Mountain Lions at Jasper Ridge Biological Preserve:

An Exercise in Management and Policy Options

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K.Y. Epps, S.Y. Litvin, S.R. Loarie, M. Papenfus, L.M. Perkins (2011) Jasper Ridge Biological Preserve Report on Mountain Lion Management to the Jasper Ridge Advisory Committee, Stanford University Stanford, CA.

Acknowledgments

The authors gratefully acknowledge the generous help of :

Christopher Field, Ph.D., Faculty Director, Jasper Ridge Biological Preserve; Donna Krucki, Senior Park Ranger, Orange County Division of Parks and Recreation, Geoff McGhee, Creative Director of Media and Communications, The Bill Lane Center for the American West; Margaret Krebs, Academic and Research Officer, Woods Institute for the Environment, Stanford University; Mike Mastrandrea, Ph.D., Assistant Consulting Professor, Woods Institute for the Environment, Stanford University; Nicole Ardoin, Ph.D., Assistant Professor, Stanford University; Nona Chiariello, Ph.D, Staff Scientist, Jasper Ridge Biological Preserve; Pam Sturner, Managing Director, Leopold Leadership Program; Patrick Dunkley, J.D., Senior Counsel, Stanford University; Rodolfo Dirzo, Ph.D., Professor, Stanford University; Sandy DeSimone, Ph.D., Director of Research and Education, Starr Ranch Sanctuary, Audubon California; Sherril Green, DVM, Ph.D., Director, Stanford Veterinary Service Center; Steve Felt, DVM, MPH, Associate Director, Stanford Veterinary Service Center; Trevor Hebert, GIS and Data Manager, Jasper Ridge Biological Preserve; Winston Vickers, DVM, Wildlife Veterinarian, Wildlife Health Center, UC Davis; Zara McDonald, Executive Director, Felidae Conservation Fund; and Mark Shwartz, Communications Manager, Woods Institute for the Environment, Stanford University. This report is based in part upon work supported by the National Science Foundation under Grant Number 0934210.

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Executive Summary

Introduction

Since October 28, 2008, wireless digital camera traps have been active at Jasper Ridge Biological Preserve (JRBP). On September 10, 2009, ten and a half months after the first camera was activated, a mountain lion (*Puma concolor*) was photographed for the first time. Over the following 12 months, the network expanded to 10 cameras (including one video camera) and photographed mountain lions on 23 dates. The confirmation of repeated occurrences of this keystone species within JRBP raises both challenges and opportunities for the Jasper Ridge and greater Stanford communities.

In response to a request by the Jasper Ridge advisory committee in June 2010 that JRBP's policies relating to the presence of mountain lions be reviewed, Jasper Ridge invited members of the Rising Environmental Leaders Network to serve as academic consultants. With the collaboration of the Woods Institute for the Environment, Jasper Ridge convened a two-day workshop featuring invited experts in mountain lion behavior and conservation (Appendix I). A synthesis of the workshop, additional interviews, relevant literature, and an analysis of the camera trap data, this report highlights:

1. Human safety risks resulting from mountain lion presence on JRBP, and how best to mitigate those risks.
2. Opportunities presented by camera trap data and mountain lion presence in the context of JRBP's mission statement of research, education, and conservation.

The following summarizes the findings and recommendations of the consulting group.

Risk assessment and recommended protocols for mitigating risk

<u>Presence and abundance of mountain lions at JRBP.</u> Current camera trapping data at Jasper Ridge suggest that mountain lions are present on the preserve about 24% of the time. The probability that a single wireless digital camera will detect a mountain lion when it is present is only about 6%. The fact that no mountain lions were photographed by earlier camera-trapping efforts suggests a recent change—in detection, mountain lion occurrence, or both.

<u>Chances of negative human-mountain lion encounter.</u> Based on statewide historical data, the annual risk of a mountain lion attack on a person at Jasper Ridge is estimated to be 1 in 10 million. Historically, mountain lion attacks in the United States and Canada have been more frequent when and where human activity is greatest. Previous studies have suggested that the victim's age and number of companions did not influence the probability of attack, although posture (crouching versus standing) while separated from a group did. Most victims did not notice the mountain lion before being bitten or clawed. Also, time of day did not seem to influence the likelihood of attack. Fighting back greatly reduced the probability and severity of injury.

Protocols for mitigating risk. Given the extremely low risk of an attack at Jasper Ridge, precautionary measures that would hinder the main mission of JRBP[1] are not advised, and the following standard best practices are recommended:

Recommendations:

1. Implement protocols for JRBP staff to follow in responding to normal as well as unusual mountain lion behavior. Consider protocols similar to those from Orange County Parks and vet with Stanford legal counsel.
2. Develop field protocols for all JRBP users and visitors, such as working in groups of two or more at dusk, nighttime, or dawn; avoiding crouching; and fighting back in the unlikely event of an attack. (See, for example, Orange County Internal Protocols, Appendix II.)
3. Train staff and docents to recognize signs of mountain lion presence and to use proper safety protocols in areas with active mountain lion populations.
4. Release timely (e.g., weekly) mountain lion reports by email – with secured link to the mountain lion database –to JRBP staff, students, and researchers to foster awareness of mountain lion activity.
5. Release periodic (e.g., monthly) summaries of mountain lion activity to interested students, visitors, and community members. The aggregated data should include number of sightings each month and selected, recent camera-trap photographs.
6. Revise JRBP's standard liability waiver form, which must be signed by all non-Stanford users, to specifically mention mountain lion presence. Vet statement with Stanford legal counsel.
7. Along perimeter fencing, post signs that indicate private property; no trespassing; mountain lion habitat.

Research, education and outreach opportunities afforded by camera trap data

Short- and long-term opportunities. Camera trap data can be incorporated immediately into research, education, and outreach activities that Inform management practices and public safety while contributing to the understanding of ecology of mountain lions in the region. Short-term efforts include monitoring for signs and analyzing the database of collected images. The participation of students, docents, and visitors in supplemental activities, such as monitoring signs of mountain lion presence, can aid in estimating mountain lion abundance and simultaneously build positive awareness of living and working in mountain lion habitat. Future long-range efforts that incorporate more direct monitoring of mountain lions through marking or tagging should include collaborations with academic research groups and conservation organizations.

[1] JRBP Mission Statement: The mission of Jasper Ridge Biological Preserve is to contribute to the understanding of the Earth's natural systems through research, education, and protection of the Preserve's resources.

Recommendations (Short-term):

1. Explore the use of “near-infrared” cameras to improve identification of individual pumas.
2. Consider unbiased camera placement as a means to estimate the population size of mountain lions at Jasper Ridge.
3. Incorporate mountain lion ecology in classes for docents and ecology students, and explore using the classes, and the docent community, to support mountain lion–related research at Jasper Ridge.

Recommendations (Long-term):

1. Encourage collection, identification, and genetic analysis of mountain lion scat.
2. Encourage experimental and observational research addressing the cascading effects of mountain lions, including effects on herbivory and food web structure, on Jasper Ridge ecosystems, particularly in riparian corridors.
3. Encourage radio collaring of mountain lions at Jasper Ridge through collaboration with existing research programs. As an intermediary strategy, explore the possibility of passively marking mountain lions to allow individuals to be more readily identified from camera trap photos, while posing less risk to researchers than radio collaring.

Education and outreach. Jasper Ridge should use mountain lion images as the basis of an education and outreach initiative aimed at informing and promoting support for the conservation of mountain lions and their shrinking habitat. New media, existing courses, and emerging research constitute three avenues for launching a mountain lion educational campaign. Care should be taken in the manner in which images are released (temporal delay) and presented, with a priority on safety and managing the perception of risk. Existing courses at Jasper Ridge can serve as venues for both disseminating information about mountain lion behavior and instructing community members and others about the best responses to direct encounters.

Recommendations:

1. Encourage the development and maintenance of an interactive website focused on the importance of wildlife corridors and challenges related to maintaining these corridors in the face of road expansion, suburban development, and habitat shifts due to climate change.
2. Expand current educational programs within Jasper Ridge to incorporate mountain lion ecology. Courses should serve as venues for gathering more data on mountain lion presence and activity, as well as for conveying information on mountain lion behavior and the proper response to a mountain lion encounter.
3. Collaborate with faculty and students in environmental journalism programs to develop and disseminate compelling and appropriate media about mountain lions. Key information to convey includes the actual risk of human–mountain lion encounters, the importance of wildlife corridors in preserving ecosystem health and wellbeing, and the opportunities and benefits of studying mountain lions at Jasper Ridge.
4. Develop and implement citizen science programs that allow Jasper Ridge visitors and resident neighbors to participate in monitoring mountain lion activity.

1. Introduction

1.1 Background

Since October 28, 2008, wireless digital camera traps have been active at Jasper Ridge Biological Preserve (JRBP). On September 10, 2009, a mountain lion (*Puma concolor*) was photographed on the preserve for the first time. Over the following 12 months, the camera network expanded to 10 cameras (including one video camera) that photographed mountain lions on 23 dates. These results contrast with previous camera-trapping efforts that did not detect mountain lions.

The confirmation of repeated occurrences of this keystone species within Jasper Ridge suggests opportunities as well as challenges for Jasper Ridge and the greater Stanford community. How might photographic evidence of mountain lion presence contribute to new research activities concordant with the preserve's mission? Moreover, does the established presence of mountain lions alter JRBP's obligations to visitors and the greater Stanford community?

In June 2010, the Jasper Ridge advisory committee responded to the growing number of mountain lion photos by recommending that JRBP policies relating to the presence of mountain lions be reviewed. The Woods Institute for the Environment and Jasper Ridge convened a two-day workshop, inviting a consulting group drawn from members of the Rising Environmental Leaders Network to interview experts on a range of topics related to mountain lion behavior and conservation (See Appendix I). This report represents the culmination of the workshop, additional interviews, a literature review, and an analysis of the camera trap data through July 2010.

1.2 Scope of this report

In this report, we review mountain lion ecology and the camera-trapping data to better understand whether mountain lion presence on the preserve has changed. We then examine the potential impacts of mountain lions on the ecology of Jasper Ridge and opportunities for communicating these results to the public. Our analysis is presented in two sections:

1. We evaluate the risk to human safety related to mountain lion presence based on camera trap sightings, and we present recommendations on strategies for conveying that risk and related safety protocols. We also address whether and how camera trap data should be made available.

2. We summarize the scientific, educational, and public outreach opportunities presented by the mountain lion camera trap data. We outline recommendations for research and media outreach.

1.3 Mountain lion presence and detection

Assessment of regional mountain lion presence based on available data and other studies

Although the possibility that Jasper Ridge is an important corridor used by several transient mountain lions cannot be excluded, there are likely at most one male, one female, and possibly several cubs

whose territory includes Jasper Ridge (Winston Vickers, pers. com). Mountain lions are considered territorial and have large home ranges of 763 km^2 and 161 km^2 for males and females respectively (Dickenson and Beier, 2002). Given Jasper Ridge's relatively small size of 5 km^2, there is a 4% probability of the presence of an adult mountain lion on the preserve at any one time, assuming uniform use of their home ranges (Figure 1). A more grounded estimate of the probability of a mountain lion being on the preserve in a given day, however, depends on how actively mountain lions patrol their range.

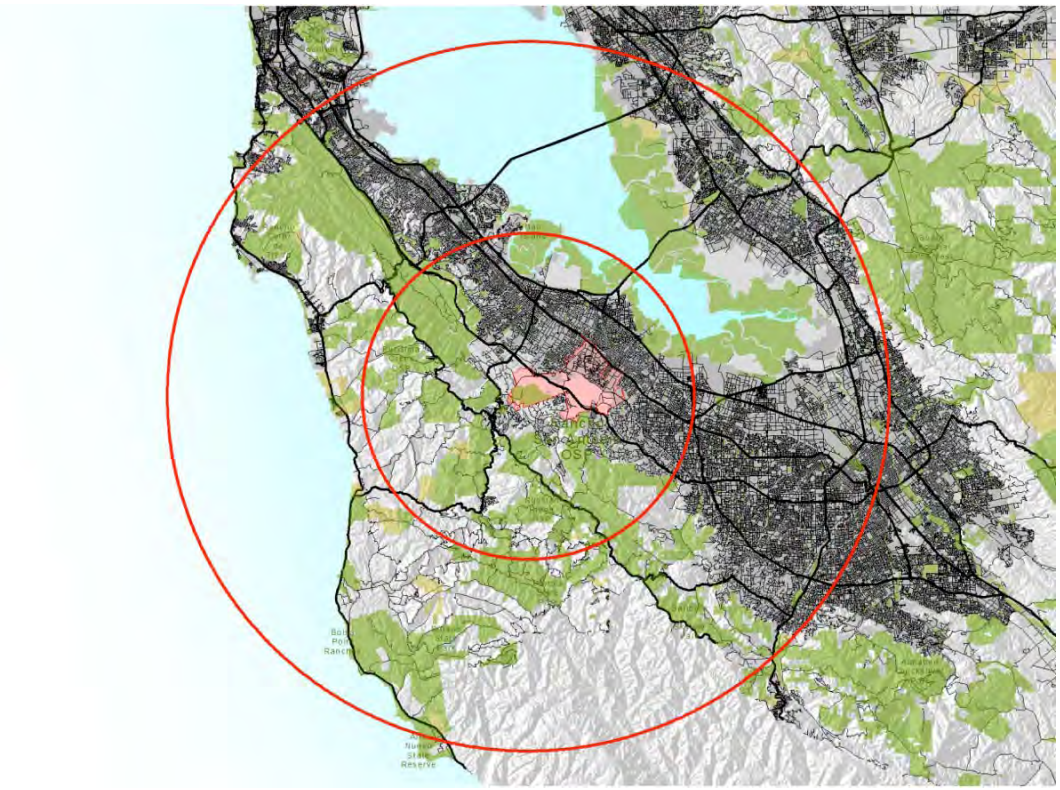

Fig 1. Red circles are estimates of male (larger circle) and female (smaller circle) mountain lion home ranges centered on Jasper Ridge Biological Preserve. The pink polygon represents Stanford lands.

Mountain lion occurrence based on wireless digital camera traps

Beginning on October 28, 2008 up to 10 active camera traps detected mountain lions on 24 out of 680 days at Jasper Ridge Biological Preserve. On six days, mountain lions were detected on multiple cameras. These detection rates were used to solve a set of equations that describe the probability of a mountain lion being present at Jasper Ridge and the probability of its detection by a camera trap.

For a single camera, the probability of photographing a mountain lion is the probability of detecting a mountain lion with a camera (ϕ) multiplied by the probability that a mountain lion is present on the preserve (θ). Conversely, the probability of not photographing a mountain lion is the probability no mountain lions are present on the preserve ($1-\theta$), plus the probability that a mountain lion was present but not detected. If **t** is the number of days, **n** is a t-length vector of the number of operational cameras each day, and **y** is a t-length vector of the number of cameras *recording* mountain lion photographs each

day, then we can sample the probability that a mountain lion was present, x_i, given the condition that no mountain lions were observed on a single day, ***i***, as:

$$P(x_i|y_i = 0) = \frac{\theta \times (1-\varphi)^{n_i}}{(1-\theta)+\theta \times (1-\varphi)^{n_i}}$$

The binomial likelihood is often used to model both detection and presence. If we use a beta prior probability distribution (describing uncertainty in the absence of observations) because they are conjugate to the binomial, the posterior probability of presence (probability of presence given observational data) can be expressed as:

$$\theta|\mathbf{x}, \alpha_\theta, \beta_\theta \sim Beta(\theta|\sum_{i=1}^{t} x_i + \alpha_\theta, t - \sum_{i=1}^{t} x_i + \beta_\theta)$$

and the posterior probability of detection (probability of detection given camera recordings) as:

$$\varphi|\mathbf{y}, \mathbf{n}, \alpha_\varphi, \beta_\varphi \sim Beta(\varphi|\sum_{i=1}^{t} y_i + \alpha_\varphi, \sum_{i=1}^{t}(n_i - y_i) + \beta_\varphi)$$

where prior parameters α_ϕ, $\beta_\phi \alpha_\theta$, and β_θ are all set to non-informative values of 1. Gibbs sampling, a hierarchical Bayesian method, was used to simultaneously estimate posterior probabilities for the parameters ϕ, θ, and **x** (Smith and Roberts, 1993).

Analysis of this model reveals that the probability of detecting mountain lions when they are present on the preserve by a single camera, ϕ, is 0.06 (with a 95% credible interval, or Bayesian confidence interval, of 0.02-0.11). Likewise, the probability that a mountain lion is on the preserve on any given day, θ, is 0.24 (0.11-0.53). The parameters co-vary in the solution to the model such that high presence co-occurs with low detection and vice-versa (Figure 2).

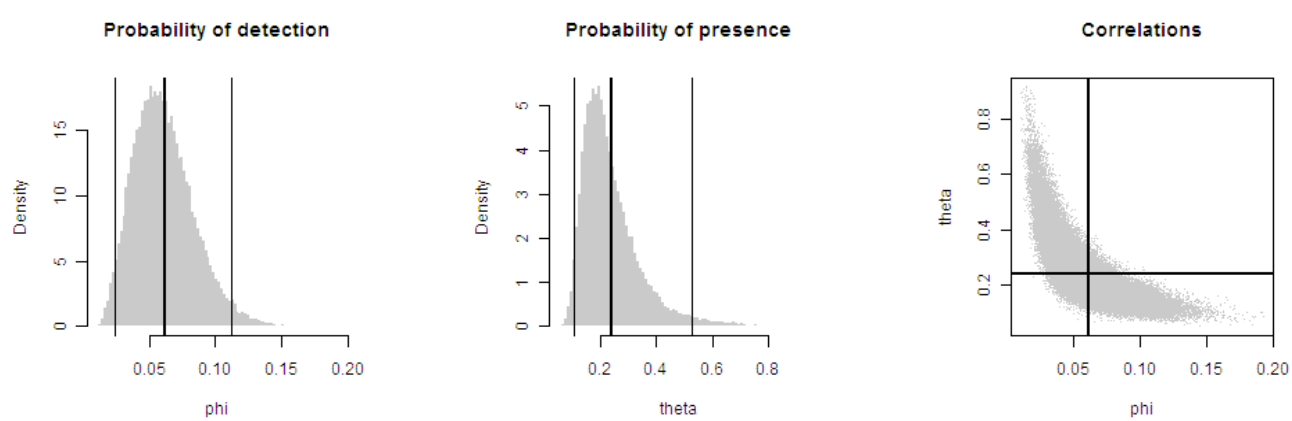

Fig 2. Probabilities of detection (ϕ), presence (θ), and correlations between these two probabilities.

This model assumes a single probability for presence across all days and a single detection probability across all cameras, which may not be the case. Restricting the analysis to the seven cameras that have photographed mountain lions yields similar estimates with a slightly higher detection estimate of 0.09 (0.03-0.17) and an unchanged presence estimate of 0.24 (0.10-0.52). However, on 10 of the 24 days that mountain lions were photographed, a single camera was responsible for the captures. Repeating this analysis using only this camera produces much more uncertain estimates with higher average detection estimates of 0.46 (0.14-0.95) and presence estimates of 0.44 (0.14-0.95). The wide credible intervals, however, do not suggest that these differences are statistically significant.

Mountain lion occurrence based on early camera traps

Estimates of mountain lion occurrence based on wireless digital camera traps can be compared with estimates based on an earlier camera trap study at Jasper Ridge that did not detect mountain lions. From March 2006 to September 2008, a separate array of 12 cameras was active for 880 days. Combining the above probability estimates with the array of 12 cameras, there would be a 0.11 (0.07-0.16) probability of photographing a mountain lion on any given day, and the probability of *not detecting* a mountain lion over the period would be very small, 5.6×10^{-46}. It is, therefore, unlikely that rates of detection and/or mountain lion presence were as high in the interval March-September 2006, as estimated for the current wireless digital camera trap study. This suggests a change in conditions at the Jasper Ridge Preserve. An experiment reactivating the older cameras could be used to test whether detection or presence has increased.

Temporal analysis

An analysis of time stamp data from the current set of mountain lion photographs reveals that activity peaks just before midnight (Figure 3). This may include events in which a camera took multiple photos of a single animal pausing or walking slowly. The majority of captures occur during periods of low human activity at Jasper Ridge.

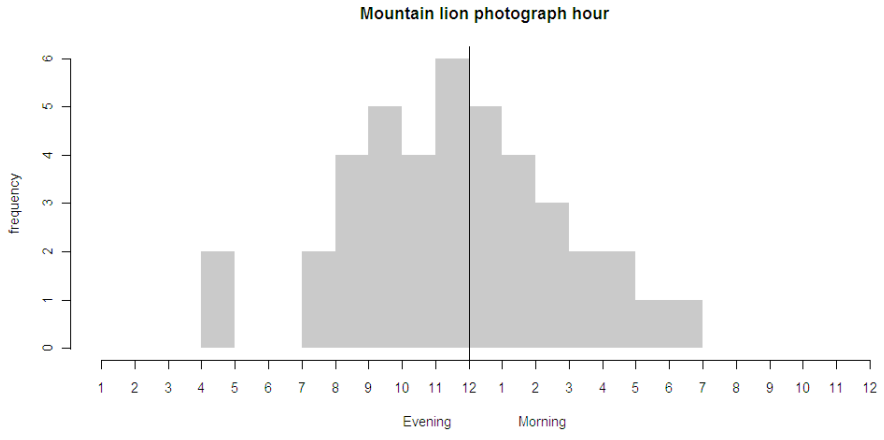

Fig 3. The number of mountain lion photographs broken down by hourly intervals (Pacific Standard Time). The vertical line is midnight.

2. Risk and risk management

2.1 Risk assessment

Risk of human-mountain lion encounters and attack

Despite the common occurrences of mountain lions in the western United States and Canada, human-mountain lion interactions are rare. According to a study conducted in British Columbia (Thompson, 2010), there were three human-mountain lion interactions per 1000 hikers per year. The relatively low number of recorded human-mountain lion interactions may be due to the animal's inclination to retreat from human approach. In a study in which researchers approached mountain lions, 66% of mountain lions left the area, 24% stayed or did not notice the researchers, and 9% made threatening displays when coming within 50 meters of humans. Of the mountain lions making threatening displays, 88% were with cubs (Sweanor et al., 2005).

A review of the literature suggests that a very small percentage of human-mountain lion interactions result in attacks. To understand the risk of an attack at Jasper Ridge, we examined studies conducted in other sites. Beier (1991) examined all attacks from 1890 to 1990 in the United States and Canada and reported nine fatal and 44 non-fatal attacks. However, discrepancies exist among studies. Coss et al. (2009) report 185 attacks from 1890 to 2000 in the U.S. and Canada. In the state of California, there have been 15 verified attacks by mountain lions and six fatalities since 1890 (California Department of Fish and Game, 2007). Considering that an average of about 30 million people resided in California during each of the last three decades when the 12 attacks occurred, we estimate that an individual's probability of being attacked by a mountain lion on a given day is 3.6×10^{-11}. Assuming that 10 people frequent Jasper Ridge each day, the estimated probability of an attack at the preserve is about 1 in 10 million. To put this in perspective, the annual probability of lightning striking someone on Jasper Ridge is 250 times greater than an attack by a mountain lion. These estimates assume that risks of mountain lion attacks are evenly distributed across the state, and that risk at Jasper Ridge is representative of the state as a whole.

In the United States and Canada, most attacks have occurred during the summer months and daytime hours (Beier, 1991). This finding suggests that the attacks reflect patterns of human activity more than those of mountain lions. It is therefore likely that the probability of attack at Jasper Ridge is more strongly correlated with human activity patterns than the abundance and distribution of mountain lions.

Several studies have investigated ways to minimize the risk of attack. Some studies indicate that children are at the greatest risk. Kadesky et al. (1998) reported that 59% of all attacks and 70% of all fatal attacks were on children. By contrast, Coss et al. (2009) found that age and group size had no statistically significant impact on the probability of attack; however, being separated from a group and adopting a crouching stance increased attack probabilities. Typically, lions attack from behind with a bite to the neck (Conrad, 1992). Because 75% of victims did not see the mountain lion before being clawed or bitten (Beier, 1991), there are few opportunities to deter an impending attack. However, multiple studies found that the probabilities of injury from attack decreased when the victims did not remain stationary, fought back, and used pepper spray (Coss et al., 2009; Brown and Conover, 2008).

Perceived risk

The risk of attack by a mountain lion remains very low compared with the perceived risk. For example, 54% of people surveyed in Alberta, Canada, thought that the risk from mountain lions was tolerable, and 43% thought the presence of mountain lions improved their quality of life (Thornton and Quinn, 2009). Therefore, management of the perceived risk associated with mountain lion presence at Jasper Ridge should be included in designing general safety guidelines and educational materials.

2.2 Risk mitigation recommendations

2.2.1 Camera trap monitoring

Confirmation of mountain lion presence at Jasper Ridge presents a challenge for Jasper Ridge staff in managing the information about mountain lion locations, and providing safety training and guidance to users and visitors. The creation of a Wildlife Working Group is strongly recommended to facilitate the implementation of mountain lion safety protocols. In its safety role, the Working Group, consisting of specific members of the JRBP community and Stanford University, would receive the live feed from the cameras and rotate responsibility for processing camera trap data according to procedures they establish. JRBP could consider including non-Stanford-affiliated community members once the operation of the Working Group is streamlined and working well. As the frontline in image processing, the Working Group can also oversee its scientific and media applications (Section 3).

Regular and timely sharing of camera trap information among JRBP staff and regular users will enhance human safety and minimize Stanford's liability. An individual who is aware of the frequency of mountain lion traffic in the preserve is more likely to exercise appropriate caution and less likely to file suit against the preserve or the university since they have been made fully aware of the potential risks. The presentation of images, however, should be framed in a positive-to-neutral manner and on an aggregated time frame, so that the posting of images serves to advise rather than to alarm.

2.2.2 Recommended response protocols for safety and liability

Other organizations have developed protocols for standardizing their response to mountain lion presence and encounters. Several examples are attached in Appendices II, III, and IV, and span the range of possible interactions at JRBP, with the exception of the response to camera trap data. Our research suggests that the passive automated camera trap data should be handled in the same way as other passive signs, such as mountain lion tracks, scat, or kills.

To ensure consistent reporting, each mountain lion interaction can be classified using the following definitions, each of which includes examples of possible associated responses. For each level of interaction, there should be a required action taken and a clear chain of command for carrying out the requisite steps:

Recommended classification of mountain lion–human interactions

A. **Level 0: Camera trap sighting:** A mountain lion recorded by any of the automated camera traps located on JRBP property, with no human contact or human sighting.

   Action:
   a. Notify California Department of Fish and Game, unless advised otherwise by the Dept. of Fish and Game.
   b. Record sighting in JRBP Mountain Lion Database.
   c. Consider processing camera trap data within 30 minutes during working hours in the rare case that a kill or den is captured in an image in close proximity to a trail or road.

B. **Level 1: Casual human sighting:** Any sighting of a mountain lion in which the animal is seen at a distance and/or exhibits non-aggressive behavior.

   Action:
   a. Mountain lion sighting form completed. (See Appendix II for example.)
   b. Notify California Department of Fish and Game (unless they advise otherwise) and JRBP administrative director with attached mountain lion sighting form.
   c. Record in Mountain Lion Database.

C. **Level 2: Bold and/or aggressive sighting**: Any sighting or evidence of a mountain lion in immediate proximity to a picnic area or JRBP building; or a mountain lion that holds its ground in close proximity to a person or otherwise indicates aggressive behavior.

   Action:
   a. Implement Mountain Lion Response List to notify:
      i. Jasper Ridge administrative director.
      ii. California Department of Fish and Game.
   b. Request investigation by California Department of Fish and Game personnel.
   c. Initiate action to notify JRBP staff, researchers and visitors:
      i. Inform all JRBP permit holders.
      ii. Activate emergency text system with location and time of aggressive sighting.
   d. Director may restrict use of part of JRBP until investigation is complete.
   e. Trails and public areas may be evacuated by director to protect staff, researchers, or visitors.
   f. Complete sighting form and incident report consistent with Level 2 sighting. (See Appendix II for example.)

D. **Level 3: Mountain lion attack**: When a human suffers bodily injury or is killed by a mountain lion.

   Action:
   a. Attend to injured.
   b. Request emergency assistance by radio or telephone 911.
   c. Initiate Mountain Lion Incident Response List.
   d. Close and evacuate JRBP.
   e. Protect attack area and document all information and action taken relative to incident.
   f. Inform neighbors and everyone on the notification list.
   g. Complete incident report (See example in Appendix II).

Appendices II, III, and IV provide examples of the classification levels and related actions used in Orange County Parks and the adjoining private reserve, Audubon Starr Ranch. Upon deciding the most appropriate required protocols and actions, JRBP should confer with the university legal counsel. Instituting mandatory protocols removes the burden of "heat-of-the-moment" decision-making from those charged with the duty and will expedite the most prudent actions. These internal protocols will also help limit the liability exposure of JRBP and Stanford University in the unlikely event of an attack.

2.2.3 Develop general safety protocols

The question of whether the detection of mountain lions since September 2009 is a result of the increased presence of mountain lions or improved detection capability is unknown. What is known is that risk of human-mountain lion encounters varies as a function of human activities. Accordingly, guidelines that relate directly to student, docent, and public safety should be created in tiered levels—high, medium, low—corresponding to potential mountain lion abundance and the likelihood of overlap with people. The risk scenarios may be described as follows:

- "High" is associated with increased abundance of mountain lions in the last 10 years and increased probability of mountain lion presence in areas of high human activity at peak times of human activity.
- "Medium" is associated with no change in abundance and high probability of presence in areas of high human activity at peak times of human activity.
- "Low" is associated with no change in abundance and low probability of presence in areas of human activity at peak times of human activity.

Note that these risk scenarios are related but not equivalent to sightings such that the response protocols described above in Section 2.2.2 can be activated independently of general safety guidelines.

The following recommendations are put forth with the understanding that the risk associated with mountain lions is a function of (1) the abundance of mountain lions on the preserve; (2) the probability of a human–mountain lion encounter; and (3) the harm associated with an encounter. Because improved information will affect the estimate of risk, the protocols leave room for individual judgment, as a single set of protocols may be too stringent in the low-risk scenario and/or insufficiently cautious in a high-risk one.

2.2.3.1 Recommendations: All JRBP users (staff, researchers, students, docents, and visitors)

1. Revise JRBP's standard liability waiver form, which must be signed by all non-Stanford users, to specifically mention mountain lion presence. Develop statement in conjunction with Stanford legal counsel.
2. Distribute timely (e.g., weekly) digest email that includes information on the number of lions recorded by camera traps or reported by people, with a link to the secure website for Jasper Ridge community members only, where the time, date, and location of each record is displayed on the map of JRBP (See Appendix V, for example).

3. Provide informational pamphlets that summarize how to recognize signs of mountain lions, including tips for correctly identifying them (See, for example, the pamphlet created by the Oregon Department of Fish and Wildlife, Appendix VI).
4. Along perimeter fencing, post signs indicating: private property; no trespassing; mountain lion habitat. Develop wording with help from Stanford legal counsel.

2.2.3.2 Recommendations: Staff and researchers affiliated with JRBP

1. Within JRBP establish a chain of command for who will decide when to implement higher risk measures, such as restricting research areas, closing trails, moving kills, and requiring more stringent safety measures.
2. Develop JRBP field protocols for appropriate mountain lion safety, including strongly recommending traveling in groups of two or more when working at dusk, nighttime, or dawn (See, for example, Orange County Internal Protocols, Appendix II).
3. Institute policy and procedures whereby all camera trap sightings, personal sightings, and confirmed tracks and kills are recorded on a worksheet on the website, and a map of the sighting is generated.
4. Incorporate a unit on mountain lions into docent training that includes mountain lion identification, recognizing scat, tracking other mountain lion signs, and behaving appropriately in mountain lion country.
5. Incorporate mountain lion behavior into trail planning, modification, and maintenance. Mountain lions seek adequate vegetative cover when hunting, traveling, and breeding. JRBP personnel should take these facts into consideration when opening or modifying existing trails. Edge cover types are particularly important while hunting, and dense cover provided by chaparral, woodland, and chaparral-woodland edge may be important for breeding.
6. Develop a policy on prey caches of mountain lions that are close to trails or human activities. Mountain lion prey caches are often within 300 m of trails (Sweanor et al., 2004). If a mountain lion cache is observed in close proximity to a human activity area (< 100 m) and the cache consists of wild, acceptable prey (e.g. deer), the prey should be dragged a distance away from the activity area (100 – 300 m). The area could also be closed to human access so that the mountain lion can return to feed with a reduced chance of a human encounter. If the prey is completely removed, the mountain lion will be forced to hunt and kill another animal.

As additional references, the Internal Protocols and Mountain Lion Report for Orange County appear in Appendix II.

2.2.4 Risk mitigation beyond the Jasper Ridge Biological Preserve

Although there is very little legal risk to JRBP from an attack or incident from beyond the preserve's borders, the following measures are recommended:

1. Post on the public website periodic digests of all mountain lion sightings (without location or time, or date), along with educational materials.

2. Consider broader community engagement with immediate neighbors by distributing informational brochures for safe practices and contributing information to local newspapers and magazines to decrease the chance of a mountain lion attack. This approach would serve JRBP's greater educational, outreach, and conservation mission.

3. Refer local police departments (e.g., Stanford and Woodside) to best practices, best contact information for California Department of Fish and Game, and nonlethal options when dealing with mountain lions in communities bordering JRBP.

3. Opportunities for research, education, and conservation

3.1 Research opportunities

Relatively confined borders, status as a biological reserve, location within the territory of one or more mountain lions (or its function as a habitat corridor), and close proximity to inhabited areas all define Jasper Ridge. Together, these attributes make Jasper Ridge well positioned in terms of opportunities for research and communication, especially in the context of biological corridors and lands where suburban and wildlife communities intersect.

3.1.1 Immediate use of mountain lion camera trap data

The analysis of currently available images and the collection and integration of supporting data present ample opportunities for traditional research by Stanford students and faculty, as well as participatory research by members of the greater JRBP community. In line with JRBP's mission to monitor the urban/wildlife interface and to engage surrounding landowners in preserving local biodiversity, prudent sharing of camera trap data with the greater public should stimulate respect and support for the conservation of mountain lion habitat. Two main areas identified for immediate scientific investigation are: (1) determining mountain lion abundance, and (2) mapping mountain lion movement through JBRP. Work in this realm will help to determine the level of risk strategy to adopt and lay the foundation for future scientific inquiries.

Incidence and abundance of wildlife at Jasper Ridge Biological Preserve

Frequent sightings of mountain lions and deer kills have been reported in recent months in areas adjoining the Jasper Ridge Preserve. Mountain lions have also been noted at Webb Ranch and the Dish foothills, with many sightings occurring near the San Francisquito, Matadero, and Los Trancos creeks (personal communication Alan Launer, Stanford biologist). Although the camera traps confirm the presence of mountain lions in the preserve, questions remain as to their abundance and residence time.

Three factors may contribute to the images gained in the past year: low-impact, "stealth" camera technology; advantageous positioning of cameras along trails, road junctions and previous kill sites; and increased mountain lion presence. A series of camera substitution and placement studies will help assess the increase in camera trap sightings of mountain lions—whether it is the result of increased mountain lion presence or higher detection due to camera sensitivity or location. In conjunction with new efforts aimed at supplying supporting data (such as tracks or kills), information of incidence gained from the camera trap images may be scaled to provide estimates of mountain lion numbers on the preserve.

Mountain lion movement

The location of JRBP at the boundary of the northern edge of the Santa Cruz Mountains and a dense metropolitan area, coupled with the physical geography of the San Francisquito Creek Watershed, could make Jasper Ridge an important place to monitor the status of the regional mountain lion population. Within the San Francisco Bay Area, the Santa Cruz Mountains remain a critical region for the survival of

mountain lions, a species highly sensitive to habitat fragmentation and fragment isolation (Crooks 2002). Encompassing 1316 km^2, the Santa Cruz Mountains are below the estimated cutoff area for viable mountain lion populations (Beier 1993) and also run a high risk of isolation due to development in Santa Clara County (Thorne et al. 2006).

Within the preserve, the highest count of camera trappings occurred on roads near a riparian corridor (see camera B-6, Fig. 4), suggesting preference for riparian vegetation for diurnal locations and nocturnal travel (Dickinson and Beier 2007), and roads for general dispersal (Beier 1995). Not only is Jasper Ridge an outcropping of favorable habitat, but the drainage of many mountain creeks into Searsville Lake and the passage provided by San Francisquito Creek to and from San Francisco Bay may also constitute a significant travel route for regional mountain lions. Expansion and repositioning of the wireless, digital camera trap systems within JRBP and in neighboring areas will afford better understanding of the movement of mountain lions into, out of, and within the preserve.

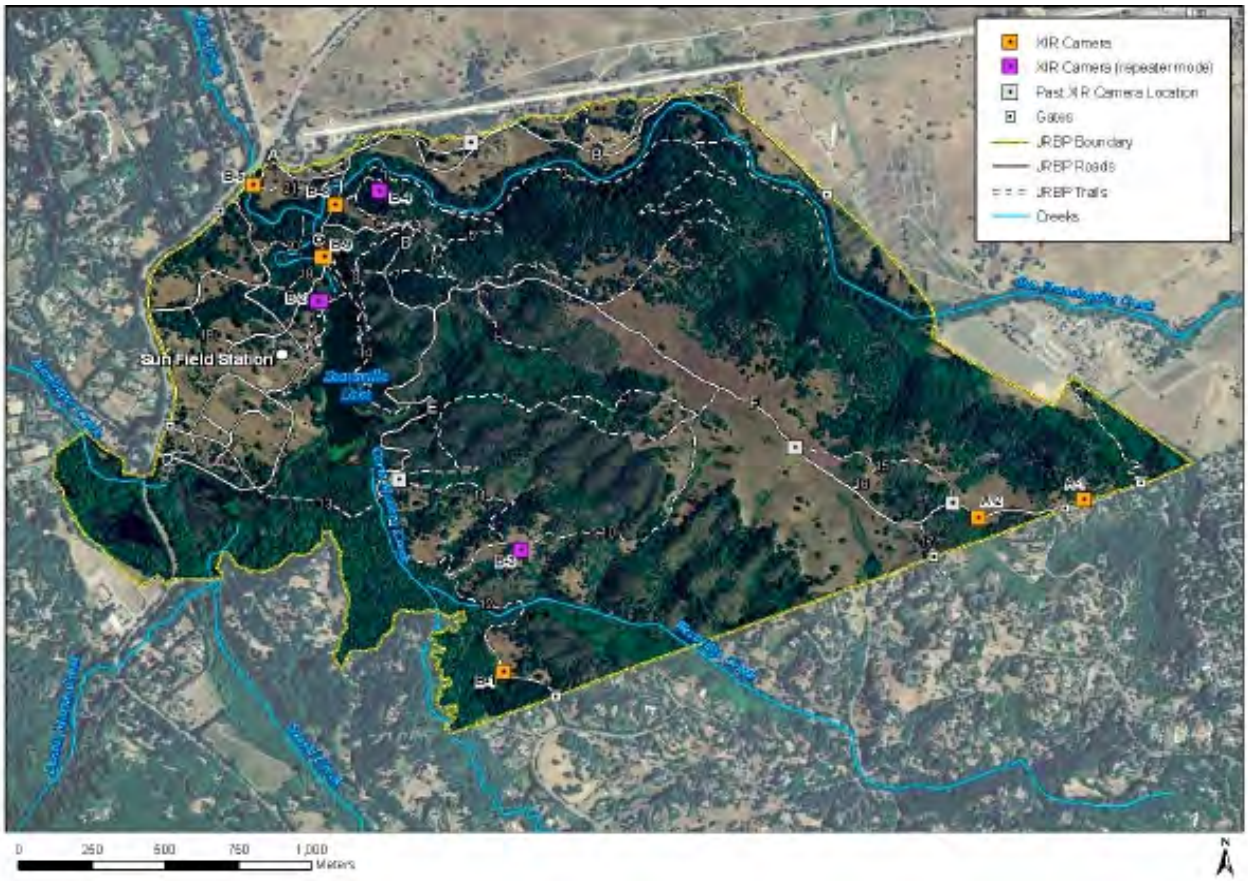

Fig 4. The configuration of camera traps in Jasper Ridge in September 2010. Five creeks originating in the Santa Cruz Mountains and foothills drain into Searsville Lake, while San Francisquito Creek provides passage to and return from San Francisco Bay. Image supplied by Trevor Hebert.

3.1.2 Recommended areas for immediate research

The following present ready research opportunities given currently funded camera resources and can be used to formulate more detailed management recommendations and/or lay a scientific foundation for future investigations. The results of this research will also aid in long-term preservation of mountain lion populations and provide information to prevent or mitigate future mountain lion–human conflicts:

1. Activate old cameras in new places and new cameras in former positions to determine the impact of new technology on increased image capture.
2. Deploy cameras in varying schemes (stratified or random) to assess preferential paths or vegetation cover.
3. Analyze images for relative animal size or identifying features to determine whether images represent the same or different individuals. Deploying pairs or sets of cameras at multiple angles will improve the ability to identify individual mountain lions in the images.
4. Identify diel activity patterns in relation to people and prey animals.
5. Determine whether there is temporal separation between mountain lions and human activity.
6. Determine whether physical separation between mountain lions and human activity areas varies by day, crepuscular, or night periods.
7. Monitor JRBP and surrounding areas for signs of mountain lion presence (scat, kills).

3.1.3 Future research opportunities

With additional funding support and collaborations/resources, more complex investigations of mountain lion ecology could be undertaken in the preserve. The following introduces methods that could be used for population monitoring and specific research questions that would exploit the unique conditions of Jasper Ridge:

Camera trapping

Aside from the expansion and repositioning of the BuckEye XIR camera trap systems (see above), a range of camera-based research opportunities related to mountain lions at Jasper Ridge are possible. First is the utilization of “near infra-red” cameras and flashes, which are visible to humans as a faint red glow. This system provides additional illumination and clearer pictures relative to invisible infrared units, and has the potential to improve our ability to identify individual mountain lions without resorting to visible flash photography or other more resource-intensive approaches.

Visible flash photography is still the standard in wildlife ecology (Cutler and Swann 1999, Rowcliffe and Carbone 2008), and, with the currently available technology, is more likely to provide images that will allow for individual identification of mountain lions. However, the general impact of visible flash on mountain lions and nocturnal wildlife is not well understood (Kays and Slauson 2008) and must be considered in the context of the broader research and conservation goals at Jasper Ridge. The tradeoff between infra-red and visible flash images may be minimized by thoughtful and unbiased camera

placement, which may provide reasonably precise estimates of mountain lion populations without the need for recognition of individuals (Karanth et al. 2004, Rowcliffe et al. 2008).

For camera-based research, there is potential to collaborate with the De Anza College Wildlife Corridor Project (http://www.deanza.edu/es/wildlifecorrproj/). This group has used field-based surveys and remote cameras to research the importance of corridors for wildlife—including mountain lions—in the Coyote Valley and Santa Cruz Mountains, and confers a Wildlife Corridor Technician Certificate of Achievement as part of its associates degree program in wildlife management.

Collaring

Genetic and radio-collar methods have the potential to identify individuals and provide estimates of the population size of mountain lions utilizing Jasper Ridge. In addition, these approaches are more likely to provide data that will support the greater mountain lion research and conservation efforts within the region. Noninvasive sampling and genetic analysis of scat can identify individual mountain lions, estimate population sizes, separate individuals that feed regularly in Jasper Ridge from those that use it as a transient habitat (by identifying individuals more likely associated with kills), and help assess the genetic structure of lion populations over larger scales (Ernest et al. 2000, Ernest et al. 2002, Schwartz and Monfort 2008). Radio collars provide sub-daily telemetry data on individual mountain lions, their utilization of space, and habitat preferences across a large and continuous landscape. This is a distinct advantage over the aforementioned methods, which provide a "snapshot" measure of habitat occupancy and are limited by the placement of instruments or location of scat. In addition, collars provide a marker to distinguish individuals in photo traps.

Although radio collars will likely provide the best information on the utilization of Jasper Ridge by mountain lions (either as a home territory or a corridor in the context of the larger landscape), the technique is the most demanding in terms of resources. Because Stanford University is not equipped to undertake this approach, collaboration with existing programs–such as the Bay Area Puma Project (http://bapp.org/) and Chris Wilmers at the University of California, Santa Cruz (http://people.ucsc.edu/~cwilmers/)–is advised. Even with a collaborative effort, it is unclear how many collars could be reasonably fitted, which could limit the effectiveness of this approach.

Exploiting Jasper Ridge to explore top-down effects

The cascading effects of mountain lions are well known, including the size of deer populations, extent of plant communities and the presence and population size of amphibians and insects (Fig 5). Riparian areas, such as those found at Jasper Ridge, may be especially sensitive to changes in the strengths of these cascades. Moreover, in riparian ecosystems, cascading effects commonly extend beyond the biotic into the abiotic environment, including changes in erosion and hydrology (Ripple et al. 2010). Jasper Ridge's ongoing history of research in ecosystem responses to environmental and ecological changes, along with its reserve status and size, provides a unique opportunity to understand these top-down effects.

Preliminary work in this area is already being conducted by Professor Rodolfo Dirzo and his collaborators. In a pilot study, they have shown that caging, which simulates the removal of herbivores, has an effect on the performance of *Quercus lobata* (valley oak) after one year (Fig. 6, Dirzo and Guevara, personal communication). This result implies that cascading effects on plant survival resulting from top-down control of herbivores, primarily deer, by mountain lions may be an important driver of ecosystem structure at Jasper Ridge. In addition, this work could be extended to include comparable sites inside and outside of Jasper Ridge with varying degrees of conservation and/or abundance of mountain lions. This work would, ideally, be done in collaboration with other groups, such as the Bay Area Puma Project. Every effort should be made to leverage movement, habitat utilization, and resource-usage data on mountain lions with parallel studies investigating their cascading biotic and abiotic effects in the context of other forces shaping the ecosystems within the reserve.

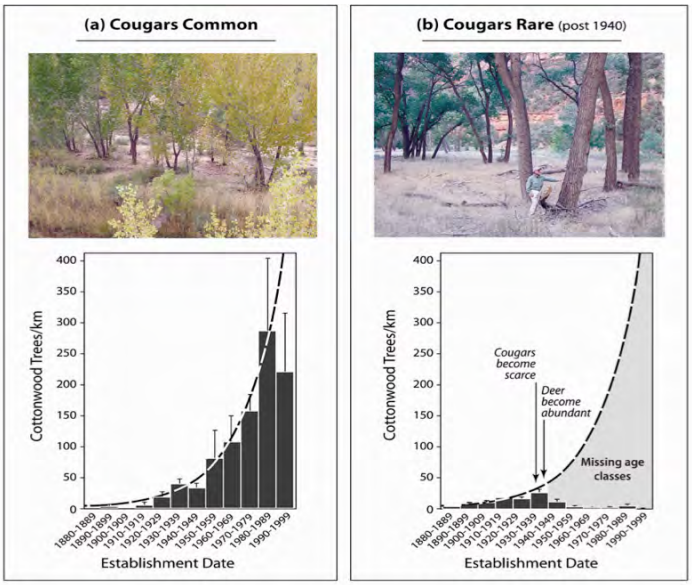

Fig. 5 (Fig. 4, Ripple et al. 2010). Photographs of cottonwoods (above) and corresponding cottonwood age structure (below) for riparian areas in Zion National Park: North Creek where cougars were common (control) (a), and Zion Canyon where they were rare (treatment) (b). The exponential function (dashed line) for tree recruitment cohorts in the control reaches (a) was also plotted in (b) for comparison after cougar became scarce. "Missing age classes" in (b) indicate the difference between expected (exponential function) and observed tree frequencies (bars) post-1930s when cougar were scarce. Error bars represent standard error of the means.

3.1.4 Recommendations for future research

1. Explore the usage of "near-infrared" cameras as a means to improve identification of individual lions.

2. Consider unbiased camera placement as a means to estimate the population size of mountain lions at Jasper Ridge.

3. Support radio collaring of mountain lions at Jasper Ridge through collaboration with existing research programs.

4. Support collection, identification, and genetic analysis of mountain lion scat.

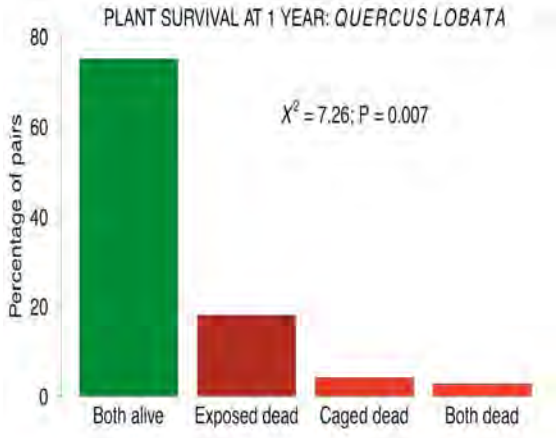

Fig. 6 Performance of *Quercus lobata* after one year in paired "caged" vs. "exposed" treatments

5. Support experimental and observational research addressing the cascading effects of mountain lions, including effects on herbivory and food web structure, on the Jasper Ridge ecosystem, particularly in riparian corridors.

3.2 Education and outreach opportunities

The presence of mountain lions in Jasper Ridge provides several opportunities for proactive education and communication with the Stanford and greater area communities. First, because of the growing database of captured images, Jasper Ridge will inevitably be associated with mountain lion presence and should be prepared to communicate general knowledge on mountain lion ecology and safety to the public. Second, JRBP's standing as a highly reputable center of scientific research puts it in a position to direct interested parties to reliable information sources. Lastly, the preserve's existing ties to the greater community provide avenues for participatory science in mountain lion research. The following describe recommended courses of action in the areas of media, education, and participatory science that integrate elements of a mountain lion management and research plan at Jasper Ridge:

3.2.1 Media recommendations

The body of images collected by the wireless digital cameras can and should be shared with the intent to inform, mitigate fear, elicit interest, and educate. While the sharing of images has been addressed in terms of safety protocols (Section 2), the "invisible" technology required to capture images of mountain lions should be emphasized as well. The surreptitious technology needed to acquire mountain lion images should be underscored to illustrate their innate elusiveness. Not only may this help balance the fear that might arise when the images are made public, it may also reinforce the non-confrontational behavior of typical mountain lions.

As "charismatic mega-fauna," mountain lions can serve as an icon for communicating to the public on the interface of suburban and wildlife communities, and on the importance of biological corridors within this landscape. Interactive web-based outreach utilizing photos and video from the camera traps is a potentially powerful tool for communicating these concepts and has been used successfully by a wide range of conservation and research groups. This type of effort is not trivial. Beyond the technical aspects of resourcing the appropriate software and the initial design and development of the layout, the long-term maintenance and updating of the content must be accounted for. Therefore, we highly recommend resources be directed toward both the development of such a website and its maintenance. Geoff McGhee, Creative Director of Media and Communications at the Bill Lane Center for the American West, has expressed interest in helping conceptualize and develop the proposed web presence (See Appendix VII).

When developing media, three main audiences should be recognized: (1) Stanford students, researchers, and Jasper Ridge staff; (2) resident neighbors of Jasper Ridge; and (3) the greater public. Print media can be directed to outlets that target such audiences. Collaboration with the environmental journalism programs at Stanford University and the University of California, Santa Cruz, can assist in generating articles on mountain lion presence and future research at Jasper Ridge, as well as extending the educational component.

We recommend the following strategies:

1. Revise the JBRP page on mountain lions to highlight the rarity of the image capture in contrast to portrait-style images typical of National Geographic publications. The site can provide links to other sites about mountain lion behavior and research (e.g., Bay Area Puma Project), JRBP safety protocols, and guidelines set forth by the U.S. Fish and Wildlife Service. Showcase images as a means to access the preserve visually without human presence and associated impact.

2. Display infographics about mountain lion images aggregated over weekly, monthly, or longer intervals.

3. Design interactive activities, such as "Test your Mountain Lion IQ," to dispel basic myths about mountain lion abundance, density, and innate aggression.

4. Solicit the Environmental Journalism Program at Stanford and U.C. Santa Cruz to write articles of interest on mountain lions for local newspapers and news websites.

5. Create an educational brochure or media fact sheet that includes information on mountain lion biology and behavior, as well as how respond to a human–mountain lion interactions.

3.2.2 Recommendations for educational purposes

Courses

The Jasper Ridge docent training (Biology 105 A/B) and the experimental laboratory for ecology (Biology 44Y) classes provide further opportunities to educate Stanford and greater area communities on mountain lion ecology in formal and informal settings. Incorporating the ecology of mountain lions and their role in the Jasper Ridge ecosystem into the docent training will have the added benefit of raising community awareness through outreach efforts that include tours and field classes. Biology 44Y can be adapted to educate Stanford biology majors, who will ultimately serve as conduits of knowledge on mountain lion ecology to their individual communities. Linkages between the Biology 44Y curriculum and research on mountain lion effects on Jasper Ridge ecosystems can be readily established. In addition, the docent community could conduct biological surveys and assist in the collection of evidence of the presence of mountain lions (identifying tracks or kills or collecting scat), similar to the way they support bird and bat research at the reserve.

3.2.3 Outreach recommendations

Participatory science

JRBP's mission emphasizes science education that is grounded in field study. The inclusion of mountain lion research into its scientific program can integrate conservation with JRBP's research and education missions. The preserve already hosts various educational programs featuring Stanford and non-Stanford students, neighboring K-12 schools, and outreach programs. Through its coordinating council, Jasper Ridge also engages regularly with local land management agencies, local governments, fire districts, water agencies, and open space groups. Given this extensive and diverse audience, opportunities exist for incorporating participatory approaches into mountain lion research.

Participatory science may be a two-pronged strategy for building a regional database of mountain lion activity and promoting positive public participation in local wildlife conservation. Participation in data collection and monitoring by students, docents, visitors, and neighboring residents may provide channels of engagement that foster a sense of control over one's surroundings. The Woodside Backyard Habitat Program (Appendix VIII) may serve as an initial model on which to design modes for visitor and citizen information collection.

Recently, Jasper Ridge was awarded an NSF grant to fund new infrastructure to support its revised mission of monitoring the urban and wildlands boundary. Engagement with surrounding landowners and the local community in preserving local biodiversity features prominently in this directive. As part of the award, at least two wireless cameras plus sensors are dedicated for student-initiated activities. The extension of camera trapping within and outside of Jasper Ridge's boundaries is an easy first step toward meeting the goals of the redefined mission, while establishing a baseline of mountain lion presence and movement in the area.

In brief, the recommendations for education and outreach surrounding mountain lions at Jasper Ridge are the following:

1. Incorporate mountain lion ecology in docent and experimental laboratory for ecology classes. Explore using the classes and the docent community to support mountain lion-related research at Jasper Ridge.

2. Develop avenues to engage the greater community in the research on mountain lions in the region, such as camera trapping and sign monitoring beyond the preserve's boundaries.

3. Support the development and maintenance of an interactive web presence focused on the interface of suburban and wildlife communities and the importance of biological corridors within this landscape, featuring the range of species that inhabit/occupy Jasper Ridge. This page can also be designed to accommodate interactive citizen science activity to register mountain lion signs.

4. Use the newly created Jasper Ridge Speakers Bureau (defined within NSF grant) to connect JRBP researchers with community groups, with particular emphasis on how efforts at JRBP relate to urban/wildland issues.

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Appendix I: Jasper Ridge Mountain Lion Workshop, September 2010

Jasper Ridge Mountain Lion Workshop
September 7-8, 2010, Jasper Ridge Biological Preserve

Background

Since September 2009, camera traps at Jasper Ridge Biological Preserve (JRBP), five miles from the main Stanford University campus, have recorded mountain lion presence at nearly all corners of the preserve as well as some interior locations. As of August 2010, the number of mountain lion photos totaled three dozen. Most of the photos were taken at night, but a few were taken during morning and afternoon hours when people are likely to be on trails. One very active camera-trap site in terms of mountain lions is a trail junction a quarter mile from the Sun Field Station, an area that is heavily used by researchers, students, and docent-led tours.

For years, the presence of mountain lions has been suggested by occasional deer kills, but the recent camera-trap data were unexpected. A first-generation camera-trap study operated 12 camera stations from February 2006 until September 2008 and recorded over 15,000 photos of animals, including bobcats, coyotes, and gray foxes, but not a single mountain lion. The current camera-trap project differs in that its cameras are probably less detectible by animals. The cameras use an infrared flash and camera at night, rather than a visible flash; they are installed with less habitat disturbance; and they have less human scent because they operate for long periods without servicing, sending photos by wireless network. Another difference, however, is that the current camera traps are on trails and dirt roads rather than undisturbed habitats, which suggests that JRBP user activity is not deterring mountain lions. Given the differences between the two studies in camera technology and placement, it is not possible to determine whether the recent camera-trap data reflect an increase in mountain lion abundance or an increase in detection.

In June 2010, the Jasper Ridge advisory committee reviewed the mountain lion data. The presence of mountain lions was welcomed as an index of ecosystem health and habitat connectivity. At the same time, questions were raised regarding safety issues, such as whether field research carries special risks because researchers often work alone, off-trail, crouching down for long periods, and/or closely focused on their study subject. Mountain lion presence was also discussed in the context of JRBP's growing focus on managing the suburban/wildland interface through research and outreach on biological corridors.

In addition to suggesting some specific changes in JRBP's "field safety" website, the advisory committee recommended a review of Jasper Ridge policies. Some key issues are:

1. How should the risks from mountain lion presence be evaluated, managed, and conveyed to Jasper Ridge users?
2. How should the camera trap data on mountain lions be used and shared—and on what time frame—for scientific, educational, or management purposes, especially regarding biological corridors that traverse JRBP?
3. Are there unique opportunities for Jasper Ridge to contribute to research and communication on mountain lion ecology in ways that are consistent with Stanford's research policies?

To address these questions the Woods Institute for the Environment and Jasper Ridge are convening this mountain lion workshop. The participants of the workshop are members of the Rising Environmental Leaders Network (RELN) formed by the Woods Institute. The RELN members have been asked to approach the issue of mountain lions at Jasper Ridge from a multidisciplinary perspective based on interviews with experts in the areas of mountain lion ecology, risk assessment, graphic communication, institutional liability, university policy on research on wild animals, and regional conservation and coordination. Professors Nicole Ardoin and Christopher Field will outline the goals of the workshop during lunch on Tuesday, Sept 7, following a training session for the RELN members (outlined in a separate document).

The expert interviews will take place at Jasper Ridge on Tuesday afternoon and Wednesday morning. RELN members will present their preliminary findings on September 22, and make final recommendations to the Jasper Ridge advisory committee in the fall.

Tuesday afternoon, September 7

Overview of goals, noon – 1pm (during lunch)

Nicole Ardoin, Assistant Professor, School of Education and the Woods Institute for the Environment. An authority on motivations for environmental behavior as influenced by sense of place and geographic scale. (http://ed.stanford.edu/faculty/nmardoin). Nicole will discuss the RELN workshop's role as consultant to the Jasper Ridge advisory committee.

Christopher Field, Faculty Director of Jasper Ridge, and Director of the Dept of Global Ecology, Carnegie Institution. (http://dge.stanford.edu/labs/fieldlab/CHRIS/CHRIS.HTML). Chris will present the challenge to the workshop on behalf of the Jasper Ridge advisory committee.

Expert interviews, 1 - 4:30pm

Trevor Hébert, GIS and Data Analyst, Jasper Ridge. Installed, configured, and operates current camera traps. (http://jrbp.stanford.edu/db/projects/project_display.php?project_id=93). Camera trapping at JRBP—capabilities, results to date, and data management.

Zara McDonald, Founder and Executive Director, Felidae Conservation Fund (http://www.felidaefund.org/about_us/) which supports the Bay Area Puma Project and other Felid conservation studies (http://www.felidaefund.org/research/bapp.html). Mountain lion biology, conservation, and research needs.

Winston Vickers, Wildlife veterinarian and Co-investigator, Southern California Puma Project, Wildlife Health Center of UC-Davis. Running a mountain lion research program.

Patrick Dunkley, Senior University Counsel, Stanford. Specializes in matters related to business law. (http://www.stanford.edu/dept/legal/about/bios/dunkley.html). Stanford perspective on liability issues.

Stephen Felt, Assistant Professor of Comparative Medicine and Associate Director of the Veterinary Service Center, which oversees research on animals in conjunction with the Administrative Panel on Laboratory Animal Care (http://med.stanford.edu/profiles/compmed/researcher/Stephen_Felt/). Institutional policies and procedures relevant to mountain lion research (will interview with Sherril Green).

Sherril Green, Professor and Chair of the Department of Comparative Medicine, Director of Veterinary Service Center (http://med.stanford.edu/profiles/compmed/researcher/Sherril_Green/). Institutional policies and procedures relevant to mountain lion research (will interview with Steve Felt).

~ 4:30 - 5pm

As time permits, a panel discussion with experts, or the RELN members can use this time to review interviews.

Wednesday, September 8

Recap, 8:30 - 9am (during continental breakfast)

Expert interviews, 9am - noon

Mike Mastrandrea, Assistant Consulting Professor at the Woods Institute, Stanford. Climate vulnerability, impacts assessment, risk management. (http://www.stanford.edu/~mikemas/index.htm). Evaluating and communicating risk.

Geoff McGhee, Creative Director of Media and Communications, Bill Lane Center for the American West, Stanford. Communication via maps, narratives and interactive data visualization. (http://knight.stanford.edu/fellows/2010/mcghee/). Maps, media, and outreach.

Rodolfo Dirzo, Professor of Biology and Director of the Center for Latin American Studies, Stanford. An authority on tropical ecology, defaunation (loss of large mammals), biodiversity. (http://www.stanford.edu/group/dirzolab/dirzo.html). Current and prospective JRBP research that is relevant to mountain lion presence, networking across camera-trap studies.—*phone interview if possible*

Lunch, noon – 1pm

RELN group meets to review interviews and next steps, 1 – 5pm

Workshop participants (all are members of the Rising Environmental Leaders Network)

Kimberly Epps (Kye), Postdoctoral Research Associate, Dept of Environmental Earth System Science. Terrestrial biogeochemistry, biodiversity and ecosystem function, sustainable agricultural systems. (http://pangaea.stanford.edu/~kepps/Kye/Home.html).

Steve Litvin, Postdoctoral Research Associate, Hopkins Marine Station. Ecological interactions, marine protected areas, aquatic food webs. (http://micheli.stanford.edu/SteveLitvin.html).

Scott Loarie, Postdoctoral Fellow, Dept of Global Ecology, Carnegie Institution. Biodiversity and species movements under changing landscapes and climate. (http://www.stanford.edu/~loarie/).

Michael Papenfus, Economist, Natural Capital Project. Economic valuation of ecosystem services. (http://www.naturalcapitalproject.org/people.html#Papenfus).

Lena Perkins, Doctoral candidate, Mechanical Engineering and Global Ecology. Carbon sequestration through Biochar; "exergy" efficiency. (http://www.stanford.edu/~lendog/).

Organizers, orientation leaders, staff members

Nona Chiariello, Staff Scientist, Jasper Ridge. Liaison to the Jasper Ridge advisory committee for the mountain lion workshop.

Philippe Cohen, Administrative Director, Jasper Ridge.

Nicole Holthuis, Education Specialist and Consultant, science education and interdisciplinary research. Leader of training and orientation for RELN members.

Margaret Krebs, Program Manager, Leopold Leadership Program, Woods Institute for the Environment. (http://leopoldleadership.stanford.edu/about/about/staff)

Pam Sturner, Managing Director, Leopold Leadership Program, Woods Institute for the Environment. (http://leopoldleadership.stanford.edu/about/about/staff)

Appendix II: Orange County Parks Internal Protocols & Report Sheet

RESOURCES & DEVELOPMENT MANAGEMENT DEPARTMENT
POLICIES AND PROCEDURES

No. 7.3.401

TITLE: Mountain Lion Sighting Guideline

Effective: October 14, 2005

I. PURPOSE

To establish a procedure for investigating and reporting Mountain Lion sightings and incidents within Resources & Development Management Department (RDMD)/Harbors, Beaches and Parks (HBP) facilities.

II. REFERENCES

The following underlined reference is hyperlinked:

A. P&P 7.3.402 - Mountain Lion Incident, Level 2 & 3 Sightings

III. DEFINITIONS

N/A

IV. POLICY

All incidents involving mountain lions will be evaluated by the on-duty ranger-in-charge to ascertain the appropriate actions required. All park rangers and other park employees shall use sound judgment based on the scope of their training, authority and experience while exercising due regard for their personal safety and the safety of staff and visitors at all times.

V. PROCEDURE

A. Level 1: Casual Sighting

1. Any sighting of mountain lions in which the animal is seen at a distance and/or exhibits non-aggressive behavior.

2. Action

a. Park Ranger or park employees complete a Mountain Lion Sighting Report.

b. Information recorded in the Mountain Lion Sighting Report is based upon personal observation of the park ranger or other park employee or is based upon interview with a park visitor reporting said sighting.

c. Park rangers and other park employees as assigned investigate mountain lion sightings.

d. Park rangers and other park employees shall use sound judgment based on the scope of their training, authority and experience while exercising due regard for their personal safety and the safety of staff and visitors at all times.

e. Route sighting form to all of the following:

1) Parks District Supervisor

2) HBP Superintendent

3) O.C. Animal Control

4) California Department of Fish and Game

5) Resource Management Specialist -

6) CEO Risk Management

B. Level 2: Bold and/or Aggressive Sighting

1. Any sighting or evidence of a mountain lion within or in immediate proximity to a campground, picnic area, or similar recreation area; or holds its ground in close proximity to visitors or staff anywhere within the park; or otherwise indicated aggressive behavior.

2. Action

a. Implement Mountain Lion Response List to notify:

1) Ranger-in-charge

2) District Supervisor

3) HBP Superintendent

4) HBP Director

5) RDMD Director

6) Resource Management Specialist -

7) CEO Risk Management

8) O.C. Animal Control

9) California Department of Fish and Game

b. Request an investigation of sighting by O.C. Animal Control and California Fish and Game personnel.

c. Initiate action to notify park visitors:

1) Inform campers and day-use visitors

2) Inform entering park visitors of sighting(s)

3) Post signs stating "Recent Mountain Lion Sighting in This Area

d. The ranger-in-charge or other park employee as directed may restrict visitors from all or portions of park until investigation is complete

e. The ranger-in-charge or other park employee as directed shall close and evacuate a picnic area, campground, trail or wilderness area when it is determined that possible public danger exists due to mountain lion activity.

f. Closed areas must be temporarily posted (*"Closed Area OCCO 2-5-46"*) and all entering visitors must be informed of the closure.

g. The ranger-in-charge or other park employee as directed closing a park or portion thereof shall verbally notify immediate supervisor of closure as soon as practicable and prepare an incident report of action taken.

h. Complete sighting form and Incident Report and route same as Level 2 sighting.

3. Follow-Up

a. Pending information from investigation by Animal Control and/or California Department of Fish and Game, RDMD/HBP management staff will decide on park operational status.

C. Level 3: Lion Attack

1. A mountain lion attacks a visitor, neighbor, or park staff member.

2. Action

a. Attend to injured

b. Request emergency assistance by radio (Control One) or telephone (911)

c. Initiate Mountain Lion Incident Response List

d. When supervisor is contacted and informed, he/she will instruct employee to continue or discontinue calling from call-out list of contacts

e. Close and evacuate park

f. If necessary, request Sheriff's helicopter to aid in evacuating park trails

g. Protect attack area and document all information and action taken relative to incident

h. See notification list; inform "neighbors" of incident

i. Inform park visitors (campers only) to retain their receipts for refunds at a later date

j. Complete and route incident report per level 3 status

VI. ATTACHMENTS

A. Mountain Lion Sighting Report

4) Orange County Fire Authority

5) Orange County Communications/Mobile Command Vehicle

6) Orange County Red Cross/Mobile Supply Unit

B. Agency Responsibilities

1. RDMD/HBP

a. Ranger-in-charge is responsible for

1) All park operations

2) Initial organization of response team activities

3) Park and trail evacuation and/or closure

4) All matters involving park rules, regulations, and operations

b. Parks District Supervisor

1) Serves as the agency representative under the incident command system (ICS) for all park operations matters.

c. RDMD Public Information Officer

1) Serves as the primary public information officer (PIO) for all major mountain lion incidents in a park or recreational area owned, operated, or managed by the County.

c. RDMD/HBP PIO

1) Assist the RDMD PIO and acts as primary PIO in his/her absence

2. California State Fish and Game (CDFG)

a. CDFG is responsible for all investigations pertaining to:

1) Mountain lion incidents

2) Clearances of removal and depredation permits

3) Notification of hunter and dog teams

4) Organizing capture teams and actual hunt, chemical darting of animal, safe transportation of animal, and

5) All matters involving State codes relating to mountain lions.

3. Orange County Animal Control (OCAC)

a. OCAC serves as a back-up or support to CDFG personnel for major incidents involving mountain lions within a regional park.

b. May be the lead animal regulatory agency for minor incidents involving mountain lions within a County park or recreational area.

c. Shall be included in all meetings, reports and investigations involving mountain lion incidents within Orange County regional parks.

4. Orange County Sheriff/Search and Rescue (OCS) assist with:

a. Park/trail evacuation and/or closure

b. Search and rescue teams

c. Enforcement of applicable codes and ordinances, unless otherwise proscribed

5. Orange County Fire Authority (OCFA)

a. Responsible for treatment and transportation of all injured park visitors

b. This responsibility may be assumed by another municipal fire/rescues agency as appropriate to the location of the park or recreational area.

6. Orange County Communications/Mobile Command Vehicle (OCC)

a. In charge of the mobile command vehicle

b. Assist with set-up for command center

7. Orange County Red Cross/Mobile Supply Vehicle

a. May be requested to staff a mobile supply vehicle and to provide support services (i.e., food drinks, etc.) for capture team and other incident personnel.

C. Mountain Lion Monitoring Program

1. All RDMD/HBP employees will be trained in basic mountain lion tracking and proper mountain lion incident response procedures.

2. RDMD/HBP employees shall routinely inform the visiting public of the potential presence of mountain lions within parks and recreational areas verbally and through the use of interpretive and informational signage and/or handouts.

3. Park staff shall also maintain a mountain lion sighting log to document mountain lion sightings within County-owned, operated, and managed parks and recreational areas.

4. The following procedures may be implemented at the discretion of the ranger-in-charge and shall be continued until otherwise directed:

a. Park attendants shall specifically inform entering park visitors of recent mountain lion sightings and urge precautions.

b. Park staff shall monitor tracks and pre-assigned areas for mountain lion tracks and document this procedure in the park "Mountain Lion Tracking Study" book.

D. Notification Procedure

1. The Board of Supervisor(s) Office and CEO will be notified if deemed necessary by the Director of Resources and Development Management Department.

2. Each park shall maintain a list of local/neighboring property owners, businesses, and communities that will be contacted in the event of mountain lion incidents that may affect public safety.

VI. ATTACHMENTS

A. Mountain Lion Sighting Report

County of Orange
Orange County Community Resources
Orange County Parks

RMS use only ID#

Mountain Lion Sighting Report – ***to be completed by park staff only***

Date sighted (11/29/09)		Time sighted	7 AM		
Park		If "Other," specify			
Location					
Landmark 1					
Landmark 2					
UTM (last four digits)	North		East		
Direction of travel	south				
General description					
Behavior		If "Other," specify			
Date reported (11/29/09)		Time reported	7PM		
How reported?		If "Other," specify			
Reporting person – contact information				No contact information available ☐	
Name (first, last)					
Address					
Address					
City		State		ZIP	
Telephone (inc. area code)	949-728-0330				
Telephone (inc. area code)					

Additional observers	Address	Telephone

Park staff follow-up

Date field checked						
Field staff (first initial, last name)			Classification		Senior Ranger	
Observations	Tracks	None	Scat	None	Animal	None
Length		Weight		Height at		
Fur color			Marks			
Prey cache		Scrape				

If "Other," specify:
No tracks found at that area under the bridge.

T1		L		W		T2		L		W		SL		Cast?	

Sighting level	1	Incident report?	no	Incident report no.	

Notifications	Date (	How notified
Department Director (level II or III only)		
Division Director (level II or III only)		
Operations Superintendent		
Parks District Supervisor		Email
Donna Krucki-Senior Park Ranger		Email
Ron Slimm-Ops. Sup.		Email
Ev Mena-Ops. Sup		Email
Kevin McKeown		Email
CA Dept. of Fish and Game		Fax
HCA/Animal Care Services		Fax
Other (specify):		
Other (specify):		

Form Rev: 07/10/07

Appendix III: Starr Ranch Reserve Safety Protocols #1

Safety Issue	Measure(s)
Cougars	If approached by cougar:
	Instruct group - do not run
	Adults encircle all children
	Adults yell and look threatening - if possible move group to vehicles
	Instructors carry long, heavy "cougar sticks" and two way radios (see radio safety protocol file)
	All programs with children - adult:child ratio 1:5; creek days 1:3
	Kids - no running
	FNW - During intro. - all kids < or = 6 yrs old within 2' of adults, all other kids , or = 10 feet from adults
	Adults on walks in front and rear
	Meet with adult volunteers and "bodyguards" to review safety protocol - all kids < or = 10 feet from adults
	Bathroom visits - kids always accompanied by adults; high school kids in pairs
	Overnights - adults drive to bathrm fr. bunkhouse; lab spotlight on
	Send or hand out "Cougar Management Guidelines" to adults
	Staff will stay updated on current cougar research and safety
Rattlesnakes	Do not approach - stay at least 6 feet away
	If bitten walk calmly and quietly to vehicle or use cell phone for help; staff will drive victim to
	Mission Hospital emergency room
Ticks	Inspect pants as walk and remove ticks; after walk through shrubs, inspect selves and all children
	Low incidence and no reports of Lyme's disease at Starr Ranch, watch for bull's eye rash around bite
Poison oak	Instruct group-leaves of 3, let it be. Wash any areas of contact with cold water and dish detergent 2-3 x.
General first aid	First aid kits go out with every group
	B-E's first aid and CPR certified
	Motorola radios or cell phones out with all groups (eventually radios with line to 911)
	Pete meet with paramedics for helicopter evacuation procedures
	MInor cuts - wash with soap and water, apply a small amount antibiotic ointment, bandage - **wear latex gloves**
Communications	B-E's carry radios for all programs/walks.
	Adult child ratio during day programs at least 1:5 or 1:7
Bathroom visits	From lab or conference room all children accompanied by an adult, preferably same sex.
	From creek, have extra vehicle - same sex instructor will drive any single children to clivus
	General bathroom visits - kids always accompanied by adults; high school kids in pairs
Stream macrointertebrates, ecology	Swimming only in one designated pool
	Large adult tests grape vine before any swinging session
	Adult stationed in front of vine tree at all times. Two adults on bank at all times.
	Adult:child ratio = 1:3 or 1:2
	Sandy inform leader - GMC specs (for transport to creek)
	Check for active bee and wasp nests
Predators and their prey - owl pellets	Owl pellets not yet microwaved handled only with latex gloves (later in recycle bucket)
	Microwave all owl pellets 15 seconds
	Pete Bloom, Jason Bennett (master's on GHO in southern CA), Marnie Koopman (Ph.D. on boreal owls) - handle pellets with bare hands, no sterilization - no concern about parasites or disease
	NEW 2007: see owl pellet folder - bake in oven at 350 deg 45-60 min. before put out

Polluted water sampling	All sampling done by adults only; kids do not go near the creek - samples brought up for examination with latex gloves. Kids wear latex or nitril gloves for handling water samples
Night programs - general	Adult:child ratio = 1:3 or 1:2
	All kid bathroom visits with adult
Cougars, Bobcats, and Coyotes	Summer - place scent stations in the shade if possible
	Store gypsum box (scent stn demo) in mouse proofed storage room.
"light" version	Either 1) whole group stays together to visit scent stations or 2) Group splits into 2-3 small
	groups, each with an adult - all groups STAY TOGETHER. B-E's float
Stinging insects	Audubon policy - no untrained, unauthorized staff is to use epi pens with minors (see anaphylactic shock file in Public)
	Apply "sting ease" swab then ice pack (on for 10 min. off for 15 min. repeat); keep eye on for signs of shock [1]
All "return visit" programs	Enrollment forms with info. on allergies, medications, doctors + photo release/liability forms
(i.e. SRJB, after school, etc.)	
All "return visit" programs (i.e. SRJB, after school, etc.)	Parents sign in at drop off and out at pick up

Appendix IV: Starr Ranch Reserve Safety Protocols #2

Cougar Protocol Research – "urban cougars" and education programs in cougar habitat

1/13/04 Boulder Colorado Department of Parks and Recreation, Open Space Mountain Parks, Lynn Sullivan (720) 564-2058.

1. With the increasing exposure of cougars to humans and its potential for habituation, how does CO Dept. of P & R deal with education programs and cougar safety?

Lynn prefaced the following description of their protocol by saying that so far "problem" cougars (not shy of people, stalking people, attacks, etc.) have been very rare in their park system and their protocol reflects this situation.

1. They map all cougar sightings within their park system to try and monitor activity patterns. Thorough communication among all staff of cougar activities, particularly when near high-use areas.

2. If they get reports that a cougar is hanging out near a trail the park rangers will go and check out the situation.

-- If there is a kill near the trail, the Rangers will move the kill away from the trail and haze the cougar away from the trail (however, this protocol is variable depending on other environmental variables such as time of year, intensity of trail use by people, etc.).

-- If mountain lion is lingering in area, they have a crew of volunteers that hang out at key points redirecting recreational users away from that area and they move any planned educational programs in that area to another site.

2. Our education and research headquarters are in a riparian corridor that we have been told by cougar experts is prime cougar habitat. Cougars pass through regularly (every couple of weeks or so). Furthermore, we have had more daytime sightings in the past year (about 8) than in the past 5 – 10 years. In about half of these sightings the cougar did not retreat until seriously provoked (and the sightings were not clumped within a one-two week period <as if the cougar were on a kill>, there were weeks or months in between). Given this situation – any advice? I also explained to her our current cougar safety protocol.

1. Current protocol sounds good, bear spray (counter assault) works well on cougars and could be added to protocol, particularly good for negative reinforcement. However, downside is that if the person using it loses their head in a moment of panic, they could spray themselves or the kids.

2. Work closely with your local department of fish and game, division of wildlife, and parks system. Find out what their safety protocols are and how they manage groups and cougars.

3. Our agencies in OC are just beginning to deal with the idea that cougars may be becoming habituated to human activities and how this might change their behavior. Prior to the past few weeks, the county byline has been that cougars are shy animals that avoid people. My understanding is that Boulder has been dealing with the idea of "urban cougars" for a bit longer. Is there anyone else in Boulder you could recommend to me that may be able to provide more information on the Colorado situation?

1. Colorado Division of Wildlife, district wildlife manager, John Koehler. John.Koehler@state.co.us (303) 291-7146.

1/14/04 Ken Logan, PhD., Wildlife Researcher – Carnivores, Colorado Division of Wildlife, (970) 252-6013, ken.logan@state.co.us. PI (with others) on the UC Davis/CA FG study in Cuyamaca Rancho State Park on the human/cougar interactions. Also co-author of *Desert Puma*: *Evolutionary Ecology and Conservation of an Enduring Carnivore.*

I spoke with him on the phone, I explained our situation here, the relatively frequent interactions with cougars on the Ranch in the past year, etc. My questions to him were as follows.

1. The state byline for cougar behavior has always been that cougars are shy predators that tend to avoid people. Exposure of cougars to humans has increased in the past 15 years in OC as development has lurched further into cougar habitat, could this cause cougars to be less wary of humans?

Ken said that their data from Cuyamaca Rancho State Park in San Diego County (where they receive .5 million visitors a year) indicated that exposure to humans in the park altered the cougar's behavior in the following ways:

-- Overall, the cougars were most active in this park at night and at dusk and dawn – times with lowest human activity.

-- Cougars avoided areas of high human use, especially during the day.

In other words, even though cougar home ranges at Cuyamaca Rancho State Park overlapped with human high-use areas, the cougars in his study still avoided humans temporally. So, **yes**, cougar exposure to humans does alter cougar behavior (activity patterns), however their data indicate that it **does not** appear to make them less wary of humans.

2. In the past year at Starr Ranch, we have had several "unusual" cougar interactions where the cougar was sighted at close distance during the day and the cougar would not retreat until the observers harassed it. Is this unusual cougar behavior and does it indicate that the cougar(s) in our area are becoming less afraid of people (i.e. habituated)?

He and Linda Sweanor conducted a study looking at behavioral responses of cougars in New Mexico to encounters with researchers. He said that these cougars in NM were the wildest in North America – not much exposure to humans at all. Nonetheless, many of these cougars responded to approaches with humans with either "no response" or "stayed put and watched." Ken felt, based on this research, that it is perfectly normal for some cougars not to retreat quickly during an encounter with humans and that such interactions does not indicate a "change" in cougar behavior due to habituation.

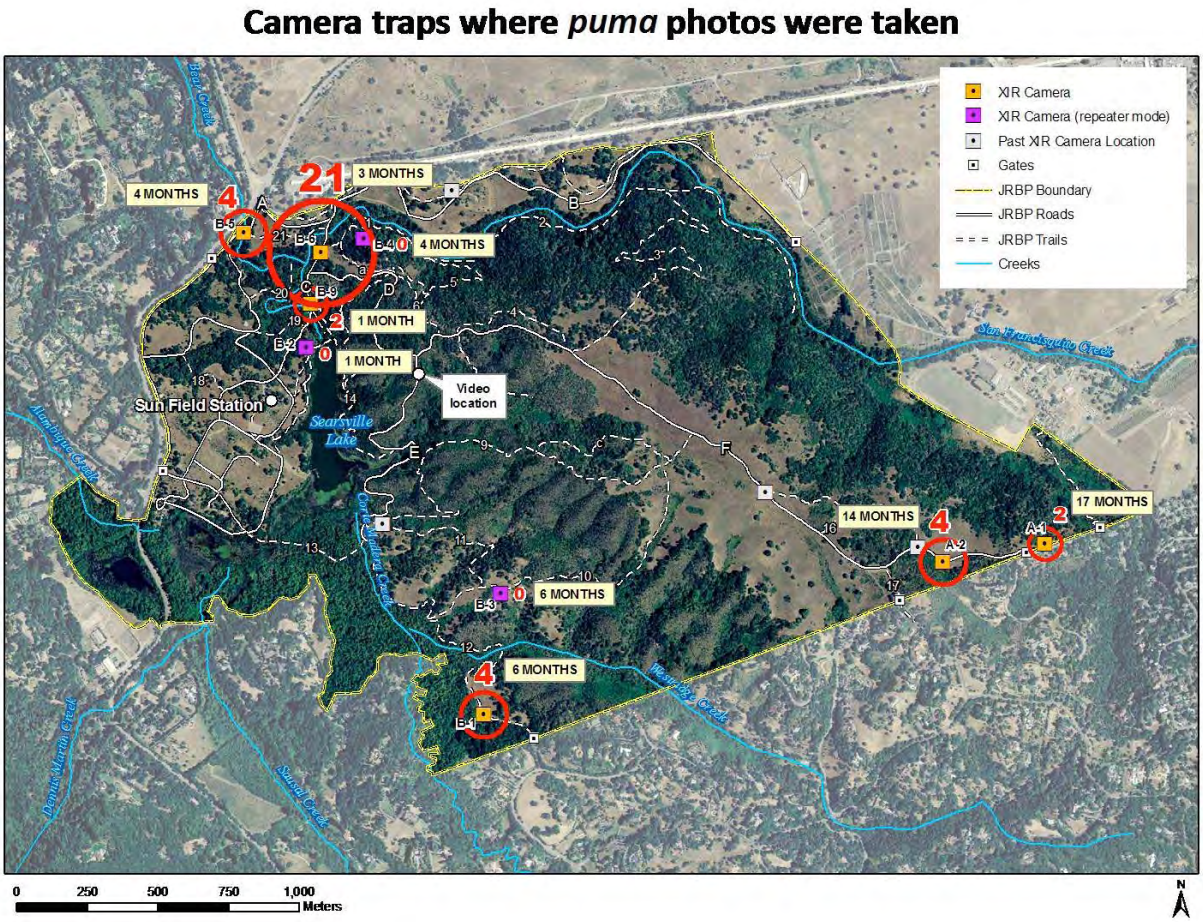
3. Also, our main concern at Starr Ranch is safety of the children participating in our education programs. Our current cougar safety protocol is based on information we have gathered from local agencies, parks, and local cougar biologists. *I explained our current protocol…*Anything you would add? Do you have an opinion on the usefulness of bear spray on cougars?

He said that our protocol was good and cautious. Carrying walking sticks and keeping adults with kids essential. Said bear spray is not a bad idea, knows of people who have used it on cougars and it has been effective.

4. Are there any scientific papers you could refer me to on any of the above subjects?

He is sending me the report from the Cuyamaca study and from the NM research.

Appendix V: Map of Mountain Lion Camera Trappings at the Jasper Ridge Biological Preserve



Appendix VI: Oregon Educational Brochure

Cougars, also called mountain lions, are Oregon's largest cat species. While cougar sightings and encounters are relatively rare, it is wise to educate yourself about cougars.

Native to Oregon, cougars range throughout the state. Population densities vary depending on habitat — the highest densities occur in the Blue Mountains in the northeastern part of the state and in the southwestern Cascade Mountains. Oregon's current cougar population is estimated at more than 5,000. Cougars are carnivores. Their primary food source is deer, but they also will take elk, raccoons, bighorn sheep and other mammals and birds. As a top predator, the health of the cougar population is a good indicator of the health of the entire ecosystem.

Attention on these animals has increased as Oregon's human population expands and more people work, play and live in areas inhabited by these big cats. By following the guidelines in this brochure, you can reduce your chances of a negative encounter.

Cougar tracks versus dog tracks

Cougar tracks

- **Tracks do not generally include claw marks because cougars have retractable claws.**
- **The heal pad has three distinct lobes at the base and is indented at the top, forming a distinct "M" shape.**

Dog tracks

- **Tracks usually include claw marks.**
- **The heel pads are more rounded.**

Oregon Department of Fish and Wildlife

3406 Cherry Avenue NE
Salem, Oregon 97303-4924
503-947-6000
www.dfw.state.or.us

1/05/2006

Living and Recreating in

COUGAR COUNTRY

Guidelines for living with cougars

Oregon Department of Fish and Wildlife

Living in Cougar Country

Some common sense guidelines can keep you and your neighborhood safe.

- ❑ Learn the neighborhood. Be aware of any wildlife corridors or places where deer or elk concentrate.
- ❑ Walk pets during the day and keep them on a leash.
- ❑ Keep pets indoors at dawn and dusk. Shelter them for the night.
- ❑ Feed pets indoors.
- ❑ Don't leave food or garbage outside.
- ❑ Use animal-proof garbage cans if necessary.
- ❑ Remove heavy brush from near the house and any play areas.
- ❑ Install motion-activated light outdoors along walkways and driveways.
- ❑ Be more cautious at dawn and dusk when cougars are most active.
- ❑ Do not feed any wildlife. By attracting other wildlife, you may attract a cougar.
- ❑ Keep areas around bird feeders clean.
- ❑ Deer-proof your garden and yard with nets, lights and fencing.
- ❑ Fence and shelter livestock. Move them to sheds or barns at night.
- ❑ Report any cougar sighting or encounter to a local ODFW office or Oregon State Police office.

Recreating in Cougar Country

Cougars usually will sense people and leave an area, but by following these guidelines you can further minimize your risk of encountering one.

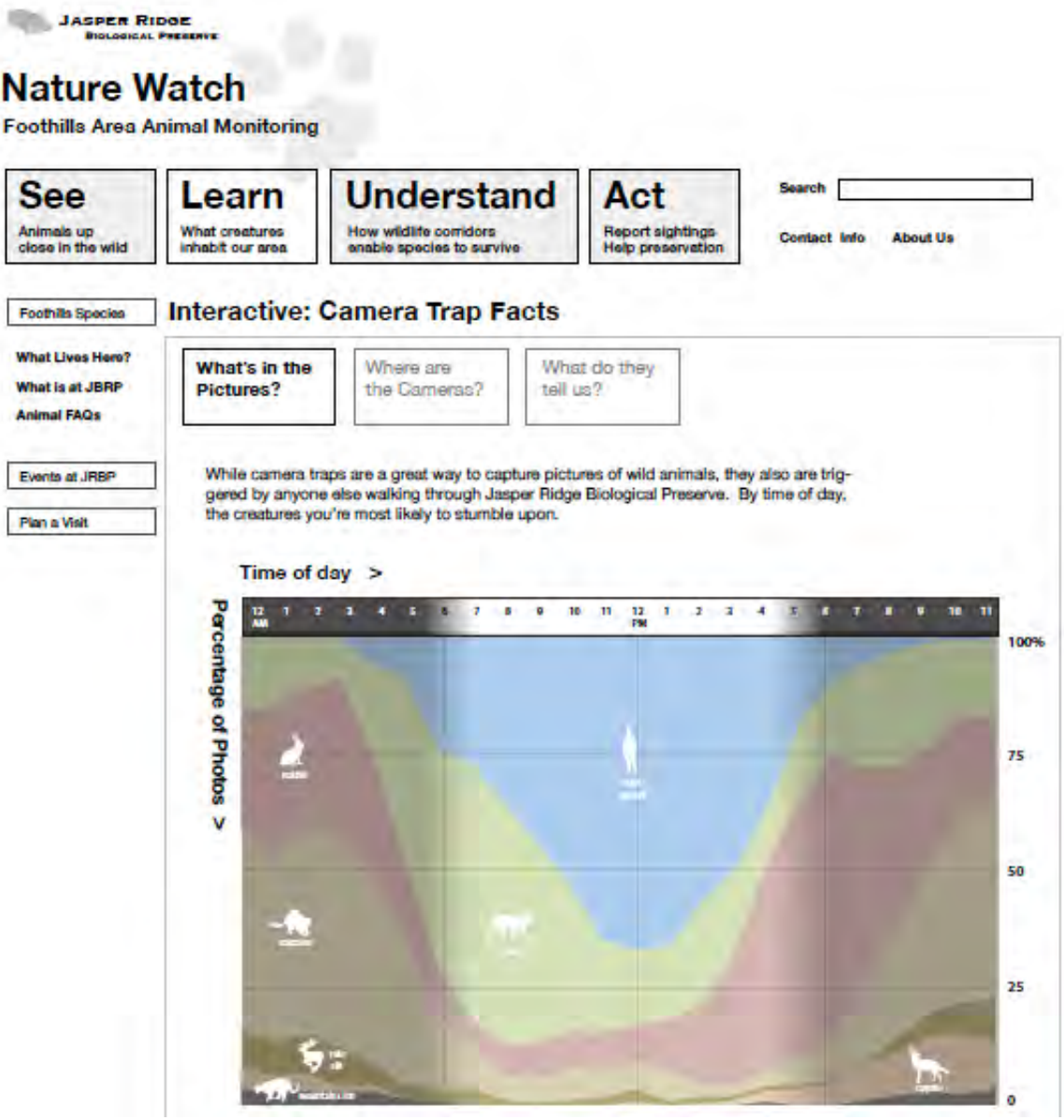
- ❑ Be aware of your surroundings at all times.
- ❑ Leave your dog at home or keep it on a leash. Pets running free may lead a cougar back to you.
- ❑ Hike in groups. Make noise to alert wildlife of your presence.
- ❑ Keep children close to you. Teach them about wildlife.
- ❑ Keep campsites clean. Sleep 100 yards from cooking areas.
- ❑ Store food in animal-proof containers.
- ❑ Carry deterrent spray.
- ❑ Be cautious at dusk and dawn.
- ❑ Never feed any wildlife. Prey attracts predators.
- ❑ Do not approach any wildlife; stay at least 100 yards away.
- ❑ Steer clear of baby wildlife. The mother is likely nearby.
- ❑ Be alert when sitting quietly or stopping to rest.
- ❑ Hunters must be especially alert at dawn and dusk when cougars are most active.
- ❑ Be aware that animal calls and animal kills can attract a cougar.
- ❑ Report any cougar sighting or encounter to a local ODFW office or Oregon State Police office.

Encountering a Cougar

Cougars often will retreat if given the opportunity. Always leave the animal a way to escape.

- ❑ Stay calm and stand your ground.
- ❑ Maintain direct eye contact.
- ❑ Pick up any children, but do so without bending down or turning your back on the cougar.
- ❑ Back away slowly.
- ❑ Do not run. Running triggers a response in cougars which could lead to an attack.
- ❑ Raise your voice and speak firmly.
- ❑ If the cougar seems aggressive, raise your arms to make yourself look larger and clap your hands.
- ❑ If in the very unusual event that a cougar attacks you, fight back with rocks, sticks, garden tools or any other items available.

Appendix VII. Prototype of Interactive Website



Appendix VIII: Woodside Backyard Habitat Program

WOODSIDE BACKYARD HABITAT PROGRAM

"Keep the Woods in Woodside"

The Woodside General Plan talks about Open Space in the following way:

> *Open Space means many things to many people and has many scales and many forms. It can be a wooded mountainside, rolling grass covered oak studded hills, streamside areas, a local park, a scenic road, or the intimate open spaces of one's "own backyard".*

The Open Space Committee's charter dictates that committee responsibilities include the dissemination of information to the community that enhances awareness of the benefits of open space. The purpose of the Backyard Habitat program outlined in this document is to educate Woodside residents about why it is important to preserve these intimate, "backyard" open spaces, provide them with guidelines and resources to help them, and to recognize them for doing so.

****

Woodside's Backyard Habitat Program is a voluntary award program inspired by a similar effort by the National Wildlife Federation to provide habitat, food and shelter on private properties across the country. The Town of Woodside is in the unique and favored position of being almost completely surrounded by *natural* areas of habitat which provide food and shelter. In fact this area, designated as part of the California Floristic Province, is home to some of the most diverse flora and fauna in the world. Our open-space tracts support hundreds of species of plants and wildlife, some of which are endangered. In this world of ever-shrinking habitat, Woodside residents still have the opportunity to re-create avenues and havens for wildlife on their own property. These areas, left in a natural state and made accessible to the animals, can vastly expand the ability of our native creatures to find food and shelter, and more importantly, to travel between populations and maintain a healthy gene pool. One of the greatest causes of species extinction is the isolation that occurs in little islands of habitat that are cut off by development, fencing and roads. If Woodside can create safe passageways down its stream corridors and other undisturbed natural areas, perhaps other semi-rural communities will follow our example and we can mitigate the human footprint on this magnificent corner of the earth.

1

Our Purpose

The Committee has identified the following community-specific goals for the program:

- Preserve and recreate wildlife habitat throughout Woodside on privately owned property.
- Promote the concept of habitat connectivity.
- Create conditions that allow wildlife to move within and through our Town safely in order to access existing or newly created habitat and to travel between our Open Space Preserves.
- Encourage the preservation of stream corridors, creeks and wetlands in open, natural condition in recognition of the important role they play in providing habitat, water and migratory corridors for wildlife.
- Promote a more judicious use of pesticides, fertilizers and household chemicals to protect local hydrology.
- Educate residents about ways to create a balance between preserving wildlife habitat and new fire safety regulations.
- Educate residents about the importance of minimal landscape lighting to allow night time foraging by wildlife.

Backyard Habitat Guidelines

Preserving and Recreating Habitat:

The most effective method of preserving or restoring wildlife habitat on a property is to allow part of the property to remain in relatively undisturbed natural state and to encourage the propagation of native vegetation in that area. This habitat might be designed to attract insects including pollinators such as honey bees, butterflies, or moths; it might be designed to attract birds including ground dwelling birds such as quail; an area in the farthest reaches of a property might allow for burrowing animals such as gophers, rodents, and snakes.

Riparian Areas: Preserving riparian habitat on creekside properties or properties containing ponds and wetlands is of utmost importance as all wildlife needs water and uses riparian corridors for migration. The Town of Woodside and other regulatory bodies govern much of what can be done in riparian areas. In general the Woodside municipal code considers a riparian area to be 25ft from the top of the bank or 50ft from the center of the stream whichever is greater. Development in these areas is severely restricted and removal and planting of vegetation is regulated and requires permits. In all cases it is important to encourage native vegetation such as bay trees, willows and oaks and to eliminate invasive species such as acacia, pampas grass, and French broom. Additionally it is important to preserve the natural characteristics of the stream itself wherever possible, including riffles, pools, gravel beds, stable undercut banks, overhanging vegetation & in-stream woody debris in order to promote fish and amphibian habitat.

A healthy and undisturbed riparian area is important not just for the benefits it provides to wildlife but also for the role it plays in preventing stream pollution including siltation.

Hillside Areas: Preserving undisturbed natural habitat in hillside areas is encouraged by the Town of Woodside through both Zoning and Site Development ordinances in order to prevent slope destabilization. Properties with slopes in excess of 12.5% must leave a certain percentage as open space. Much of the hillside areas consist of Redwood and mixed evergreen forests including Douglas-fir, California Bay Laurel, Buckeye and Madrone. Appropriate understory plants in this habitat would include Huckleberry, Hazelnut, Creeping Snowberry, Wax Myrtle and herbaceous plants such as Redwood Sorrel, Fat Salomon's Seal, Sword Fern, Wood Rose, Woodland Strawberry and Evergreen Violet.

The Valley Floor: Properties on the valley floor are mostly made up of oak woodlands and perennial grasslands. Appropriate understory plants for oaks would include Manzanitas, Toyon, Coffeberry, Poison Oak, Monkeyflower and Ceanothus and in the grassland areas would include native Needlegrasses, Bromes, Blue-eyed Grass, California Buttercups and Blue Wild Rye.

Wildlife Access to Habitat

Fencing: The purpose of saving or restoring habitat is for wildlife to be able to access it. This may involve making modifications to perimeter fencing or sections of it so that it is more wildlife friendly. The current Town fencing ordinance encourages open fencing. Historically this has been interpreted as open-looking fencing, as opposed to fencing that is open to allow for the passage of wildlife. As a consequence many properties have become wildlife- free zones. Property owners interested in enhancing habitat values on their land are encouraged to use open post and rail fencing which complements the Town of Woodside's rural atmosphere and provides for the unhindered and safe movement of wildlife. If the fence contains wire mesh then space can be left under the bottom of the wire for wildlife to pass through or gaps left in the fence itself.

Wildlife Corridors and Habitat Connectivity: Additionally, where possible, this program is intended to encourage property owners to think about preserving and restoring habitat in such a way that it sustains a network of habitat including wildlife corridors so that wildlife may move around Town without using the road system as migratory corridors.

One of the greatest dangers many animal species face today is the fragmentation of their habitat due to human activities and development. An animal population that is isolated in a small area declines due to inability to find suitable mates, and because its food sources can be negatively affected by the proximity of humans. Wildlife corridors are being established on a large scale in and between our National Parks in an effort to allow animal populations to travel between large areas of protected habitat. This improves the diversity and hence the resiliency of the species. Woodside is in the unique position of being able to follow this model on a smaller scale. The town's many open space and natural areas support a remarkable array of wild creatures, whose populations may stay wild if they are given the opportunity to migrate through areas resembling their natural habitat. Streams, even ephemeral ones, are the most important elements of this network, as they are the key to *connecting* the various habitat areas. They provide excellent cover in addition to natural pathways for animals to follow.

If all the properties along a given stream are kept in a natural undeveloped and unfenced state, the result will be a wildlife corridor, which allows free migration and keeps the animals out of roadways. Key to our effort is the issue of connectivity: If neighboring properties work together to align their natural spaces, particularly if one of the properties abuts a preserve or other designated open space area, our local wildlife face a far smaller risk of isolation and extinction.

Habitat Preservation and Fire Safety

The Town of Woodside and the Woodside Fire protection District have adopted more stringent wildfire prevention guidelines based on changes in state law. The primary goal is to reduce local fuel load, especially invasive exotic species, through brush removal and thinning. However, adhering to certain landscape design principles can allow for the existence of habitat without compromising safety: the fuel load should be minimized within 30 – 100 ft of structures and habitat areas should be located as far from the primary residence as possible in order to provide the least disturbance to wildlife. Preventing fire from spreading by interrupting its horizontal and vertical path is also extremely important so islands of habitat consisting of low clumps of native shrubbery or brush piles are permissible. Habitat in riparian corridors is of less concern because of the type of vegetation, the presence of water and the fact that most structures are not located close to them.

New Ways of Thinking about Landscaping

Woodside's forests contain a stunning array of flora, and these plants are designed by nature to thrive in this particular climate. In terms of landscape design, we encourage residents to take cues from the undeveloped land around them, creating a comfortable progression from formal landscaping around the house to natural woodlands in the further reaches of the property. Gardeners might change their focus from *installing* a landscape to *husbanding* what would naturally occur. Plantings near one's house might be well-ordered flowerbeds and manicured shrubs, but we can allow nature to take over as we move away from the heavily-trafficked areas. The transition can be accomplished by incorporating native plants into the landscape design, placing them where they should naturally occur, and utilizing the existing features of the property. Working outward from the house, lawns can give way to meadows, terraces to rock gardens, and wooded areas provide shade for the native understory plants which will germinate on their own.

As the wildland interface is reached, take care to disturb the sensitive understory as little as possible. Excessive dead material which could present a fire danger should be cut but dropped and left in place. Gardening efforts should be limited to removal of non-native invasive plants. For more information on invasive plants please see the Resources Guide.

Other Important Things to Know*:*

Don't feed the animals: The aim of this program is to encourage wildlife to exist as it would with minimal interference from humans, so homeowners should not provide any artificial forms of food or shelter. Garbage and pet food should be stored inaccessibly and no additional food should be placed outside for wildlife to enjoy. Rather, they should be able to seek the sustenance and shelter provided by native vegetation and natural features of the land. Steps should be taken to prevent wild creatures from nesting in and under houses. Many creatures make use of snags (dead trees left standing) for shelter and food storage. These should be left in place wherever it is reasonable to do so.

Lighting: Woodside's lighting regulations are intended to comply with the Dark Sky Initiative and since wildlife foraging does not take place where there is night lighting, outdoor lighting close to habitat areas should be minimal, face downward and toward the house.

Domestic Animals: Domestic pets, particularly cats, are at risk of predation and in turn are the largest cause of mortality for small wildlife.

Organic Gardening: Organic gardening practices will help maintain a healthy ecosystem – Use of pesticides and herbicides should be curtailed, especially next to water sources and pollinator habitat. For those with septic systems, the use of household cleaning chemicals such as bleach and antibacterial soaps can poison the soil. These products should be used sparingly.

We encourage keeping all organic waste on site. Composting keeps excess carbon dioxide and sheer mass out of the landfill and improves soil microbiology. Take advantage of Woodside's chipper program and use all cuttings and chips to form brush piles and to mulch your landscaping. This, combined with use of drought-tolerant native plants, will reduce your water consumption, keep invasive weeds at bay and help reduce our carbon footprint!

Easy steps towards creating backyard habitat:

- Landscape with Bay Area native plants.
- Allow little-used areas of the property to revert to a wild state. Keep activity closer to the house and concentrate gardening activities there.
- Reassess perimeter fencing needs – If fencing is for safety then consider leaving some part of the property away from the residence unfenced; if fencing is for privacy then create gaps for wildlife to pass through or under; if fencing is to keep a dog in check, consider leaving a front or back portion of the property unfenced; if it is to protect plantings then place the fence only around a small area of edible plants, and landscape the rest of the property with deer-resistant foliage.
- Make sure any streambed is totally unobstructed and left with its natural riparian vegetation intact, for at least 50 feet from its center or 25ft from the top of the bank.
- Leave low-growing native shrubbery and brush piles at some distance from the house to provide cover for small creatures.
- Work with your neighbors to line up natural areas and create adjoining bands of open space, fostering ease of wildlife travel from one property to the next.
- Try to eradicate invasive nonnative vegetation including but not limited to Scotch or French Broom, Pampas grass, Vinca, ivy, Slender False Brome, Burr clover, Star Thistle and other thistles, and Bermuda grass.
- Follow the lead of Woodsiders who have planted native meadows or drought-tolerant ground cover instead of lawns
- Reduce dependence on chemical fertilizers and cleaning products.

Criteria for a Property to Receive the Award

1. A significant portion of the property should be maintained in a natural state, dominated by native vegetation and free of nonnative invasive plants.
2. This part of the property would be unfenced or have wildlife friendly fencing such as open post and rail.
3. Streams, including designated stream corridors, intermittent and ephemeral streams, ponds, marshes etc should remain in an open, natural condition (including a clear uninterrupted riparian buffer zone dominated by native vegetation) and must remain accessible to wildlife.
4. Where applicable the habitat area should abut designated open space or similar natural areas on neighboring properties.

WOODSIDE BACKYARD HABITAT

APPLICATION for BACKYARD HABITAT AWARD

NAME(S) _____ PHONE _____

E-MAIL ADDRESS _____

ADDRESS _____

I (We) have been a resident of Woodside since _____.

PLEASE ATTACH A PHOTOGRAPH THAT IS REPRESENTATIVE OF NATIVE HABITAT ON YOUR PROPERTY.

PLEASE CHECK ALL THAT APPLY: ON MY PROPERTY:

____ There is a creek or stream _____ I see a lot of wildlife _____ I share a boundary with open space

____ There are backyard open spaces Approximately _____% of my property is in a natural state

____ Riparian areas are in a natural state _____ I encourage native plants (and/or propagation of natives)

____ I have problems with invasive plants _____ I work to control invasive plants

WHAT TYPE OF FENCING EXISTS ON YOUR PROPERTY?

_____

PLEASE TELL US WHY YOU ARE INTERESTED IN RECEIVING THIS AWARD :

_____

_____

_____

IN WHAT WAYS DOES YOUR PROPERTY EXEMPLIFY THE SPIRIT OF THE BACKYARD HABITAT PROGRAM?

_____

_____

_____

_____ _____

Signature Date

Please return completed application to: Town of Woodside, 2955 Woodside Rd, PO Box 620005, Woodside, CA 94062, Tel: 650 - 851- 6790, Fax 650 – 851 2195, Attn: Open Space Committee

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Woodside Backyard Habitat Resources Guide

Books and Publications

Plants And Landscapes For Summer-dry Climates Of The San Francisco Bay Region
East Bay Municipal Utility District

Riparian Native Plant Planting Guide for Homeowners
Published by Coyote Creek Riparian Station, P.O. Box 1027 Alviso, CA 95002 or call (408) 262-9204

Online Resources

- Acterra http://www.acterra.org/findanswers/home/index.html publications and pamphlets

- California Invasive Plant Council http://www.cal-ipc.org ("Don't plant a pest")

- California Native Plant Exchange http://www.cnplx.info/nplx/cprofile?cc=SMT

- California Native Plant Library http://www.theodorepayne.org/gallery/glossary.htm

- California Native Plant Society Yerba Buena Chapter http://www.cnps-yerbabuena.org

- California Water Service Company http://www.calwater.com/conservation/index.php

- California Native Plant Society
http://voyager.ento.cornell.edu/public/IthacaCampus/ExtOutreach/Outreach/Students/pageBodySections/0112/text_files/file/Zielnicki%20-%20Resource%20Guide.pdf
Conservation Gardening (low water-use and drought resistant planting guide – note: this has non-natives in it)

- San Mateo County Water District
Sustainable Gardening http://www.recycleworks.org/compost/sustainable_gardening.html
Going Native Garden Tour http://goingnativegardentour.org

Stream Care and Erosion Control

San Mateo Countywide Guide to Creek and Wetland Project Permitting
http://sfep.abag.ca.gov/projects/JARPA/Crkstop.pdf

Nurseries and Landscapers who work with local native plants

Blue Sky Designs –Ken Coverdell, Half Moon Bay, http://www.blueskydesignsinc.com

Blue Sky Farms (nursery),Half Moon Bay,
http://www.hmbreview.com/articles/2008/06/21/news/doc48596efa55209028892163.txt

Michael Thilgen, http://www.fourdimensionlandscape.com/index.html

Yerba Buena Nursery, Woodside, http://www.yerbabuenanursery.com