisheries closures on loggerhead and Kemp's ridley strandings in the western Gulf of Mexico. *Conservation Biology*, 17:1089-1097.
- Lewison, R. L and L.B. Crowder. 2003. Estimating fishery bycatch and effects on a vulnerable seabird population. *Ecological Applications*, 13: 743-753.
- Lewison, R. L., L. B. Crowder and S. Freeman. 2004. Quantifying the effects of fisheries on threatened species: the impact of pelagic longlines on loggerhead and leatherback sea turtles. *Ecology Letters*, 7: 221-231.
- Lewison, R. L., L. B. Crowder, A. Read, and S. Freeman. 2004. Understanding impacts of fisheries bycatch on marine megafauna. *Trends in Ecology and Evolution*, 19 (11): 598-604.
- Lewison, R. L. and L. B. Crowder 2007. Putting longline bycatch of sea turtles into perspective. *Conservation Biology* 21: 79-86.
- Lyon, B., J. A. Smirnoff, T. Eguchi, and P. H. Dutton. 2006. *Chelonia* in and out of the Jacuzzi: Diel movements of East Pacific green turtles in San Diego Bay, USA. Annual Turtle Symposium, Island of Crete, Greece. April 3-April 8, 2006. Abstract.
- Seminoff, J.A., K.A. Bjorndal, and A.B. Bolten. In press. Stable carbon and nitrogen isotope discrimination and turnover in Pond Sliders *Trachemys scripta*: insights for trophic study of freshwater turtles. *Copeia*

- Seminoff, J.A., T.T. Jones, T. Eguchi, and P.H. Dutton. 2006. Stable isotope discrimination ($\delta^{13}\text{C}$ and $\delta^{15}\text{N}$) *between soft tissues of green sea turtles *Chelonia mydas* and their diet*. Marine Ecology Progress Series 308: 271-278
- Seminoff, J.A., S. Benson, T. Jones, and P. Dutton. In prep. Trophic status of leatherback turtles *Dermochelys coriacea* foraging near California USA: integrating isotopic discrimination values with field predator and prey data. In prep for *Oecologia*
- Schaffner, F.C., and Swart, P.K. 1991. Influence of diet and environmental water on the carbon and oxygen isotopic signatures of seabird eggshell carbonate. Bulletin of Marine Science 48 (1): 23-38.
- Thayer, G.W., K.A. Bjorndal, J.C. Ogden, S.L. Williams, and J.C. Ziemann. 1984. Role of larger herbivores in seagrass communities. Estuaries 7: 351.
- Thayer, G. W., D. W. Engel, and K. A. Bjorndal. 1982. Evidence for short-circuiting of the detritus cycle of seagrass beds by the green turtle, *Chelonia mydas* L. Journal of Experimental Marine Biology and Ecology 62:173.
- Williams, S. L. 1998. *Thalassia testudinum* productivity and grazing by green turtles in a highly disturbed seagrass bed. Mar. Biol. (Berl.) 98:447-455.

Appendix C
Curriculum Vitae for Dr. Rebecca Lewison

Assistant Professor
San Diego State University
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EDUCATION

Ph.D., Ecology, University of California, Davis. Dec 2001
B.A., Biopsychology, Vassar College, Poughkeepsie, NY. June 1993

PROFESSIONAL EXPERIENCE

Assistant Professor, San Diego State University, Jan 2005 - present
Research Scientist, Duke University, Jan 2003 – Jan 2005.
Postdoctoral research associate, Duke University, Jan 2001- Jan 2003.

FIVE PUBLICATIONS MOST RELEVANT TO THE PROPOSED PROJECT

- Lewison, R. L., C. Soykan, J. Franklin. 2009. Mapping the bycatch seascape: Utility and complexity in spatial patterns of fisheries bycatch. *Ecological Applications*, in press
- Moore, J.E., B.P. Wallace, R.L. Lewison, R. Žydelis, T.M. Cox, and L.B. Crowder. 2008. A review of marine mammal, sea turtle, and seabird bycatch in USA fisheries and the role of policy in shaping management. *Marine Policy* doi:10.1016/j.marpol.2008.09.003.
- Soykan, C.U., J.E. Moore, R. Žydelis, L.B. Crowder, C. Safina, and R.L. Lewison. 2008. Why Study Bycatch? *Endangered Species Research* 5: 91–102. doi: 10.3354/esr00175
- Lewison, R., S. Hooker, D. Hodgson, D. Agnew, D. Oro, C. Tisdell, H. Marsh, R. Wilson, B. Godley, S. Cooke, A. Cunningham, J. Matthiopoulos, C. Hammer, J. Seminoff (eds.). 2008. Fisheries bycatch: problems and solutions, ESR Theme Section. *Endangered Species Research* 5 (2-3).
- Schipper, J, Chanson, J.S., Chiozza, F., Cox, N.A., Hoffmann, M. et al. 2008. The status of the world's land and marine mammals: diversity, threat, and knowledge. *Science*, 322, 225-230.
- Wallace, B. P., S.S. Heppell, R. L. Lewison and S. Kelez. 2008. Using reproductive value analyses to assess relative impacts of fisheries bycatch on loggerhead turtle populations worldwide. *Journal of Applied Ecology* 45(4), 1076-1085.
- Sims, M., T.C. Cox and R. L. Lewison. 2008. Modeling spatial patterns in fisheries bycatch: Improving bycatch maps to aid fisheries management. *Ecological Applications* 18(3), 649-661.

PROFESSION AFFILIATIONS

Ecological Society of America
American Association for the Advancement of Science
World Conservation Union (IUCN), Species Survival Commission
Association of Zoos & Aquariums
Society for Conservation Biology

Appendix D
Curriculum Vitae for Dr. Jeffrey Seminoff

Division of Protected Resources
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EDUCATION

2000-2002 Post-Doctoral Fellow, Archie Carr Center for Sea Turtle Research, University of Florida, Gainesville.
2000 Ph.D. Wildlife and Fisheries Science, University of Arizona, Tucson.
1994 M.S. Ecology & Evolutionary Biology, University of Arizona, Tucson.
1989 B.S. Ecology & Evolutionary Biology, University of Arizona, Tucson.

CURRENT POSITIONS

2008- present Program Leader, Marine Turtle Ecology & Assessment Program, Southwest Fisheries Science Center, NOAA – National Marine Fisheries Service
2003- present Associate Editor for the United States, Ciencias Marinas. Institute of Oceanological Research of the University of Baja California. (ISSN 0185-3880)
2003- present Adjunct Faculty, Department of Zoology, University of Florida, Gainesville, Florida.
2002- 2008 Ecologist, Southwest Fisheries Science Center, NOAA – National Marine Fisheries Service

SPECIES STATUS ASSESSOR

2007 Evaluator, US Endangered Species Act 5-yr Re-evaluation for the Green Sea Turtle, United States Fish & Wildlife Service / National Marine Fisheries Service USA
2001-2004 Assessor, IUCN Red List Assessment of the Green Sea Turtle, Marine Turtle Specialist Group, World Conservation Union (IUCN) Species Survival Commission.

PUBLICATIONS MOST RELEVANT TO THE PROPOSED PROJECT

Seminoff, J.A., T.T. Jones, M. Hastings, T. Eguchi, and D. Jones. In Review. Stable carbon and nitrogen isotope discrimination between soft tissues of leatherback turtles (*Dermochelys coriacea*) and their diet. Comparative Biochemistry and Physiology B. Submitted 3/09
Seminoff, J.A. In press. Sea Turtles of the Sea of Cortez: biology, culture, and conservation. In: R. Brusca (ed). Biodiversity and its conservation in the Sea of Cortez. University of Arizona Press.
Seminoff, J.A. and P. Zárata. 2008. Satellite-tracked migrations by Galápagos green turtles and the need for multinational conservation efforts. Current Conservation. 2:11-12
Seminoff, J.A. and K. Shanker. 2008. Marine turtles and IUCN Red Listing: a review of the process, the pitfalls, and novel assessment approaches. Journal of Experimental Marine Biology and Ecology 356:52-68
Seminoff, J.A., K.A. Bjorndal, and A.B. Bolten. 2007. Stable carbon and nitrogen isotope discrimination and turnover in Pond Sliders *Trachemys scripta*: insights for trophic study of freshwater turtles. Copeia 2007(3):534-542
Seminoff, J.A., F.V. Paladino, and A.G.J. Rhodin. 2007. Refocusing on leatherbacks: conservation challenges and signs of success. Chelonian Conservation and Biology 6:1-6

Appendix E
Curriculum Vitae for Dr. Tomoharu Eguchi

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Education

- 2003 M.S. Statistics, Montana State University, Bozeman, MT
2003 Ph.D. Biological Sciences, Montana State University, Bozeman, MT
Ph.D. Dissertation: A hierarchical Bayes approach to capture-recapture abundance estimation (Adviser: Daniel Goodman)
1998 M.S. Marine Biology, Moss Landing Marine Laboratories, California State University, Fresno, CA.
M.S. Thesis: Morphology, movements, and diving behavior of the Pacific harbor seal (*Phoca vitulina richardii*) in the Monterey Bay area (Adviser: James T. Harvey)
1990 B.S. Marine Science, University of the Ryukyus, Okinawa, Japan. (March 1990).

Current Appointments

- 2008-current. NRC Research adviser
2008-current. Associate Editor, Endangered Species Research (Inter-Research, ISSN 1863-5407)
2004-current. Ecologist for the Marine Turtle Ecology and Assessment Program at SWFSC, NOAA Fisheries, La Jolla, CA.

Selected Referred Publications

- Eguchi, T. and Gerrodette, T. In Press. A Bayesian approach to line-transect analysis for estimating abundance. Ecological Modelling.
Eguchi, T., Gerrodette, T., Pitman, R.L., Seminoff, J.A., and Dutton, P.H. 2007. At-sea density and abundance estimates of the olive ridley turtle *Lepidochelys olivacea* in the eastern tropical Pacific. Endangered Species Research 3:191-203.
Eguchi, T., Seminoff, J.A., Garner, S.A., Alexander-Garner, J. and Dutton, P.H. 2006. Flipper tagging with archival data recorders for short-term assessment of diving in nesting female turtles. Endangered Species Research 1:7-13.
Eguchi, T. and Harvey, J.T. 2005. Diving behavior of the Pacific harbor seal (*Phoca vitulina richardii*) in Monterey Bay, California. Marine Mammal Science 21:283-295.
Eguchi, T. 2002. A method for calculating the effect of a die-off from stranding data. Marine Mammal Science 18:698-709.

Appendix F
Curriculum Vitae for Dr. Chun-Ta Lai

Address Department of Biology, San Diego State University, 5500 Campanile Drive, San Diego, CA 92182-4614, Tel: 619-594-0678, Fax: 619-594-5676, Email: lai@sciences.sdsu.edu; Homepage: <http://ctlai06.googlepages.com/home>

Professional preparation

2001 Ph.D. Nicholas School of the Environment, Duke University, Durham, NC
1993 B.S. Marine Environment and Engineering, Sun Yat-sen University, Taiwan

Appointments

Jan 2007 - present Assistant Professor, San Diego State University
2004 – 2006 Research Assistant Professor, University of Utah
2001 – 2004 Postdoctoral Associate, Department of Biology, University of Utah
1997 – 2001 Graduate Research Assistant, Duke University

Honors

June 2006 Taiwan Outstanding Scholar Fellowship, Ministry of Education, Taiwan.
May 2001 Paul A. Humphrey/AMS chapter's Academic Achievement Award, Central North Carolina Chapter of the American Meteorological Society.

Professional activities

Proposal review for NSF *Ecosystem Studies Program*; DOE/NICCR program
Article review for *Agricultural and Forest Meteorology*, *Crop Science*, *Ecosystems*, *Environmental Science and Technology*, *European Journal of Soil Science*, *Geochimica et Cosmochimica Acta*, *Global Change Biology*, *Global and Planetary Change*, *Journal of Geophysical Research – Atmosphere*, *Journal of Geophysical Research – Biogeosciences*, *Plant, Cell and Environment* and *Water Resources Research*

Five publications most relevant to the proposed project

Lai, C.-T., A. Schauer, C. Owensby, J.M. Ham, B.R. Helliker, P.P. Tans, and J.R. Ehleringer (2006) Regional CO₂ fluxes inferred from mixing ratio measurements: estimates from flask air samples in central Kansas, USA, *Tellus*, 58B, 523-536.

Lai, C.-T., W. Riley, C. Owensby, J. Ham, A. Schauer, and J. Ehleringer (2006), Seasonal and interannual variations of carbon and oxygen isotopes of respired CO₂ in a tallgrass prairie: Measurements and modeling results from three years with contrasting water availability, *Journal of Geophysical Research-atmosphere*, 111, D08S06, doi:10.1029/2005JD006436.

Lai, C.-T., J. Ehleringer, B. Bond, and K.T. Paw U (2006), Contributions of evaporation, isotopic non-steady state transpiration, and atmospheric mixing on the δ¹⁸O of water vapor in Pacific Northwest coniferous forests, *Plant, Cell and Environment*, 29(1), 77-94, doi: 10.1111/j.1365-3040.2005.01402.x.

Lai, C.-T., J. Ehleringer, A. Schauer, P. Tans., D. Hollinger, K.T. Paw U, J. Munger, and S. Wofsy (2005), Canopy-scale δ¹³C of photosynthetic and respiratory CO₂ fluxes: observations in forest biomes across the United States, *Global Change Biology*, 11, 633-643, doi: 10.1111/j.1365-2486.2005.00

Lai, C.-T., J. Ehleringer, P. Tans, S. Wofsy, S. Urbanski, and D. Hollinger (2004), Estimating photosynthetic ¹³C discrimination in terrestrial CO₂ exchange from canopy to regional scales, *Global Biogeochemical Cycles*, 18, GB1041, doi:10.1029/2003GB002148.

Appendix G
Tax exempt status declaration

Appendix H
Proposer's Equal Opportunity Program