*Human–Wildlife Interactions* 6(1):147–154, Spring 2012

# Effects of hikers and boats on tule elk behavior in a national park wilderness area

BENJAMIN H. BECKER, Pacific Coast Science and Learning Center, Point Reyes National Seashore, Point Reyes Station, CA 94956, USA *ben_becker@nps.gov*
CHRISTOPHER M. MOI, Department of Landscape Architecture and Environmental Planning, University of California, Berkeley, CA 94720, USA
THOMAS J. MAGUIRE, 582 Heather Way, San Rafael, CA 94903, USA
ROBERT ATKINSON, Division of Natural Resources, Point Reyes National Seashore, Point Reyes Station, CA 94956, USA
NATALIE B. GATES, Division of Natural Resources, Point Reyes National Seashore, Point Reyes Station, CA 94956, USA

***Abstract***: Human disturbance of wildlife may cause disruption of normal feeding, resting, reproduction, or care for juveniles. Such disturbance may be particularly undesirable in federally managed wilderness areas designed to minimize human influences on natural resources. We recorded tule elk (*Cervus elephus nannodes*) responses (standing, walking away, running) to off-trail hikers, off-shore boats, and other natural and anthropogenic factors in Point Reyes National Seashore in northern California during 2002 to 2008. Most disturbance behaviors were related to other elk exhibiting rutting behaviors, but off-trail hikers still explained a 100% increase and off-shore boats a 15% increase in baseline disturbance behaviors by elk. However, off-trail hikers and boats did not cause elk to enter or leave the study area during the sample periods. Elk were more prone to human disturbance when herd sizes were <15 individuals. Off-trail hiking and, to a lesser extent, offshore boats appear to disturb natural tule elk behavior, but the physiological or population-level effects of this disturbance are unknown. Our quantitative results may help park managers minimize or mitigate human–elk interactions in wilderness areas.

***Key words***: *Cervus elephus nannodes*, disturbance, human–wildlife conflicts, national park, tule elk, wilderness

THE BEHAVIORAL RESPONSES of wildlife to human disturbance, either through recreation or other activities, have been compared to their behavior toward predators (Frid and Dill 2002, Beale 2004). Human disturbance stimuli can distract animals from pursuing fitness-enhancing activities (e.g., feeding, mating), alter normal behavior, and cause animals to avoid suitable habitat or to reduce the size of their ranges (Boyle and Samson 1985, Knight and Cole 1995, Cole and Anthony 1997, Shively et al. 2005, Borkowski et al. 2006). For example, Phillips and Alldredge (2000) found that experimentally induced human disturbance of elk (*Cervus elaphus*) during the calving period reduced calf and cow proportions by 0.23. Human disturbance can also lead to habituation of wildlife (Knight and Cole 1995, Knight and Gutzwiller 1995, Thompson and Henderson 1998), which may pose safety problems to humans.

Studies have shown that pedestrians have great potential to disturb wildlife (Schultz and Bailey 1978, Boyle and Samson 1985, Cassirer et al. 1992, Taylor and Knight 2003). Schultz and Bailey (1978) found that elk took flight at a greater distance when approached on foot. Stankowich (2008) found that, in general, humans on foot are the most disturbing to ungulates—more than humans on horseback and bicycling—although, humans on bikes have the opportunity to disturb more wildlife per unit of time than people on foot (Cassirer et al. 1992, Taylor and Knight 2003). Such disturbances may lead to population declines (Phillips and Alldredge 2000) or behavioral impacts. Other studies have shown no demonstrable population level effects attributable to moderate to minor disturbances (Stankowich 2008). These potential disturbance effects have implications for wildlife managers with the task of conserving wildlife in a relatively undisturbed state, especially in areas designated as wilderness (Kloppers 2005).

Similar to other wildlife, elk may become habituated or alter their behavior due to human disturbance (Mcullough 1969, Edge and Marcum 1985, Thompson and Henderson 1998, Klopper 2005). At Point Reyes National Seashore in northern California, the Avalis

Beach drainage and White Gulch area, located in the Tomales Point Elk Reserve, are year-round, core-use areas for tule elk (*Cervus elephus nannodes*) females (Howell et al. 2002). With approximately 350,000 visitors annually to Tomales Point, there is a potential for repeated disturbances to elk throughout the 10-km² elk reserve, especially by off-trail hikers (Moi 2009).

We report on an observational study from 2002 to 2008 designed to measure the potential impacts of off-trail hikers on elk behavior in the 2 core-use elk areas of Tomales Point. We evaluated (1) what natural and anthropogenic variables, including the presence of off-trail hikers and off-shore boats, might be related to elk behavior, and (2) if anthropogenic activities and any subsequently induced behaviors caused elk to leave these core habitat areas.

## Methods

We observed elk and visitors within the Avalis Beach drainage and White Gulch core-use areas by elk as defined by Howell et al. (2002; Figure 1). The study areas bordered, but did not include, an established hiking trail. Between autumn 2002 and summer 2008, park staff and trained volunteers recorded 139 observation sessions of elk behavior, elk group sizes, and sources of disturbance. Surveys were pre-scheduled for 60 or 120 minutes, but some (<10%) ended early due to logistics (not elk behavior). Surveys occurred at various times of day and days of the week, including weekends.

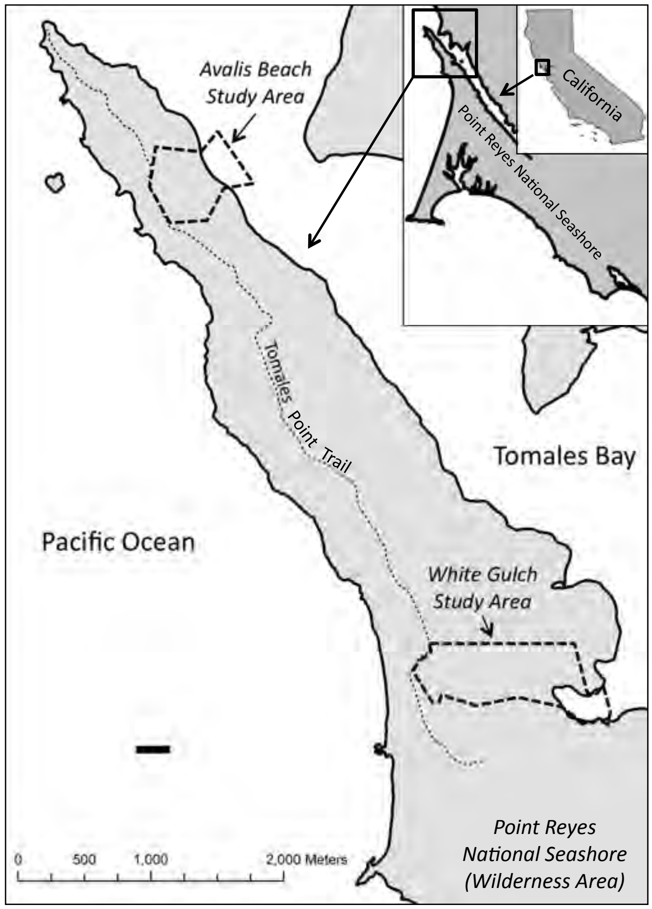


**Figure 1**. Tomales Point at Point Reyes National Seashore and the Avalis Beach and White Gulch elk study areas. Boundaries of the study area that extend into Tomales Bay are areas where boats were recorded.

Observers recorded the observation session start and end times, elk numbers present at these times, the number of off-trail visitors within the study area, the minimum distance between elk and the established hiking trail, and whether the elk exhibited any of 6 different behavioral responses: no response, head up, stand, move off, run, or alarm call. Human and elk activities were recorded continuously throughout the observation session. Because the Tomales Point tule elk do not have a specific and well-defined rut season (Howell et al. 2002), we, instead, considered rut behavior (bugling, herding, flehmen, sparring) as indicative of rut.

To qualify as a response behavior, normal activity (e.g., sleeping or grazing) of an elk must have been interrupted by a known or unknown disturbance. Elk looking back at a stimulus was considered an indication that normal activities were interrupted. Head up was the number of times an elk raised its head with ears raised and alert in response to a disturbance. Stand was the number of times an elk stood in response to a disturbance. Move off and run were the number of times that elk showed directed movement away from a disturbance source (walking or running).

Elk behavior was enumerated as the total number of active (stand, walk, run) behaviors occurring during the survey, regardless of number of elk or repeated behavior by an individual. We analyzed the most vigorous active responses by each individual elk. Thus, if an elk stood, walked, and then ran as a sequence of events within a short period of time (approximately 1 minute), it was analyzed only as a running behavior, with the lesser behaviors ignored when superseded by a greater behavior. The experimental unit was the observation session, and the dependent variable was the number of most vigorous active responses observed during a session. While our primary interest was the potential effect of off-trail hikers on elk behavior, we also investigated the potential impacts of several other potential explanatory variables on elk behavior, such as the minimum distance of elk to the official trail, size of the elk herd (to control for the likelihood that more elk might result in more enumerated behaviors or that elk behaviors were not independent from other elk), annual elk population size at Tomales Point, time to dusk or dawn (which could affect activity levels; Bowyer 1981; Green and Bear 1990), location (Avalis Beach or White Gulch), weekend (more visitors on weekends), survey duration (because longer surveys should detect more behaviors), presence of boats off shore that did not land and resulted in off-trail hikers, and whether rutting behaviors were being exhibited. Any boats that landed and resulted in people hiking off trail were categorized as off-trail hikers.

Twenty *a priori* candidate models with biologically plausible combinations of covariates were developed from these independent variables; the top final models are listed in Table 1. Using this suite of *a priori* models, we built generalized linear models (GLM) using a negative binomial distribution (Venables and Ripley 2002, Zuur et al. 2009) for the dependent variable (frequency of elk behaviors that consisted of standing, walking, or running, with only the most active behavior recorded). Models were ranked using the corrected Akaike's Information Criterion ($AIC_c$; Burnham and Anderson 2002). The negative binomial dispersion parameter (θ) was derived from the full model (all 10 potential covariates) and subsequently held constant for all other models to allow comparison of $AIC_c$ values (Venables and Ripley 2002). We also used this same model structure to examine for effects on running behavior only (because this might be considered more important than simply standing or walking), as well as the percentage of change in elk herd size from the beginning to the end of a survey, using a binomial GLM to compare the number of elk present at the beginning (versus the end) of the survey. Coefficients from models with the lowest $AIC_c$ values were weighted for all models within ~2.5 $AIC_c$ units of the best model (Burnham and Anderson 2002).

To assess if there was a nonlinear relationship between per capita frequencies of active disturbance behaviors, we used a quasi-Poisson generalized additive model (GAM) with the number of active behaviors observed during the study session divided by the mean herd size as the response variable. Off-trail hikers, survey duration, herd size, and rut behaviors were the independent variables. All statistical analyses were done using R 2.9 (R Foundation for Statistical Computing, Vienna, Austria).

## Results

From 2002 to 2008, we made 182 hours of observations during 139 sessions (112 weekday session and 27 weekend sessions). Eighty-one sessions took place at White Gulch and 58 sessions at Avalis Beach. Of the 139 surveys, 26 surveys had off-trail hikers present, 36 surveys had off-shore boats, and 37 surveys documented elk exhibiting rutting behavior.

Negative binomial GLM models were not overdispersed, as the residual deviance was close to the degrees of freedom. The θ parameter for the full active behavior model was 0.46 and was 0.14 for the run only model. Residual plots showed some patterns in the data due to the large number of zeros, but this was explicitly modeled with the negative binomial distribution.

Multimodel weighted coefficients of the best ranking GLM models indicated that the presence of off-trail hikers, herd size, survey duration, and rutting behavior were associated with increased elk disturbance behavior (Tables 1 and 2; Figures 2A–C). Model fit for the top models ranged from 0.31 to 0.43 (Table 1), suggesting reasonable, but not excellent, fits. Annual population size had a small negative relation to disturbance responses, and offshore boats had a weak positive association with

**Table 1**. Top-ranking (lowest $AIC_c$) models explaining the number of elk behaviors of standing, walking, or running in respose to a natural or human disturbance. Presence of off-trail hikers, duration of survey, offshore boats, and rutting behavior appear in most of the top 3 models with Akaike Weights (wi) consistently greater than 0.01. No other variables were selected other than "boaters present" in 2 of the top 3 models. The top models for "run only" were mostly similar, but location and weekend were more important, and survey duration and annual population size were less important than for all active behaviors. Δi represents distance from the lowest $AIC_c$ model. The models with reasonable support ($\Delta i < 4.0$) are in bold.

| | | Human disturbance | | | | | | | Natural effects | | | Model fit | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Elk response | Model | Hikers present | Distance to trail | Weekend | Boaters present | Loca-tion | Survey duration | Annual population size | Time to dawn or dusk | Herd size | Rut behavior | Δi | wi | $r^2$ |
| Stand | **1** | **x** | | | | | **x** | | | **x** | **x** | **0.0** | **0.51** | **0.42** |
| Walk | **2** | **x** | | | **x** | | **x** | | | **x** | **x** | **1.1** | **0.29** | **0.42** |
| Run | **3** | **x** | | | **x** | | **x** | **x** | | **x** | **x** | **2.3** | **0.16** | **0.43** |
| | 4 | x | | | x | x | | | | x | x | 7.1 | 0.01 | 0.40 |
| | 5 | x | | x | x | x | | | | x | x | 8.5 | 0.01 | 0.40 |
| | 6 | | | | | | x | x | | x | x | 8.8 | 0.01 | 0.38 |
| | 7 | x | | | | x | | | x | x | x | 10.6 | 0.00 | 0.38 |
| | 8 | | x | x | | x | x | x | x | x | | 12.2 | 0.00 | 0.40 |
| | 9 | x | | | | | | | | x | x | 12.2 | 0.00 | 0.36 |
| | 10 | x | | | | | x | | | | x | 13.5 | 0.00 | 0.36 |
| Run only | **1** | **x** | | **x** | **x** | **x** | **x** | | | **x** | **x** | **0.0** | **0.47** | **0.36** |
| | **2** | **x** | | **x** | **x** | **x** | | | | **x** | **x** | **0.7** | **0.33** | **0.34** |
| | **3** | **x** | | | **x** | **x** | | | | **x** | **x** | **2.8** | **0.12** | **0.31** |
| | 4 | x | | | | | x | | | x | x | 4.9 | 0.04 | 0.27 |
| | 5 | x | | | x | | x | | | x | x | 6.0 | 0.02 | 0.28 |
| | 6 | x | | | x | | x | x | | x | x | 7.9 | 0.01 | 0.28 |
| | 7 | | x | | | x | | | | x | x | 8.3 | 0.01 | 0.24 |

**Table 2**. Multimodel averaged coefficients (± 1 SE) for the change in the number active behaviors (stand, walk, run) exhibited by elk herd in relation to independent variables. For example, during surveys when there was rutting behavior, there was an 186% increase in disturbance-related active behaviors, presumably due to other elk. Off-trail hikers elicited 100% more active behaviors than expected.

| Variable | Coefficient | t-value |
|---|---|---|
| Intercept | -1.02 ± 0.69 | -1.47 |
| Rut behavior | 1.86 ± 0.36 | 5.14 |
| Herd size (per 10) | 0.19 ± 0.05 | 3.59 |
| Survey duration ($h^{-1}$) | 1.05 ± 0.40 | 2.64 |
| Off-trail hikers | 1.00 ± 0.42 | 2.37 |
| Annual population size (per 100) | -0.03 ± 0.04 | -0.82 |
| Off-shore boaters | 0.15 ± 0.19 | 0.78 |

increased disturbance responses. Elk at White Gulch were much more likely to exhibit running behavior in response to a disturbance than those at Avalis Beach. Rutting behavior led to a 186% increase in the number of disturbance behaviors, off-trail hikers a 100% increase, and offshore boats a 15% increase (Table 2). The disturbance responses, while weak, increased by 20% for every increase in herd size by 10 elk, and decreased by 3% for every increase in the annual population size by 100 elk. We also modeled the effects of number of off-trail hikers in groups, but this did not fit nearly as well as the presence–absence of off-trail hikers and would rank much lower in Table 1.

Binomial GLMs indicated only that rutting behaviors had a significant negative influence on the total herd size of elk between the beginning and end of a survey (Tables 1 and 2).

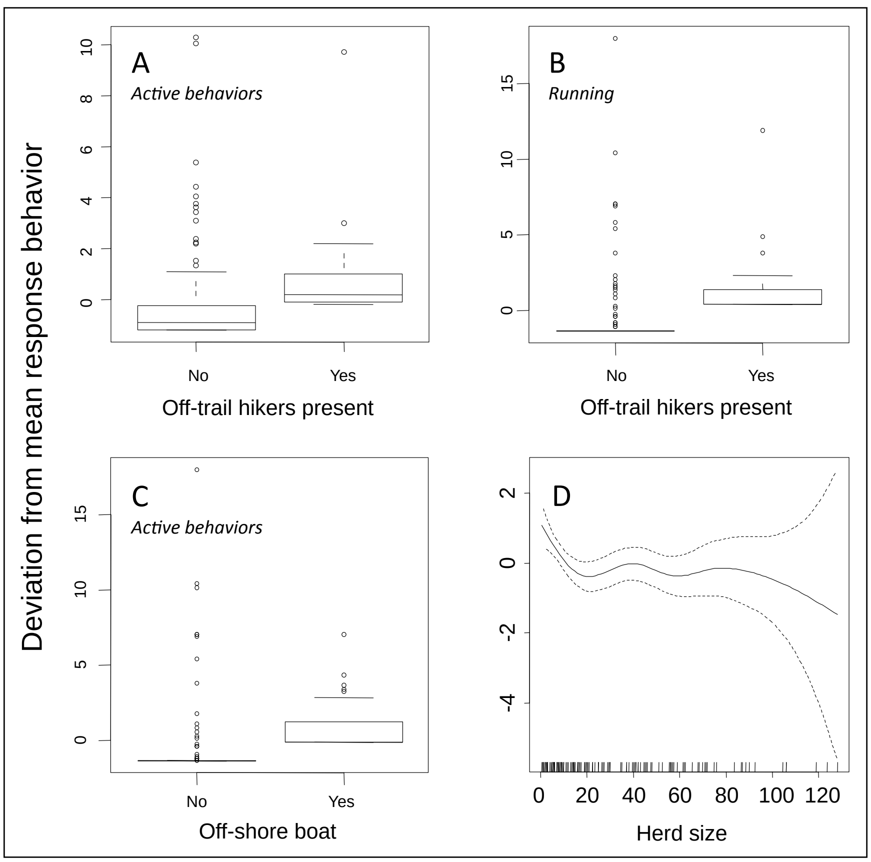


**Figure 2**. Effects plots (scaled as deviation from mean) from the best performing models for relationship between off-trail hikers and elk (**A**) active behaviors, and (**B**) running. (**C**) Relationship between off-shore boats and active elk behaviors for the top model (multimodel results were slightly weaker; see Table 2). (**D**) Relationship between herd size and deviation from mean number of active behaviors.

*P* values for all other variables were >0.25, and, therefore, no $AIC_c$ model selection was used. Thus, there is no evidence that offshore boats, off-trail hikers, or other factors modeled here caused elk to leave the study areas during a survey. The GAM indicated that elk were more prone to react to disturbance at small herd sizes (1 to 15 animals), and, thereafter, had a relatively constant rate of reaction to disturbances ($P$ = 0.016; Figure 2D). Variance inflation factors for all models (negative binomial and binomial GLMs and the GAM) were 1.1 to 2.1, indicating no issues with collinearity of independent variables (Zuur et al. 2009).

## Discussion

Elicitation of response behaviors to disturbances by off-trail hikers and, to a much smaller degree, boats suggests that there is an anthropogenic effect on Tule elk behavior in the Tomales Point Wilderness Area at Point Reyes National Seashore. Because the elk reserve is in a federally designated wilderness area, management actions to minimize disturbance may be appropriate. The magnitude of the observed disturbance effect (an increase of 100% for off-trail hikers and 15% for boats) would vary seasonally on weekends with time of day and with other variables.

Liley and Creel (2007) found that elk vigilance was related to a combination of internal (group size, cow, and calf numbers), predator (wolf [*Canis lupus*] numbers and distance), and environmental (snow cover and distance to forest cover) factors. Here, we found a similar pattern where herd size and rutting behavior (internal variables) and off-trail hikers and boats (external variables) both affected elk responsiveness. We did not measure distance to cover because it was less relevant on the open habitat of our study area. Presumably, the disturbance caused by rutting behavior of other elk is perceived differently by the elk than disturbance by humans. So, while the differences in impact are unknown, it is reasonable to suggest that the human disturbance is either similar to predator disturbance or could lead to habituation over time (Knight and Gutzwiller 1995, Thompson and Henderson 1998, Frid and Dill 2002, Beale 2004).

Elk at Yellowstone National Park, after repeated disturbances from skiers, avoided desirable habitat (Cassirer et al. 1992). Reindeer (*Rangifer tarandus*) studies suggest that movement away from optimal habitat to less optimal habitat may have a large effect on animal condition (Reimers 2003). We found no short-term evidence of elk avoiding core-use areas due to human disturbance. Howell et al. (2002) determined that from 1996 to 1998, both White Gulch and Avalis Beach were used as core areas by Tule elk cows, calves, and bulls, for calving, rut, and winter and summer range. But, unfortunately, neither Howell et al. (2002) nor this study addresses the possibility that the location and size of these core areas might have been determined by earlier human activities. Nonetheless, our results support the Howell et al. (2002) finding that both areas are used year-round by elk, but there is no evidence here that elk-use of these areas is negatively (or positively) impacted by human activity.

Several researchers have hypothesized that the unpredictability of the locations of off-trail hikers causes greater behavioral impacts to wildlife than do humans or vehicles on established trails (Cassirer et al. 1992, Olliff et al. 1999, Reimers et al. 2003, Papouchis et al. 2001). Thus, off-trail use may have a greater impact on elk than use of established trails.

Liley and Creel (2007) found that elk are less vigilant or responsive as herd size increases. Vigilance was highest for elk groups of 10 to 20 animals, with decreasing vigilance in groups >20 animals. Our results corroborate this finding, as per capita disturbance response rate was highest for small herds of elk (1–15), and then was relatively constant after that (Figure 2D). One potential problem with our estimated herd size coefficient, as well as the higher per capita rate at small herd sizes, is that observers might be less likely to detect individual elk behaviors as the number of elk and corresponding behaviors became more frequent.

The physiological and biological consequences of the observed behavioral changes to Tomales Point elk are unknown. The impacts may or may not influence elk fitness, and detailed telemetry or physiological studies would likely be required to test any fitness effects. However, the elk population at Tomales Point did not show any trend during the study period (447 ± 83 elk, $F_{1,5}$ = 3.8, $P$ > 0.10; NPS unpublished data) and appears to have actually increased from 416 elk in 2002 to 585 animals in 2008. Elsewhere, researchers have demonstrated that disruptions of normal feeding, resting, and ruminating in ungulates can lead to decreased fitness (White 1983, Reimers 1997). Avoidance and displacement behaviors can result in decreased food intake and increased energy expenditures, with reduced survival, particularly in harsh environments. While the mild climate of Point Reyes likely minimizes stress for Tule elk compared to ungulates in harsher climates, behavioral disturbance could still result in reduced efficiency of reproductive activities.

## Acknowledgments

We thank the wildlife volunteers at Point Reyes National Seashore for performing many of the surveys. P. Gogan (U.S. Geological Survey), E. Cole (U.S. Fish and Wildlife Service), and 2 anonymous reviewers who provided helpful comments on an earlier draft of this paper. The conclusions in this paper are those of the authors and do not represent an official policy of the U.S. National Park Service.

## Literature cited

Beale, C. M., and P. Monaghan. 2004 Human disturbance: people as predation-free predators. Journal of Applied Ecology 41:335–343.

Borkowski, J. J., P. J. White, R. A. Garrott, T. Davis, A. R. Hardy, and D. J. Reinhart. 2006. Behavioral responses of bison and elk in Yellowstone to snowmobiles and snow coaches. Ecological Applications 16:1911–1925

Bowyer, R. T. 1981. Activity, movement, and distribution of Roosevelt elk during rut. Journal of Mammalogy 62:574–582

Boyle, S. A., and F. B. Samson. 1985. Effects of nonconsumptive recreation on wildlife—a review. Wildlife Society Bulletin 13:110–116.

Cassirer, E. F., D. J. Freddy, and E. D. Ables. 1992. Elk responses to disturbance by cross-country skiers in Yellowstone National Park. Wildlife Society Bulletin 20:375–381.

Cole, E. K., M. D. Pope, and R. G. Anthony. 1997. Effects of road management on movement and survival of Roosevelt elk. Journal of Wildlife Management 61:1115–1126.

Crawley, M. J., 2007. The R Book. Wiley, West Sussex, UK.

Edge, W. D., and C. L. Marcum. 1985. Movements of elk in relation to logging disturbances. Journal Wildlife Management 49:926–930.

Frid, A., and L. M. Dill. 2002. Human-caused disturbance stimuli as a form of predation risk. Conservation Ecology 6:11.

Green, R. A., and G. D. Bear. 1990. Seasonal cycles and daily activity patterns of Rocky Mountain elk. Journal of Wildlife Management 54:272–279

Howell, J. A., G. C. Brooks, M. Semenoff-Irving, and C. Greene. 2002. Population dynamics of tule elk at Point Reyes National Seashore, California. Journal of Wildlife Management 66:478–490

Kloppers, E. L., C. C. St. Clair, and T. E. Hurd. 2005. Predator-resembling aversive conditioning for managing habituated wildlife. Ecology and Society 10:31.

Knight, R. L., and D. N. Cole. 1995. Wildlife responses to recreationists. Pages 51–69 *in* R. L. Knight and K. J. Gutzwiller, editors. Wildlife and recreationists: coexistence through management and research. Island Press, Washington, D.C., USA.

Knight, R .L., and K. J. Gutzwiller. 1995. Wildlife and recreationists: coexistence through management and research. Island Press, Washington, D.C., USA.

Liley, S., and S. Creel. 2008. What best explains vigilance in elk: characteristics of prey, predators, or the environment? Behavioral Ecology 19:245–254.

McCullough, D. R. 1969. The tule elk: its history, behavior, and ecology. University of California Press, Berkeley, California, USA.

Moi, C. M. 2009. An approach for park managers to identify areas of recreation–wildlife conflict. Thesis, University of California, Berkeley, California, USA.

Olliff, T. K. L., and B. Kaeding, editors. 1999. Effects of winter recreation on wildlife of the Greater Yellowstone area: a literature review and assessment. Report to the Greater Yellowstone Coordinating Committee. Yellowstone National Park, Wyoming, USA.

Papouchis, C. M., F. J. Singer, and W. B. Sloan. 2001. Responses of desert bighorn sheep to increased human recreation. Journal of Wildlife Management 65:573–582.

Phillips, G., and A. W. Alldredge. 2000. Reproductive success of elk following disturbance by humans during calving season. Journal of Wildlife Management 64:521–530.

Reimers, E. 1997. Rangifer population ecology: a Scandinavian perspective. Rangifer 17:105–118.

Reimers, E., S. Eftestol, and J. Colman. 2003. Behavior responses of wild reindeer to direct provocation by a snowmobile or skier. Journal of Wildlife Management 67:747–754.

Shively, K. J., A. W. Alldredge, and G. E. Phillips. 2005. Elk reproductive response to removal of calving season disturbance by humans. Journal of Wildlife Management 69:1073–1080.

Stankowich, T. 2008. Ungulate flight responses to human disturbance: a review and meta-analysis. Biological Conservation 141:2159–2173

Taylor, A. R., and R. L. Knight. 2003. Wildlife responses to recreation and associated visitor perceptions. Ecological Applications 13:951–963.

Thompson, M. J., and R. E. Henderson. 1998. Wildlife Society Bulletin 26:477–483.

White, R. G. 1983. Foraging patterns and their multiplier effects on productivity of northern ungulates. Oikos 40:377–384.

Venables, W. N., and B. D. Ripley. 2002. Modern applied statistics with S. Springer-Verlag, New York, New York, USA.

Zuur, A. F., A. Mira, F. Carvalhom, E. N. Ieno, A. A. Saveliev, and G. M. Smith. 2009. Mixed effects models and extensions in ecology with R. Springer-Verlag, New York, USA

BENJAMIN H. BECKER earned his B.A. degree at the University of California–Los Angeles,

M.F.S. degree at Yale University, and a Ph.D. degree at the University of California–Berkeley. He is a science coordinator and marine ecologist for the National Park Service at Point Reyes National Seashore and enjoys using long-term ecological data sets to test multiple competing hypotheses in natural and human-modified systems.

CHRISTOPHER M. MOI earned his B.A.degree in environmental studies from Sonoma

State University and his M.L.A. degree from the University of California–Berkeley, modeling the spatial interactions between Tule elk and humans. He is currently working as a land conservation project manager with the Sequoia Riverlands Trust in Visalia, California. He lives with his wife in Fresno, California, and enjoys hiking and photographing the human and natural environment.

THOMAS J. MAGUIRE (photo unavailable) has been a volunteer at Point Reyes National Seashore since 2004, spending countless hours collecting data on elk and human behavior in the field at Tomales Point Tule Elk Reserve.

ROBERT ATKINSON (photo unavailable) served as a wildlife technician with the National Park Service until 2003, He currently works as a biologist for the state of Michigan.

NATALIE B. GATES earned her B.A. degree in biology at Harvard College, her D.V.M. degree at

Cornell University, and her M.S. degree at the University of California–Berkeley. She is currently employed by the National Park Service at Point Reyes National Seashore where she is the chief of natural resource management. Her professional interests include wildlife disease, ungulate ecology and management, and the impacts of climate change on wildlife populations.