A Remote Behavioral Study of Five, Female Rescued Southern Sea Otters (*Enhydra lutris nereis*) at the Monterey Bay Aquarium

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INTRODUCTION

The COVID-19 pandemic has devastated zoos and aquariums across the U.S. and worldwide. In addition to providing jobs, establishing educational programs, and funding crucial conservation measures, zoos and aquariums present a unique opportunity for scientists to carry out important research on animal welfare and behavior, which is especially vital to the preservation of endangered species, such as the Southern sea otter. With many zoos and aquariums still closed to the public or open at a very limited capacity, such research opportunities are limited. The goal of this study is to turn the challenge of limited in-person research to an opportunity to assess live exhibit web cameras as a means for meaningful behavioral research. The focal subjects of this remote naturalistic observation are five female captive, rehabilitated Southern sea otters (*Enhydra lutris nereis*) at the Monterey Bay Aquarium, which has provided a high-quality webcam of its sea otter exhibit since before the beginnings of the pandemic.

The Monterey Bay Aquarium runs a comprehensive sea otter rehabilitation program, including a highly successful surrogacy program for orphaned infants and a multi-stage reintroduction program which allows otters to gradually adjust to a wild environment before they are released and subsequently monitored in the field. Classified as a keystone species, Southern sea otters are vitally important to coastal marine ecosystems in the north Pacific (Larson et al., 2012). By feeding on sea urchins and keeping populations in check, sea otters exert a strong top-down effect by protecting kelp beds from excessive herbivory and thus their ecological role is crucial to the foundation and integrity of kelp forest ecosystems (Estes & Duggins, 1995). Despite years of conservation efforts, remaining sea otter colonies comprise a fraction of that which once existed, both in numbers and genetic diversity (Larson et al., 2012). Without a continued rise in wild populations and successful re-establishment throughout their native range, the future kelp forest ecosystems are vulnerable.

Although the goal of the Monterey Bay Aquarium's Rehabilitation Program is reintroduction, not all rescued otters are successfully transitioned to their native habitat. Often after multiple attempts at reintroduction, some otters are deemed as "unreleasable." That is, they have become too familiar with humans, they are unable to forage for food, or their foraging is consistently unsuccessful. These otters may provide fostering support at the rehabilitation center or serve as ambassadors at other zoos and aquariums. As these otters live out the rest of their lives in a captive environment, the degree to which environmental stimulation enhances or diminishes otter welfare in captivity must be evaluated as too little can contribute to boredom and too much (i.e., ambient noise, visitor proximity and number, etc.) can cause withdrawal. In both instances, abnormal repetitive behavior or stereotypy can occur and although stereotypy can emerge without stressors, stressors almost always result in stereotypy (Mallapur & Chellam, 2002). Naturalistic observations while captive, rehabilitated otters are on exhibit offer an opportunity to monitor their behavior, identify any welfare related questions, assess how response to stressors is manifested, and draw conclusions about how their behavior might relate to stress-response in the wild.

This project entails a live webcam-based behavioral study of five rehabilitated southern sea otter residents of the Monterey Bay Aquarium's Southern sea otter exhibit. In this study, we observed abnormal repetitive behaviors that occurred among Monterey Bay Aquarium otters from December 2020 to March 2021. The two recurring behaviors of interest involve Rosa, rescued as a pup in 1999 and Ivy, rescued as a pup in 2011. Both Rosa and Ivy engaged in a repetitive, pacing-like sequence that occurred continuously in designated exhibit zones.

Empirical Questions

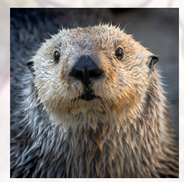
1. Is it feasible to conduct meaningful behavioral research of captive animals from remotely viewed web cameras?

2. Among five rescued, female sea otters involved in a surrogacy program, what are the behavioral dynamics (e.g., socially engaged or autonomous play, grooming, etc.)?

3. If abnormal repetitive behaviors occur, under what context are they most frequent? The least frequent?

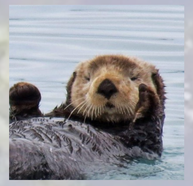
METHOD

SUBJECTS



Ivy was stranded as a two-week-old pup in November 2011 on Cayucos State Beach in San Luis Obispo. After seven weeks of care by Monterey Bay Aquarium staff she was introduced to Toola, an experienced surrogate mother. After multiple factors interfered with her successful transition into the wild, Ivy was declared non-releasable by U.S. Fish and Wildlife Service. She was added to the sea otter exhibit in 2012 and serves as a surrogate mother when not on exhibit.

Rosa was stranded at four weeks old in 1999. She was released back into the wild for two years but was deemed unfit for survival on her own. She spent six years at SeaWorld in San Diego and eventually joined the Monterey Bay Aquarium sea otter exhibit in 2013. She is the oldest otter on exhibit.



Abby was rescued as a newborn pup in July 2007. She was raised at SeaWorld San Diego and transferred to the Monterey Bay Aquarium in 2012. She has served as a surrogate mother in the Monterey Bay Aquarium otter surrogacy program and was a surrogate mother to pup, Sina, in 2013.

Selka, identifiable by her distinctly darker coloring, was found at Cayucos State Beach at one week old in July 2012 and cared for by the sea otter program at Monterey Bay. She was re-released in 2013 but suffered from shark bites. Unable to survive in the wild, she was added to the Monterey Bay Aquarium sea otter exhibit in 2016.

Kit was found in Morro Bay Harbor as a 5-week-old pup in January 2010. She became the youngest otter to be raised on exhibit at just 11 weeks old. She was transferred to Sea World, San Diego in 2012 and transferred to the Monterey Bay Aquarium sea otter exhibit at 3 years old in January 2013.

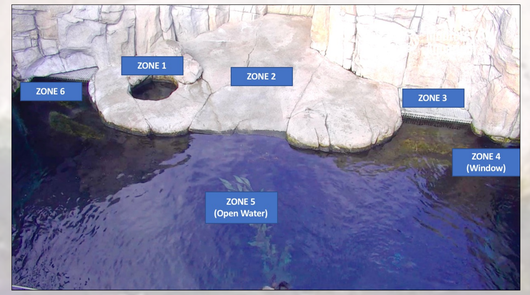
Source: Otter biographies and photos are from the Monterey Bay Aquarium

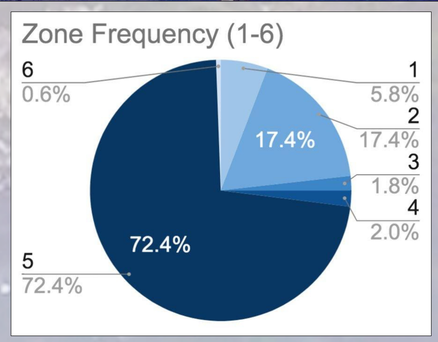
DESIGN AND PROCEDURE

This naturalistic study began in December 2020 and persisted until March 2021, for a total of 19 days of observation. Observers carried out 0-1 scan-sampling in 10-minute intervals with an average of 63 minutes per day and an inter-rater reliability score of 0.85. Observations were recorded using a 40-item ethogram across 6 exhibit zones.

EXHIBIT

The zones reflect six exhibit boundaries delineated by changes in the topography. The six zonal regions allow observers to track where in the enclosure the sea otters spend time and in which zones specific behaviors occur.





RESULTS

To determine whether abnormal repetitive behaviors were occurring, we conducted a phi correlation for each of the dichotomous behaviors from the ethogram in conjunction with abnormal repetitive behavior. Behaviors were marked as abnormal and repetitive if they occurred in a repetitive sequence at least three consecutive times and were not goal-directed. Early in observations, it was clear two of the otters, Rosa and Ivy were engaging in repetitive behavioral swim sequences . Both Ivy and Rosa's repetitive behaviors consisted of a repeated "loop", the equivalent of a captive terrestrial mammal walking in a repeated path around the exhibit. To assess the constituents of Rosa's ARB sequence, Φ=.65, p<.001 we calculated Phi coefficients for all binary (i.e., absent = 0; present = 1) ethogram behaviors, yielding significant coefficients for: Periscope/Scull, Φ=.08, p=.016, Underwater Swim, Φ=.09, p=.011, and Backward Dive, Φ=.14, p<.001. Ivy's ARB sequence, Φ=.77, p<.001 yielded significant Phi coefficients for: Periscope/Scull, Φ=.12, p=.001, Underwater Swim, Φ=.22, p<.001, Forward Dive, Φ=.09, p=.02, Surface Swim, Φ=.22, p<.001, and Log Roll, Φ=.19, p<.001 . Other welfare variables (e.g., enrichment, feedings, grooming, play, ride, and raft) were not correlated with abnormal repetitive behavioral occurrences except Play Enrichment, Φ= -.13, p<.001, which was negatively correlated, suggesting that when enrichment was available, the occurrences of ARBs among all otters was significantly less.

CONCLUSIONS

After completing this study, we can ultimately conclude that it is feasible to conduct meaningful behavioral research of captive animals from remotely viewed web cameras. The results describe two abnormal repetitive behaviors that were exhibited by otters Ivy and Rosa at the Monterey Bay Aquarium. These behaviors were negatively correlated with the Play Enrich behavior (Φ= -.13, p<.001), which suggests that they were less likely to occur when the option to interact with enrichment was available to the otters. We were also able to identify key advantages and disadvantages of carrying out web camera based, remote observational research. Principal benefits of remote research include accessibility, ease of scheduling and recording observations, and a greater range of observation hours (zoos and aquariums have limited guest hours while many live web cameras offer 24-hour viewing). Live web cameras can also offer better visibility than in-person field research, although the positioning of the web cameras varies and is not always optimal. Key drawbacks of remote behavioral research also became apparent. Firstly, the vantage point from above the exhibit, which is most commonly the case, can make it difficult to contextualize behavior. There are also inevitable technical difficulties that arise from poor internet connection either on the end of the institution providing the live video or the researchers. Finally, as there is no audio provided and no view of the guest viewing areas, there is no way to gage the visitor effect on the animals and whether or not it may be significantly related to the presence of absence of abnormal repetitive behaviors.

FUTURE DIRECTIONS

Although advancements towards the end of the COVID-19 pandemic are in motion, the future is uncertain. Despite the temporary shutdown of zoos and aquariums due to shelter-in-place and social distancing orders, live exhibit web cameras allowed us to successfully carry out meaningful behavioral research which led to meaningful results that not only gave us insight the welfare of captive, rehabilitated animals but may allow us to draw conclusions about Southern sea otter behavior and stress-response in the wild. Although researchers may soon be able to return to in-person observations, remote research via live web cameras presented many advantages. Completely remote behavioral research is certainly feasible and allows scientists to study hundreds of species from anywhere in the world with internet access. Even further, behavioral research via live web cameras could serve as an invaluable supplement to in-person behavioral research. Web cameras can provide more comprehensive or novel angles of the exhibit and allow observers to view the animals during times such as dawn and dusk when visitors are not usually able to observe the animals. Some zoos and aquariums also offer web cameras in behind-the-scene areas which offers further insight into their activity budgets, social dynamics, and welfare. Remote behavioral research has abundant potential in the field of behavioral research in the future.

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