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California Wildlife: Wildlife Habitat
Relationships and Ecological Monitoring in the
Golden Gate National Recreation Area

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Dr. Judd A. Howell
Marcia Semenoff-Irving

Biological Resources Division
Western Ecological Research Center
United States Geological Survey

Golden Gate Field Station
Ft. Cronkhite, Bldg 1063
Sausalito, CA 94965

Abstract

Surrounded by an increasingly urban landscape, the Golden Gate National Recreation Area furnishes critical habitat for 29 federally listed threatened and endangered species. Although now managed for the protection of biological diversity, the park's past history is one of human occupation and intense agricultural use. Over the past 8 years, EarthCorps teams have established and inventoried 520 permanent study plots in an effort to gather critical baseline data on the abundance and distribution of plant and animal species throughout the Park. This work provides a model for understanding the patterns and processes of ecosystem recovery following human alteration of the landscape and sets the stage for the implementation of monitoring programs designed to detect long-term ecological changes in plant and animal communities along the central coast of California.

Objectives

Since the summer of 1990, this project has contributed to an ongoing biological diversity-based inventory of wildlife resources within the G.G.N.R.A., the primary objective of which has been to document the abundance and distribution of terrestrial vertebrates in habitats throughout the park. Furthermore, this study seeks to examine the patterns and rates of ecosystem-level change following the abandonment of agricultural regimes and to describe the mechanisms influencing the landscape-level diversity of flora and fauna. Data collected during this study will be used to guide the implementation of long-term ecological monitoring programs within the park.

In 1997, the study objective expanded to include an examination of the behavior and ecology of coyote (Canis latrans) populations in southern Marin County. These large carnivores were extirpated from the San Francisco Bay Region within the last 40 years. During the past decade, they have begun recolonizing sites within their former range, including areas within the Golden Gate National Recreation Area. The protection and proper management of this highly adaptable native species will require the continued collection of data on the population size, structure, and habitat requirements of individuals living within and adjacent to the park.

Methods

Terrestrial Vertebrate Inventory

Plot Location-- During the 1997 field season, four Earthwatch teams sampled vertebrate diversity and abundance at 146 ecological study plots within the G.G.N.R.A. 70 new plots were established within the old growth forests of Muir Woods National Monument, 12 miles north of the Golden Gate Bridge. Plots were distributed at 30-m intervals along ten randomly placed transects within three habitat types: old growth redwood (*Sequoia sempervirens*) forest, old growth Douglas fir (*Pseudotsuga menziesii*) forest, and ecotonal areas adjacent to redwood forest. Muir Woods, named in honor of Scottish naturalist John Muir, is one of the few remaining stands of old growth redwoods remaining in the San Francisco Bay Area. This sampling effort represented the first systematic terrestrial vertebrate inventory undertaken in Muir Woods since the monument was established in 1908.

The remaining 76 plots sampled during the 1997 season represented a random subset of the original 200 plots established between 1990-1992 within the grassland/coastal scrub matrices of southern Marin County (immediately north of the Golden Gate Bridge). Plots were chosen using a computer-based randomization algorithm and were relocated in the field using a Global Positioning System (GPS) unit. This resampling effort represented the first iteration in the process of describing long-term trends in vertebrate species distribution and abundance within the G.G.N.R.A.

Vertebrate Sampling-- As in past years, animal abundance was determined using a variety of double-sampling methods. Small vertebrate trapping was accomplished using one 5-gallon bucket (pitfall trap) placed in the ground. Pitfalls in use had lids raised 5 cm above the lip of the bucket; those not in use were covered with 1.3-cm plywood lids, covered with soil. Additional trapping was accomplished using Sherman live traps baited with peanut butter and rolled oats. All small mammals were marked with metal ear tags for later identification. Reptiles and amphibians were identified and released without marking. Carnivores were sampled using sooted track plate stations baited with canned cat food. Remote camera systems were installed along transect routes and checked on a daily basis. In addition, incidental observations of species were recorded along established transects connecting study plots.

Coyote Population Study

In June and August of 1997, the United States Department of Agriculture, Wildlife Services Division, installed padded leg-hold traps within the G.G.N.R.A. Traps were checked daily during the trapping period, which varied from 10 days to three weeks. The goal of trapping was to radio collar adult coyotes within the Marin Headlands district of the park—a high use area encompassed by dense urban development. Radio telemetry equipment would then be used to track the locations and daily activity patterns of radio-collared animals. Tracking of individual coyotes would continue for several years in order to determine both seasonal and yearly home ranges and to investigate the spatial patterns of home range selection.

Throughout the study period, observations of coyote movement and behavior were made on an opportunistic basis. In addition, locations of tracks, scat deposits, and vocalizations were recorded daily and entered into a geographic information system (GIS) for future analysis.

Results

Volunteer Effort

During the 1997 field season, 42 Earthwatch volunteers devoted over 3300 total hours to the inventory and monitoring process. Since 1990, project volunteers have logged well over 20,000 hours in the field.

Terrestrial Vertebrate Inventory

Muir Woods-- 246 detections of 15 species were recorded at the 70 study plots established in Muir Woods. Species detected included coyote (Canis latrans), opossum (Didelphis virginiana), spotted skunk (Spilogale gracilis), and gray fox (Urocyon cinereoargenteus). The gray fox detections were particularly significant in light of a recent decline in the local population size of this native species. In past years, gray fox populations were found throughout southern Marin County. In 1995; however, these populations were negatively affected by an outbreak of canine distemper. During the 1997 field season only one gray fox was detected at 76 study plots in the Marin Headlands. Conversely, 15 detections were recorded at 11 different plots within Muir Woods. This difference appears to confirm the very localized nature of the outbreak.

Marin Headlands-- 459 detections of 22 species were recorded at 76 study plots within the Marin Headlands. Species detected included coyote (Canis latrans), bobcat (Lynx rufus), California vole (Microtus californicus), deer mouse (Peromyscus maniculatus), and vagrant shrew (Sorex vagrans). In 1998, this dataset will be compared to that collected during the 1990-1992 field seasons. Further, study plot data for all years will be incorporated into a geographic information system and will be used to model landscape-level vertebrate and habitat diversity within the park. In addition, this baseline data will be used to test the statistical power of the terrestrial vertebrate inventory sampling effort.

Coyote Population Study

A single juvenile female coyote was captured during the summer trapping session. She was examined but was released without collaring due to insufficient body size. No adult coyotes were captured. Consequently, radio telemetry could not be carried out during this field season. Coyotes; however, were successfully observed within the study area throughout the remainder of the field season.

A total of 14 visual observations of coyotes were made between June 15 and September 30, 1997. Coyotes were frequently observed hunting small mammals in grassland patches and were seen either individually or in small groups. In addition, 25 sets of tracks were observed and 3 howling observations were recorded. One den site, discovered in early June, was used throughout the summer by an adult pair and at least four pups. This family group was often observed traveling together near the den site and over into an adjacent valley.

Discussion

Since the summer of 1990, this project has contributed to an ongoing biological diversity-based inventory of wildlife resources within the G.G.N.R.A., the primary objective of which has been to document the abundance and distribution of terrestrial vertebrates (mammals, reptiles, and amphibians) in major park habitats. Terrestrial vertebrates are particularly vulnerable to habitat alteration and fragmentation (due to their general inability to cross large barriers and to expand and establish successfully in new environments) and, thus, provide an important index for examining and monitoring changes in habitat quality. Since many habitats within the G.G.N.R.A. have been subjected to sustained grazing regimes for over a century, this study also sheds light on the impacts that agricultural use have had on the biological diversity of

plant and animal communities within the park. Because areas in and adjacent to the park are characterized by varying chronologies of use, ranging from current range production to post-grazing abandonment, they provide a unique comparative basis for studying ecosystem structure and function along a successional timeline from initial disturbance to long-term recovery and community stabilization. A heightened understanding of this process and of the mechanisms influencing species diversity over time will, in turn, lead to the design of improved conservation strategies for the management and protection of biological resources within the Park.

In addition, protocols developed during this inventory phase will be used to guide the implementation of long-term ecological monitoring programs within the G.G.N.R.A. These programs are designed to detect changes in important natural resources and potential resource losses from factors such as park management activities, natural succession, animal influences, fire management, and global warming. Long-term monitoring of ecosystem change over time will be crucial to ensuring the maintenance of biological diversity within the park. In addition, data collected during this study will be incorporated in a park-wide geographic information system (GIS). Layers of geo-referenced data, including habitat type, species distribution, geology, and soils, will provide park management with a powerful tool for assessing the impact of management policies and continuing use practices on the Park's many natural resources.

As the general population increases and more intense recreational pressure is placed on all units of the National Park system, wildlife habitats will be subject to increasing fragmentation, isolation, and degradation. As the largest urban national park in the world, and one of the most heavily visited in the system, the Golden Gate National Recreation Area exemplifies many of the potential resource issues and problems likely to impact all National Parks in the future. Such pressures will require more intensive management strategies and, thus, more informed decision-making on the part of Park managers. Baseline ecological data, such as that gathered during this inventory and from scheduled monitoring programs will be crucial to insuring the maintenance of biological diversity within all National Park ecosystems.

This work also contributes to an ongoing international effort to document biological diversity and landscape-level change on a global scale. Since 1992, this project has been part of a comparative study examining the natural recovery of human-impacted plant and animal communities at two International

Biosphere Reserves: the Central California Coast, of which the Golden Gate National Recreation Area is a part, and the mer d'Iroise, France (Howell and Bioeret 1995). It is hoped that this work will contribute to a global sharing of experience in ecological monitoring and ecosystem analysis well into the 21st century.

Finally, the intensive study of recolonizing coyote populations will be useful on a number of levels. Because data on other native carnivores (bobcat and gray fox) was collected prior to the re-emergence of coyotes, the potential impact of this top-level carnivore on local native populations can be better studied. Furthermore, because coyotes are repopulating parklands immediately adjacent to urban communities, the potential exists for coyote-human interactions and conflicts. An examination of the behavior and habitat requirements of emergent coyote populations will be vital in understanding and predicting the success of these new predators in, what are now, highly fragmented habitats. In addition, knowledge of the impact of different land use practices and increasing urbanization on wildlife species such as the coyote will provide a crucial link in the National Park Service management and decision-making process.

Publications

The following publications have already stemmed from this project.

- Howell, J.A. 1992. *Coastal scrub and prairie wildlife inventory, Golden Gate National Recreation Area, California*. pp 134-140. Proceedings of the Symposium on Biodiversity of Northwestern California, October, 1991, Santa Rosa, CA 283 pp.
- Howell, J.A. 1993. *Wildlife habitat inventory and monitoring, Golden Gate National Recreation Area, California: a pilot study*. Ph.D. Dissertation. University of California, Berkeley 195 pp.
- Howell, J.A. 1993 *National Park Service inventory and monitoring: a California park perspective*. George Wright Forum 10:16-23.
- Howell, J.A. 1995. Remote sensing of wildlife habitat for inventory and long-term monitoring: A California perspective. Conference for Remote Sensing and

Environmental Monitoring for the Sustained Development
of the Americas, San Juan, Puerto Rico, March 1995.
University of Puerto Rico, Mayaguez, PR 19 pp.

Howell, J.A. and R.H. Barrett. 1995. *California Wildlife-
Habitat-Relationships System: a test in coastal scrub
and grassland*. California Fish & Game 32 pp.

Howell, J.A. and F. Bioret. 1995. Comparative study of
terrestrial ecosystem dynamics between two MAB coastal
Biosphere Reserves, France and United States.
Proceedings of the 8th Conference on Research and
Resource Management in Parks and on Public Lands -
Portland, OR April, 1995 George Wright Society. pp
81-92.

The following papers will be published in 1998:

- (1) Power Test of a Terrestrial Vertebrate Resource
Inventory within the Golden Gate National Recreation
Area
- (2) Effects of Post-grazing Succession on the Diversity of
Terrestrial Vertebrates

Also, in conjunction with Silicon Graphics, Inc., we have
developed a slide presentation-- "Explorations into
Biological Diversity: An Inventory for the 21st Century" for
use in Earthwatch volunteer orientations, park-wide wildlife
habitat training modules, and scientific presentations.
Topics include project development, goals, methodology, and
preliminary findings.

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