Speaking with the frogs: changes in call types and call rate in *Rana clamitans* due to stimuli of varying amplitudes and time

BIOS 35502: Practicum in Environmental Field Biology

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Abstract

This study looked at choruses of *Rana clamitans*, or Green Frogs, and the effect of call stimuli with different amplitudes on call types and call rate over time. The purpose of this was to link energetic motives to the use of more costly and aggressive calls in the case of a territorial intruder. We hypothesized that amplitude would have an effect on the amount of calls and types of calls from responding frogs and that the beginning and end minute of the sound stimuli would elicit different numbers of calls and different types of calls within the treatments. The experiment involved 12 different bodies of water in Northern Wisconsin and the Upper Peninsula of Michigan, where we mimicked a male calling. We used three different treatments, a low amplitude, a high amplitude, and a control with no call. We then recorded the response of the chorus to measure the number of total responding calls, the number of aggressive calls and the number of aggressive notes within the aggressive calls. We found our hypotheses to be partially supported where treatment (df=2, p=.0739<.10) and the minute measured after the stimulus began (df=1, p=.0705<.10) significantly influenced the number of aggressive calls. Additionally, treatment and minute measured also both had a significant effect on average number of aggressive notes within these calls. These results are important in understanding the social interactions of breeding males and how they use energy when there are tradeoffs between survival, growth, and reproduction.

Introduction

In the natural world, there is a battle between allocating energy for reproductive success or for survival and growth. If a behavior is energetically expensive, but increases an individual’s chances of reproducing, then energy may be allocated to the costly behavior. However, the alternative may also be true, depending on the mating strategies and total cost of the behavior for the organism. This can be seen in frog mating strategies, where many of their mating strategies include flashy and costly behavior such as splashing, moving, or calling (Wells 1978). Elmberg and Lundberg (1991) analyzed this concept of energy allocation and tradeoffs in populations of male *Rana temporaria,* or male common frogs. They found by studying different populations at different altitudes, calling creates more active success in gaining a mate, but active males may have an increased mortality due to depleting their energy reserves (Elmberg and Lundberg 1991). In populations that live at comparatively high altitudes, males have shorter feeding seasons, while males who live in populations at lower altitudes have longer feeding seasons. Mating activity was higher in the low altitude populations and long feeding seasons. Mating activity was lower in high altitude populations, where males had shorter breeding seasons, weaker calls, and generally were slower to move (Elmberg and Lundberg 1991).

In our study system *Rana clamitans*, or green frogs, we also observe this tradeoff. Selection of mates for *R. clamitans* is based on the territory a male is residing in, where the territory serves as a site for sexual display and where the females will oviposit (Wells 1977). Wells (1977) found that ovipositing female frogs prefer areas with dense cover, in the corners of ponds, shallow areas near shore, and territories with dense vegetation. Once they find a suitable territory, they will mate with whichever male frog is in this territory. To protect their territories, males employ five calls: type I non-aggressive advertisement calls, type II aggressive high intensity advertisement calls, type III and IV aggressive contact calls, and type V release calls (Wells 1978). According to Wells (1978), a type I "advertisement call", is given at random intervals to broadcast a male's location not only to warn off opposing males, but also to attract females. This call is considered to be non-aggressive. Type II calls are "high intensity advertisement calls", often consist of multiple notes, and are seen as a more aggressive call. This multiple note call is used in response to a disturbance in a frog's territory, such as an intruder, and it is often accompanied with loud splashing, jumping, or other aggressive movements (Wells 1978). These calls begin with a relatively low amplitude and progressively increase in amplitude (Perrill and Bee 1996). Wells (1978) observed that when a male gave a type II call, the other males in the chorus often responded with the same call. Wells (1978) also describes a type III call, which is given in close range between two males as a warning before a fight. He also presents a type IV call, which is a low frequency growl, and a type V or release call produced by clasped females or males losing a wrestling match.

In studies where a call is simulated towards an individual frog, type II responses are rarely produced (Perrill and Bee 1996). Most responses are multiple note type I calls, and often the individual approaches the speaker platform (Perrill and Bee 1996). Additionally, with increasing amplitude of an intruder in a territory, males increase both their calling and movement rates, while duration of notes has varied by study (Owen and Gordon 2005, Perrill and Bee 1996). Type II high intensity calls elicit more type II response calls than either the single-note or multiple note stimuli (Perrill and Bee 1996). Wells (1978) also found that males lose weight during the breeding season, suggesting that they are under energy stress, and data has shown that aggressive responses to intruders are energetically costly (Owen and Gordon 2005). Additionally, more aggressive responses make the male more visible to predators (Owen and Gordon 2005).

Because of energy expenditure, frogs may find it advantageous to switch calling strategies (Garcia et al. 2018). Since larger males produce lower frequency calls and smaller males produce higher frequency calls, signals can reveal the "quality" of the signaller, and frogs may adjust their strategy and responses to the caller (Garcia et al. 2018). One strategy utilized by smaller, less competitive males is satellite behavior (Wells 1977). In satellite behavior, *R. clamitans* males sit silently in another male's territory with low posture in the water, in hopes of intercepting a female (Wells 1977, Humfield 2008). However, it has been shown that in eavesdropping satellite *Hyla cinera* males, they assess their competitive stance against other males based on their own size and the call frequency of other males, and they may switch between assessment strategies based on mutual assessment when facing inferior or superior opponents (Garcia, et al. 2018). Having a strong chance of winning is important in looking at energy expenditure, as losses have been found to have physiological effects and can create stress (Leary & Crocker-Buta 2017).

So while it has been shown that size influences behavior and has physiological impacts, our experiment looked specifically at how behavior and calling strategies may change in the face of an approaching intruder in a chorus setting. In order to look at this, a speaker was used to mimic an intruding male frog at different distances within a chorus. To change the distances perceived between the frogs, we used increased amplitude to replicate the sound of a male. We wanted to look at the changes between treatments, changes within a treatment over time, and how the frogs in a chorus might respond, especially in the use of more energetic costly calls. In this study, one specific hypothesis tested was that amplitude would have an effect on the amount of calls and types of calls. We predicted that there would be more calls in general with the higher amplitude treatment, and there would be more aggressive type II calls with higher amplitude treatment. We also hypothesized that the beginning and end of the sound stimuli would elicit different numbers of calls and different types within the treatments. We predicted that because of energetic costs, there would be more advertisement calls and more aggressive calls at the onset of the stimuli in the first minute compared to the end.

Methods

Experiment

Green frogs (*Rana clamitans)* were used in this experiment. These are the ideal system of study because they are diurnal, territorial, and their calls are easily identified. The calls of these males are very loud in order to protect their territory and attract females, making them a relatively easy subject to find and study.

Nineteen sites within the University of Notre Dame Environmental Research Center property were identified as male chorusing territories, located on both sides of the state line between Wisconsin and Michigan's Upper Peninsula, USA. Sites consisted of 12 bodies of water, including lakes of different sizes, creeks, vernal ponds, permanent ponds, and dystrophic bogs. Within these aquatic habitats, 19 locations were tested overall (Table 1). These were based on confirmations of green frogs being present, either through sight or by hearing the frogs. In order to mimic a male calling, we used a pre-recorded type I advertisement call edited to repeat with a 15 second period, and used three different treatments, a low amplitude, a high amplitude, and a control. We set up the stimuli by measuring the amplitude 50 cm away from the front of the speaker. There was a control of no call (silence), a high amplitude of around 90 dB, and a low amplitude of about 70 dB. This simulated a close-intruding male versus a male frog at a further distance. This was based on the inverse square law, which states that your decibel level decreases by the inverse square of distance because of the way that sound attenuates over a distance.

We considered the first minute of each treatment as an adjustment period for the frog, and then followed with four minutes of the treatment. To prevent frogs from being recorded twice, a cut off was used to ensure frogs did not overlap with other locations. This cutoff was 30 decibels below the highest amplitude stimulus on the recording. If it was below that, it would be excluded.

Throughout the months of June and July, 2019, a location was selected and between the hours of 11 am and 6 pm, we would enter the field and do our experiment. After locating a spot with frogs, the speaker was set on the side of the embankment, as close as possible while keeping the speaker dry. Then, we used a handheld Sony Stereo Digital Voice Recorder ICD-SX2000 about 0.707 m diagonally in front of the front edge of the speaker. This varied due to the terrain, but was around the same location for each recording. To account for the variability in recording position, the cutoff was based on the loudest stimulus of the trial within each recording. The treatments, control, medium amplitude, and high amplitude, were then randomized, and each would be successively played for five minutes each, while responses were recorded. If a frog was located at a visible distance, we would measure its beginning and final location. Temperature, date, and time were also recorded with each trial.

Call Types and Data Analysis

In this study we only looked at type I advertisement calls (Fig. 1) and type II high intensity advertisement calls (Fig. 2). Since Type II calls are used aggressively, it will henceforth be referred to as an aggressive call. Since types III, IV, and V are elicited in close range of the males, they were not able to be analyzed in a chorus setting.

To analyze the recordings, we used the sound analysis software Ravenpro (Cornell Lab of Ornithology 2014). After the acclimation minute, the second minute of each recording, the 1:00, 6:00, and 11:00, was analyzed for number of type I advertisement calls, number of type II aggressive calls, and the average number of type II aggressive notes within each call. This was also done for the final minute of the treatment, or at the 4:00, the 9:00, and 14:00 mark. Average call length was also recorded for this last minute.

Statistics

We normalized abnormal data using a log +1 transformation, due to many recordings that contained no calls. Then we ran ANOVAs to compare treatment and minute measured to number of total calls, number of advertisement calls, number of aggressive calls, and number of aggressive notes.

Results

We used a significance level of $\alpha=.10$. Our ANOVAs revealed there was no significant effect of treatment ($df=2$, $p=.106>.10$) or minute measured ($df=1$, $p=.732>.10$) on total number of calls. In addition, neither treatment ($df=2$, $p=.160>.10$) or minute measured ($df=1$, $p=.797>.10$) had a significant effect on number of advertisement calls.

However, in running ANOVAs for aggressive calls, treatment ($df=2$, $p=.0739<.10$) and the minute measured after the stimulus began ($df=1$, $p=.0705<.10$) significantly influenced the number of aggressive calls (Table 2), and treatment ($df=2$, $p=.0577<.10$) and minute measured ($df=1$, $p=.0860<.10$) also both had a significant effect on average number of aggressive notes within these calls (Table 3). In looking at the treatments for these two variables, post hoc tests of Tukey's Honestly Significant Differences showed that the number of aggressive calls varied significantly between the high amplitude and control treatment, where $p=.0667784<.10$ (Table 4). In the high amplitude treatment, there were significantly more aggressive calls in both the final (Figure 6) and initial minutes (Figure 5) than the control treatment. The post hoc test for the number of aggressive notes showed a significant difference between the low amplitude and control treatment, where $p=.0801589 <.10$ (Table 5). In the low amplitude treatment, there were significantly more aggressive notes than in the control treatment for both final (Figure 8) and initial minutes (Figure 7). For the final minute, there were only two instances in which frogs had an aggressive call. In one location for the high amplitude treatment, there was one call with two notes, and in another location during the low amplitude, there were six calls with an average of 3.3333 notes per call. We also noticed frogs moving towards the speaker, and even splashing aggressively, but this only occurred three times.

Discussion

Our prediction that there would be more total calls and more aggressive type II calls with the higher amplitude treatment was only partially supported. There was no significant difference in the average amount of advertisement calls between treatments. This may be due to the fact that these calls have a bifunctionality and are not only used for defending territory, but also for advertising location to females, which causes these calls to be more random and not influenced by the presence of an intruder (Wells 1978). However, there was a significant difference between the high amplitude treatment and control treatment for the average amount of aggressive calls. This suggested that the high amplitude is provoking the frogs to use more costly or aggressive calls (Owen and Gordon 2005). However, Owen and Gordon (2005) demonstrated that frogs rarely respond with type II high intensity advertisement calls in direct response to a stimulus, but rather respond to a male eliciting type II high intensity advertisement call within the chorus. This contradicts our findings, where we elicited an aggressive type II high intensity call significantly more often in response to our high amplitude stimulus. In previous studies, a speaker was directly floated towards the male being studied, so this might indicate that to evoke an aggressive type II high intensity advertisement call, the frog may switch calls once they have a visual target of the intruder (Owen and Gordon 2005). This suggests that they may not solely assess other males phonetically, but may also use visual cues. Perhaps if a male visually deems the intruder inferior, it may switch to a less energetically expensive call. Further research would be needed to compare visual and auditory cues of males in response to territory intruders.

Our prediction that there would be more advertisement calls and more aggressive calls at the onset of the stimuli compared to the final minute was partially supported. As mentioned, there was no significance in the number of advertisement calls, but there were significantly more aggressive type II high intensity advertisement calls in the initial minute than in the final minute. This could be due to energy usage, where a frog is using its energy to produce more aggressive calls, but eventually has to stop due to energy depletion (Owen and Gordon 2005). An alternate hypothesis is that the frogs could began to view this consistent call as a superior male, where its persistence threatens the frog's confidence. If this is the case, the male could switch strategies and exhibit satellite behavior, where it simply sits quietly in the water and eavesdrops to save energy (Wells 1977, Garcia et al. 2018). It has been shown that in vocal contests, corticosterone, a stress hormone, is higher in males that lost vocal contests in natural choruses compared to contest winners and non-aggressive males, while testosterone levels are lower in contest losers compared to non-aggressive males (Leary 2018). These high corticosterone levels in losers have been found to mediate detrimental effects on male courtship signals and behavior that reduces the losers' probability of attracting female mates (Leary & Crocker-Buta 2017). Additionally, corticosteroids mobilize stored energy, inhibit energy storage, and stimulate gluconeogenesis, suggesting that it is energetically expensive to lose these contests (Denver 2009). Because of this, switching to satellite behavior could be energetically beneficial for males facing superior competitors. It could also simply be that the frog is acclimated to the stimulus, and eventually does not see it as a threat to its territory.

Average number of aggressive notes was significantly higher in the low amplitude treatment than the control. This finding contradicted our prediction that there would be more calls overall in the higher amplitude, since each aggressive call was essentially a more aggressive multiple advertisement note call. Additionally, since it was the low amplitude treatment that differed significantly, this seems to contradict past studies, where increasing amplitude of an intruder in a territory, males increased both their calling rates and movement rates (Owen and Gordon 2005, Perrill and Bee 1996). In playing an advertisement call stimuli, Perrill and Bee (1996) found that frogs lowered their dominant frequency in their call, so this may be more important in communication than the number of calls, however this was not something investigated in this experiment. Further research would be needed.

This study has several limitations. First of all, the breeding season started several weeks later than previous years, preventing the maximum amount of data from being collected within the ten week study period. Additionally, by looking at the chorus overall, it was difficult to tell the number of frogs within the chorus, which may influence the rate in which males call. In *Hyla versicolor*, males in dense choruses call at half the rate of frogs in less dense choruses (Wells & Taigen, 1986). This phenomenon could also be present in *R. clamitans.* Furthermore, the position of the speaker could be nearer to frogs of the chorus in one trial versus another. This would change the frogs' responses, where Type III and IV are elicited in close range encounters (Wells 1978). These are not picked up easily by recordings, especially type IV low frequency growls, which cannot be heard by humans more than 2-3 meters away (Wells 1978). Therefore, this could have been an important response by close frogs that we were not able to hear. In future studies, it would be interesting to look at the frequencies of the aggressive calls and see if this data aligns itself with previous studies. To have a better idea of the chorus being tested, we could compare for the amount of frogs calling in the chorus and other characteristics between choruses. It would also be interesting to look at the energetics of the frogs, like looking at the pond water temperature and doing hormonal assays. One other interesting aspect would be to look at the individual sizes of territories, as this would determine the amount of food that frogs can use and in turn determine the amount of energy available for calling (Elmberg, J., & Lundberg, P. 1991).

In conclusion, there was a significant difference between the initial minute of treatment to the final minute of the treatment for average number of aggressive calls, there was a significant difference between the high amplitude treatment and control for the average amount of aggressive calls, and the average number of aggressive notes was significantly higher in the low amplitude treatment (70 dB) than the control. Understanding the social interactions of breeding males and their implications with energy usage is important for looking at reproduction and fitness, as this could be impacted by a multitude of factors, such as human development, climate change, and pollution. This easy study system can help identify these implications and determine how different species may be impacted.

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Tables

Number of Locations	Number of Sites	Average Air Temperature	Date Range
12	19	27.21	6/11/19- 7/9/19

Table 1. In the experiment, there were 12 different bodies of water used, and within these locations, 19 sites were tested on. The average air temperature for these locations was 27.21degrees Celsius. The dates in which trials were conducted ranges from June 11, 2019 to July 9, 2019.

Effect of Treatment and Minute Measured on Number of Aggressive Calls	Df	F-Value	P-Value
Treatment	2	2.668	0.0739
Minute Measured	1	3.336	0.0758

Table 2. ANOVA testing significance of treatment and minute measured on number of aggressive calls. Both were significant, with p-values less than 0.10.

Effect of Treatment and Minute Measured on Average Number of Aggressive Notes	Df	F-Value	P-value
Treatment	2	2.93	0.0577
Minute Measured	1	3.002	0.086

Table 3. ANOVA testing significance of treatment and minute measured on average number of aggressive notes. Both were significant, with p-values less than 0.10.

Post Hoc for Number of Aggressive Calls	Difference	Lower	Upper	P-value
High amplitude-Control	0.25015765	-0.01351518	0.5138305	0.0667784
Low amplitude-Control	0.17342897	-0.09024385	0.4371018	0.2660721
Low amplitude-High amplitude	-0.07672867	-0.3404015	0.1869442	0.7689278

Table 4. Post Hoc tests of Tukey’s Honestly Significant Differences for ANOVA comparing effect of treatment on number of aggressive calls. There is a significant difference in number of aggressive calls between the high amplitude and control treatment, where p=.0667784<.10.

Post Hoc for Number of Aggressive Notes	Difference	Lower	Upper	P-value
High amplitude-Control	0.187877	-0.03448819	0.4102421	0.1151754
Low amplitude-Control	0.203489	-0.01887619	0.4258541	0.0801589
Low amplitude-High amplitude	0.015612	-0.20675316	0.2379772	0.9847721

Table 5. Post Hoc Tukey’s Honestly Significant Differences for ANOVA comparing effect of treatment on average number of aggressive notes. There is a significant difference in number of aggressive calls between the medium and control treatment, where p=.0801589<.10.

Initial Average Number of Aggressive Calls	**Median**	**Mean**	**N**
Control	0	0	19
Low Amplitude	0	0.789473684	19
High Amplitude	0	1.578947368	19

Table 6. For the initial minute average number of aggressive calls, the median for the control was 0, the mean 0, and n=19. The median for the low amplitude was 0, the mean was 0.787473684, and n=19. The median for the high amplitude was 0, the mean was 1.578947368, and n=19.

Initial Average Number of Aggressive Notes per Aggressive Call	**Median**	**Mean**	**N**
Control	0	0	19
Low Amplitude	0	0.888157895	19
High Amplitude	0	0.564549811	19

Table 7. For the initial average number of aggressive calls, the median for the control was 0, the mean 0, and n=19. The median for the low amplitude was 0, the mean was 0.888157895, and n=19. The median for the high amplitude was 0, the mean was 0.564549811, and n=19.

Figures

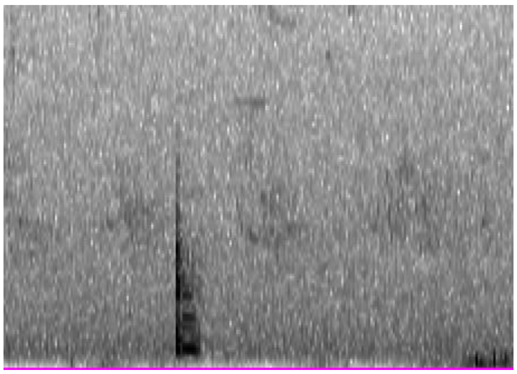

Figure 1. Spectogram of Type I Advertisement Call. Tender Bog, UNDERC

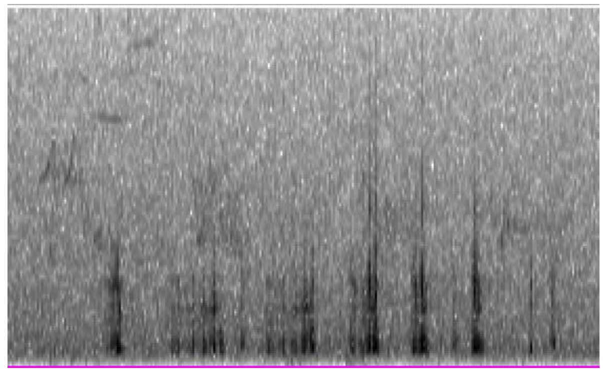

Figure 2. Spectogram of Type II High Intensity Advertisement Call. Tender

Effect of Treatment and Minute Measured on Average Number of Aggressive Calls

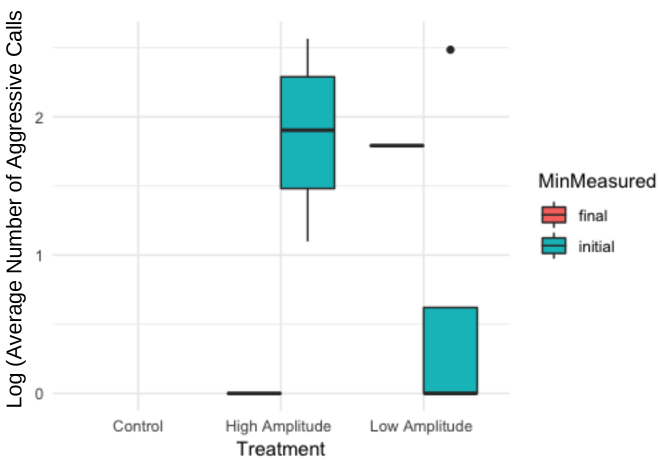

Figure 3. The effect of treatment and minute measured on the average number of aggressive calls per trial. The initial treatment had significantly more aggressive calls than the final treatment. For both final high amplitude (90 dB) and final low amplitude treatment (70 dB), there was only one data point and none for the control.

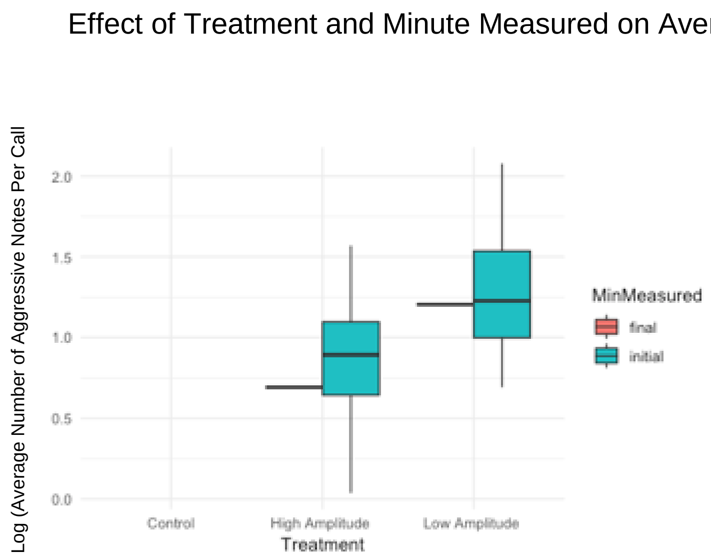

Figure 4. The effect of treatment and minute measured on the average number of aggressive notes per trial. The initial treatment had significantly more aggressive calls than the final treatment. For both final high amplitude (90 dB) and final low amplitude treatment (70 dB) there was only one data point and none for the control.

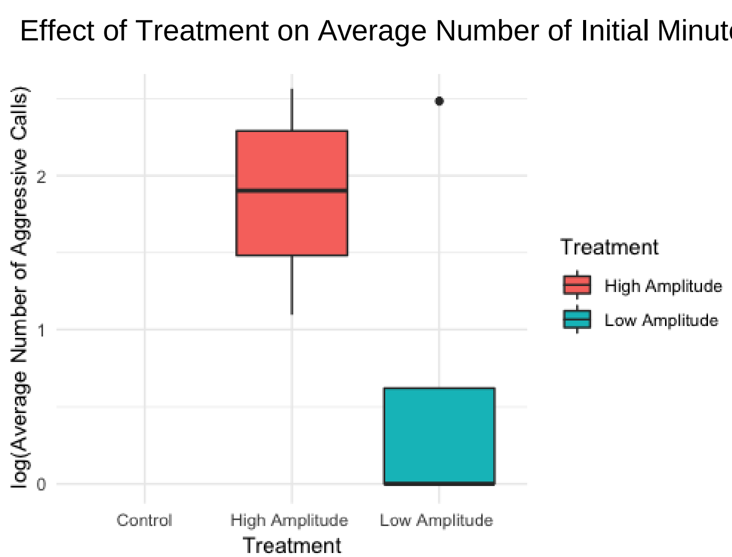

Figure 5. The effect of treatment on the average number of initial minute aggressive calls per trial. There were significantly more calls in the high amplitude (90 dB) treatment than the control treatment.

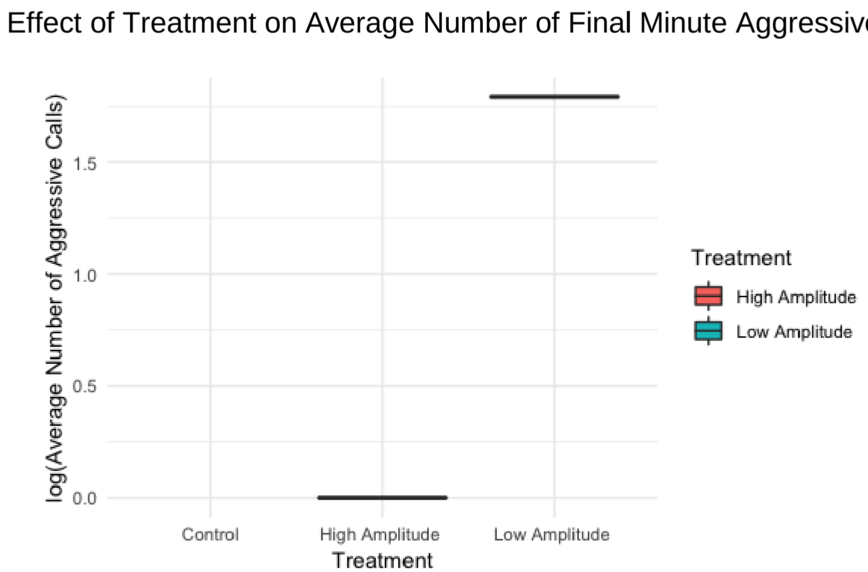

Figure 6. The effect of treatment on the average number of final minute aggressive calls per trial. There were significantly more calls in the high amplitude treatment (90 dB) than the control treatment. There was only one data point for the low treatment (70 dB) and one for the high amplitude treatment (90 dB). No frogs called aggressively in the control treatment.

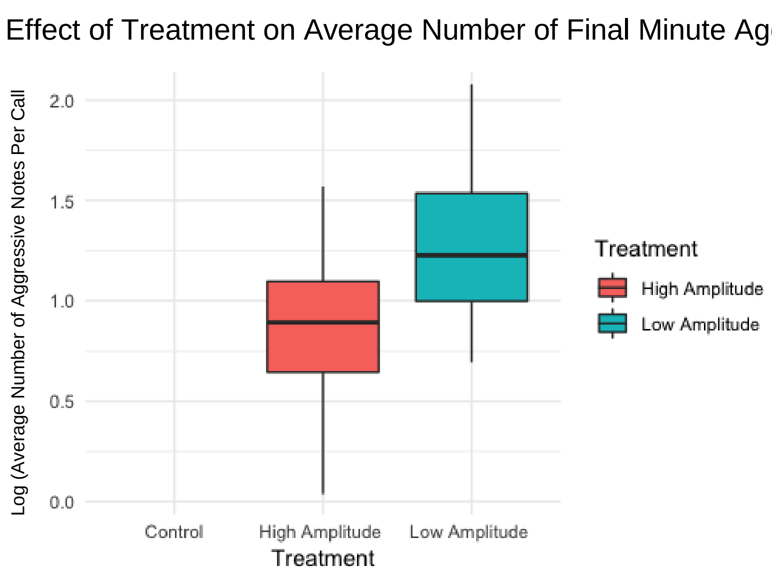

Figure 7. Effect of treatment on average number of initial minute aggressive notes per aggressive call per trial. There are significantly more notes in the low amplitude treatment (70 dB) than the control treatment.

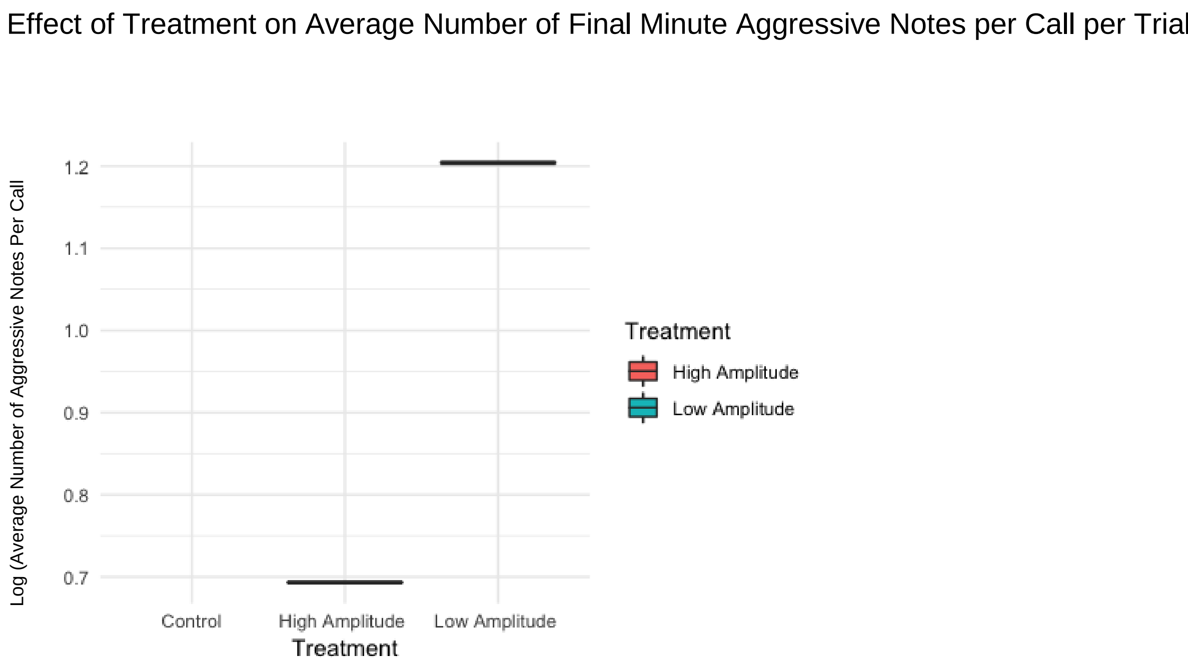

Figure 8. Effect of treatment on average number of final minute aggressive notes per call per trial. There are significantly more notes in the low amplitude treatment (70 dB) than the control treatment. There was only one data point for the low amplitude treatment (70 dB) and one for the high amplitude treatment (90 dB). No frogs called aggressively in the control treatment.

Appendix

Raw Data

Date	DateNum	Location	Treatment	NumCalls	NumAdvert	NumAggress	AvgNumAggressiveNotes	Temp	AvgCallLengthAdvert	MinMeasured
11-Jun	43627	GrasshopperNationN	Control	16	16	0	0	27C	0.0909375	final
11-Jun	43627	GrasshopperNationW	Control	9	9	0	0	27C	0.151111111	final
13-Jun	43629	CranberryN	Control	0	0	0	0	26C	0	final
13-Jun	43629	CranberryNE	Control	0	0	0	0	26C	0	final
9-Jul	43655	BayNW	Control	0	0	0	0	26C	0	final
9-Jul	43655	BayW	Control	0	0	0	0	26C	0	final
26-Jun	43642	Bulger	Control	14	14	0	0	24C	0.142785714	final
17-Jun	43633	RoachE	Control	0	0	0	0	23C	0	final
2-Jul	43648	RoachSW	Control	2	2	0	0	27C	0.1915	final
9-Jul	43655	Hummingbird	Control	1	1	0	0	30C	0.21	final
9-Jul	43655	MorrisNE	Control	1	1	0	0	32C	0	final
13-Jun	43629	MorrisW	Control	0	0	0	0	23C	0	final
8-Jul	43654	TenderfootBog	Control	2	2	0	0	32C	0.085	final
8-Jul	43654	TenderfootLakeS	Control	4	4	0	0	31C	0.16625	final
8-Jul	43654	TenderfootLakeNE	Control	0	0	0	0	27C	0	final
21-Jun	43637	TenderfootCreek	Control	4	4	0	0	29C	0.225	final

9-Jul	43655	WillowAlderN	Control	4	4	0	0	24C	0.1605	final
9-Jul	43655	WillowAlderS	Control	1	1	0	0	31C	0.17	final
8-Jul	43654	WoodduckE	Control	0	0	0	0	26C	0	final
11-Jun	43627	GrasshopperNationN	Low Amplitude	31	31	0	0	27C	0.106385965	final
11-Jun	43627	GrasshopperNationW	Low Amplitude	5	5	0	0	27C	0.157111111	final
13-Jun	43629	CranberryN	Low Amplitude	0	0	0	0	26C	0	final
13-Jun	43629	CranberryNE	Low Amplitude	0	0	0	0	26C	0	final
9-Jul	43655	BayNW	Low Amplitude	1	0	0	0	26C	0.157	final
9-Jul	43655	BayW	Low Amplitude	0	0	0	0	26C	0	final
26-Jun	43642	Bulger	Low Amplitude	8	8	0	0	24C	0.1452667	final
17-Jun	43633	RoachE	Low Amplitude	1	1	0	0	23C	0.063	final
2-Jul	43648	RoachSW	Low Amplitude	2	2	0	0	27C	0.1375	final
9-Jul	43655	Hummingbird	Low Amplitude	2	2	0	0	30C	0.1275	final
9-Jul	43655	MorrisNE	Low Amplitude	3	3	0	0	32C	0.18466667	final
13-Jun	43629	MorrisW	Low Amplitude	0	0	0	0	23C	0	final
8-Jul	43654	TenderfootBog	Low Amplitude	3	3	0	0	32C	0.118166667	final

8-Jul	43654	TenderfootLakeS	Low Amplitude	6	6	0	0	31C	0.150667	final
8-Jul	43654	TenderfootLakeNE	Low Amplitude	0	0	0	0	27C	0	final
21-Jun	43637	TenderfootCreek	Low Amplitude	23	17	6	3.3333	29C	0.252405405	final
9-Jul	43655	WillowAlderN	Low Amplitude	4	4	0	0	24C	0.19075	final
9-Jul	43655	WillowAlderS	Low Amplitude	1	1	0	0	31C	0.192	final
8-Jul	43654	WoodduckE	Low Amplitude	0	0	0	0	26C	0	final
11-Jun	43627	GrasshopperNationN	High Amplitude	20	20	0	0	27C	0.2265	final
11-Jun	43627	GrasshopperNationW	High Amplitude	9	9	0	0	27C	0.215333	final
13-Jun	43629	CranberryN	High Amplitude	6	5	1	2	26C	0.15766667	final
13-Jun	43629	CranberryNE	High Amplitude	0	0	0	0	26C	0	final
9-Jul	43655	BayNW	High Amplitude	1	1	0	0	26C	0.134	final
9-Jul	43655	BayW	High Amplitude	2	0	0	0	26C	0.0985	final
26-Jun	43642	Bulger	High Amplitude	34	33	1	2	24C	0.154626866	final
17-Jun	43633	RoachE	High Amplitude	3	3	0	0	23C	0.0315	final
2-Jul	43648	RoachSW	High Amplitude	7	7	0	0	27C	0.167857143	final

9-Jul	43655	Hummingbird	High Amplitude	8	8	0	0	30C	0.12325	final
9-Jul	43655	MorrisNE	High Amplitude	0	0	0	0	32C	0	final
13-Jun	43629	MorrisW	High Amplitude	2	2	0	0	23C	0.2355	final
8-Jul	43654	TenderfootBog	High Amplitude	0	0	0	0	32C	0	final
8-Jul	43654	TenderfootLakeS	High Amplitude	5	5	0	0	31C	0.184333333	final
8-Jul	43654	TenderfootLakeNE	High Amplitude	1	1	0	0	27C	0.093	final
21-Jun	43637	TenderfootCreek	High Amplitude	6	6	0	0	29C	0.2195	final
9-Jul	43655	WillowAlderN	High Amplitude	5	5	0	0	24C	0.1616	final
9-Jul	43655	WillowAlderS	High Amplitude	2	2	0	0	31C	0.2265	final
8-Jul	43654	WoodduckE	High Amplitude	0	0	0	0	26C	0	final
11-Jun	43627	GrasshopperNationN	Control	15	15	0	0	27C		initial
11-Jun	43627	GrasshopperNationW	Control	6	6	0	0	27C		initial
13-Jun	43629	CranberryN	Control	0	0	0	0	26C		initial
13-Jun	43629	CranberryNE	Control	0	0	0	0	26C		initial
9-Jul	43655	BayNW	Control	1	1	0	0	26C		initial
9-Jul	43655	BayW	Control	1	1	0	0	26C		initial

26-Jun	43642	Bulger	Control	26	26	0	0	24C	initial
17-Jun	43633	RoachE	Control	2	2	0	0	23C	initial
2-Jul	43648	RoachSW	Control	0	0	0	0	27C	initial
9-Jul	43655	Hummingbird	Control	2	2	0	0	30C	initial
9-Jul	43655	MorrisNE	Control	2	2	0	0	32C	initial
13-Jun	43629	MorrisW	Control	0	0	0	0	23C	initial
8-Jul	43654	TenderfootBog	Control	1	1	0	0	32C	initial
8-Jul	43654	TenderfootLakeS	Control	4	4	0	0	31C	initial
8-Jul	43654	TenderfootLakeNE	Control	1	1	0	0	27C	initial
21-Jun	43637	TenderfootCreek	Control	3	3	0	0	29C	initial
9-Jul	43655	WillowAlderN	Control	6	6	0	0	24C	initial
9-Jul	43655	WillowAlderS	Control	3	3	0	0	31C	initial
8-Jul	43654	WoodduckE	Control	0	0	0	0	26C	initial
11-Jun	43627	GrasshopperNationN	Low Amplitude	30	30	0	0	27C	initial
11-Jun	43627	GrasshopperNationW	Low Amplitude	3	3	0	0	27C	initial
13-Jun	43629	CranberryN	Low Amplitude	3	2	1	3	26C	initial
13-Jun	43629	CranberryNE	Low Amplitude	0	0	0	0	26C	initial

9-Jul	43655	BayNW	Low Amplitude	0	0	0	0	26C	initial
9-Jul	43655	BayW	Low Amplitude	1	0	1	8	26C	initial
26-Jun	43642	Bulger	Low Amplitude	5	5	0	0	24C	initial
17-Jun	43633	RoachE	Low Amplitude	0	0	0	0	23C	initial
2-Jul	43648	RoachSW	Low Amplitude	2	2	0	0	27C	initial
9-Jul	43655	Hummingbird	Low Amplitude	2	2	0	0	30C	initial
9-Jul	43655	MorrisNE	Low Amplitude	0	0	0	0	32C	initial
13-Jun	43629	MorrisW	Low Amplitude	0	0	0	0	23C	initial
8-Jul	43654	TenderfootBog	Low Amplitude	37	25	12	3.875	32C	initial
8-Jul	43654	TenderfootLakeS	Low Amplitude	4	4	0	0	31C	initial
8-Jul	43654	TenderfootLakeNE	Low Amplitude	0	0	0	0	27C	initial
21-Jun	43637	TenderfootCreek	Low Amplitude	5	4	1	2	29C	initial
9-Jul	43655	WillowAlderN	Low Amplitude	3	3	0	0	24C	initial
9-Jul	43655	WillowAlderS	Low Amplitude	0	0	0	0	31C	initial
8-Jul	43654	WoodduckE	Low Amplitude	0	0	0	0	26C	initial

11-Jun	43627	GrasshopperNationN	High Amplitude	35	26	9	2.555556	27C	initial
11-Jun	43627	GrasshopperNationW	High Amplitude	8	8	0	0	27C	initial
13-Jun	43629	CranberryN	High Amplitude	8	5	3	2.3333	26C	initial
13-Jun	43629	CranberryNE	High Amplitude	1	1	0	0	26C	initial
9-Jul	43655	BayNW	High Amplitude	27	22	5	4.8	26C	initial
9-Jul	43655	BayW	High Amplitude	4	4	0	0	26C	initial
26-Jun	43642	Bulger	High Amplitude	22	9	13	1.0375904	24C	initial
17-Jun	43633	RoachE	High Amplitude	0	0	0	0	23C	initial
2-Jul	43648	RoachSW	High Amplitude	4	4	0	0	27C	initial
9-Jul	43655	Hummingbird	High Amplitude	3	3	0	0	30C	initial
9-Jul	43655	MorrisNE	High Amplitude	1	1	0	0	32C	initial
13-Jun	43629	MorrisW	High Amplitude	12	12	0	0	23C	initial
8-Jul	43654	TenderfootBog	High Amplitude	0	0	0	0	32C	initial
8-Jul	43654	TenderfootLakeS	High Amplitude	0	0	0	0	31C	initial
8-Jul	43654	TenderfootLakeNE	High Amplitude	1	1	0	0	27C	initial

21-Jun	43637	TenderfootCreek	High Amplitude	6	6	0	0	29C	initial
9-Jul	43655	WillowAlderN	High Amplitude	5	5	0	0	24C	initial
9-Jul	43655	WillowAlderS	High Amplitude	4	4	0	0	31C	initial
8-Jul	43654	WoodduckE	High Amplitude	0	0	0	0	26C	initial