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Basking Western Pond Turtle Response to Recreational Trail Use in Urban California

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ABSTRACT. – **The presence of human activity near freshwater turtle habitat can have a negative impact on a range of turtle behaviors. We assessed whether human use of a recreational trail had an effect on basking behavior of western pond turtles (*Actinemys marmorata*) by observing individuals basking while we monitored recreational disturbances. Based on our results, we suggest limiting the number or times of operation of motor vehicle traffic adjacent to western pond turtle habitat to restrict impacts on basking behavior.**

Recreational opportunities in the San Francisco Bay area, California, are widespread and diverse including activities such as hiking, biking, fishing, and boating. These activities may have significant negative effects on populations of western pond turtles (*Actinemys marmorata*). Moore and Seigel (2006) found that fishing, boating, and jet ski activity caused yellow-blotched map turtles (*Graptemys flavimaculata*) to abandon nesting and basking activity, often for the duration of the day. Similarly, Selman et al. (2013) found that frequent human disturbance can decrease turtle basking duration.

Behavioral disruption of basking can lead to a variety of harmful consequences for freshwater turtles. Basking is an essential behavior for freshwater turtle species because it allows individuals to elevate their body temperatures, thus increasing metabolism, ensuring proper digestion, and allowing turtles to operate more effectively in feeding, reproduction, growth, and predator avoidance (Schwarzkopf and Brooks 1985; Bodie 2001; Edwards and Blouin-Demers 2007). *Actinemys marmorata* is the only remaining native freshwater turtle in California and is listed as a California Species of Special Concern (California Department of Fish and Wildlife 2015). As the human population grows within the state, human activity encroaches upon western pond turtle habitat. A remnant *A. marmorata* population exists in a greatly altered water channel near Moffett Naval Air Station in northern California. The canal occurs alongside a recently opened section of the San Francisco Bay Trail, which exposes turtles to high rates of human activity through recreational trail use. *Actinemys marmorata* is a wary species while basking (Bury et al. 2012). Wariness may increase the disturbance potential for basking individuals and may lead to a decreased ability to thermoregulate. Recent research suggests that *A. marmorata* is less likely to bask in areas of high human disturbance than a common nonnative competitor, the red-eared slider (*Trachemys scripta elegans*), which could limit quality basking sites (Selman et al. 2013). Other research suggests that recreational human activities can decrease basking durations of other turtle species (Moore and Seigel 2006; Selman et al. 2013). The goal of our research was to assess whether human recreational trail use had an effect on western pond turtle basking behavior along a 3.2-km section of the San Francisco Bay Trail.

Moffett Federal Airfield is located at the south end of the San Francisco Bay in Mountain View in Santa Clara County, California (lat 37°25′N, long 122°02′W). Here, turtles occur in channels adjacent to active trails located atop levees (Fig. 1). These channels are bordered on each side by steep slopes with a uniform width of 12 m and an average depth of 2.5 m. The basking substrate consists of muddy banks, tule (*Schoenoplectus acutus*) clumps, and occasional large woody debris. Water temperatures during the study ranged from 18°C to 21°C with a mean of 19.3°C (SD ± 1.03). The section of the Bay Trail we examined was first opened to recreational traffic in September of 2010, 9 mo before we collected data. The start of the observations coincided with the first basking season during which this population of turtles was exposed to recreational human activity in 2011. Vehicular traffic on the levee consisted primarily of infrequent trips by heavy-duty pickup trucks transporting equipment and materials for routine maintenance along the levee system. After trail opening, the level of vehicular traffic is likely to have been similar to pretrail opening, while recreational human activity has almost certainly increased as more people discover this area. Trail users were typically between 3 and 30 m from turtles along the trail.

From June through August 2011, we collected observational data on turtle response rates to various types of recreational activity and recorded basking durations. We observed turtles at 3 locations known to be well-used basking sites based on previous studies (C. Alderete, *pers. comm.*, March 2011). We were concealed behind surrounding vegetation and natural barriers while observing both human activity and turtle behavior using binoculars and spotting scopes (Moore and Seigel 2006). Our distance to basking turtles was approximately 20–30 m. Data on human activity included type of recreational activity (categorized as walker, runner, bicyclist, or motor vehicle), number of people, and general noise level. Observations of turtle behavior included number of turtles, basking duration, initial and submergence behaviors, location, and whether submergence appeared to be associated with human activity or not.

Figure 1. Western pond turtle (*Actinemys marmorata*) habitat at the study site along the San Francisco Bay Trail in Mountain View, California (photographs by P. Nyhof).

We analyzed the data using SYSTAT® 13. The total rate of recreational activity along the Bay Trail and rates for each category of recreational activity were calculated by dividing the number of human activity events by the total observation time. Pearson chi-square (χ^2) tests were used to compare the disturbance rates for each category of recreational activity. The mean basking duration (in minutes) of disturbed turtles was compared with the mean basking duration when no recreationists were present. Because the data did not meet assumptions for parametric tests, we used the Mann-Whitney U-test to compare means.

We observed for a total of 68.5 hrs, with 1238 total human activity events recorded, 346 of which involved basking turtles. We observed 52 individuals basking during June (n = 7), July (n = 24), and August (n = 21). Basking was rarely interrupted by human activity, as only 25 of 346 (7%) possible events ended with turtles abandoning their basking site. However, the rate at which turtles abandoned basking differed by type of human activity (χ^2 = 52.88, df = 3, $p < 0.0001$, n = 346). Turtles abandoned their basking sites at rates of 2%, 5%, and 6% in response to runners, walkers, and bicyclists, respectively (Table 1). However, turtles abandoned basking sites 45% of the time when a motor vehicle passed by on the trail.

The average turtle basking duration of 22 individuals that submerged naturally was 42.8 ± 5.0 SD/min. We recorded 30 individuals that submerged in apparent response to trail use, with an average basking duration of 16.5 ± 2.8 SD/min for each event. Natural basking duration was significantly longer than disturbed basking times (U = 542.5, df = 1, $p < 0.0001$, n = 52), with natural basking being 2.5 times longer than disturbed basking. The 22 natural submergence events were representative of the 30 disturbed submergence events in that they took place in similar temperatures, times of day, and locations.

Table 1. Type, number, and frequency of human activity events that caused turtles to abandon basking at the Moffett Federal Airfield, California, from June through August 2011.

Type	Individuals disturbed	Total no. of individual	Disturbance frequency (%)
Runner	2	99	2
Walker	4	84	5
Bicyclist	9	141	6
Vehicle	10	22	45
Total	25	326	7

Most human activity along the trail was pedestrian traffic (bicyclists, runners, and walkers). Vehicular traffic was largely due to heavy-duty pickup trucks traveling along the levee system, which merges with the Bay Trail in several areas. The overall rate of human activity recorded in this study (18 events/hr) was much lower than observed in other recreational studies involving San Francisco Bay Area Trails, one of which reported 68 human recreational events per hour while observing shorebirds (Trulio and Sokale 2008). Our study site was in a newly opened section of the Bay Trail and, as it becomes more widely recognized, human activity levels could increase.

Overall rates of disturbance were low, which suggests that current human traffic along the trail may only have a limited impact on turtle basking behavior. However, analysis of disturbance types showed western pond turtles were much more likely to respond to motor vehicles than to any other type of disturbance. Motorized vehicles may be especially disruptive to turtles. For example, Moore and Seigel (2006) observed that *G. flavimaculata* frequently abandoned basking behavior due to recreational boat traffic, and Selman et al. (2013) found that boat traffic negatively impacts basking duration for the same species. Intense response to loud and fast-moving vehicles is well documented in bird species, especially when vehicles are approaching animals (Rodgers and Schwikert 2002, 2003; McGowan and Simons 2006). We observed turtles only during the summer months and thus lack data for other seasons. Also, human recreational activity may change throughout the seasons and is likely to increase over time as this section of trail becomes more widely known. The vehicular traffic, on the other hand, remains

rather steady throughout the year (Santa Clara Valley Water District, *pers. comm.*, April 2011).

Our observations indicate that basking periods interrupted by human disturbance are significantly shorter than undisturbed basking periods. Disturbances of this nature reduce time for thermoregulation and loss of heat energy, which could have profound effects on a turtle's ability to survive and reproduce (Crawford et al. 1983; Edwards and Blouin-Demers 2007). There are some benefits that could be gleaned from habitat alteration, as Lambert et al. (2013) concluded that basking sites shielded from human activity may lead to higher-quality basking potential, especially for native freshwater turtles. Thus, we recommend 1) limiting vehicular traffic near important *A. marmorata* basking habitat whenever possible, 2) encouraging drivers of required service vehicles to avoid driving near basking habitat during peak basking times, and 3) investigating installation of high vegetation and other ways to conceal turtles from trail use, especially by vehicles.

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Conservation Research Needs of Easter Island (*Rapa Nui*) Marine Turtles

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ABSTRACT. – Easter Island has experienced a marked increase in tourism during the past few decades; this has intensified the use of natural resources, which has in turn posed new threats to marine wildlife. To gather