**The Effects of Human Activity on the Tameness of Common Loons (Gavia immer) in Northern Wisconsin**

The Common Loon (*Gavia immer*) is an aquatic diving bird that lives in freshwater habitats in Canada and the northern U.S. and is an important bioindicator of its environment. Human activity on a loon’s resident lake may affect its fitness and behavior, yet few studies identify or quantify these effects. We modified existing techniques that measure escape distances in other species to measure tameness as the distance at which individual loons dove in response to human approach by canoe. Tameness was similar between pair members, suggesting that common lake conditions or the behavior of a mate might influence the behavior. Sex, size within sex, and human activity did not influence tameness. However, our data for human activity characterized a lake for an entire breeding season rather than measure the amount of human activity present at the time tameness data was collected. Further studies using our technique for measuring tameness are needed to determine whether tameness is a momentary adjustment to present human activity, a learned response, or if loons are unable to adjust their behavior in response to human activity. If loons do not have the ability to adjust their behavior to human activity, conservation efforts should lengthen the distance at which it is legally allowed to near loons to protect them from potential harm.

**Introduction**

Understanding how human activity affects the fitness and behavior of a species is critically important for conservation efforts (Bennett et. al. 2009; Fernández-Juricic and Tellería 2000; Grear et. al. 2009). Such activity may affect that species’ ability to feed, rest, and breed if it is unable to habituate to the disturbance the activity creates (Rodgers & Schwikert, 2002; Bennet et. al. 2009; Fernández-Juricic and Tellería 2000; Kaplan 2003). Common Loons (*Gavia immer)* in Canada and the northern U.S. are routinely exposed to a variety of human activities during the breeding season and several studies suggest that such activity negatively impacts their fitness (Titus and VanDruff, 1981; Ream, 1976; Heimberger, 1983; Robertson and Flood, 1980). However, few studies specifically identify these effects or quantify the degree of their impact.

Common Loons are ecologically important and behaviorally interesting. Due to their top trophic-level position, high visibility to people, limited dispersal ability, and relatively slow replacement rate, loons are an indicator species of local aquatic integrity (Evers et. al. 2010; Piper et. al. 2012). For example, Common Loons are commonly used as a biosentinel of persistent bioaccumulative contaminants, particularly mercury, lead, and organochlorines (Evers et. al. 2010). Human activity may artificially affect the health of loons such that it inaccurately reflects environmental health, removing their ability to serve as a bioindicator. Also, the process of habituation, defined as a decreased response to a recurring and insignificant stimuli, is of large interest to behavioral ecologists. Loons have displayed the ability to adjust their behavior to shoreline development (Heimberger et. al. 1983), and the analysis of the ways loons react with other types of human disturbancemay lead to insights into how they habituate.

In avian species, a commonly used method of quantifying the sensitivity to human disturbance is the measurement of Escape Distances (ED) (Madsen and Fox 1994), also known as Flight Initiation Distances (FID) (Bonenfant and Kramer 1996 Ydenberg and Dill 1986). ED is typically defined as the distance at which birds fly away in response to an approaching threat and is commonly measured by walking directly at the bird until it flies off  (Bregnballe et. al. 2009; Blumstein 2003). Techniques do exist to measure ED in water birds (Haley et. al., 2015; Rogers and Schwikert 2002), but no techniques exist for diving birds. Common loons have several traits that make them highly skilled divers, yet these same traits cause them to be less efficient at flying compared to other water birds. For the sake of energetic favorability (Lima 1993; Lima 1985; Ydenberg and Dill 1986), common loons tend to dive rather than fly away from human disturbances on open water. Therefore a method for measuring EDs should use diving distance as an indicator of response to approach rather than flush distance.

Additionally, EDs in other birds are typically considered a proxy for their response to an approaching predator (Madsen and Fox 1994; Bonenfant and Kramer 1996; Ydenberg and Dill 1986). In loons, however, ED is more accurately characterized as a direct response to human approach. With the exception of conspecific interactions, loons do not often have to perform evasive maneuvers because there are few natural predators of adults, although some predators, such as bald eagles (*Haliaeetus leucocephalus*), will occasionally attack incubating loons in order to get their eggs (Miller 1988; Vlietstra and Paruk 1997; Paruk 1999a). Therefore, measurement of ED for an individual loon can be equated to an accurate measure of its tameness.

There were two goals of this study: The first goal of this research was to develop a technique that could adequately quantify a loon’s response to an approaching human to measure its tameness, defined as the distance at which individuals dive in response to human approach by canoe. The second was to use the data collected with this technique to analyze various factors that could explain this response, specifically what role human activity had on a loon’s tameness.Since loons had been shown to adjust their behavior in response to increasing shoreline development (Heimberger et. al. 1983), we expected a clear trend between the amount of recreational watercraft use and tameness of the resident loons on that lake.

**Methods and Materials**

*Study Area*

For our study we mainly observed the loons on their resident lakes in Oneida County, Wisconsin, USA (45842’N, 89836’W), which encompassed an area of roughly 800 km2. Additional observations came from lakes in Vilas, Iron, and Forest Counties. (Piper et. al. 2013).

*Marking of loons*

Systematic capture and banding of loons in our study areas allows observers to identify individual loons by looking at their band color combination. The technique, more thoroughly described in Evers (1993) and Piper (1997a), involves spotlighting adults and chicks 5 weeks or older and netting them from small motorboats, banding each of the captured birds with a unique combination of colored plastic leg bands, and releasing the family units within their territories. (Piper et. al. 2013)

*Quantifying human activity*

To quantify the amount of human activity on a lake, each of the 57 lakes used in this study were ranked on a scale of 1 to 5 by a researcher who has worked in the study area since 1991 (W. Piper, personal observation). Higher rankings reflect increased human recreational activity on the open water of a lake, mainly due to personal watercraft. A more quantitative ranking scale is currently in development and will be used beginning in the 2015 summer next breeding season.

*Measuring Escape Distance (i.e. Tameness)*

All observations were made by one of 5 observers between early morning and afternoon (0500 and 1400) on one of 57 lakes in the two study areas from June 05 to August 30 2015. Each of the observers followed the same technique using the same equipment. To ensure that the bird did not dive for reasons other than the approaching observer, measurements were only initiated when the bird was either in a state of resting, preening, or locomoting (swimming without diving). Individual loons were identified by locating their leg band combination using the technique described by Piper (1997a). For analysis purposes, this identification took priority over the acquisition of a tameness measurement, so more often than not the measurement technique was not applied until after an individual loon had been identified.

Following the identification of a loon, an observer pointed the canoe directly towards the loon and initiated the tameness measurement. Distances between the loon and the observer were determined using a Laser Technology TruPulse 200 laser rangefinder aimed directly at the bird. After acquiring the starting distance, the observer incrementally approached the bird by traveling 2 to 4 paddle lengths and before measuring the distance to the loon again. This allowed the observer to measure the distance just before the loon dove and to ensure that the direct approach was slow and similar across observers. This technique is very similar to the one used by Haley et. al. (2015). This ordering of events (Identification first, tameness approach second) meant that the loons were aware of the observer’s presence before the tameness measure was conducted, removing the concern that starting distance is not an accurate proxy for alert distance **(**Dumont et. al., 2007).



**Figure 1 -** An observer in pursuit of a pair of loons. This style of approach was used to collect a tameness measurement Photo Credit Linda Gresler.

***(e) Verification that tameness is a repeated behavior across observers***

We used interobserver reliability, a simple regression analysis, to find the degree of similarity between tameness measures for a single bird collected by several observers. For the analysis, the measurements of the observer who collected data on the greatest number of individuals were compared to the averaged measurements of all other observers for each corresponding individual. This consistency between observer’s measurements of individual loons also served as a control for the possible acclimation or aversion to the observer that the loon could have developed during the time the bird’s ID was being collected.

***(f) Exploring factors that contribute to tameness***

 Subsequent analyses were conducted in an attempt to characterize the factors that determined the tameness behavior of individuals. Analyses included sex vs. tameness (two-tailed t-test), size (based on weight) within sex vs. tameness (simple regression), tameness between pair members (simple regression), and human activity vs. tameness (one-way ANOVA).

**Results and Discussion**

Consistancy of tameness measures between observers was comfirmed by analysis of interobserver reliability (linear regression, P = 0.0013, R**2** = 0.4450) (Figure 2). In an attempt to understand the causes of tameness, we then analyzed various factors that correlated to this response, specifically looking for the degree to which human activity related to tameness.

Using this approach, we demonstrated that that neither sex (two-tailed t-test, T = 0.27, P = 0.78) nor size within sex (linear regression, P = 0.66, R2 = 0.0076 for male and linear regression, P = 0.35, R2 = 0.027 for female) predicted individual tameness. Few, if any, behaviors relevant to tameness in loons are driven by sex (Evers, 1994), so this is not a surprising result. Regarding size, loons do recognize size differences of conspecifics, especially with regards to territorial disputes (Mager & Piper, 2007). However, it is likely that the size of an observer approaching in a canoe is so comparatively large that it eliminates differences in behavior between loons of different sizes.

Tameness between pair members was significantly similar (linear regression, P = 0.0043, R2 = 0.61). This could possibly be explained either by the influences of proximate conspecifics (i.e. social context) (Fernandez et. al., 2002; Laurson, 2005), homogenization of tameness between pair members as a function of living together. However, tameness data were collected without regard to social context and without this data the way these first two influences may factor into tameness cannot be analyzed.

It was also found that the degree of human activity did not correlate to the tameness of both intruders (one-way ANOVA, F = 0.60, P = 0.5533) and resident pair members (one-way ANOVA, F = 1.6, P = 0.2257). This could mean loons are not affected by the human activity that occurred in the study area and therefore would not need to adjust their behavior. However, negative fitness impacts of such activity have been documented in other populations (Titus and VanDruff, 1981; Ream, 1976; Heimberger, 1983; Robertson and Flood, 1980) and it is likely that they also occur in the Northern Wisconsin population. Another possible explanation is loons are unable to adapt to the threats posed by increasing amounts of human activity. Loons do display the ability to adjust their behavior to counterbalance disturbance caused by shoreline development and human approach while nesting (Titus and Vandruff, 1981). Interesting comparisons can be made to determine why similarly effective adjustments do not exist on the open water, where tameness data was collected**.** Nevertheless, if loons are not able to adjust their behavior to compensate for on-lake activity, these disturbances should be minimized with the institution of greater or more rigid set back distances, or the minimum length at which human activity is legally allowed (Rogers and Smith, 1995; Blumestead et. al., 2003; Rogers and Schwikert, 2002)*.*

Additionally, studying potential causes of tameness not involved with human habituation could lead to a better characterization of the behavior. Though not considered in this study, the tameness may vary depending on a pair’s reproductive status (i.e. nest searching, nesting, etc.) or at different stages of a chick’s development (Badzinski, 2004). Further collection and analysis of tameness data complimented with data on reproductive status or chick development could help characterize tameness and aid in the determination of proper set back distances.

In conclusion, tameness cannot be explained by habituation to human on-lake activity, sex, or size within sex. However, there is a significant relationship between the tameness of pair members that could be elaborated with further research that accounts for social context. While the drivers of tameness have yet to be identified, tameness data can reliably be collected using the highly reproducible approach developed in this study. This approach technique has opened the door to many possible threads of research that will allow for a greater behavioral understanding of Common Loons and greater ability to protect them from human disturbance.

**Fig 2 –** The Interobserver Reliability regression analysis measured the similarity between every observer’s determined tameness values for a single loon. The Standard Tameness Measure contains the measurements of the observer who collected the greatest number of tameness measurements. The Pooled Tameness Measure contains the measurements of all other observers. Each of the 20 loons is represented by a single point. If a loon had multiple measurements within either the pooled tameness measures group or the standard tameness measures group, those measurements were averaged to produce the value that was graphed.

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Online publication date: 14-Feb-2015

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